5-1998

Air-water gas exchange and the carbon cycle of Green Bay, Lake Michigan

James Waples
University of Wisconsin - Milwaukee

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

AIR-WATER GAS EXCHANGE AND THE CARBON CYCLE

OF

GREEN BAY, LAKE MICHIGAN

by

James Touchstone Waples

A Dissertation Submitted in
Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy

in

Biogeochemistry

at

The University of Wisconsin - Milwaukee

MAY 1998

UMI Number: 9834639

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

AIR-WATER GAS EXCHANGE AND THE CARBON CYCLE OF
GREEN BAY, LAKE MICHIGAN

by

James Touchstone Waples

A Dissertation Submitted in
Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy

in

Biogeochemistry

at

The University of Wisconsin - Milwaukee

May 1998

J. Val Klump 4/30/98

Major Professor Date

William R Rayburn 6/23/98

Graduate School Approval Date

AIR-WATER GAS EXCHANGE AND THE CARBON CYCLE OF GREEN BAY, LAKE MICHIGAN

by

James Touchstone Waples

The University of Wisconsin - Milwaukee, 1998

Under the Supervision of Dr. J. Val Klump

The purpose of this study was to constrain estimates of the kinetics of gas transfer across the air-water interface as well as quantify the net flux of carbon between southern Green Bay (1635 km^2) and the atmosphere.

In 1994 and 1995, over 3500 measurements of surface water CH_4 and CO_2 were made using a continuous sample disk equilibrator. Estimates of CH_4 flux from southern Green Bay to the atmosphere based on air-water concentration gradients, shear corrected wind speeds and the U/K (wind speed / transfer coefficient) relationship of Broecker et al. (1978) agreed to within ~10% of the estimate of CH_4 influx from sediments and rivers (Klump and Fitzgerald (1998) and this study). Corrections for wind shear based on air-water temperature differences resulted in flux estimates that were ~30% higher than those based on a neutral drag coefficient of 1.3×10^{-3}. The implied support for the U/K relationship of Broecker et al. (1978) suggests that the kinetics of air-water gas exchange are ~2.2 times higher than that predicted by the frequently used U/K relationship of Liss and Merlivat (1986).

Southern Green Bay exported 13 x 10^7 moles CH_4 yr^{-1} in 1994 and 16 x 10^7 moles CH_4 yr^{-1} in 1995. Inter-annual differences in CH_4 flux were shown to be largely due to dramatic differences in wind direction—which altered the hydrodynamics of the bay and ultimately, sediment temperatures. In Sturgeon Bay (a shallow, isolated section of the study site), spatially weight averaged CH_4 concentrations rose by a factor of 2.1 for every 10°C increase in water temperature ($r^2 = 0.82$); CH_4 flux to the atmosphere increased by a factor of 1.8 ($r^2 = 0.46$).

Southern Green Bay exported 180 x 10^7 moles of CO_2 to the atmosphere in 1994 and 240 x 10^7 moles of CO_2 in 1995. However, the spatial and temporal direction and magnitude of flux were far from uniform. Using published rates of primary productivity, the ratio of areal primary productivity to heterotrophic respiration as a function of distance from the Fox River is presented along with a preliminary budget for allochthonous carbon inputs.

J. Val Klump	J. Val Klump	4/30/98
Major Professor	(Signature)	Date

ACKNOWLEDGMENTS

I thank my major advisor—Val Klump—for hiring me on blind faith and providing me with full financial support, unlimited equipment and complete freedom—a situation that most students can only dream about. His patience and kindness apparently know no bounds.

I thank my committee (and teachers): David Armstrong, Russell Cuhel, Brian Eadie, David Edgington and Ken Nealson. Their patient instruction and guidance over the years—in the classroom, their own lab or home—will always be appreciated.

To the hundreds that were pressed into field work (for at least one day) under the pretense that a pleasant boat-ride on Green Bay might not be so bad, my apologies and thanks. I especially thank Don Szmania and Rich MacKenzie who knew better but kept coming back. Their help, enthusiasm and humor made all the difference. I could not have done this work without them.

My field work was carried out on the R/V NEESKAY—pound for pound, the finest research vessel afloat. I thank her present and former captain and crew—Ron Smith, Clyde Winter, Greg Stamatelakys and Terry Snowball—for sailing anywhere at any time under (almost) any weather condition. Their positive attitude and ability to solve problems saved many-a-day.

I must also thank David Schink for lending me his disk equilibrator—and Chris Sabine for telling me what it did. No other tool played a greater role in this project.

Financial support was provided by the Wisconsin Sea Grant Institute. Additional funding was provided through a fellowship from the Great Lakes Foundation and scholarships from the International Association for Great Lakes Research and the University of Wisconsin - Milwaukee (Mortimer Award). I am particularly indebted to the Great Lakes Foundation—set up and supported by members of the Great Lakes Cruising Club. As private citizens, their devotion to and appreciation for our lakes sets a new mark in stewardship. Their willingness to support basic research is unusual and appreciated.

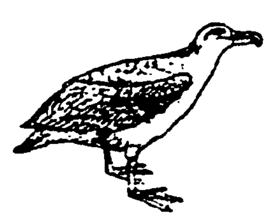


TABLE OF CONTENTS

LIST OF FIGURES

List of Tables

List of Common Symbols

γ = activity coefficient
δ = cross virial coefficient for non ideal gas mixture (Chapter 2)
b = equilibrator response constant (Chapter 4)
B = virial coefficient for non-ideal gas (Chapter 2), Revelle factor (Chapter 5)
C = concentration, degrees Celsius
C_D = drag coefficient (Chapter 3)
C_{DN} = neutral drag coefficient (Chapter 3)
D = molecular diffusion coefficient ($cm^2\ sec^{-1}$)
f(gas) = fugacity of a gas (µatm)
I = ionic strength
J = flux ($mol\ m^{-2}\ day^{-1}$)
K = air-water transfer coefficient ($m\ day^{-1}$)
k = von Karmen's constant (Chapter 3)
L = Obukhov scale length (Chapter 3)
P = pressure (atm), primary productivity (Chapter 5)
p(gas) = partial pressure of a gas (µatm)
R = heterotrophic respiration (Chapter 5)
Sc = Schmidt number (Chapter 3)
se = stripping efficiency (Chapter 2)
t = time
t = temperature (°C)
T = temperature (°K)
U^* = friction velocity ($cm\ sec^{-1}$)
U_z = wind speed ($m\ sec^{-1}$) at z meters above air-water interface
x(gas) = mole fraction of a gas (ppm)
z = height above air-water interface (Chapter 3), ionic charge (Chapter 5)
z_{BL} = boundary layer thickness (µm)

Chapter 1

Introduction

Carbon is arguably the keystone element in an ecosystem and an understanding of the carbon cycle is essential to understanding how an ecosystem functions. However, the chemistry of both organic and inorganic carbon is complex and the flux of carbon within and between biological and non-biological compartments can be rapid.

On a global scale, many aspects of the carbon cycle are still poorly understood. Of primary concern is a better understanding of the role the ocean plays as a sink for atmospheric CO_2. This is difficult not only because of the ocean's size and heterogeneity, but also because the rate of CO_2 uptake is very close to the rate of CO_2 release (Siegenthaler and Sarmiento 1993, Sarmiento and Sundquist 1992, Tans et el. 1990). For this reason, many process-oriented studies of the carbon cycle have been carried out in more manageable systems such as lakes.

In the Great Lakes and their estuarine-like bays, large gradients in both physical and biological forcing over small spatial and temporal scales produce disequilibria in the carbon dioxide system that are relatively easy to measure. Moreover, because these lakes are essentially closed systems, a carbon mass balance can be constrained much more easily than in an open system such as the ocean.

The task is far from simple though. Along with complex chemical and biological transformations, several carbon species— namely carbon dioxide and methane—are volatile and pass freely across the air-water interface. Resolving fluxes within the carbon cycle and closing the carbon budget, therefore, requires an unusually large suite of measurements.

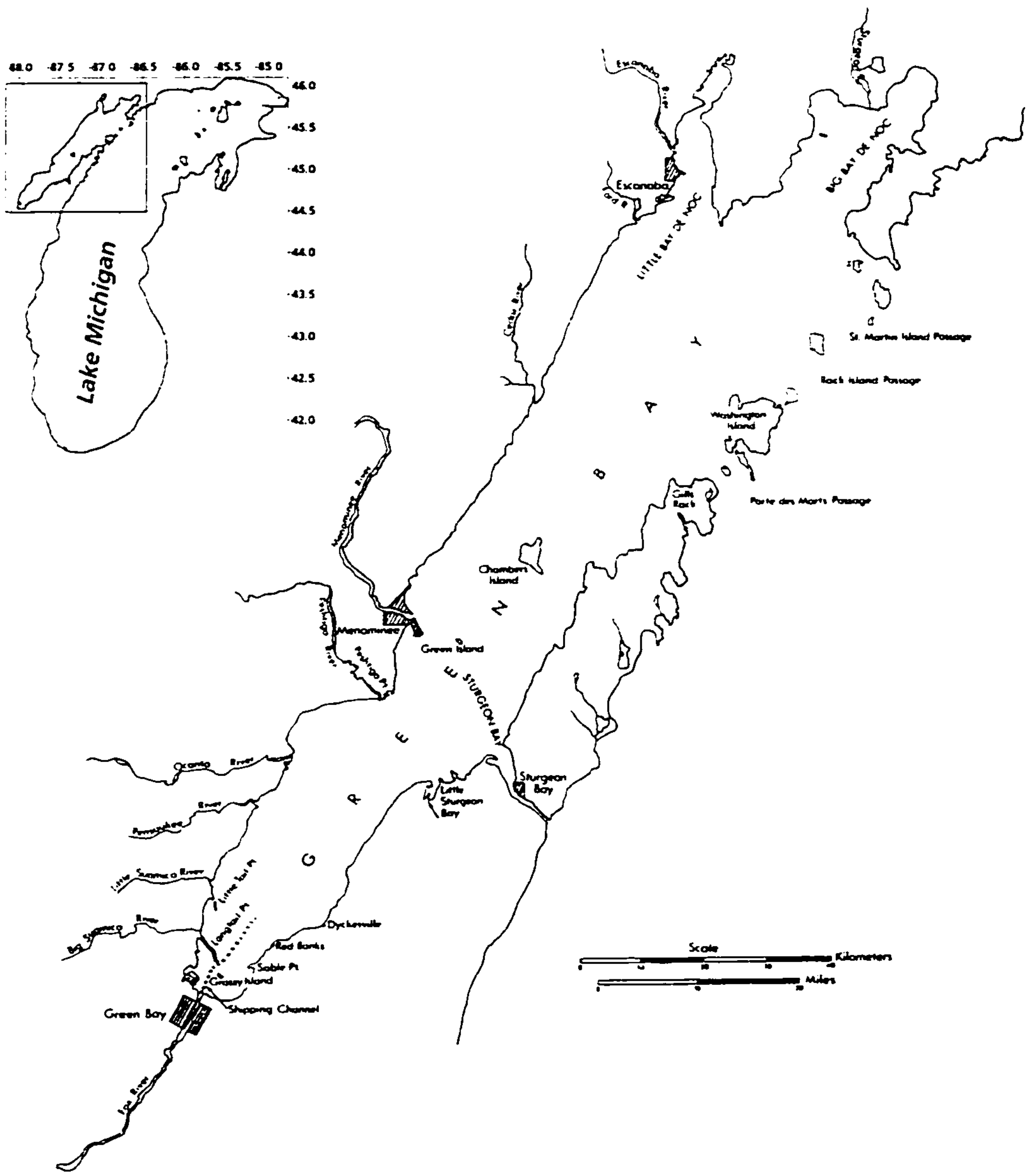
Several key components of a carbon budget for southern Green Bay have been measured by Klump and Fitzgerald (1998) (Figure 1-1). These include estimates of organic carbon sedimentation, burial and bacterial remineralization (Figure 1-2). The objective of this study was to determine the net exchange of carbon between the southern bay and atmosphere.

To estimate the flux of carbon across the air-water interface, several approaches were possible. A mass balance approach required measuring all other sources and sinks of carbon to southern Green Bay (see Eadie and Robertson 1976). The difference between the carbon sources and sinks would approximate the net flux of carbon to the atmosphere. However, due to the relatively high concentration of inorganic carbon (~ 2.3 mM), any error in the flushing rate with northern Green Bay (past Chambers Island) would have resulted in a large error in air-water carbon exchange (see Miller and Saylor 1993).

Measuring the change in the ratio of the stable isotopes of dissolved inorganic carbon over time has also been used to estimate air-water carbon exchange, but only in lakes with low concentrations of inorganic carbon (Quay et al. 1986, Herczeg 1987). In Green Bay, the background concentration of inorganic carbon was so high—and the net isotopic fractionation of carbon so low—that this method was also of little use (see Appendix 5). Therefore, estimates of the flux of carbon across the air-water interface were determined using Fick's first law.

Fick's first law states that

Figure 1-1. a) Green Bay, Lake Michigan (from Torrey 1976). Study site includes all area south of Chambers Island to the mouth of the Fox River. b) Bathymetry of southern Green Bay.


Lake Michigan
46.0
45.5
45.0
44.5
44.0
43.5
43.0
42.5
42.0
Escanaba
LITTLE BAY DE NOC
BIG BAY DE NOC
St. Martin Island Passage
Rock Island Passage
Washington Island
Porte des Morts Passage
Chambers Island
Menominee
Green Island
STURGEON BAY
Sturgeon Bay
Little Sturgeon Bay
G R E E N B A Y
Oconto River
Little Suamico River
Dyckesville
Red Banks
Sable Pt
Grassy Island
Green Bay
Shipping Channel
Scale
Kilometers
Miles

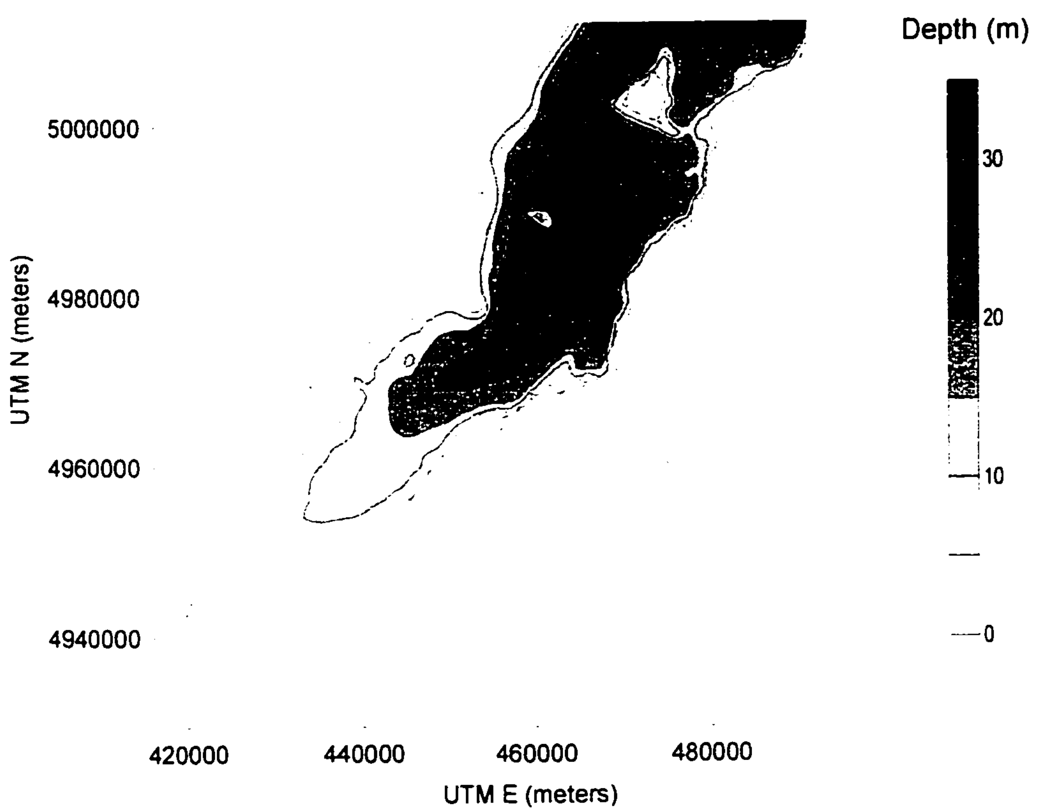
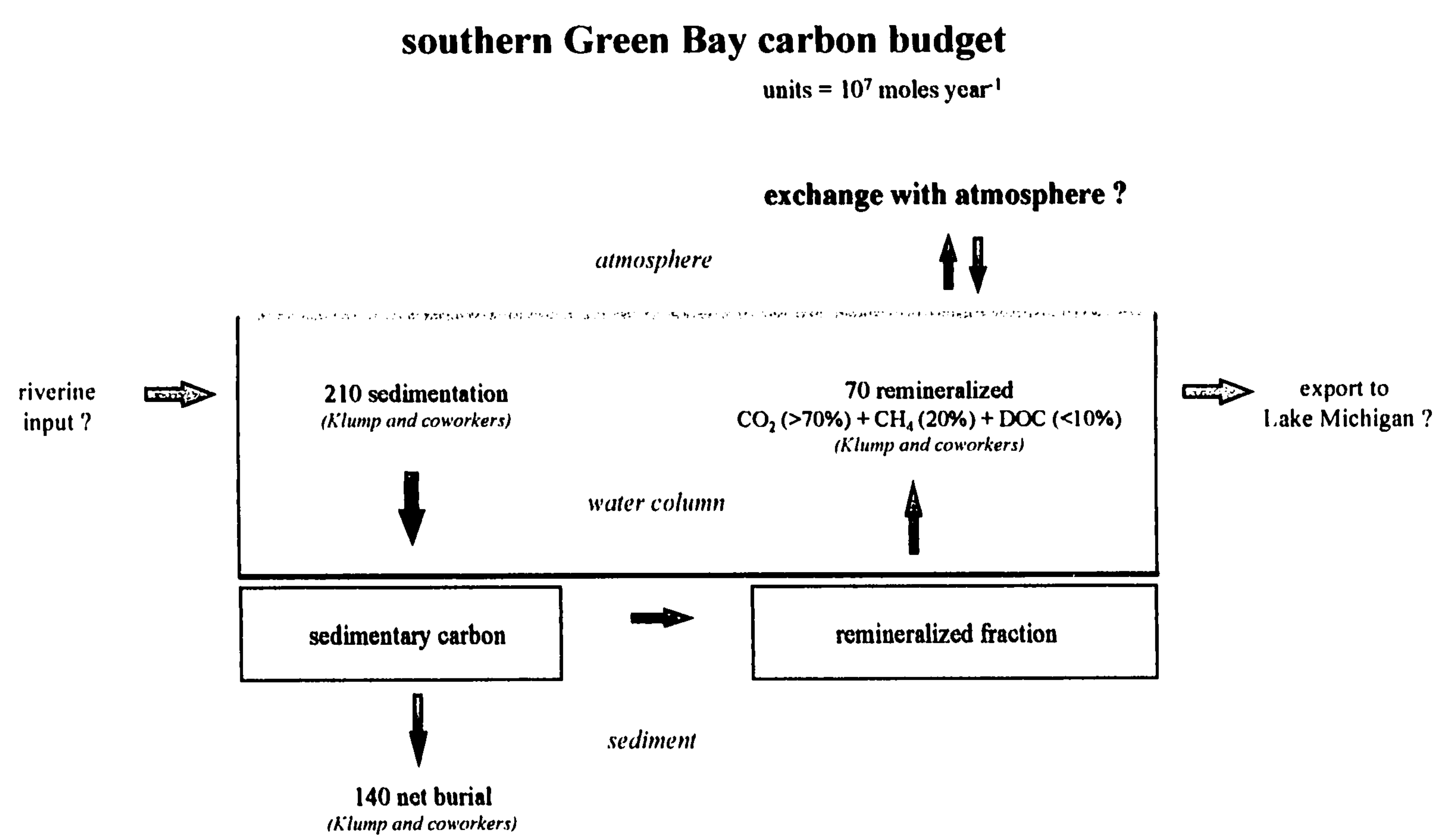

Depth (m)
30
20
10
0
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
UTM E (meters)

Figure 1-2. Preliminary terms in the carbon budget for southern Green Bay as determined by Klump and Fitzgerald (1998).


southern Green Bay carbon budget
units = 10^7 moles $year^{-1}$
exchange with atmosphere ?
atmosphere
riverine input ?
210 sedimentation
(Klump and coworkers)
70 remineralized
CO_2 (>70%) + CH_4 (20%) + DOC (<10%)
(Klump and coworkers)
export to Lake Michigan ?
water column
sedimentary carbon
remineralized fraction
sediment
140 net burial
(Klump and coworkers)

$$J_{aw} = K \, \Delta C,$$

where J_{aw} is equal to the flux of a gas across the air-water interface, K is an empirically derived transfer coefficient and ΔC is the concentration gradient of the gas across the air-water interface (Liss 1983). While measuring the concentration gradient of carbon dioxide or methane across the air-water interface was a straightforward process (see Chapter 2 for methods), measuring or estimating the transfer coefficient was not.

Estimates of K have been determined in the field as well as in wind-water tunnels and have usually been correlated with concurrently measured wind speeds (see Broecker and Peng 1984 and Liss 1983). Knowledge of the wind speed, therefore, could be used to estimate K. Unfortunately, the relationship between wind speed and K is poorly constrained. Estimates of K for a given wind speed span nearly two orders of magnitude (Liss 1983, Broecker et al. 1986, Wesley 1986).

Part of the discrepancy may stem from uncertainties in the stability of the air column—resulting in uncertainties in wind shear over height. Measurements of the dependency of K on the wind speed have been determined from wind speeds measured at ~ 0.1 to 10 meters above the air-water interface. To standardize these measurements, wind speeds have typically been scaled to a height of 10 meters by assuming wind speeds increase with height according to a classical logarithmic profile. In reality, the shear of the atmospheric surface layer depends on a variety of meteorological factors; the most significant being the air-water temperature gradient (Kraus and Businger 1994).

In Chapter 3, estimates of K are determined using several wind speed / transfer coefficient relationships and hourly wind speeds recorded at a nearby meteorological buoy. The effects of air-water temperature differences on air column stability are also explored using a computer program written by Arlindo da Silva (see Appendix 6).

To constrain the relationship between wind speed and K, an independent estimate of methane flux across the air-water interface is derived in Chapter 4. Methane flux across the air-water interface was determined as the difference between all other methane source and sink terms in southern Green Bay (i.e. a methane mass balance). The mean value of K which supported this flux based upon the observed air-water methane concentration difference (ΔC) could then be used to constrain estimates of K based on wind speed.

In Chapter 5, measured values of the concentration gradient of CO_2 across the air-water interface and the constrained estimates of K (derived in Chapters 3 and 4) are used to estimate the flux of CO_2 from southern Green Bay to the atmosphere.

Finally, estimates of the ratio of areal primary production to heterotrophic respiration are calculated using published estimates of primary productivity in Green Bay (Sager and Richman 1990, 1991). Preliminary constraints on the carbon budget for southern Green Bay are discussed in light of the estimates of carbon flux across the air-water interface.

Chapter 2

Methods

Sampling frequency

Gas concentrations in the surface waters of Green Bay were measured aboard the R/V NEESKAY on 13 separate cruises (31 days) from November 2, 1993 to November 9, 1995. Shipboard sampling began as early as ~ two weeks after ice out and continued until icing threatened ship safety in late fall. Additional samples were taken through the ice of Green Bay in 1995, 1996, and 1997. Sampling through the ice was generally limited to the months of February and (early) March. The distribution of sampling dates during the 1994-1995 field seasons are shown in Figure 2-1. Specific sampling dates can be found in Appendix 3.

Spatial coverage

Each cruise generally lasted three days with each day beginning and ending in either Sturgeon Bay or the Fox River. Transects for each cruise totaled approximately 250 km and covered the southern half of Green Bay from Chambers Island to the Fox River. Weather, schedule conflicts, and equipment failure occasionally abbreviated or altered the intended routes. The transects completed during the 1994-1995 field seasons are shown in Figure 2-2. Water column profiles were measured at seven stations spanning the major axis of the bay during open water transects (Figure 2-3a). The station designations are those used by Klump et al. (1997). Winter sampling sites were dictated by ice conditions (Figure 2-3b). The coordinates for all stations are given in Appendix 1.

Figure 2-1. Distribution of sampling dates during the 1994-1995 field seasons.

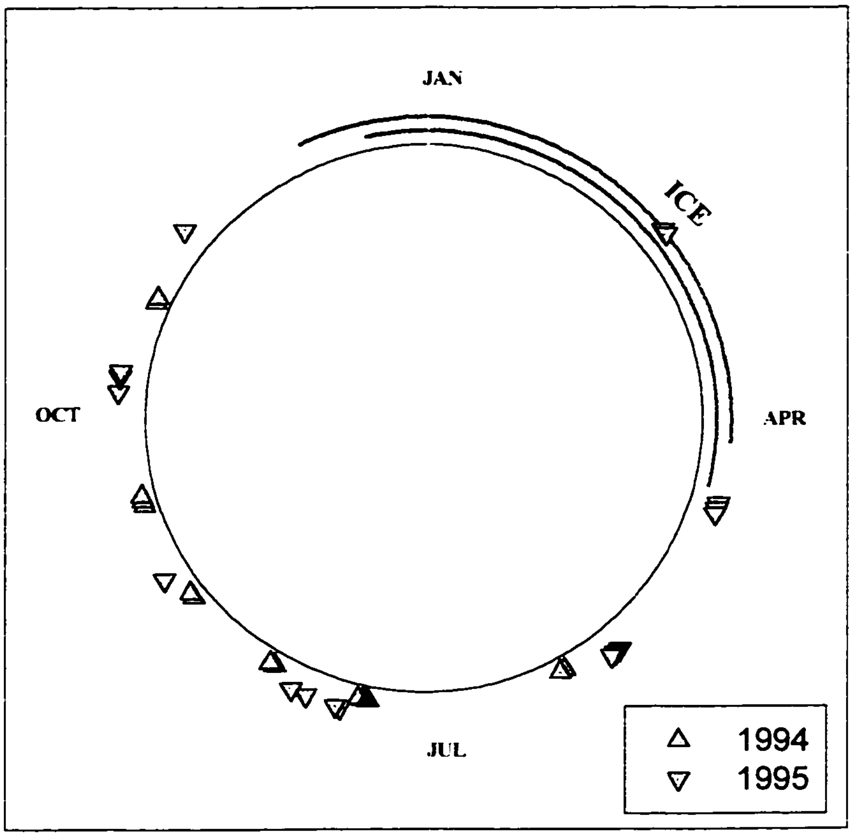

JAN
ICE
OCT
APR
JUL
1994
1995

Figure 2-2. Transects completed during the 1994-1995 field seasons. Coordinate units, shown in the upper left hand corner, are in UTM (meters). Points reflect methane sampling coordinates only.

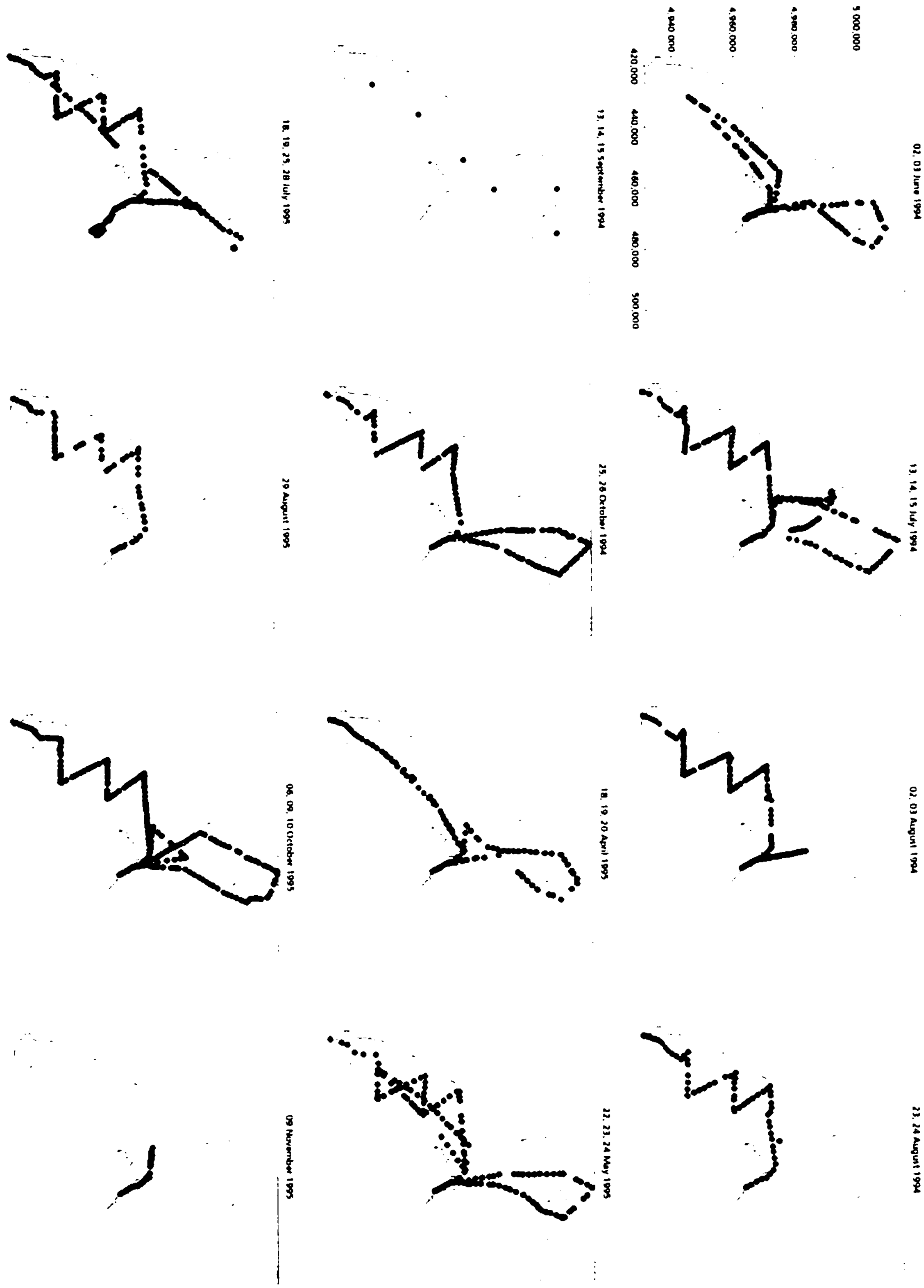
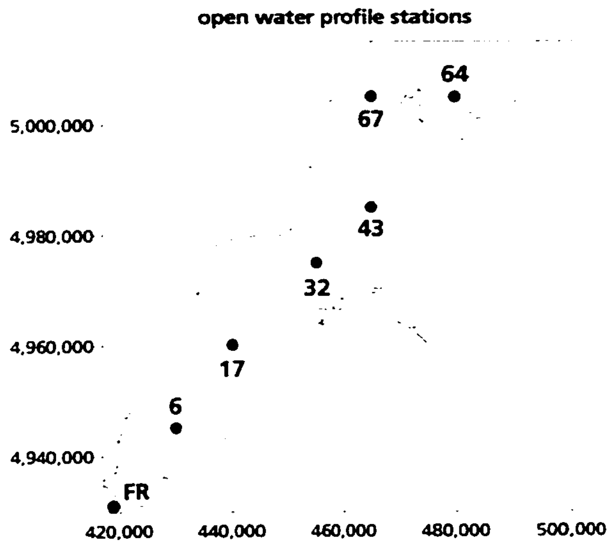
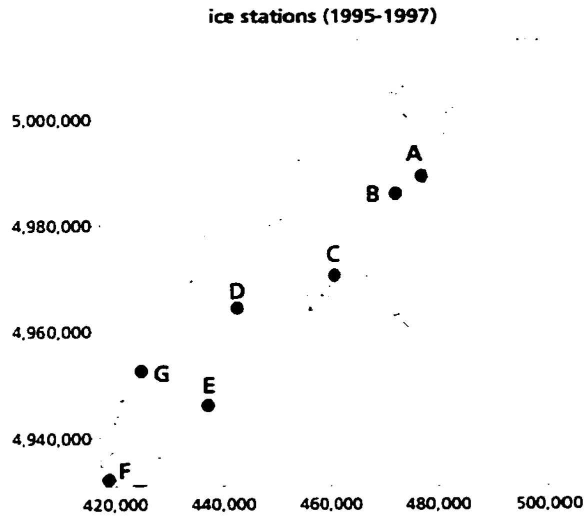

02, 03 June 1994
13, 14, 15 July 1994
02, 03 August 1994
23, 24 August 1994
13, 14, 15 September 1994
25, 26 October 1994
18, 19, 20 April 1995
22, 23, 24 May 1995
18, 19, 25, 28 July 1995
20 August 1995
06, 09, 10 October 1995
09 November 1995
5 000,000
4 980,000
4 960,000
4 940,000
420,000
440,000
460,000
480,000
500,000

Figure 2-3. Distribution of profile stations visited during the a) 1994-1995 open water field seasons and b) winters of 1995-1997. Specific coordinates for each station are given in Appendix 1.


open water profile stations
64
67
43
32
17
6
FR
5,000,000
4,980,000
4,960,000
4,940,000
420,000
440,000
460,000
480,000
500,000


ice stations (1995-1997)
A
B
C
D
G
E
F
5,000,000
4,980,000
4,960,000
4,940,000
420,000
440,000
460,000
480,000
500,000

Sample collection

Water samples were analyzed while underway and on station. The various instruments and tools were plumbed according to Figure 2-4. During a transect, water was pumped continuously from the ship's bow and split to a) a container housing an array of Sea-Bird sensors (SB) and b) a disk equilibrator (EQ). The bow pump (BP) inlet was located ~2 meters below the waterline. Measured flow rates to the Sea-Bird and equilibrator were approximately 15 and 10 liters per minute respectively. The water stream was again split just forward of the equilibrator and diverted to an inline YSI oxygen probe (Y) and Orion pH electrode (B). The flow rate to these instruments was kept at a minimum to avoid streaming effects. Additional aliquots of water (<10 milliliters per minute) where withdrawn from the disk equilibrator itself for ΣCO_2 (flow injection) analysis. The residence time of water on board was very short. A saline spike injected at the bow pump was detected by the Sea-Bird after 20 seconds (Arthur Brooks, personal communication). The turnover time for the Sea-Bird box was approximately 2 minutes. The turnover time for the equilibrator was ~ 1 minute.

Data from the Sea-Bird included time and Loran (L) coordinates which were coordinated with gas measurements and stored electronically on a computer (C). The disk equilibrator was used to measure dissolved concentrations of methane, carbon dioxide, and radon. Details on its operation are discussed below. A typical view of the wetlab is shown in Figure 2-5.

On station, a submersible pump (SP) and HydroLab (HL) were lowered through the water column. The water pumped up was either sent to the disk equilibrator for

Figure 2-4. A schematic of the apparatus used on R/V NEESKAY during the 1994-1995 field seasons. Abbreviations: (SB) Sea-Bird, (BP) bowpump, (BS) bulk sample water station, (HL) HydroLab, (SP) submersible pump, (L) Loran, (C) Computer, (B) Orion pH electrode, (Y) YSI oxygen probe, (FIA) ΣCO_2 flow injection setup, (I) Shimadzu integrator, (EQ) disk equilibrator, (OW) equilibrator out-wash effluent, (AP) air sample port, (IRGA) Li-Cor CO_2 analyzer, (GC) Carle gas chromatograph, (FID) ISR flame ionization detector, (Stds) gas standards.

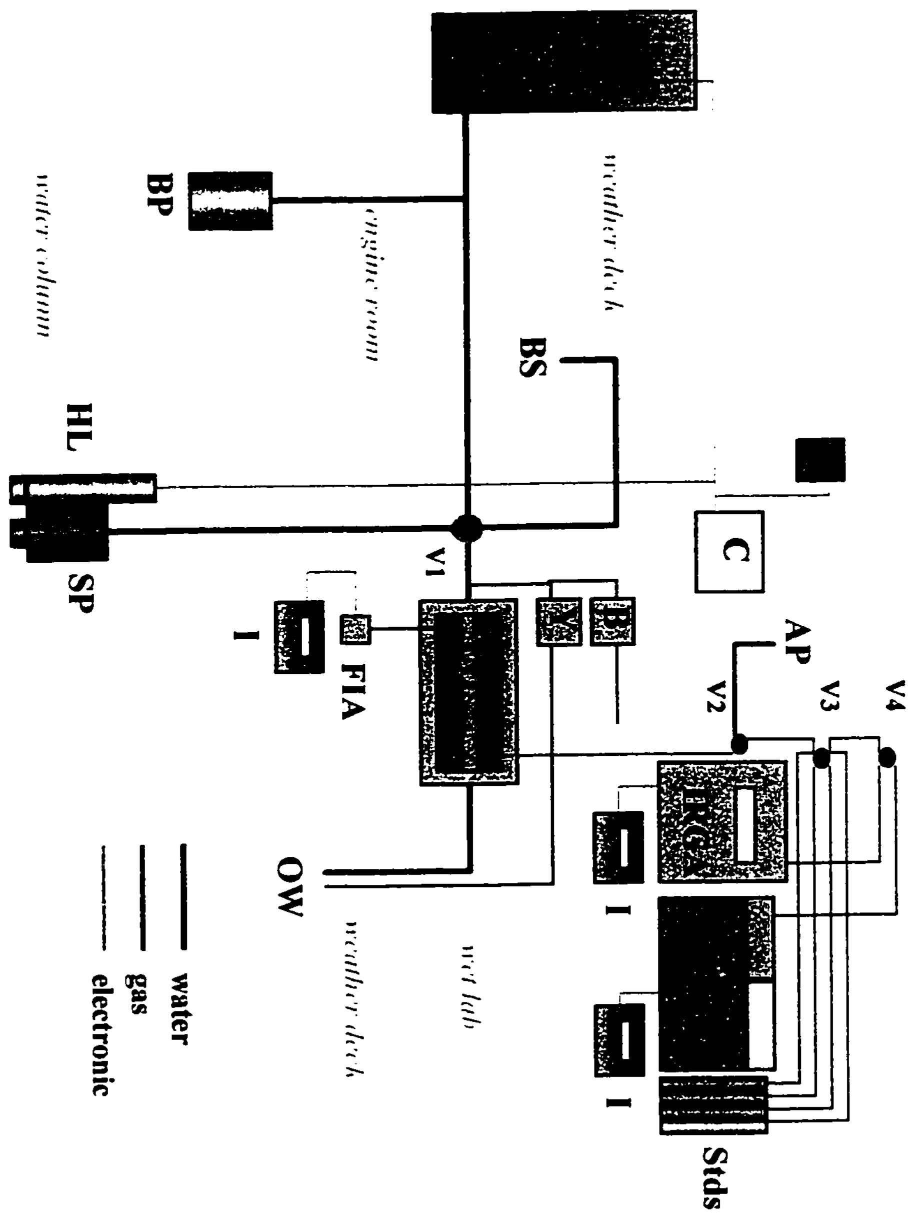
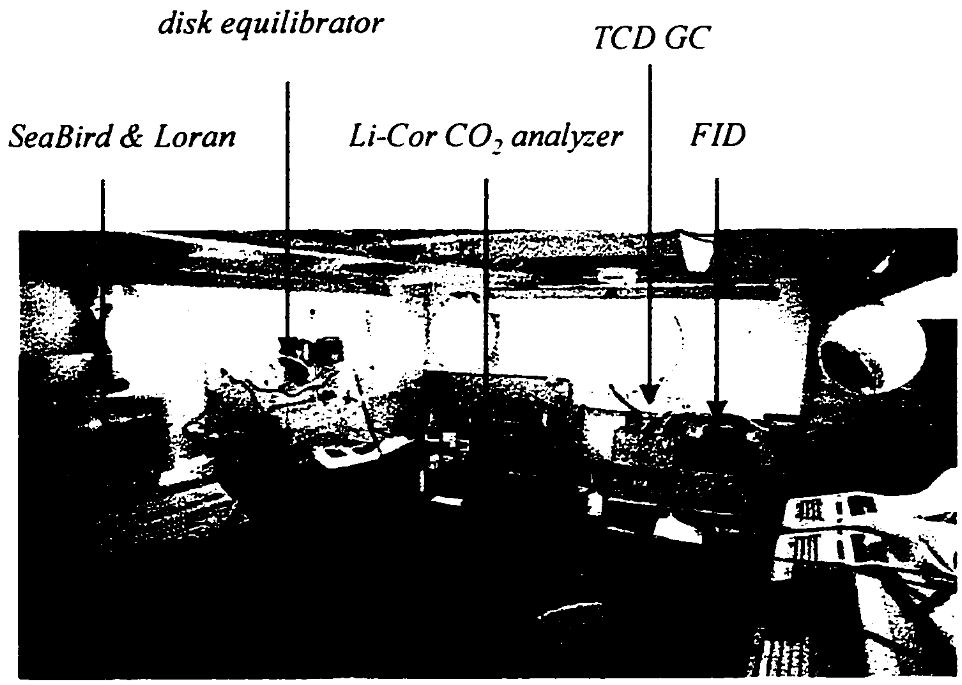

weather deck
engine room
water column
BP
BS
HL
SP
V1
I
FIA
Y
B
C
AP
V2
V3
V4
IRGA
I
I
Stds
OW
wet lab
weather deck
water
gas
electronic

Figure 2-5. Dissolved gas analysis setup on the R/V NEESKAY (1994).

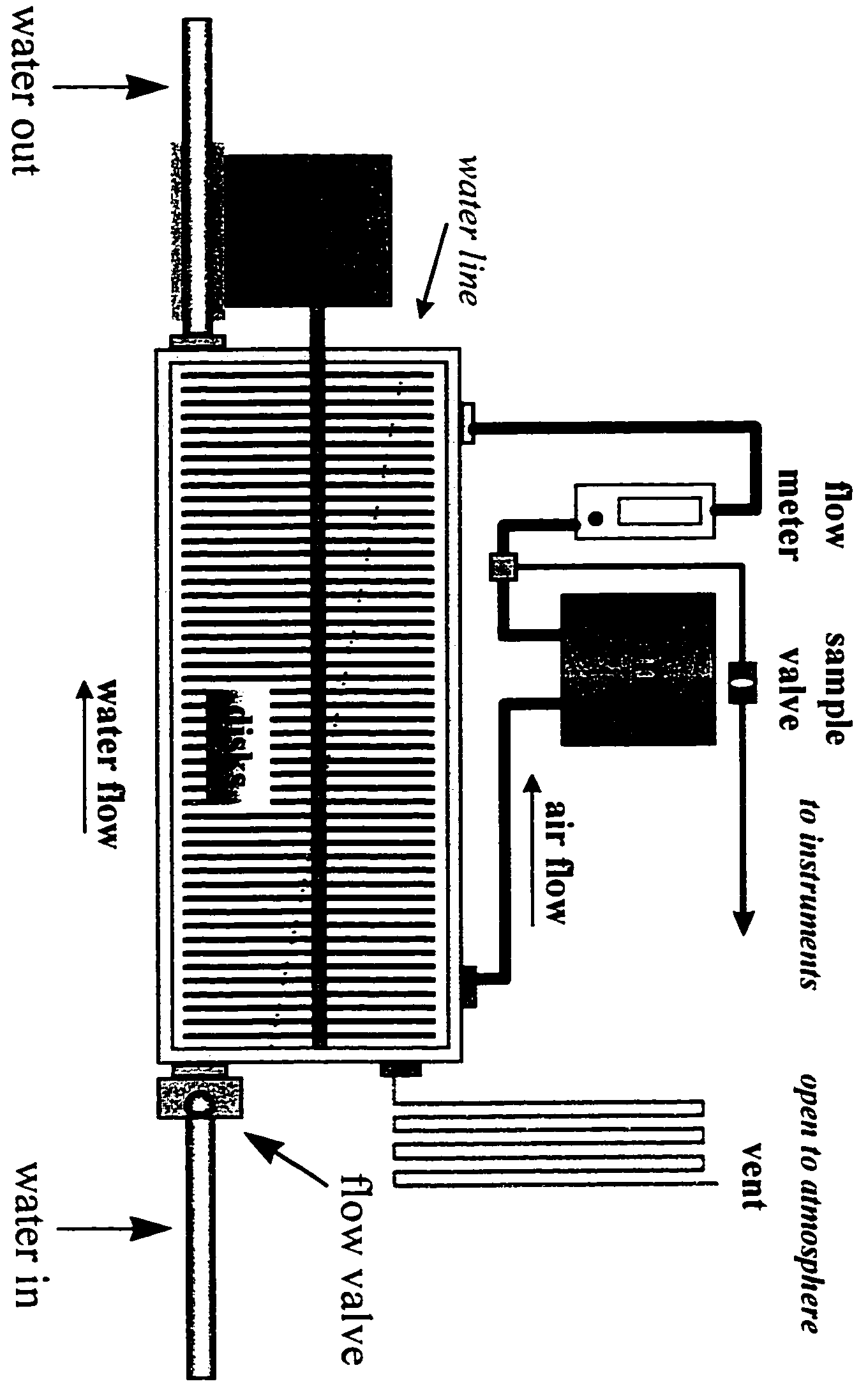

disk equilibrator
TCD GC
SeaBird & Loran
Li-Cor CO_2 analyzer
FID

dissolved gas analysis or diverted to the deck where bulk water samples (BS) were collected for ^{222}Rn, oxygen and $\Sigma^{13}CO_2$ analysis. Data from the Hydrolab were viewed in real time and used to select sampling depths. Particulate carbon was collected from either the bulk sample outflow or the equilibrator outwash (OW) and size fractionated for measurement of organic ^{13}C. Water samples were collected with a 5 liter Niskin bottle on several occasions to check for any systematic effects caused by the pump. None were found.

Disk equilibrator

Concentrations of dissolved carbon dioxide, methane and radon were determined using both discrete and continuous water sample techniques. The latter employed the use of a disk equilibrator as shown in Figure 2-6. The equilibrator consists of a series of rapidly spinning disks housed within a cylinder. When a continuous stream of water is run through the cylinder, the spinning disks carry a thin film of water into the overlying headspace. Since the process of equilibration is chiefly a function of surface area and turbulence, a dissolved gas within the liquid phase rapidly equilibrates with its gas phase fugacity (see Appendix 2 for a discussion on gas concentration nomenclature). The headspace can then be sub-sampled and analyzed to obtain the gas's mole fraction. To determine its *in situ* (lake) concentration, the 1) pressure of the headspace, 2) equilibration temperature and 3) temperature difference between equilibration and *in situ* conditions must also be known. Since it is also desirable to keep a constant headspace pressure, the headspace is opened directly to the atmosphere via a long narrow tube. Mixing between the atmosphere and headspace is negligible as long as the volume of water in the

Figure 2-6. The disk equilibrator. The 60 disks are attached to a central axle and housed in an acrylic cylinder 60 cm long and 20 cm in diameter. A motor spins the axle (and disks) at approximately 120-150 rpm. A continuous stream of water runs through the equilibrator at ~ 10 liters per minute. At steady-state, approximately two thirds (9 liters) of the cylinder is filled with water. The equilibrator is normally raised at the inflow side as shown by the water line. The remaining one third contains air. The equilibrator headspace is kept at atmospheric pressure via a long tube (vent). Mixing between the equilibrator headspace and atmosphere is insignificant as long as the water volume in the equilibrator is kept constant. Air within the headspace is rapidly circulated against the flow of water with a pump. Sub-samples are drawn from a segment of line located between the pump and a flow meter. Positive pressure forces the air along a ~ 2 meter section of 1/8 inch tubing to the instruments (flow rate: ~ 2 - 10 ml/sec).


water out
water line
flow
meter
sample
valve
to instruments
air flow
disks
water flow
open to atmosphere
vent
flow valve
water in

equilibrator is kept constant. Any fluctuation in water volume can be checked by placing the end of the vent tube in a vial of water.

The equilibrator used in this study was built by D. R. Schink (see Schink et al. 1970) and based on the original designs of Williams and Miller (1962). Significant modifications were made according to the suggestions of C. L. Sabine (1994, personal communication). A brief physical description of the equilibrator is given in the caption of Figure 2-6. During transect operations, the flow of water through the equilibrator was adjusted manually with a valve at the inlet to 10 liters per minute. The water volume and flow rate could also be manipulated by raising one end of the equilibrator or changing the head of the effluent tube. At steady state, approximately two-thirds (8 to 11 liters) of the cylinder was filled with water, leaving a headspace of ~ four to seven liters air. The equilibrator headspace was mixed by pumping against the flow of water at a rate of ~ 10 liters per minute. This arrangement, while not perfect, proved satisfactory in the field. Water levels in the equilibrator were stable while underway. A small adjustment to the flow rate typically had to be made while on station. In extremely rough weather, the heaving of the ship overwhelmed the bow pump and operations had to be canceled. Approximately 50 milliliters of headspace gas were required for methane and carbon dioxide analyses. One hundred milliliters were required for radon analysis.

Methane analysis

Methane was measured by gas chromatography using a flame ionization detector. Gas samples were injected into a 0.412 ± 0.001 ml sample loop and flushed into a nitrogen carrier stream with an Altex 6-way valve. The samples were dried with a Drierite column just prior to separation. Separation took place on a 80/100 Porapak Q column at 50 to 100 C. Voltage response from the detector was recorded with a Shimadzu C-R5A integrator. The mole fraction of methane in each gas sample was determined using one-point calibration. Methane standards of 9.98 ppm ± 2%, 107 ppm ± 2%, 9.93 ppm ± 5%, and 17.07 ppm ± 10% were obtained from Scott Specialty Gas.

For continuous sample analysis, water saturated (wet) air was sampled directly from the disk equilibrator headspace and measured for methane. The calculated mole fraction of methane (xCH_4) was multiplied by the measured atmospheric pressure to obtain the partial pressure of methane (pCH_4) inside the equilibrator headspace. The dissolved methane concentration inside of the equilibrator was calculated as:

$$[CH_4]_{eq} = pCH_4\ (\beta/22.414) \qquad (2\text{-}1)$$

Differences between the partial pressure and fugacity of methane were assumed to be negligible. The Bunsen solubility coefficient (β) was calculated using an equation given by Yamamoto et al. (1976), where

$$\ln \beta = A_1 + A_2(100/T_{eq}) + A_3 \ln (T_{eq}/100) + S[B_1 + B_2(T_{eq}/100) + B_3(T_{eq}/100)^2]. \qquad (2\text{-}2)$$

T_{eq} is the equilibrator water temperature (°K), S is salinity (‰), and A and B are the following constants

$A_1 = -67.1962$
$A_2 = 99.1624$
$A_3 = 27.9015$
$B_1 = -0.072909$
$B_2 = 0.041674$
$B_3 = -0.0064603$

Salinity was estimated from measured conductivity and temperature using the 1978 Practical Salinity Scale algorithms (Sea-Bird Operating Manual 1995).

An additional correction had to be made due to an apparent lag in equilibration time. While methane equilibration inside the equilibrator occurred nearly instantly, equilibration between *in situ* surface water methane and the equilibrator headspace was quite slow due to methane's low solubility (e-folding time ~ 14 minutes). Assuming nearly instantaneous equilibration within the equilibrator, *in situ* surface water methane concentrations were estimated with the equation:

$$[CH_4]_{in\ situ} = (C_0 + \Delta C)/(1-e^{-b\Delta t}), \qquad (2\text{-}3)$$

where C_0 is the observed concentration of methane in the equilibrator at time 0, ΔC is the observed change in concentration over time Δt and b is equal to

$$b = (f * \beta_{eq})/vol_{HS} \qquad (2\text{-}4)$$

where f is the flow rate of water entering the equilibrator, β_{eq} is the Bunsen solubility coefficient for methane at the observed equilibrator water temperature and vol_{HS} is the volume of the headspace.

Discrete water samples were measured using a modified method of Stainton (1973). The concentration of dissolved methane in a discrete sample of water was calculated using the equation

$$[CH_4] = (xCH_4 * P * vol_{HS}) / (R * T * vol_{SAM} * se) \quad (2\text{-}5)$$

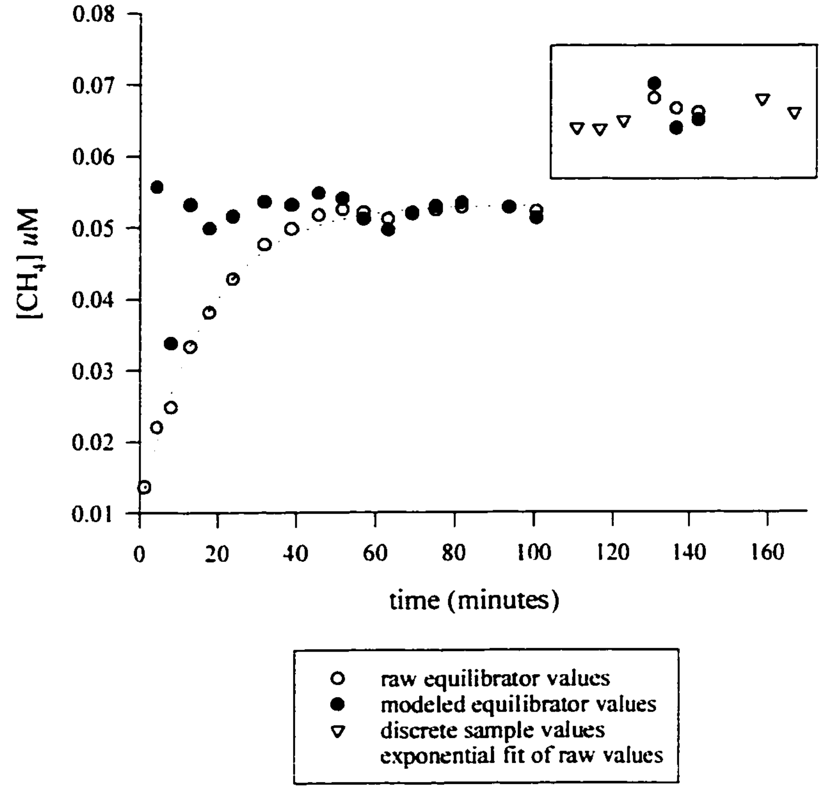
where $[CH_4]$ is expressed in molarity, xCH4 is the measured mole fraction of methane in the syringe headspace, P is the measured atmospheric pressure in atmospheres, vol_{HS} is the volume of the equilibration (gas phase) headspace, vol_{SAM} is the volume of the discrete water sample, R is the gas constant (0.0821 liter atm/mole °K), T is the temperature of equilibration in °K, and se is the stripping efficiency which is determined empirically by repeating the entire equilibration process.

Clean air samples were drawn into a 20 ml syringe while underway and analyzed for atmospheric CH_4.

A number of tests were run to determine how quickly the equilibrator responded to changing methane concentrations and whether or not the modeled corrections described above adequately corrected for the observed lag in equilibration. Discrete sample analyses were run simultaneously to check for bias between the two methods. In order to run the tests, a constant source of methane was required. Tests run in Sturgeon Bay over periods of up to four hours showed surface water methane concentrations could vary by as much 30 nM. Since the tests were usually conducted during (windy) weather days, this is not surprising. A sufficiently stable source of methane was found in Milwaukee tap water. The results of one test are presented in Figure 2-7. The gray circles show the (raw) calculated concentrations of methane derived from the partial pressure of methane measured in the equilibrator headspace. The concentrations rise exponentially with an e-folding time of approximately 14 minutes. An exponential fit of the raw data shown by the dotted line predicted a source concentration of 53 nM CH_4. The black circles show the modeled concentration of methane based on equation 2-3. Excluding the one outlying point that occurred eight minutes into the test, the model predicted a similar mean concentration of 53 ± 2 nM. At ~ 105 minutes into the test, the temperature suddenly dropped 0.3° C and the methane concentration rose ~ 20%. Discrete sample analyses (shown as triangles) gave a mean concentration of 65 ± 2 nM CH_4. Continuous sample (equilibrator) analyses run between the discrete samples averaged 66 ± 3 nM CH_4. Specific parameters used to calculate the concentrations shown in Figure 2-7 are given in Table 2-1.

A comparison of raw and modeled methane concentrations determined with the disk equilibrator on a transect of northern Green Bay on May 24, 1995 is shown in Figure 2-8. The transect began in Sturgeon Bay, ran north into Green Bay, around Chambers Island and back to Sturgeon Bay (see Chapter 4 for transect chart). In the top panel, the gray circles show the raw calculated concentrations of methane heading out of Sturgeon Bay. The open circles denote methane concentrations measured on the return leg. In the bottom panel, modeled methane concentrations are shown using the same color scheme (i.e. outbound: gray, inbound: open). The dotted line represents the raw values shown in

Figure 2-7. Methane method calibration. Continuous and discrete sample methods were compared using Milwaukee tap water. Gray circles show the calculated (equation 2-1) concentrations of methane derived from the partial pressure of methane measured in the equilibrator headspace. The dotted line shows an exponential fit of the raw data. The black circles show the modeled concentration of methane which were calculated using equation 2-3. At ~ 105 minutes into the test, the temperature suddenly dropped 0.3° C and the methane concentration rose ~ 20%. Samples run after the concentration shift are grouped inside of the box. In the statistical table below the graph, $[CH_4]_{mod1}$ is for modeled methane concentrations (black circles) outside of the box excluding the outlying point at ~8 minutes. Exp Fit gives the predicted source concentration at t_{∞}. $[CH_4]_{mod2}$ represents the modeled methane concentrations (black circles) inside the box and $[CH_4]_{discrete}$ represents the discrete samples indicated by open triangles.

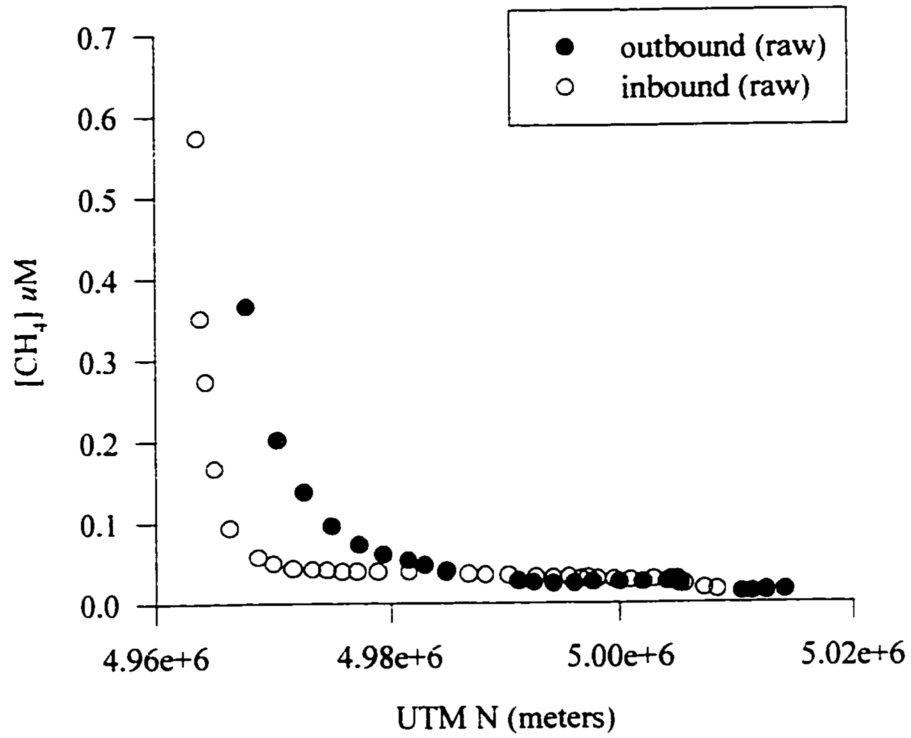


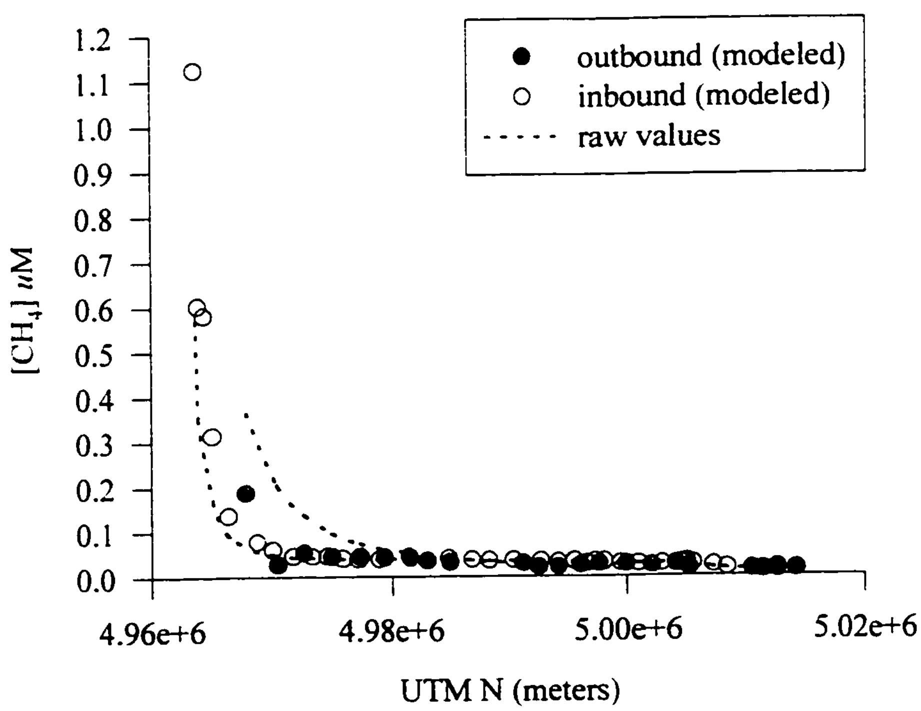
	[CH4]mod1	Exp Fit	[CH4]mod2	[CH4]discrete
Mean	0.053	0.053	0.066	0.065
Std Dev	0.002	*	0.003	0.002
Std Err	0.000	*	0.002	0.001
95% Conf	0.001	*	0.008	0.002
99% Conf	0.001	*	0.019	0.004

Table 2-1. Parameters of the methane calibration test . The parameters needed to calculate the values shown in figure 2-7 are shown below. The 1st column shows time of measurement in minutes, the 2nd column denotes whether the measurement was determined using the continuous (eq) or discrete method, the 3rd column gives the mole fraction of methane measured from either the equilibrator headspace or syringe headspace. P_{atm} is the measured atmospheric pressure; T_{room} is room temperature; T_{eq} is the measured equilibrator water temperature; warming is the amount of warming the water experienced from the source to the equilibrator in °C; sal is the estimated salinity in ‰; b is the equilibrator response constant based on the Bunsen solubility coefficient (a function of temperature), a headspace volume of 6 liters and a flow rate of 11 liters min^{-1}; se is the stripping efficiency; vol_{sam} and vol_{hs} are in milliliters; $[CH_4]$ gives the raw concentrations on the molarity scale; $[CH_4]_{mod}$ gives the modeled concentration on the molarity scale.

time (min)	type	x(CH4)	Patm	T room	T eq	warming	sal (PSU)	b	se	vol(sam)	vol(hs)	[CH4]	[CH4]mod
1.26	eq	7.95	0.984	•	14.4	0.1	0.15	0.0717	•	•	•	0.014	
4.35	eq	12.82	0.984	•	14.4	0.1	0.15	0.0717	•	•	•	0.022	0.056
8.09	eq	14.43	0.984	•	14.4	0.1	0.15	0.0717	•	•	•	0.025	0.034
13.07	eq	19.41	0.984	•	14.4	0.1	0.15	0.0717	•	•	•	0.033	0.053
17.84	eq	22.18	0.983	•	14.3	0.1	0.15	0.0719	•	•	•	0.038	0.050
23.82	eq	24.91	0.983	•	14.3	0.1	0.15	0.0719	•	•	•	0.043	0.052
31.98	eq	27.63	0.983	•	14.2	0.1	0.15	0.072	•	•	•	0.048	0.054
38.87	eq	28.89	0.983	•	14.2	0.1	0.15	0.072	•	•	•	0.050	0.053
45.49	eq	29.99	0.983	•	14.2	0.1	0.15	0.072	•	•	•	0.052	0.055
51.58	eq	30.49	0.983	•	14.2	0.1	0.15	0.072	•	•	•	0.053	0.054
56.90	eq	30.23	0.983	•	14.2	0.1	0.15	0.072	•	•	•	0.052	0.051
63.06	eq	29.72	0.983	•	14.2	0.1	0.15	0.072	•	•	•	0.051	0.050
69.34	eq	30.23	0.983	•	14.2	0.1	0.15	0.072	•	•	•	0.052	0.052
75.25	eq	30.44	0.982	•	14.2	0.1	0.15	0.072	•	•	•	0.052	0.053
81.82	eq	30.67	0.982	•	14.2	0.1	0.15	0.072	•	•	•	0.053	0.053
93.81	eq	30.68	0.982	•	14.2	0.1	0.15	0.072	•	•	•	0.053	0.053
100.65	eq	30.34	0.982	•	14.2	0.1	0.15	0.072	•	•	•	0.052	0.051
110.70	discrete	2.44	0.982	22	•	•	•	•	0.937	30.35	19.65	0.064	•
116.43	discrete	2.35	0.982	22	•	•	•	•	0.933	29.94	20.06	0.064	•
122.60	discrete	2.40	0.982	22	•	•	•	•	0.935	29.99	20.01	0.065	•
130.74	eq	39.21	0.982	•	13.9	0.1	0.15	0.0725	•	•	•	0.068	0.070
136.57	eq	38.47	0.982	•	14	0.1	0.15	0.0723	•	•	•	0.067	0.064
142.21	eq	38.16	0.982	•	14	0.1	0.15	0.0723	•	•	•	0.066	0.065
158.55	discrete	2.48	0.982	22	•	•	•	•	0.919	29.84	20.16	0.068	•
166.70	discrete	2.46	0.982	22	•	•	•	•	0.940	30.07	19.93	0.066	•

Figure 2-8. Raw and modeled surface water methane concentrations determined with the disk equilibrator on a transect of northern Green Bay on May 24, 1995. See Chapter 4 for transect chart.


outbound (raw)
inbound (raw)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[CH$_4$] uM
4.96e+6
4.98e+6
5.00e+6
5.02e+6
UTM N (meters)


outbound (modeled)
inbound (modeled)
raw values
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[CH$_4$] uM
4.96e+6
4.98e+6
5.00e+6
5.02e+6
UTM N (meters)

the top panel. As expected, the raw values show a significant discrepancy south of UTM 4980000. High levels of methane in Sturgeon Bay dropped faster than the equilibrator could respond when the NEESKAY entered Green Bay. On the return trip, the raw methane values accurately marked the boundary between Green Bay and Sturgeon Bay water masses but greatly underestimated the true concentration. The modeled values on both legs of the transect agreed with each other and with the raw values when the *in situ* methane gradient decreased to a level the equilibrator could keep up with. It should also be noted that while it was important to use the modeled methane concentrations for comparisons with physical scalars, it made little difference whether raw or modeled values were used to determine average methane concentrations for Green Bay on the whole. Using the modeled concentration values presented in Figure 2-8, the spatially weight averaged concentration over the entire transect area bounded by the shoreline of Green Bay was 46.1 nM. The raw concentrations averaged 47.9 nM.

Carbon dioxide analysis

During the past decade, continuous sample equilibrators have been routinely used in conjunction with infrared gas analysis to measure dissolved carbon dioxide. The equilibration methods used in this study were similar to those described by Wanninkhof and Thoning (1993), DOE (1994), and Sabine et al. (1994). CO_2 equilibrium between the headspace and water sample was generally reached within several minutes with an e-folding time of less than 1 minute (Sabine et al. 1994). CO_2 equilibrated much faster than methane primarily due to the fact that the solubility of CO_2 is ~25-30 times greater than that of methane.

The method of infrared gas analysis in this study differed significantly from the papers cited above. In Wanninkhof and Thoning (1993), for example, gas from the equilibrator headspace was allowed to flow continuously through the sample cell of a Li-Cor CO_2 analyzer at a rate of ~ 75 ml min^{-1} for 23 minutes. The response from the analyzer was recorded after 3 minutes and averaged over 20 minutes. During shipboard analyses, this translated to an 8 km average while underway. While this would pose no significant problem in a relatively homogenous environment like the ocean, this can not be said for Green Bay where the fugacity of dissolved CO_2 can change several hundred micro-atmospheres over the distance of a kilometer. The introduction of ~ 1.5 liters of (outside) ambient air into the equilibrator headspace would also have significantly altered the equilibration time for methane (which was being measured concurrently). It was decided therefore to inject a small standard volume of sample into a nitrogen carrier stream that ran continuously through the sample cell of a Li-Cor 6252 CO_2 analyzer. The response of the analyzer was then recorded on an integrator. Standards were run in a similar fashion and the resulting peak heights were fit to their respective mole fractions using a second order polynomial equation. Reproducibility was generally better than 1%.

Both sample and reference cells of the Li-Cor analyzer were flushed continuously with N_2 at a metered flow rate of 20 milliliters per minute and vented directly to the atmosphere. Samples and standards were introduced into the sample cell through a 0.326 ± 0.001 ml sample loop with an Altex 6-way valve. It was assumed that gases reached room temperature before being flushed into the Li-Cor. A thermistor measuring gas temperatures inside the Li-Cor sample cell showed no systematic difference between equilibrator and standard samples. The analyzer voltage output was recorded on a Shimadzu C-R5A integrator. Water vapor was removed prior to the sample loop by passing all samples through a Perma Pure Dryer and Drierite. At least three replicates of three standards were run every one to two hours depending on changes in room temperature or atmospheric pressure. The standard concentrations were chosen to bracket observed *in situ* concentrations. Standards of 100 ppm, 101 ppm, 299 ppm, 501 ppm, 1011 ppm and 1.00 % carbon dioxide in nitrogen were obtained from Scott Specialty Gas. Additional standards of 2023 ppm and 2710 ppm CO_2 in N_2 were obtained from Linox. All standards were rated at ± 2% accuracy.

An inter-lab comparison between continuous and discrete sampling methods was conducted in Egg Harbor (Green Bay) on July 12th, 1996. The CO_2 concentrations measured with the disk equilibrator were determined using a set of standards obtained from Scott Specialty Gas. The discrete sample CO_2 concentrations were determined by Susan Boehme at the Lamont Doherty Earth Observatory using a set of standards calibrated to WMO (World Meteorological Organization) CO_2 standards. Based on 3 surface water (~2 meter depth) measurements, the disk equilibrated samples had a mean wet fugacity of 486.0 ± 0.6 μatm. Only one discrete sample from a depth of ~2 meters was run with a reported wet partial pressure of 487.46 μatm. Converting both sets of samples back to mole fractions in dry air (at *in situ* temperatures), the continuous sample mean concentration of 510.1 ± 0.6 ppm compared well with the discrete sample concentration of 509.94 ppm. The raw data values measured during the continuous sample analyses are presented in Table 2-2. The equations used to calculate *in situ*

Table 2-2. Continuous sample fCO_2 calculations from Egg Harbor on July 12th, 1996. See text for equations used to calculate each parameter. "RT" = integrator retention time in minutes. "PK HT" = integrator peak height. "xCO_2" = mole fraction of CO_2 (ppm) in dry air. "eq temp" = the temperature (C°) of water inside the equilibrator. "wat temp" = the *in situ* (bay) temperature (C°). "warming" = eq temp - wat temp. "pressure" = atmospheric pressure in hPa. Salinity is in ‰. "Patm" = the atmospheric pressure in atmospheres. "Pw" = the partial pressure of water vapor in atmospheres. "B(vc) = the virial coefficient for CO_2. "sigma(cvc)" = the cross virial coefficient for CO_2 and air. "eq fugacity" = the fugacity of CO_2 in water saturated air inside the equilibrator headspace in units of micro-atmospheres. "dln fCO2/dT" = the natural log of the change in the fugacity of CO_2 caused by the temperature change between *in situ* and equilibrator conditions. "in situ fCO2" = the fugacity of CO_2 in water saturated air that is in equilibrium with *in situ* [CO_2]. "in situ xCO2" = the mole fraction of CO_2 at *in situ* conditions in dry air. The "xCO2 eq" values were calculated using the 2nd order polynomial "STANDARD CURVE" which in turn was generated from the results of the 10 standard runs shown.

date: 12-Jul-96
site: EGG HARBOR
analysis: surface water CO2 comparison with discrete sample analysis
method: disk equilibrator

SAMPLE	RT minutes	PK HT	x CO2 eq ppm (dry)	eq temp C	wat temp C	warming C	pressure hPa	salinity psu
1	4.9	2272	510.10	19.3	19.33	-0.03	991	0.14
2	6.6	2269	509.42	19.3	19.33	-0.03	991	0.14
3	8.9	2267	508.98	19.3	19.33	-0.03	991	0.14

SAMPLE	Patm atm	Pw atm	B(vc)	sigma(cvc)	eq fugacity uatm	dln fCO2/dT	in situ fCO2 uatm (wet)	in situ xCO2 ppm (dry)
1	0.978	0.022	-128.624	23.191	486.00	-0.0012	**486.58**	**510.71**
2	0.978	0.022	-128.624	23.191	485.36	-0.0012	**485.94**	**510.04**
3	0.978	0.022	-128.624	23.191	484.94	-0.0012	**485.51**	**509.07**

Standards ppm	RT	pk ht	STANDARD CURVE	
101	11.2	421	b[0]	4.94556
101	12	423	b[1]	0.2202528
101	13.9	420	b[2]	9.178E-07
299	15.6	1371	r ²	0.9995439
299	17.3	1372		
299	18.6	1357		
501	19.9	2204		
501	21.2	2175		
1011	22.8	4503		
1011	24.1	4474		

fugacities from CO_2 mole fractions determined from the equilibrator headspace are given below.

For continuous sample analysis, the procedure for calculating *in situ* carbon dioxide concentrations are described at length in DOE (1994) and Murphy et al. (1995). The equations below are taken from Murphy et al. (1995).

The fugacity of carbon dioxide in the equilibrator was calculated as

$$f(CO_2)_{eq} = x(CO_2)_{eq} * (P_{atm} - P_w) * \exp[P_{atm}(B + 2\delta) / RT] \quad (2\text{-}6)$$

where $x(CO_2)_{eq}$ is the measured mole fraction of carbon dioxide in dried equilibrator air. P_{atm} is the total barometric pressure, P_w is the partial pressure of water vapor inside the equilibrator. B is the virial coefficient for carbon dioxide (a correction for non-ideal behavior between CO_2 molecules), δ is the cross virial coefficient for carbon dioxide and air (a correction for non-ideal behavior between CO_2 molecules and the remaining gases found in air). R is the gas constant (82.056 cm^3 atm/mole °K) , and T_{eq} is the temperature of water in the equilibrator in °K.

T_{eq}, P_{atm}, and $x(CO_2)_{eq}$ were measured directly or estimated by means described below (see barometric pressure and temperature sections). P_w was calculated using an equation from Weiss and Price (1980). Assuming 100% relative humidity:

$$\ln P_w = 24.4543 - 67.4509\,(100/T_{eq}) - 4.8489 \ln (T_{eq}/100) - 0.000544S \quad (2\text{-}7)$$

where S = salinity in ‰ and T_{eq} is the temperature of water inside the equilibrator in °K. B was estimated using a power series given by Weiss (1974):

$$B = -1636.75 + 12.0408T_{eq} - 3.27957 * 10^{-2}T_{eq}^{2} + 3.16528 * 10^{-5}T_{eq}^{3} \text{ cm}^3/\text{mole} \qquad (2\text{-}8)$$

The cross virial coefficient δ was also determined by Weiss (1974) as:

$$\delta = 57.7 - 0.118T_{eq} \text{ cm}^3/\text{mole} \qquad (2\text{-}9)$$

To calculate the fugacity of carbon dioxide in equilibrium with the surface waters of Green Bay, an additional correction had to be made for any change in temperature the water experienced while in transit to the equilibrator since temperature affects not only the solubility of CO_2 but also the carbonate equilibria. An equation describing the change in fugacity with respect to temperature is given by Weiss et al. (1982):

$$\Delta \ln f(CO_2) / \Delta t = 0.03107 - 2.785 * 10^{-4}t_{eq} - 1.839 * 10^{-3}\ln f(CO_2) \qquad (2\text{-}10)$$

where $f(CO_2)$ in this case is the fugacity of CO_2 in the equilibrator headspace, t_{eq} is the equilibrator water temperature in °C, and Δt is the equilibrator temperature minus the *in situ* water temperature in °C. During the 1994 - 1995 transects, Δt was always positive and ranged from ~ 0.0°C in the summer to 0.9°C in early spring and late fall.

The warming corrected *in situ* fugacity was calculated as:

$$f(CO_2)w = \exp(\ln f(CO_2)_{eq} - \Delta \ln f(CO)_2) \qquad (2\text{-}11)$$

The warming corrected (*in situ*) mole fraction of carbon dioxide in dry air was back-calculated by rearranging equation 2-6 as:

$$x(CO_2)_w = f(CO_2)_w / ((P_{atm} - P_w) * \exp[P_{atm}(B + 2\delta) / RT]) \qquad (2\text{-}12)$$

where T, P_w, B and δ were calculated using *in situ* lake temperatures.

The concentration of carbon dioxide was calculated using the equilibrium constant of Weiss (1974). For

$$K_0 = [CO_2^*] / f(CO_2), \qquad (2\text{-}13)$$

$$\ln K_0 = 93.4517(100/T) - 60.2409 + 23.3585 \ln (T/100) +$$
$$S[0.023517 - 0.023656(T/100) + 0.0047036(T/100)^2] \qquad (2\text{-}14)$$

where T is the *in situ* temperature in °K, S = salinity (‰), and $[CO_2^*]$ in equation 2-13 is expressed on the molality scale and represents the sum of $[CO_2]$ + $[H_2CO_3]$. It should be noted that $[CO_2] \cong [CO_2^*]$ and the two are used interchangeably unless otherwise noted.

Discrete sample CO_2 analyses were performed on only a few samples collected during the winter. Discrete samples collected from under the ice were agitated (spun) for 15 minutes at surface water temperatures (or snow) in 2 liter syringes with a gas:liquid phase ratio of ~1:100. Ambient air was used to displace the headspace. As the syringe plunger was free to move, it was assumed that equilibration was carried out at atmospheric pressure. The headspace was then transferred to a dry syringe for later analysis.

Rigorous calculation of [CO_2] content in a discrete sample is quite complicated (DOE 1994). In simple terms, a known volume of air is allowed to equilibrate with a known volume of water in some sort of container. As carbon dioxide equilibrates between the two phases, the total inorganic carbon content in the liquid phase changes; the alkalinity does not. This sets up a series of adjustments between the carbonate species which ultimately affects the fugacity of carbon dioxide in the headspace. The fugacity of the perturbed sample is calculated and used along with the measured ΣCO_2 of the original sample to determine the ΣCO_2 of the perturbed sample. The fCO_2 and ΣCO_2 of the perturbed sample are then used to calculate alkalinity using a series of equilibrium constants. Finally, the alkalinity and ΣCO_2 of the original sample are used to back-calculate the fCO_2 in equilibrium with the undisturbed sample.

DOE (1994) shows that for an air:water sample volume ratio of ~ 1:9, a ΣCO_2 concentration of ~ 2m*M*, and a measured (disturbed sample) pCO_2 of 343.7 μatm, the corrected partial pressure of carbon dioxide was 341.1 μatm; a 0.7% decrease. Since the magnitude of the perturbation is proportional to the air:water volume ratio, the air:water sample volume ratio was increased to ~1:100 and mass balance corrections were ignored. This resulted in a probable bias of < 0.5% above the real fugacity.

Clean air samples were drawn into a 100 ml syringe while underway and analyzed for atmospheric CO_2. The samples were allowed to warm to wetlab temperatures before injection into the sample loop.

A number of discrete water and air samples were collected by Susan Boehme in 1995. Carbon dioxide analyses were run in John Goddard's laboratory at the Lamont Doherty Earth Observatory using a set of primary standards traceable to WMO (World Meteorological Organization) CO_2 standards.

ΣCO_2 and Alkalinity

Bulk water samples for ΣCO_2 and alkalinity analysis were collected on profile stations in accordance with the recommendations described by DOE (1994). Each sample was poisoned with 0.1 ml of a saturated mercuric chloride solution, stoppered with Apiezon ® L grease, secured and stored in a refrigerator until analysis. Coulometric analyses of ΣCO_2 were run by Brian Eadie at the Great Lakes Environmental Research Laboratory in Ann Arbor, Michigan and Susan Boehme at Princeton University. Gran titration alkalinities were run by Susan Boehme at Princeton University.

During the second year of this study (1995), total carbon dioxide was measured while underway using a flow injection analysis method described by Hall and Aller (1988). Standard solutions were prepared from dried sodium bicarbonate (J. T. Baker Chemical Co., 99.7% assay) and weighed out on a Mettler micro-balance. Problems associated with the ship's power supply and temperature regulation resulted in significant baseline drift in the conductivity detector. Precision across the range of ΣCO_2 measured (2.1 - 2.9 mM) was ~ ± 5%.

Additional estimates of ΣCO_2 were obtained manometrically during $\Sigma^{13}CO_2$ analysis of 10 ml water samples (see Appendix 5).

pH

During the 1994 field season, surface water pH was measured with a Sea-Bird (SBE 30) pH sensor. The sensor was calibrated before each cruise with commercial buffer solutions traceable to NBS standards and stored in a KCl saturated pH 4 buffer solution when not in use. Accuracy was probably no better than ± 0.1 pH units.

In 1995, an Orion semi-micro Ross combination pH electrode and thermistor were inserted into the water stream just forward of the disk equilibrator. pH values were read with a Beckman pH meter with automatic temperature compensation. Two point calibrations were performed several times each day using commercial buffer solutions traceable to NIST standards. Water flow across the probe membrane could be adjusted independently of the equilibrator flow rate. Precision across the range of temperatures measured was probably better than ± 0.03 pH units.

Stable isotope analysis

Samples for inorganic ^{13}C analysis where collected at all profile stations during the 1995 field season. A syringe was used to carefully draw 10.0 ml of bulk water flowing from the submersible pump. The sample was then gently injected into a pre-combusted 15 ml Pierce vial containing ~20 ul of saturated mercuric chloride solution and a micro stir-bar. The vial was quickly sealed with a Pierce neoprene septum and crimped with an aluminum closure. All samples were refrigerated and stripped within three weeks.

Carbon dioxide was extracted and purified with phosphoric acid and a flow-through cryogenic stripping line based on a design used by Chris Martens and coworkers (Howard Mendlovitz, personal communication). The samples were acidified and degassed in their original vials by inserting needles through the neoprene septa. The bore of the gas uptake needle was large enough so as not to cause isotopic fractionation. Leaks around the septum were checked for with a drop of Snoop ®. Samples were acidified with 1 ml of phosphoric acid that had been stripped with a steady stream of helium for >2 hours. Samples were mixed with a magnetic stirrer placed under the vial. Water vapor was removed through a magnesium perchlorate column. Carbon dioxide was trapped with liquid nitrogen, manometrically quantified using a 10 torr full-scale MKS pressure transducer, and sealed in borosilicate tubing. The primary standard was Solenhofen Limestone (NBS Isotope Reference Sample No. 20). A secondary calcium carbonate standard was also established (Fisher Chemical Lot No. 941480). Standards and samples were treated identically and run using the same method. Isotopic ratios were determined by Brian Eadie (NOAA GLERL) on a VG Prism Mass Spectrometer.

^{222}Rn analysis

Discrete radon samples were analyzed using the method and apparatus described by Mathieu et al. (1988). Depending on the expected activity of the sample, 2 to 20 liters of bulk water were collected in pre-evacuated containers. The samples were returned to the laboratory and flushed with helium within a day. Radon was collected on a charcoal column trap using a dry ice/alcohol slurry then flushed with helium to a Lucas type scintillation cell for counting (see Mathieu et al. 1988 for details).

A very good estimate of *in situ* ^{222}Rn activity was also determined by withdrawing 100 ml of headspace from the disk equilibrator and injecting it through a Drierite column directly into a Lucas cell. Helium was added to the cell to bring the internal pressure up to 1 atmosphere. The cell was then counted immediately onboard the R/V NEESKAY.

Scintillation cell efficiencies and background counts were determined by J. Val Klump. Activities were calculated using a spreadsheet developed by George Kipphut.

Wind measurements

Hourly wind speed and direction data were obtained from the NDBC meteorological buoy # 45002 through the NOAA Great Lakes CoastWatch Program. The buoy is located in northern Lake Michigan (45.30 N 86.42 W), approximately 85 km NE of Sturgeon Bay. Anemometer height was reported to be 5 meters. Wind speeds were reported in m/sec at 0.1 m/sec resolution. Accuracy was listed at ± 1 m/sec.

A similar data set from the Green Bay Austin Straubel International Airport (NOAA Station 14898, 44.48 N 88.14 W) was used to compare wind speed over water to that measured on land. The station is located approximately 75 km SW of Sturgeon Bay. Wind speeds were recorded at a height of 10 meters and reported in knots at 1 knot resolution.

AVHHR data

Green Bay surface temperatures were observed using Advanced Very High Resolution Radiometers (AVHRR) aboard two polar-orbiting satellites (NOAA-12 and NOAA-14). Observations were made twice a day by each satellite (NOAA-12: 08:00, 20:00; NOAA-14: 02:00, 14:00 hrs local time). The data were processed and made available to the public on the World Wide Web through the NOAA Great Lakes CoastWatch Program. Daily estimates of surface temperature for the entire Great Lakes region were mapped to a Mercator projection and translated to a 512 x 512 pixel grid in GIF format. Actual temperatures were embedded at 1° C resolution in the pixel color codes and 0.2° C resolution in the color palette codes (Dave Schwab, personal communication). Cloud-free areas were updated with new AVHRR information daily. Surface temperatures for cloud-covered areas were estimated from the previous day's image using a smoothing algorithm. Pixel resolution was 2.56 km. Daily images from 1994 and 1995 were "archived" in FLC movie format. This conversion erased the color palette information.

Actual temperatures were extracted from the RGB color coded images using the following procedure. The FLC movies were downloaded and converted to individual frames using Display (a shareware program written by Jih-Shin Ho). Pixel image coordinates and RGB color codes were extracted with Image Tool (a shareware program developed at the University of Texas Health Science Center in San Antonio). Geographic (Long., Lat.) coordinates for each image pixel coordinate (x, y) were provided by Dave

Schwab (NOAA GLREL. Ann Arbor. MI; personal communication). RGB color codes were converted to temperatures using the color scale included in each image.

Ice analysis

During ice season. estimates of ice on Green Bay were obtained every three days from the NOAA/NAVY Ice Center. During periods of ice growth or breakup. each of the seven study site zones were subjectively considered "iced covered" if greater than 80% of each zone was covered with ice.

Barometric pressure

During the 1994 transects. hourly measurements of atmospheric pressure were obtained from the NDBC meteorological buoy # 45002 through the NOAA Great Lakes CoastWatch Program. Pressures were given with 0.1 hPa resolution at a reported accuracy of ± 1 hPa and corrected to apparent sea level. The real (local) barometric pressure was back-calculated using the (National Weather Service) equation

$$P = (A^n - bH)^{(1/n)} + 0.3 \qquad (2\text{-}15)$$

where P is the local pressure in millibars. A is the apparent sea level pressure in millibars. H is station elevation in meters. b = 8.4288e-5. and n = 0.190284.

In 1995. the atmospheric pressure was measured on the R/V NEESKAY at a resolution of 1 hPa. Differences between locally observed pressures and those obtained from buoy # 45002 were generally less than 1 hPa at any given time.

Temperature

Temperature was measured at a number of points during each transect (Figure 2-9). The most accurate measurements were made with the Sea-Bird thermistor located on deck. The Sea-Bird is factory calibrated each year and typical accuracy/stability specifications are rated at ± 0.0004 C per year. Temperature readings from the HydroLab and YSI thermistors (0.01° and 0.1°C resolutions respectively) were compared to the Sea-Bird thermistor in a large tank and found to differ by ~+0.02°C and -0.1°C respectively. The YSI bias persisted across a range of temperatures so corrections were made accordingly.

To determine *in situ* (lake) gas concentrations, both equilibrator and *in situ* water temperatures were required. In 1994, disk equilibrator temperatures were assumed to be steadily biased to those measured by the Sea-Bird. The equilibrator effluent was measured infrequently and recorded with Sea-Bird measurements. As the seasons changed, this was found not to be the case. The temperature bias between the Sea-Bird and equilibrator changed. In 1995, disk equilibrator temperatures were more directly inferred by placing the YSI temperature probe into the water stream just prior to the equilibrator. Temperature measurements of the effluent stream agreed to 0.1° C.

In situ lake temperatures were more difficult to obtain. The HydroLab recorded *in situ* temperatures only while on station. The NEESKAY did carry a thermistor in its water coolant intake pipe, but temperatures were recorded on an analog clock-driven radial chart and difficult to interpret (later analysis showed they were accurate to ~ ±0.1° C).

Figure 2-9. Thermistor locations on the R/V NEESKAY. (B) T and (Y) T were only added in 1995. (BP) T was actually located in the water coolant intake pipe which drew water from a depth of ~2 meters.

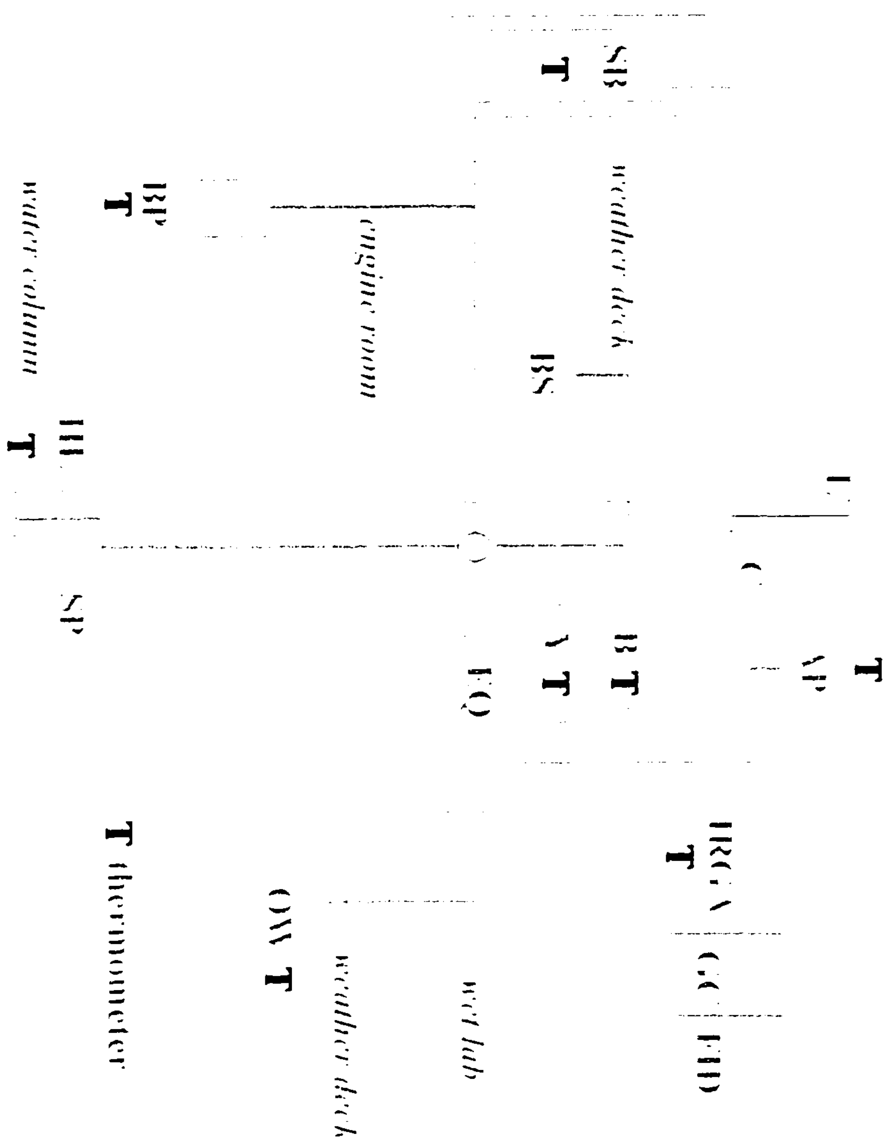
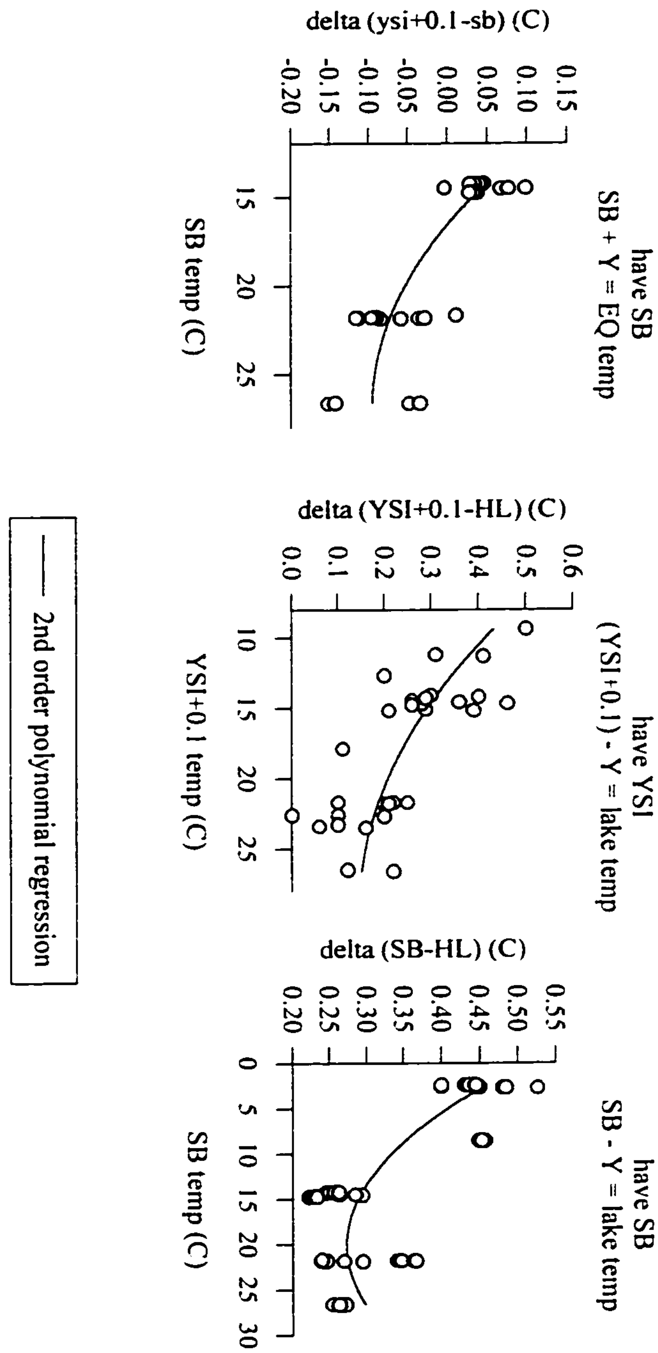

SB
T
weather deck
BS
engine room
BP
T
water column
T
SP
EQ
B T
T
IRGA
T
GC
FID
wet lab
weather deck
OW T
T thermometer

Figure 2-10. The YSI (Y) and HydroLab (HL) thermistors were calibrated with the Sea-Bird (SB) thermistor and used to observe temperature differences between the water column (2 meters), equilibrator and open deck (Sea-Bird box) at profile stations during the entire 1995 field season. The observed differences were fit to 2^{nd}-order polynomial equations and used to estimate the equilibrator temperature (1994) and *in situ* (lake) temperature (1994 and 1995).


have SB
SB + Y = EQ temp
delta (ysi+0.1-sb) (C)
SB temp (C)
have YSI
(YSI+0.1) - Y = lake temp
delta (YSI+0.1-HL) (C)
YSI+0.1 temp (C)
have SB
SB - Y = lake temp
delta (SB-HL) (C)
SB temp (C)
2nd order polynomial regression

Therefore, empirical relationships between equilibrator, lake (2 meter) and deck (Sea-Bird box) temperature were determined at profile stations throughout the 1995 field season. The results are shown in Figure 2-10. Equilibrator temperatures (EQ_t) were estimated from Sea-Bird temperatures (SB_t) with the equation:

$$EQ_T = SB_t + (0.5599 + SB_t * -0.0489 + SB_t^2 * 9.124e{-4}), \qquad (2\text{-}16)$$

where temperatures are in °C. If YSI temperatures were known, *in situ* water temperatures (WAT_t) were estimated with the equation:

$$WAT_t = YSI'_t - (0.7683 + YSI'_t * -0.0427 + YSI'^2_t * 7.333e{-4}), \qquad (2\text{-}17)$$

where YSI′ refers to the bias corrected temperature (YSI + 0.1°). *In situ* water temperatures were estimated from Sea-Bird data with the equation:

$$WAT_t = SB_t - (0.5135 + SB_t * -0.0240 + SB_t^2 * 5.972e{-4}). \qquad (2\text{-}18)$$

Geostatistics

Statistical interpolation of surface water gas concentrations, temperatures, volumes and areas were done with Surfer (Golden Software, Version 6). Calculations were simplified by converting the data coordinates from the Geographic Coordinate System to the Universal Transverse Mercator (UTM, Zone 17) Grid System using ArcInfo (a GIS software package). The chief advantage of the UTM system is that coordinates are expressed in meters. Grid interpolations were generally calculated using an exact inverse distance method. The inverse distance method was chosen over the Kriging method (linear variogram, zero smoothing) since the Kriging method tended to generate negative methane concentrations due to very steep methane gradients (in spite of this, mass estimates determined using both interpolation methods agreed to within 10%). The distance between grid nodes ranged from 100 to 2000 meters and depended on the resolution of the data points and/or the area under consideration. The inverse distance equation employed by Surfer to calculate the value of each grid node is given as:

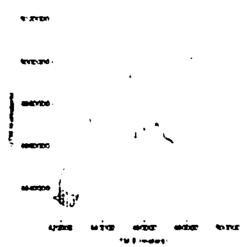
$$z = \frac{\sum_{i=1}^{n} \frac{z_i}{h_{ij}^{\beta}}}{\sum_{i=1}^{n} \frac{1}{h_{ij}^{\beta}}}, \qquad (2\text{-}19)$$

where z = the interpolated grid node value, z_i = the neighboring data point, h_{ij} = the distance between the grid node and data point, and β = the weighing power which was set to 2.

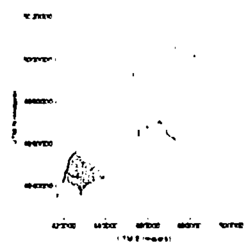
The interpolated surface water gas concentrations were averaged over seven sections (labeled zone 1 through zone 7) of southern Green Bay (Figure 2-11). The sections roughly correspond to the Green Bay hydrodynamic box model zones of Mortimer (1978) and effectively divide southern Green Bay into zones with distinct depth, temperature, riverine input and/or trophic structure characteristics (Sager and Richman 1991).

Figure 2-11. The seven zones of southern Green Bay. All mean depth, area, and volume calculations were determined using Surfer software, 100 meter grid intervals and NOAA bathymetry and boundary files. The seven zones compose a total volume of 22.5 km^3 with a total surface area of 1635 km^2.

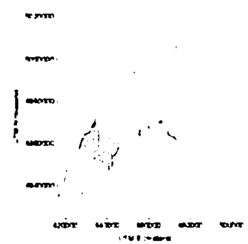
1



2

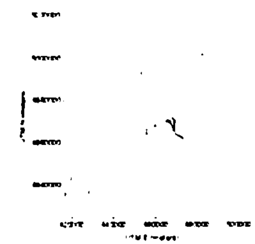


3

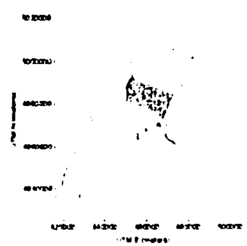


4

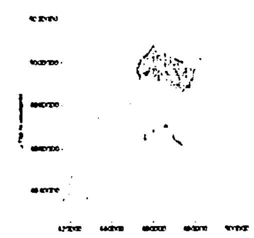
5



6



7



volume and area

	vol km3	area km2	avg depth m
zone 1	0.15	63.8	2.3
zone 2	1.25	228.3	5.5
zone 3	2.45	297.9	8.2
zone 4	4.97	380.2	13.1
zone 5	0.08	14.3	5.4
zone 6	5.66	270.5	20.9
zone 7	7.92	380.4	20.8

Chapter 3

The Kinetics of Air-Water Gas Exchange in Green Bay

Introduction

Estimating the rate of gas transport across the air-water interface of an aquatic system is important on a global scale because many of the gases that play a role in regulating the Earth's climate are in part controlled by processes that occur in aquatic systems. On a smaller scale, estimates of fluxes of biogenic gases across the air-water interface help to constrain the mass balance of biogeochemically important elements, which in turn, illuminate the trophic status of an aquatic system. Two models describing gas transfer across the air-water interface are currently in use; they are: the thin-film (or stagnant boundary layer) model, and the surface-renewal (or film-replacement) model. Both models are derived from Fick's first law of diffusion and can be abbreviated as:

$$J = K\,\Delta C, \qquad (3\text{-}1)$$

where J is equal to the flux of a gas, K is an empirically derived transfer coefficient and ΔC is the concentration gradient of the gas across the air water interface (Liss 1983). J is generally expressed in terms of mass area^{-1} time^{-1} (e.g. moles m^{-2} day^{-1}), ΔC is expressed as a concentration (e.g. moles m^{-3}), and the transfer coefficient is expressed as a velocity (e.g. m day^{-1}). The sign and magnitude of ΔC determines the thermodynamic force and direction of gas flux while K describes the kinetics of the process. In the thin-film model,

$$K = D/z_{BL} , \quad (3\text{-}2)$$

where D = the molecular diffusion coefficient of a gas and z_{BL} = the thickness of a boundary layer at the air-water interface where chemical diffusion through the layer is accomplished solely through Brownian motion. In the surface-renewal model,

$$K = (D/t)^{0.5}, \quad (3\text{-}3)$$

where t = the residence time of the surface film. The absolute difference in K between both models is small, but if the transfer coefficient for a gas other than that which was originally used to determine K is desired or if the change in ratio of two gas tracers is used to determine K, then the difference between the two models can become significant. For the equation:

$$K_1/K_2 = (Sc_1/Sc_2)^n, \quad (3\text{-}4)$$

where 1 and 2 denote different gases and the Schmidt numbers (Sc_1 and Sc_2) are the kinematic viscosity of water ($cm^2\ sec^{-1}$) divided by the molecular diffusion coefficients of the gases at a given temperature, n is equal to -1.0 for the thin-film model and -0.5 for the surface-renewal model. Though both models are still used in estimating gas flux from natural systems (thin-film: Schmidt and Conrad 1993, surface-renewal: Watson et al. 1991), it is becoming clear from multiple tracer studies that the surface-renewal model is more accurate at wind speeds above 2 m/sec (or the onset of capillary waves). Below wind speeds of 2 m/sec, n is typically assigned a value of -0.67 (Watson et al. 1991, Jähne et al. 1987b, Holmen and Liss 1984, Ledwell 1984).

The transfer coefficient is primarily a function of wind-generated turbulence and increases non-linearly with increasing wind speed. The non-linear relationship is primarily due to an increase in the interfacial area which increases as a result of wave formation and, at higher wind speeds, bubble injection (Liss 1983, Merlivat and Memery 1983, Jähne et al. 1987, Woolf 1993, Farmer et al. 1993, Livingstone and Imboden 1993). Estimates of K have been determined in the field as well as in wind-water tunnels and are usually correlated with concurrently measured wind speeds. Reviews of some of the more common techniques used to determine K are given by Broecker and Peng (1984) and Liss (1983). In natural systems, most estimates of K have involved measuring the invasion or evasion of one or more natural or purposeful tracers in the water over a period of days to months. While these methods may be measuring a time averaged K quite accurately, they have not answered questions concerning small scale or short term variability. Nor do they accurately reflect the dependence of K on the instantaneous wind speed (Broecker and Peng 1984, Broecker et al. 1986, Smith and Jones 1986, Wesely 1986). In this study, wind tunnel estimates of K versus wind speed (U) were chosen over those determined in *in situ* conditions primarily because wind speeds inside of the tunnel could be carefully controlled. U / K correlations were chosen over empirically derived *in situ* (time-averaged) transfer coefficients primarily due to the hydrodynamic complexity of Green Bay and the resultant difficulties associated with modeling the flux of a tracer (e.g. radon, Imboden and Emerson 1978).

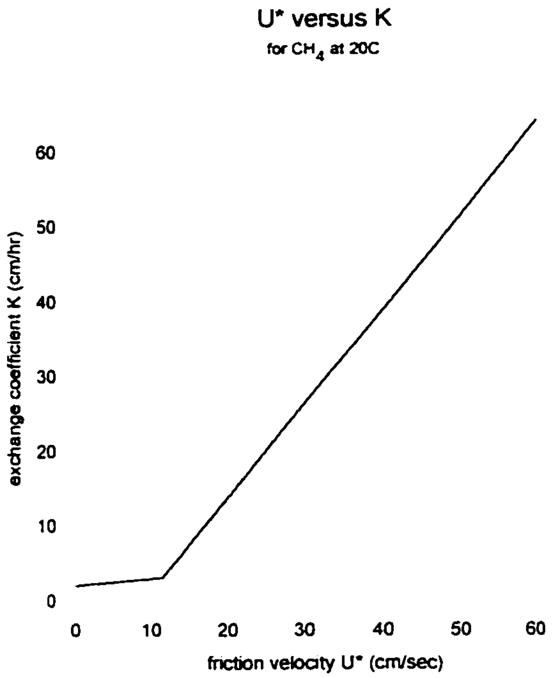
U / K Correlation

The U / K correlation has been investigated in a fair number of wind-water tunnel experiments. The results of most of these studies are compiled in Jähne et al. (1987b) and Barber et al. (1988). The wind speed / transfer coefficients of Broecker et al. (1978) (hereinafter referred to as B78) were chosen over the results of other studies due to the relatively large size of the Hamburg tunnel (18 meters), the use of CO_2 to estimate K, and the extent to which the U / K relationship was established (~ 16 m/sec wind speed at a height of 60 cm). Although the coefficients for the bilinear relationship between wind speed and K were not reported in B78 (see B78, Figure 6), the coefficients describing the bilinear relationship between the friction velocity (U^*) and K (normalized to methane at 20°C) as determined by B78 are given in Barber et al. (1988) (hereinafter referred to as B88). B88's U^* / K relationship for methane at 20°C (as determined by B78) is plotted in Figure 3-1a. In Figure 3-1a, the y intercept = 2.0 and the slope of the first line = 0.09. The critical friction velocity occurs at 11.35 cm/sec (11 cm/sec in B88) and marks the approximate point at which capillary waves begin to form. The slope of the second line = 1.26. The friction velocity (U^*) of wind is often used in lieu of the wind speed since U^* is independent of the height at which U is measured. B88 calculated U^* with the equation:

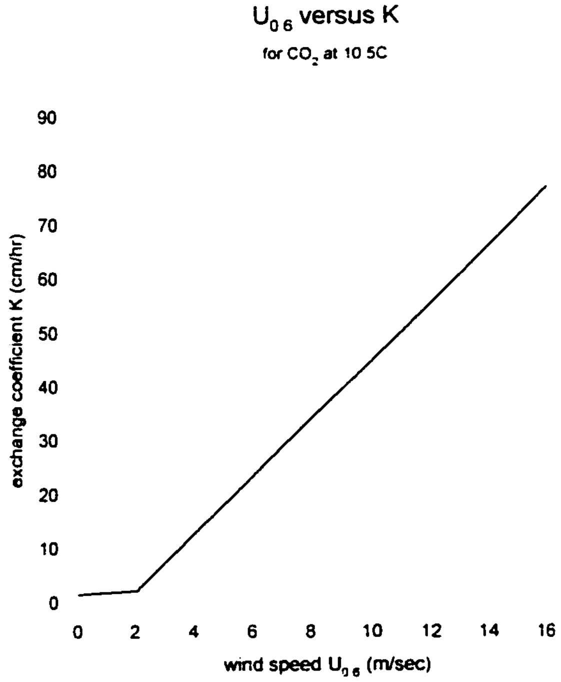
$$U^* = k\, U_z / (k / (C_{DN})^{0.5} - \ln 10 / z), \qquad (3\text{-}5)$$

where k = the von Karmen's constant, C_{DN} is the neutral drag coefficient, and z is the height at which the wind speed (U) was measured. The von Karmen's constant was taken

Figure 3-1. A comparison of the relationships between friction velocity (U^*), wind speed (U), and the transfer coefficient (K) across the air-water interface as determined by Broecker et al. (1978). a) The U^* / K relationship for methane at 20°C as given by Barber et al. (1988). See text for bilinear coefficients. b) The U / K relationship for CO_2 at 10.5°C as determined by Broecker et al. (1978).


U* versus K
for CH_4 at 20C
exchange coefficient K (cm/hr)
0
10
20
30
40
50
60
0
10
20
30
40
50
60
friction velocity U* (cm/sec)

a


$U_{0\ 6}$ versus K
for CO_2 at 10 5C
exchange coefficient K (cm/hr)
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
wind speed $U_{0\ 6}$ (m/sec)

b

as 0.4 and the neutral drag coefficient was assumed to be constant at 1.3 x 10^{-3}. The transfer coefficients were normalized to methane at 20°C using equation 3-4. It was assumed that n = -0.67 for $U_{0.6}$ values up to ~ 2.7 m/sec and n = -0.5 for $U_{0.6}$ values > ~2.7 m/sec. The Schmidt number for methane at 20°C was taken as 620. The Schmidt number for carbon dioxide at 10.5°C (i.e. the gas and temperature reported by B78) was taken as 1040. The back-calculated $U_{0.6}$ / K relationship for CO_2 at 10.5° C is shown in Figure 3-1b and agrees well with B78's Figure 6.

U / z Relationship

In the field of micro-meteorology, considerable effort has been spent on discerning the height dependency of wind. The results of these efforts have been used by geochemists to correlate wind speed dependent processes and the wind speed measured at various heights to that of a standard height (e.g. U_{10}) or, as shown above, a height independent wind speed (i.e. the friction velocity U^*). More often than not, geochemists have simplified the U / z relationship by using a neutral drag coefficient (which implies a static U / z profile). In reality, the slope of the profile depends on a variety of meteorological factors; the most significant being the air-water temperature gradient and its effect on the buoyancy and shear of the atmospheric surface layer (Kraus and Businger 1994). The extent to which temperature gradients affect the slope of the wind profile was explored with a computer program written by Arlindo da Silva at the University of Wisconsin - Milwaukee (see Appendix 6). Based on inputs of barometric pressure, dew point (or relative humidity), water temperature, air temperature, and the observed wind speed at a given height, the program was able to generate a wind / height profile based on the principles outlined in Large and Pond (1981, 1982).

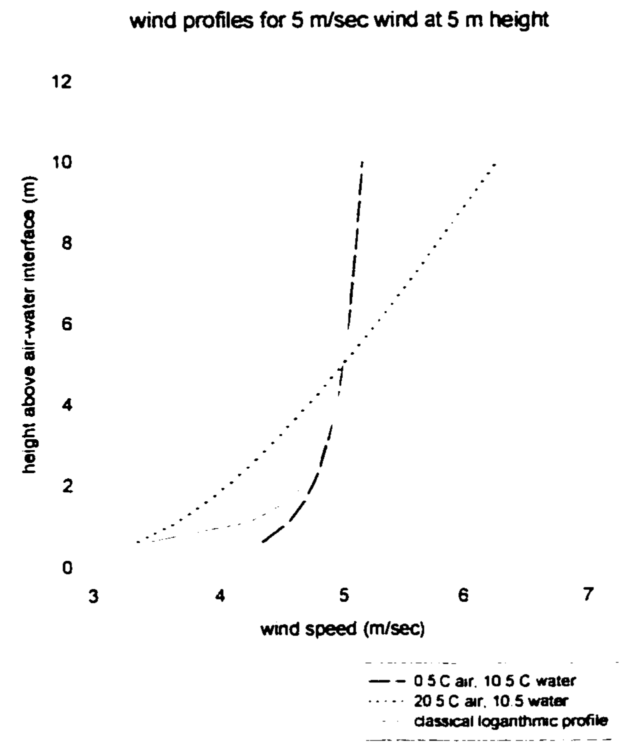
Two extreme cases for air-water temperature gradients of ± 10°C are illustrated in Figure 3-2. In Figure 3-2a, profiles for a 5 m/sec wind speed at z = 5 m show a stable (stratified) wind profile for warm air over cooler water (dotted line) and an unstable wind profile for cold air over warmer water (dashed line). The solid line shows the wind profile generated using equation 3-5 ($C_{DN} = 1.3 \times 10^{-3}$). Figure 3-2b shows similar profiles for U_{10} = 5 m/sec and illustrates the fact that the potential error associated with estimating K increases with the height at which U is measured. Though the differences in wind speed may seem trivial, the differences in corresponding transfer coefficients are huge (see Figure 3-1b). For the three profiles shown in Figure 3-2b, $K_{CO2, 10\ 5°C}$ = 3.5 cm/hr (dotted line), 9.1 cm/hr (solid line), and 13.8 cm/hr (dashed line).

Green Bay Wind Data

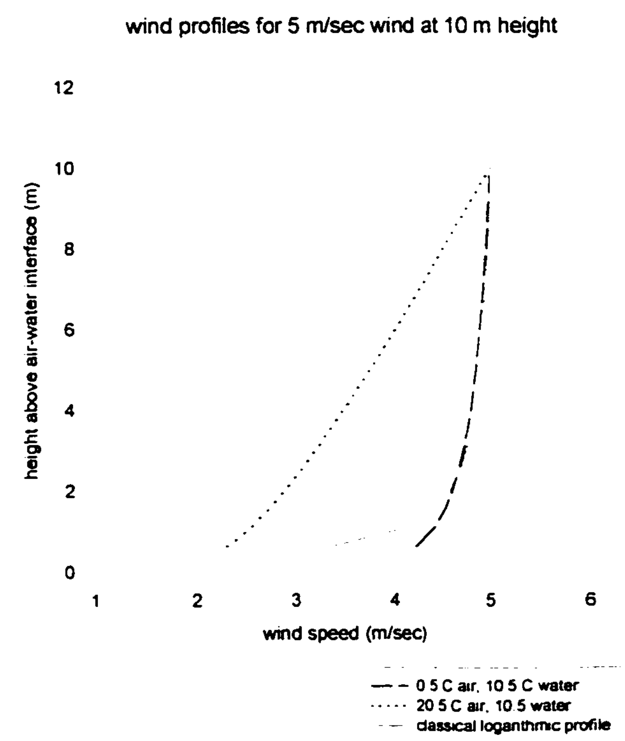
Hourly wind speeds were recorded during the 1994 and 1995 field seasons at both the Green Bay airport and NDBC buoy # 45002 (see Chapter 2). A comparison of the two data sets showed that while both data sets tracked the progression of storms in unison, the wind speeds recorded at the airport were generally lower than those recorded on open water. This is not surprising since (overland) mesoscale obstructions can reduce wind speeds by up to 50% (Schwab and Morton 1984, Fujita and Wakimoto 1982). Frequency analysis of both data sets, shown in Figure 3-3a, confirm the lower overland wind speeds.

There are a number of simple models for estimating overwater wind speeds from overland wind speeds, but none of them are particularly accurate (Schwab and Morton 1984). To demonstrate this, estimates of overwater wind speed were generated using August 1994 Green Bay airport wind speeds (n = 744) and the method of Resio and Vincent (1977) (as reported in Schwab (1978)). For:

Figure 3-2. The effect of air-water temperature gradients on the wind speed / height profile for a) U_5 = 5 m sec^{-1} and b) U_{10} = 5 m sec^{-1} (RH = 80% at 992 hPa). The profiles were calculated using a computer program written by Arlindo da Silva at the University of Wisconsin-Milwaukee and based on the principles outlined in Large and Pond (1981, 1982).

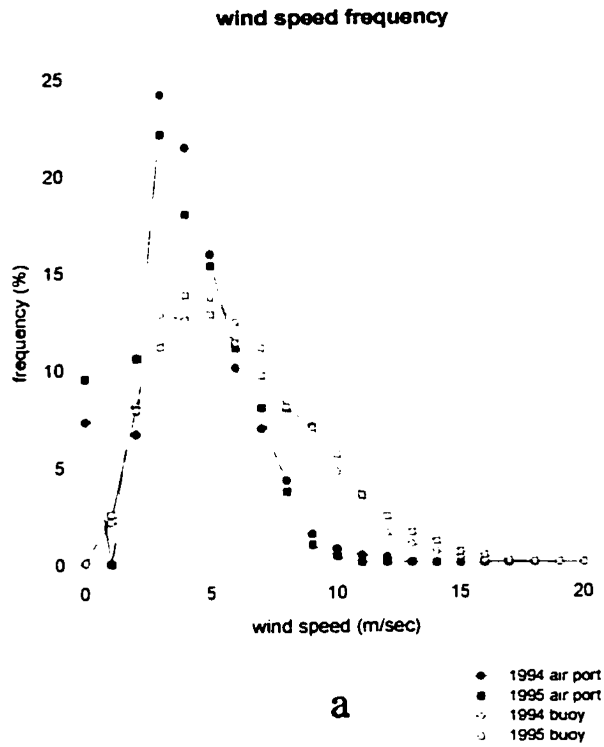

wind profiles for 5 m/sec wind at 5 m height
height above air-water interface (m)
wind speed (m/sec)
0 5 C air, 10 5 C water
20 5 C air, 10 5 water
classical logarithmic profile

a


wind profiles for 5 m/sec wind at 10 m height
height above air-water interface (m)
wind speed (m/sec)
0 5 C air, 10 5 C water
20 5 C air, 10 5 water
classical logarithmic profile

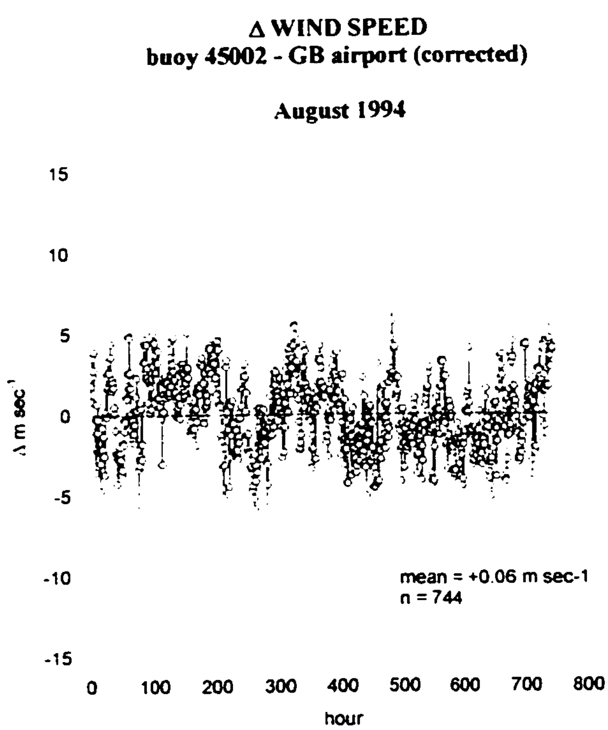
b

Figure 3-3. Comparison of hourly wind speeds recorded at the NDBC buoy #45002 (45.30 N 86.42 W, ~ 85 km NE of Sturgeon Bay) and the Green Bay airport (NOAA Station 14898, 44.48 N 88.14 W, ~ 75 km SW of Sturgeon Bay) a) Frequency (%) of wind speeds for complete 1994 and 1995 wind data sets. b) Difference between wind speeds recorded at buoy #45002 and "corrected" wind speeds from the Green Bay airport during the month of August 1994. Green Bay airport (overland) wind speeds were translated to overwater wind speeds using the method of Resio and Vincent (1977).



wind speed frequency
frequency (%)
25
20
15
10
5
0
0
5
10
15
20
wind speed (m/sec)
1994 air port
1995 air port
1994 buoy
1995 buoy

a



Δ WIND SPEED
buoy 45002 - GB airport (corrected)
August 1994
15
10
5
0
-5
-10
-15
0
100
200
300
400
500
600
700
800
hour
mean = +0.06 m sec-1
n = 744

b

$$U_W = U_L\ (1.2 + 1.9/U_L)\ [1 - \Delta t/|\Delta t|\ (|\Delta t|/1900)^{1.3}], \qquad (3\text{-}6)$$

U_W and U_L represent overwater and overland wind speeds in m/sec and Δt equals the air-water temperature difference in °C. Δt was taken as -0.4 °C based on the average air-water temperature difference recorded at buoy #45002 from 1989 to 1993. Where airport wind speeds were zero, the estimated overwater wind speed (limit) of 2.02 m/sec was used. Estimated values of overwater U_{10} were divided by 1.05 to obtain wind speeds at a height of 5 meters (see below, Table 3-1).

The differences between observed (buoy) - estimated overwater wind speeds are presented in Figure 3-3b. Estimates of overwater wind speed correlated poorly with observed overwater wind speeds ($r^2 = 0.34$), but the mean difference between the two data sets was essentially zero over the time scale of a month. Since surface water gas measurements were made on a similar (~ monthly) time scale, either wind speed data set would have resulted in similar gas flux estimates across the air-water interface as long as the frequency of wind speeds above and below the critical wind speed required to generate capillary waves (i.e. ~ 2 m/sec, see Figure 3-1b) was the same for each data set.

The high frequency of 0 m/sec wind speeds for the airport data (and the absence of wind speeds below 3 knots) are suspicious however, and suggest a faulty anemometer. In view of the complexities involved in predicting wind speed over water from land-based measurements and the poor agreement between modeled and observed wind speeds over water (Schwab and Morton 1984), the wind speeds from buoy #45002 were used to estimate transfer coefficients across the air-water interface of Green Bay.

$U_{5.0}$ to $U_{0.6}$ translation

Wind speeds recorded at buoy #45002 were translated from $U_{5.0}$ to $U_{0.6}$ with a reduction factor calculated using A. da Silva's model and the average monthly wind speed, air temperature and water temperature recorded at buoy #45002 from 1989 to 1993. The relative humidity and barometric pressure were assumed to be 80% and 992 hPa respectively. The reduction factors and monthly meteorological data are presented in Table 3-1. Wind speeds measured at a height of 5 meters were multiplied by the "0.6m x factor" to obtain $U_{0.6}$. The calculated drag coefficients (C_D) ranged from 1.31×10^{-3} in December to 0.77×10^{-3} in June. The stability parameters (z/L, where L = Obukhov scale length of turbulence) show stable stratification (z/L > 0, Kraus and Businger 1994) from April through July. The average monthly wind profiles calculated with the coefficients in Table 3-1 are shown in Figure 3-4. Average monthly wind speeds were also used to fill small gaps in the data set due to the fact that Buoy #45002 was hauled out for servicing during the winters of 1994 and 1995.

Green Bay Temperature Data

Surface water temperatures of Green Bay were obtained for every ~ 4th day of open water from AVHRR data according to the methods described in chapter 2. The temperatures were weight averaged in each of the zones outlined in Figure 2-9 (except zone 5, see below). The weight averaging method entailed interpolating the temperatures over a grid using an exact inverse distance method. The entire grid was then integrated and divided by the base area of the grid. The grid nodes were spaced at 2 km intervals corresponding with the approximate resolution of the AVHRR data. The data-set for each zone only included temperatures from within the zone; temperatures outside of the zone

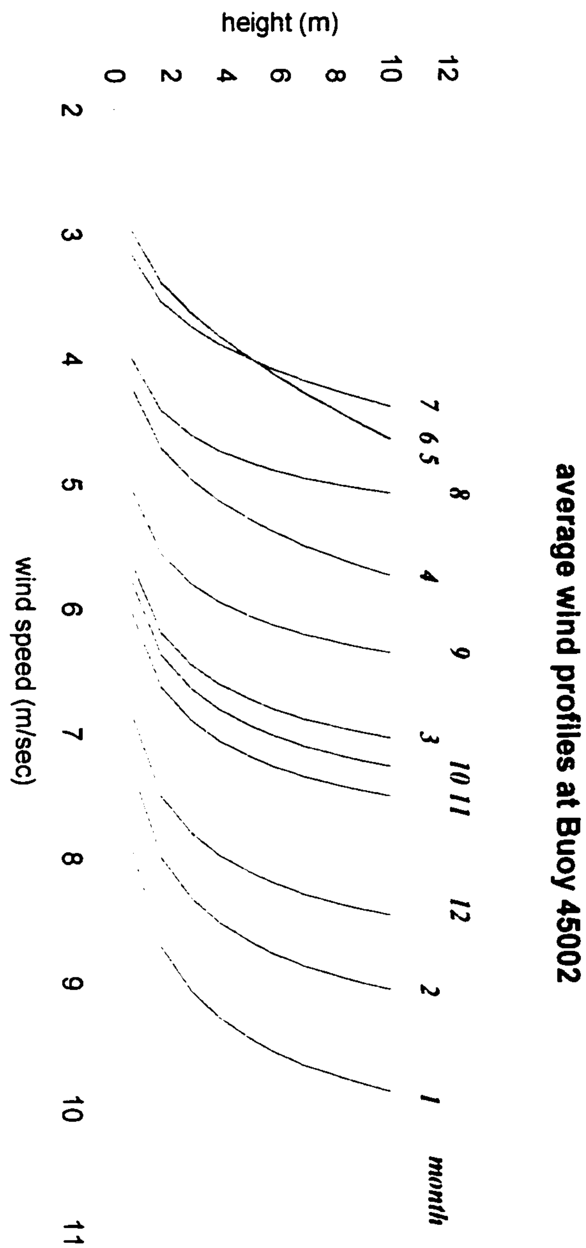
Table 3-1. Wind speed correction factors. Average (1989-1993) monthly water temperatures, air temperatures and wind speeds recorded at buoy #45002 were used to calculate specific drag coefficients (C_D), stability parameters (z/L), and wind speed correction factors where the "0.6m x factor" = $U_{0.6}$:$U_{5.0}$ and the "10m x factor" = $U_{10.0}$:$U_{5.0}$.

avg air-sea temp difference and wind speed (1989-93) at Buoy 45002

**wind data calculated according to model by A. da Silva*

month	air temp (C)	wat temp (C)	air-sea (C)	89-93 avg ws @ 5m (m/sec)	*ws @ 10m (m/sec)	10m x factor	*ws @ 0.6m (m/sec)	0.6m x factor	*CD x 1000 (10m)	*Z/L (10m)
1	-3.3	3.9	-7.3	9.47	9.88	1.04	7.92	0.84	1.28	-0.375
2	-4	2.3	-6.4	8.69	9.06	1.04	7.27	0.84	1.29	-0.390
3	-0.9	2.2	-3.1	6.74	7.04	1.04	5.62	0.83	1.27	-0.320
4	3.1	2.2	0.8	5.30	5.74	1.08	4.21	0.80	1.05	0.071
5	5.6	3	2.5	4.01	4.64	1.16	2.97	0.74	0.78	0.360
6	9.9	7.2	2.7	4.01	4.65	1.16	2.96	0.74	0.77	0.367
7	16.9	15.9	1	4.01	4.38	1.09	3.16	0.79	1.01	0.108
8	18.9	19.3	-0.4	4.84	5.08	1.05	3.99	0.82	1.22	-0.147
9	15.2	16.8	-1.5	6.07	6.35	1.05	5.03	0.83	1.24	-0.232
10	9.3	11.8	-2.5	6.95	7.27	1.05	5.77	0.83	1.25	-0.251
11	4.1	8.3	-4.3	7.20	7.51	1.04	6.02	0.84	1.28	-0.383
12	-1.1	5.8	-6.9	8.13	8.46	1.04	6.84	0.84	1.31	-0.493

Figure 3-4. Average monthly Green Bay wind profiles based on average (1989-1993) monthly wind speeds ($U_{5.0}$) at buoy #45002 and the air column stability / drag coefficients listed in table 3-1.


average wind profiles at Buoy 45002
height (m)
wind speed (m/sec)
month
7 6 5
8
4
9
3
10 11
12
2
1
0
2
4
6
8
10
12
2
3
4
5
6
7
8
9
10
11

were blanked. The 1994 -1995 surface water temperatures for zones 1-4, 6, and 7 are shown in Figure 3-5. Due to its small size (and the resultant paucity of AVHRR data), zone 5 was assumed to have the same temporal temperature profile as zone 2 based on their similar mean depth. A cursory comparison between the weight averaged satellite derived surface temperatures and directly measured Sea-Bird temperatures in 1995 (zone 4) shows fairly good agreement considering the resolution of the AVHRR data (± 0.5°C) and uncertainties in evaporative surface cooling (Schwab et al. 1992, Van Scoy et al. 1995), bias in the surface water transect route, error due to interpolation during cloud cover, and the possibility of shallow (temporary) stratification above the ~2 meter deep intake pipe that supplied water to the Sea-Bird thermistor (Figure 3-6).

Green Bay Transfer Coefficients

Daily estimates of K were determined as follows. Hourly wind speeds were converted to $U_{0.6}$ using the appropriate reduction factors given in Table 3-1. The translated wind speeds were then used to determine hourly estimates of $K_{CO2,\ 10.5°C}$ as determined by B78 (Figure 3-1b). Each estimate of $K_{CO2,\ 10.5°C}$ was then translated to K_{CH4} or K_{CO2} at *in situ* temperatures for all seven zones using equation 3-4, the temperatures shown in Figure 3-5, and the Schmidt number / temperature relationships determined by Jähne et al. (1987a). For carbon dioxide, a 3rd-order polynomial fit of Jähne's data gave:

$$Sc_{CO2} = 1911.374 - 113.676\,(t) + 2.967\,(t^2) - 0.029\,(t^3), \qquad (3\text{-}7)$$

and for methane,

Figure 3-5. Green Bay open water surface temperatures for zones 1-4, 6, and 7 based on AVHRR satellite data. The light gray line follows surface water temperatures in zone 1: the southernmost, shallow area of southern Green Bay. The dark gray line follows surface temperatures in zone 7: the northernmost, deep area of southern Green Bay.

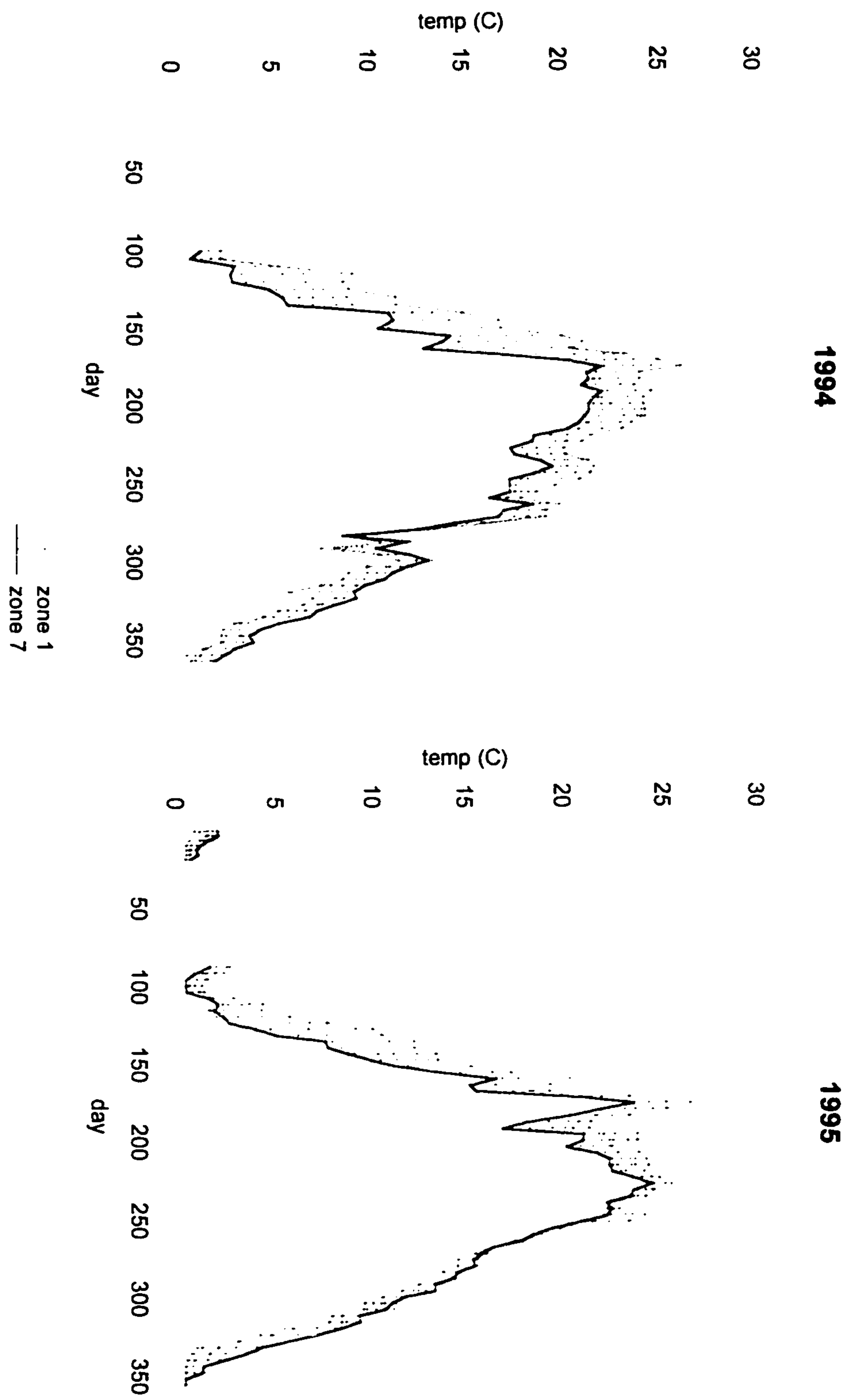
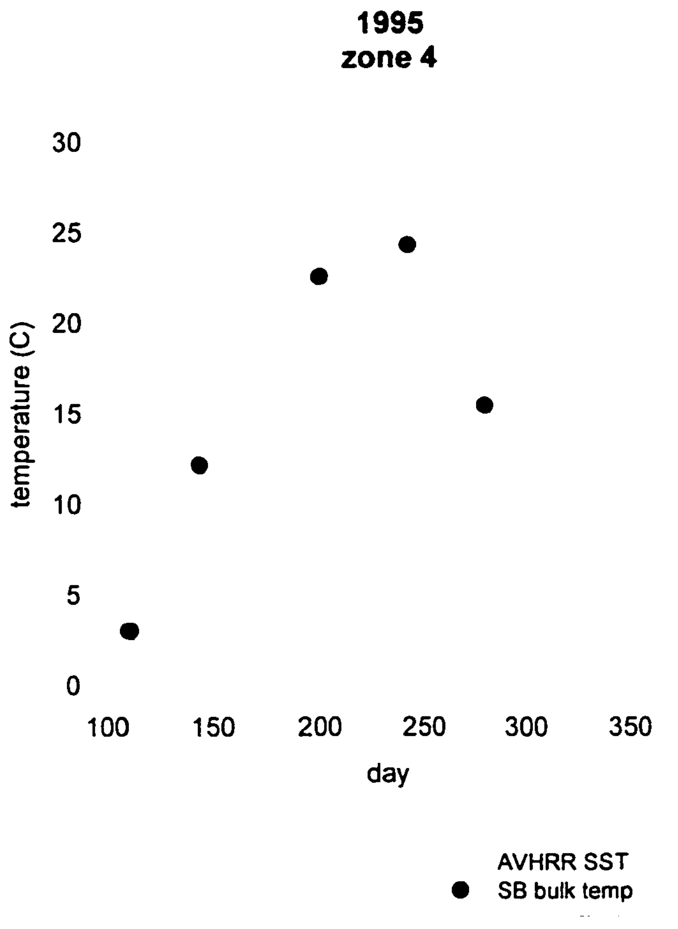

1994
temp (C)
0
5
10
15
20
25
30
50
100
150
200
250
300
350
day
zone 1
zone 7
1995
temp (C)
0
5
10
15
20
25
30
50
100
150
200
250
300
350
day

Figure 3-6. Satellite versus ground based surface water temperature. The AVHRR satellite data plotted here are averages of day and night-time surface temperatures with a temporal resolution of ~ 4 days. The ground based measurements were made on water pumped from a depth of ~ 2 meters while onboard the R/V NEESKAY during normal gas-sampling transects. The transect routes are shown in appendix 3.



1995 day	*SB bulk temp (C)*	*AVHRR surface temp (C)*
110	3.0	2.2
143	12.2	10.2
199	22.6	22.3
241	24.3	22.3
279	15.5	15.5

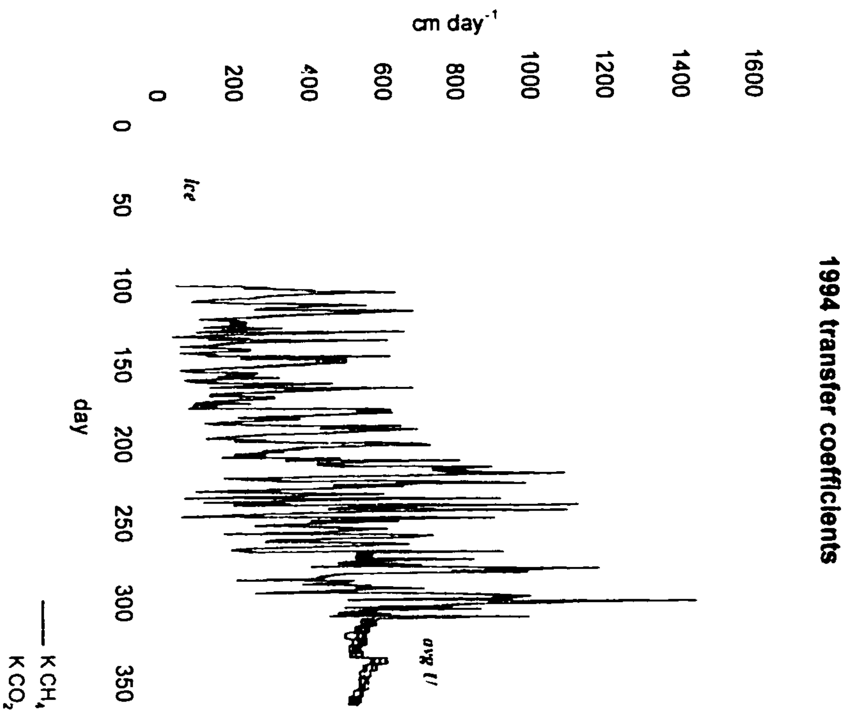
$$Sc_{CH4} = 1898.131 - 110.085\,(t) + 2.834\,(t^2) - 0.028\,(t^3) \qquad (3\text{-}8)$$

where t = the *in situ* temperature in °C. Hourly estimates of K for each gas in each of the seven zones were then summed to give daily estimates of K in each zone. The results are shown in Figure 3-7. The transfer coefficients for CH_4 and CO_2 are nearly similar due to their similar diffusion coefficients. Differences in K between zones were generally small and only became significant (~ 20%) during spring and autumn when differential heating (and cooling) occurred due to differences in water column depth. The average U labeled sections denote periods when only mean monthly wind speeds from 1989-93 were available (Figure 3-7). The zigzag pattern displayed during these periods arises due to steadily falling temperatures and a monthly jump in $\bar{U}$ (see Table 3-1). The frequencies of transfer coefficients for each month of wind data recorded during 1994 and 1995 are plotted in Figure 3-8 (transfer coefficients determined from monthly wind averages are excluded) and show good agreement with the temporal trends in average (1989-1993) temperature and wind (Table 3-1, Figure 3-4).

<u>Conclusions</u>

The calculated transfer coefficients shown in Figure 3-7 are higher than most values of K based on similar U_{50} values (see Watson et al. 1991, Barber et al. 1988, Liss 1983). This is due in part to the choice of B78's U / K relationship as well as the corrections made for the stability of the air column. The relative contribution of the stability corrections to the value of K, the effects of averaging, and equivalent estimates of K based on several other U / K relationships are presented in Figure 3-9. In zone 4 (1995),

Figure 3-7. Daily Green Bay transfer coefficients for methane and carbon dioxide based on hourly wind speeds and AVHRR derived surface temperatures. Sections labeled "avg U" denote periods when only monthly wind speed averages (from 1989-1993) were available. Both panels show all estimates of K for both CH_4 and CO_2 in all seven zones (i.e. 14 lines).


1994 transfer coefficients
cm day^{-1}
1600
1400
1200
1000
800
600
400
200
0
0
50
100
150
200
250
300
350
day
ice
avg U
K CH$_4$
K CO$_2$

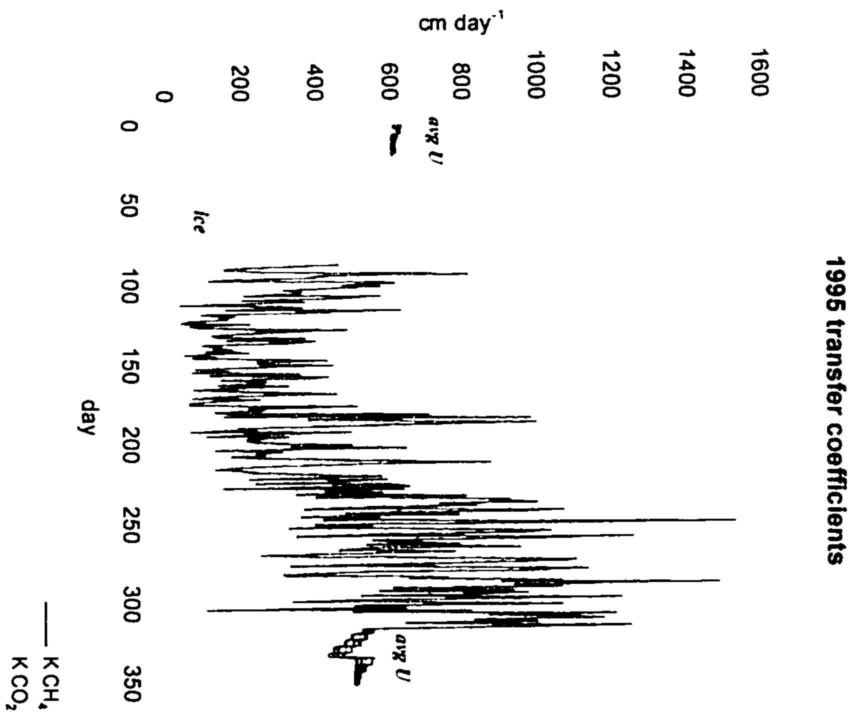

1995 transfer coefficients
cm day^{-1}
1600
1400
1200
1000
800
600
400
200
0
0
50
100
150
200
250
300
350
day
ice
avg U
K CH$_4$
K CO$_2$

Figure 3-8. Monthly frequency (%) of Green Bay transfer coefficients based on hourly wind speeds recorded at buoy #45002 during 1994 and 1995. November 1995 frequencies based on first 11 days only.

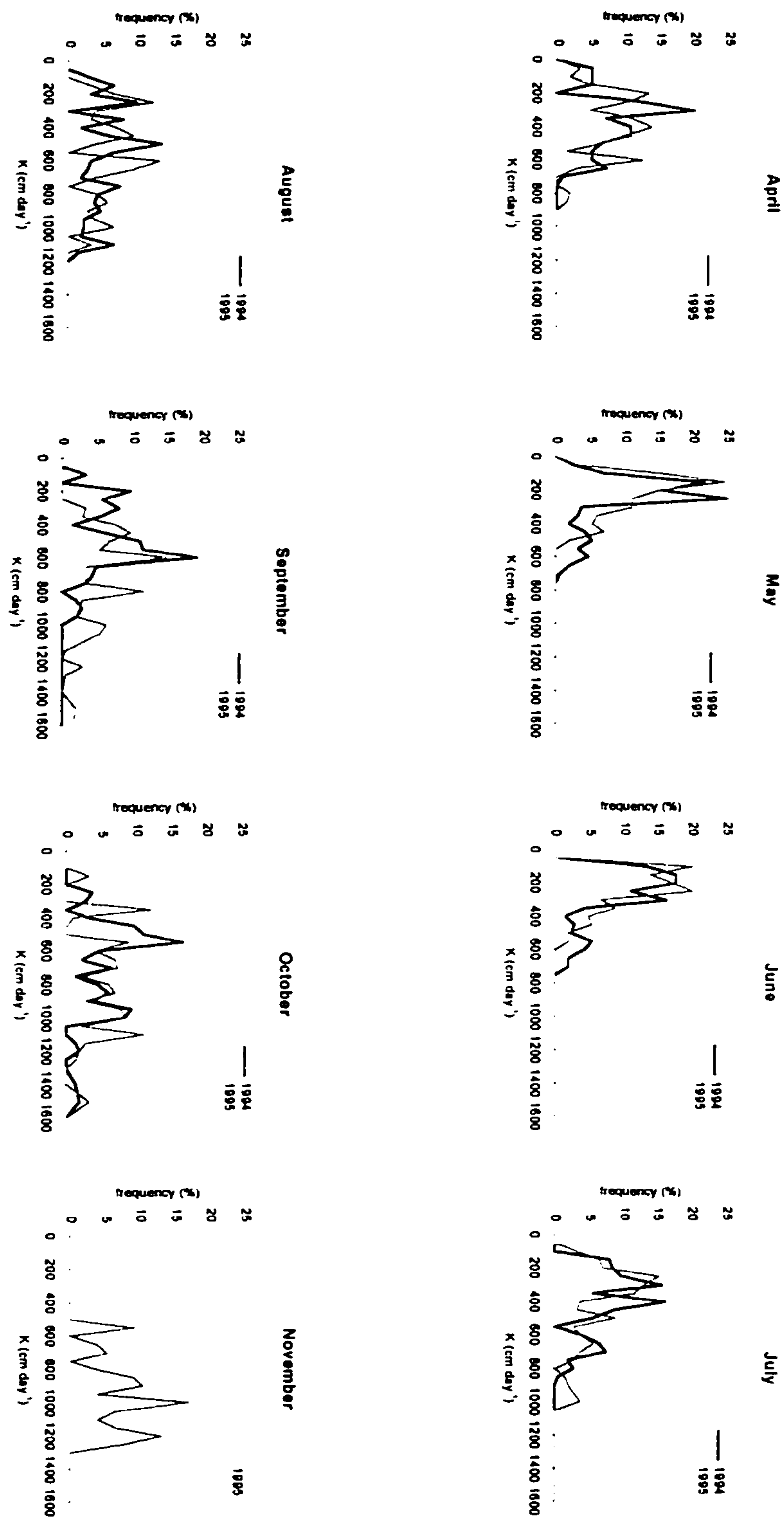
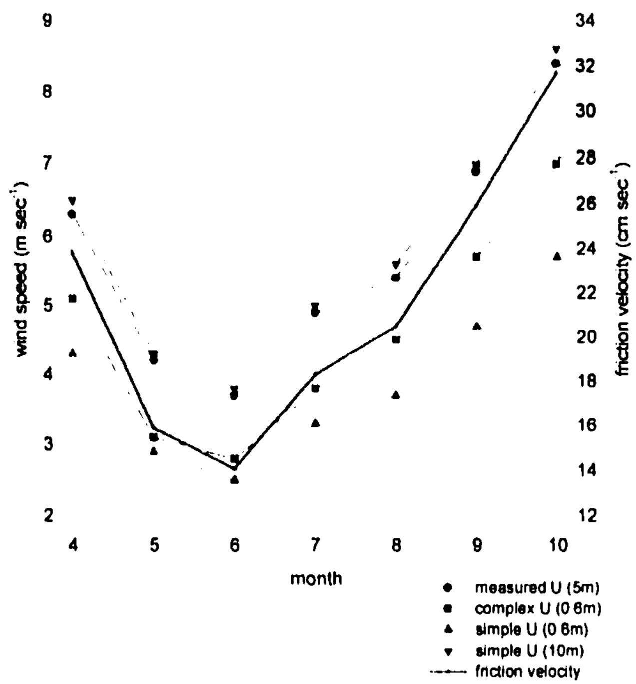
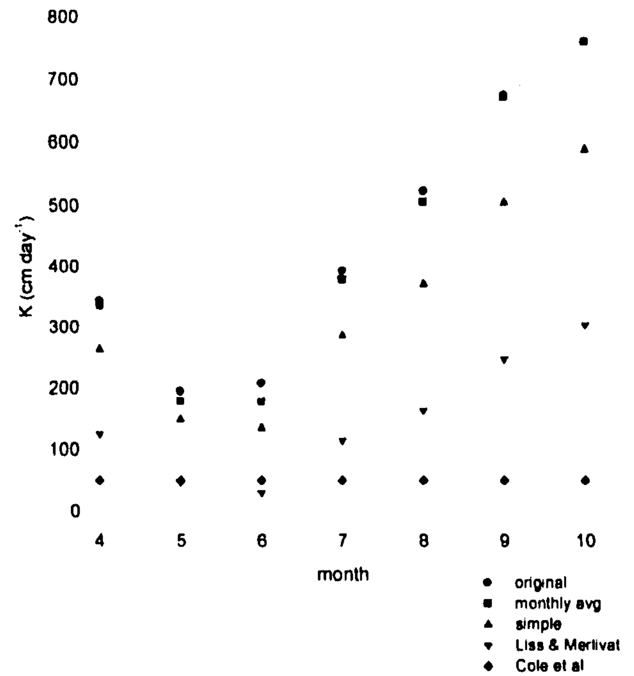

April
May
June
July
August
September
October
November
frequency (%)
K (cm day⁻¹)
1994
1995

Figure 3-9. U / K_{CH4} comparisons for zone 4 (4/1/95 - 10/31/95). The "measured U (5m)" = the averaged hourly wind speeds recorded at a height of 5 meters at buoy #45002; the "complex U (0.6m)" = U_5 x "0.6m factor" given in table 3-1; U^* = the friction velocity calculated using U_5 and equation 3-5; "simple U (0.6m, 10m)" = $U_{0.6,\,10}$ back-calculated from the friction velocity and equation 3-5; "temp" = the averaged AVHRR surface temperature. The "original" K_{CH4} = the sum of hourly K estimates divided by the number of days in each month; the "monthly avg" K_{CH4} = K estimate based on the average monthly wind speed (complex $U_{0.6}$) and temperature; the "simple" K_{CH4} = K estimate based on the friction velocity and temperature. See text for explanation and derivation of other transfer coefficients.

Green Bay 1995
average wind speeds



Green Bay 1995
CH_4 transfer coefficients



	average wind speeds						KCH4					
month	*measured U (5m)*	*complex U (0.6m)*	*U**	*simple U (0.6m)*	*simple U (10m)*	*temp*	*original*	*monthly avg*	*simple*	*Liss & Merlivat*	*Cole et al.*	*Smith et al.*
	m/s	m/s	cm/s	m/s	m/s	C	cm/day	cm/day	cm/day	cm/day	cm/day	cm/day
apr	6.3	5.1	23.8	4.3	6.5	1.7	345	337	263	125	50	4155
may	4.2	3.1	15.9	2.9	4.3	7.7	195	179	148	47	50	3031
jun	3.7	2.8	14.1	2.5	3.8	18.5	208	178	134	30	50	2749
jul	4.9	3.8	18.3	3.3	5.0	21.6	394	379	286	114	50	3341
aug	5.4	4.5	20.6	3.7	5.6	23.4	524	506	372	163	50	3646
sep	6.9	5.7	25.9	4.7	7.0	19.6	675	672	505	247	50	4449
oct	8.4	7.0	31.7	5.7	8.6	14.0	761	761	589	304	50	5317
						AVG	443	430	328	147	50	3813
						ratio	1.00	0.97	0.74	0.33	0.11	8.61

the average K_{CH4} for wind speeds recorded between April 1st and October 31st, was 443 cm day^{-1}. Estimates of K based on monthly averages of hourly wind speeds were only slightly less (~ 3%) than the monthly averages of hourly K estimates since wind speeds rarely dropped below ~ 3 m/sec (see Figure 3-1). Corrections for the stability of the air column however played a larger role. The transfer coefficients calculated using the $U_{5.0}$ / U^* relationship given in equation 3-5 were ~26 % lower. Estimates of K calculated using the Liss and Merlivat (1986) relationship as reported by Van Scoy et al. (1995) where for wind speeds greater than 3 m/sec and less than or equal to 13 m/sec:

$$K\ (\text{cm day}^{-1}) = 87.7\ [2.85U_{10} - 49.3]\ (600 / Sc)^{0.5} \times 0.274, \qquad (3\text{-}9)$$

were ~67% lower than the values calculated here. Some of the lowest transfer coefficients (20-40 cm/day) have been measured in small (presumably sheltered) lakes using isotopic tracers (e.g. ^{222}Rn and ^{3}He, Emerson 1975, Torgersen et al. 1982) Cole et al. (1994) used these values to extrapolate a constant K_{CO2} ($\cong K_{CH4}$) of 50 cm day^{-1} for all lakes (including Lake Michigan) when estimating CO_2 flux from lakes to the atmosphere. At the other end of the spectrum, small scale, short term micrometeorologic flux measurements determined using the eddy correlation technique give apparent K values that are an order of magnitude higher than the entire range of "geochemically-derived " transfer coefficients determined in either field or laboratory conditions. Smith et al. (1991) give an approximate U_{10} / K relationship of:

$$K\ (m\ sec^{-1}) = 6.5 \times 10^{-5}\ U_{10}, \qquad (3\text{-}10)$$

which translates to an average Green Bay transfer coefficient of ~ 38 meters day^{-1}. The eddy correlation technique has generated considerable debate (see Wesley 1986, Smith and Jones 1986, Broecker et al. 1986) and points out the need to resolve the dependence of K on the time scale of measurement.

The K values determined here will be used in the following chapters to estimate the net evasion (or invasion) of CO_2 and CH_4 from or to Green Bay. Constraints placed on the air-water flux estimates by previously determined components of the Green Bay carbon budget (Klump and Fitzgerald, 1998) should in turn illuminate the relationship between wind speed and the apparent kinetics of gas exchange across the air-water interface of Green Bay.

Chapter 4

The Dynamics of Surface Water Methane in Green Bay

Introduction

Biogenic methane is produced by a group of bacteria that require strict anaerobic conditions. In aquatic systems that maintain an oxygenated water column, these conditions are only found within sediments and, on a much smaller scale, the intestinal tracts of planktonic animals (Oremland 1979).

As methane diffuses away from its source it eventually crosses an oxic-anoxic interface. Where oxygen and methane coexist, a group of aerobic (methanotrophic) bacteria use methane as a carbon source for growth. The fraction of methane oxidized to that produced is typically less than one as evidenced by the fact that most of the world's surface waters are supersaturated with methane with respect to the atmosphere (Barber et al. 1988). Methane that is not oxidized eventually passes through the air-water interface to the atmosphere.

The highest rate of methane oxidation generally occurs at the oxic-anoxic interface in a narrow zone where the flux of methane and oxygen is at a maximum. Away from this zone, methane oxidation typically drops to a level below detection (Rudd and Hamilton 1978, Harrits and Hanson 1980, Kuivila et al. 1988).

A review of the literature shows that for lakes that maintain an oxygenated water column throughout the year, methanotrophic activity is limited to the sediment (Lidstrom and Somers 1984, Heyer and Babenzien 1985, Kuivila et al. 1988, Schmidt and Conrad 1993, Scranton et al. 1993, Thebrath et al. 1993). If methane is only affected by biological activity within the sediment, then the gas is essentially inert within the water column. The flux of methane across the air-water interface must therefore equal the flux of methane across the sediment-water interface over a sufficiently long time scale.

In Green Bay, the water column is oxygenated throughout the year and the oxic-anoxic interface is generally found at a depth of ~ 5 mm into the sediment (Buchholz et al. 1995; Klump et al. 1997; Val Klump, personal communication). There have been reports of anoxic "blobs" of water in the southern bay (John Kennedy, personal communication) but none were observed during this study. It was assumed, therefore, that methane oxidation within the water column of southern Green Bay is negligible relative to other source and sink terms.

If methane oxidation in the water column is negligible, then:

$$J_{aw} = J_{sw} + I - E \qquad (4\text{-}1)$$

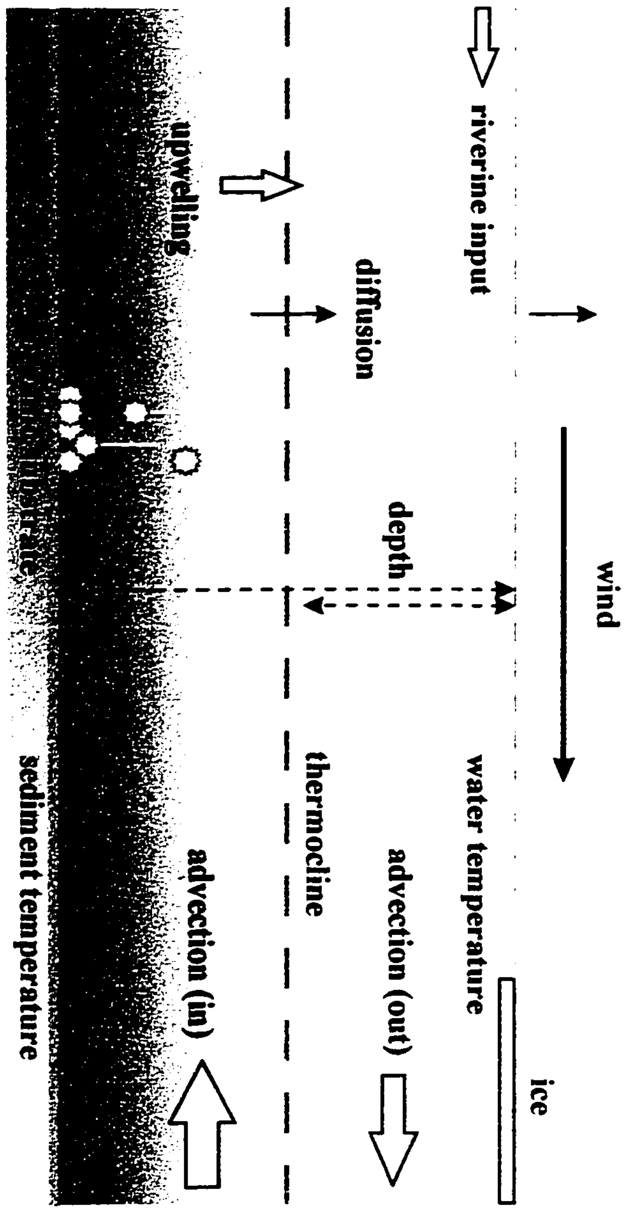
where J_{aw} = the flux of methane across the air-water interface, J_{sw} = the flux of methane across the sediment-water interface, I = riverine inputs of methane and E = methane export to northern Green Bay and Lake Michigan. The flux of methane across the sediment-water interface of southern Green Bay has been estimated at 14×10^7 moles year^{-1} by Klump and Fitzgerald (1998) and reasonable estimates of I and E can be made with a knowledge of river and water column methane concentrations, river water discharge and bay-lake exchange rates. The result (J_{aw}) is an independent estimate of the mean flux of methane across the air-water interface at steady state (equation 4-1). Hence it should be possible to calculate a mean transfer coefficient (K) which supports this flux based upon the observed air-water methane concentration difference (ΔC) (equation 3-1).

The mean value of K does not rely on measurements of its dependence on wind speed. temperature and boundary layer physics since it derives from mass balance principles. To a first approximation then. calculation of the mean transfer coefficient can serve as a "cross check" on the values of K derived in Chapter 3.

In addition to providing a constraint on the kinetics of air-water gas transfer. methane is of considerable interest in its own right. Though the atmospheric concentration of methane is relatively low (~ 1.9 ppm), methane's potential for trapping infrared radiation is approximately 25 times greater than that of carbon dioxide (Lashof and Ahuja 1990). When it was discovered in the late 1970s that current tropospheric concentrations of the gas are rising at approximately 1% per year (Blake and Rowland 1988), a concomitant search began for its source. A recently published mass balance (Schlesinger 1997) suggests that freshwater lakes and rivers contribute only ~ 0.9 % (or 5×10^{12}g CH_4/yr) of the total efflux of methane to the atmosphere. but the origin of this estimate traces back to Ehhalt (1974). Ehhalt based his estimate on two studies of summertime methane ebullition from Great Fresh Creek (Conger 1943) and Lake Erie (Howard et al. 1971), and a study of methane oxidation in Lake Beloye (Russia) by Rossolimo (1935). Results presented in this study would significantly add to the data set of methane flux measurements from lakes and help to generate a more accurate estimate of the global contribution of methane from freshwater systems.

An accurate estimate of the current flux of methane to the atmosphere, however, can in no way predict the response of methanogens to a changing environment. A variety of physical and biological factors affect the concentration of surface water methane (Figure 4-1). Though many of the factors are interdependent, some have direct bearing on

Figure 4-1. The forces influencing surface water methane in Green Bay.


riverine input
wind
diffusion
upwelling
depth
water temperature
advection (out)
thermocline
advection (in)
sediment temperature
ice

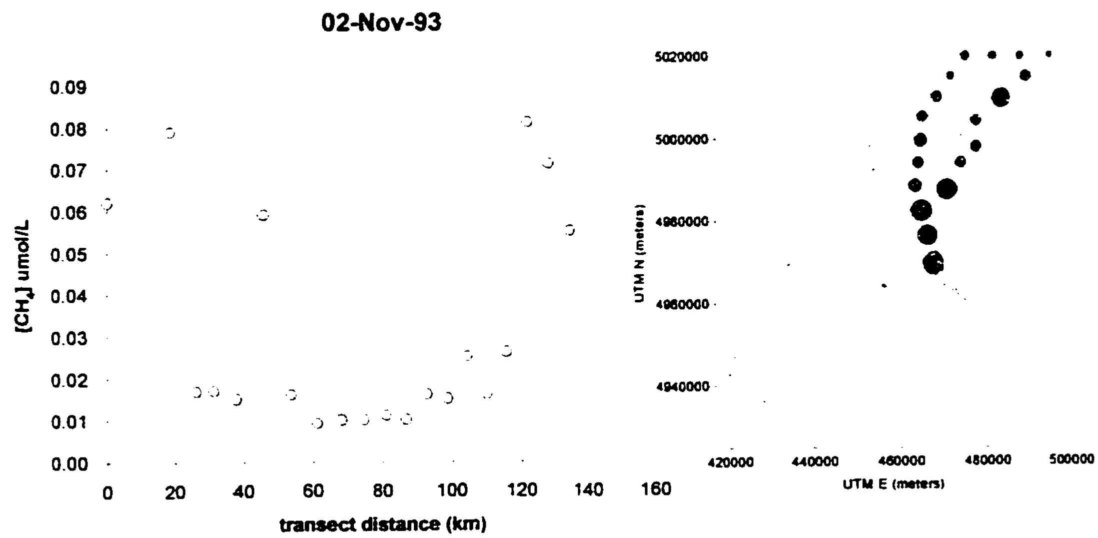
the rate of methane production while others do not. Examples of the former subset include the quantity and quality of organic substrate from which methanogens grow, the population of methanogenic bacteria (not shown) and the effect of sediment temperature on bacterial metabolism. While fluctuations in methane flux due to changes in bacterial population and/or nutrient limitation would be difficult to prove at a single study site, fluctuations in methane flux due to changes in sediment temperature would be expected. Incubation experiments in the laboratory have shown that the rate of methane production is highly dependent on temperature (Koyama 1963). In Green Bay, sediment temperatures fluctuate up to 20 °C over an annual cycle. As the sediments warm during summer months, increases in methane production should translate to higher fluxes of methane to the water column and atmosphere. Establishing a correlation between sediment temperature and methane flux to the atmosphere would improve our ability to model the effects of global warming.

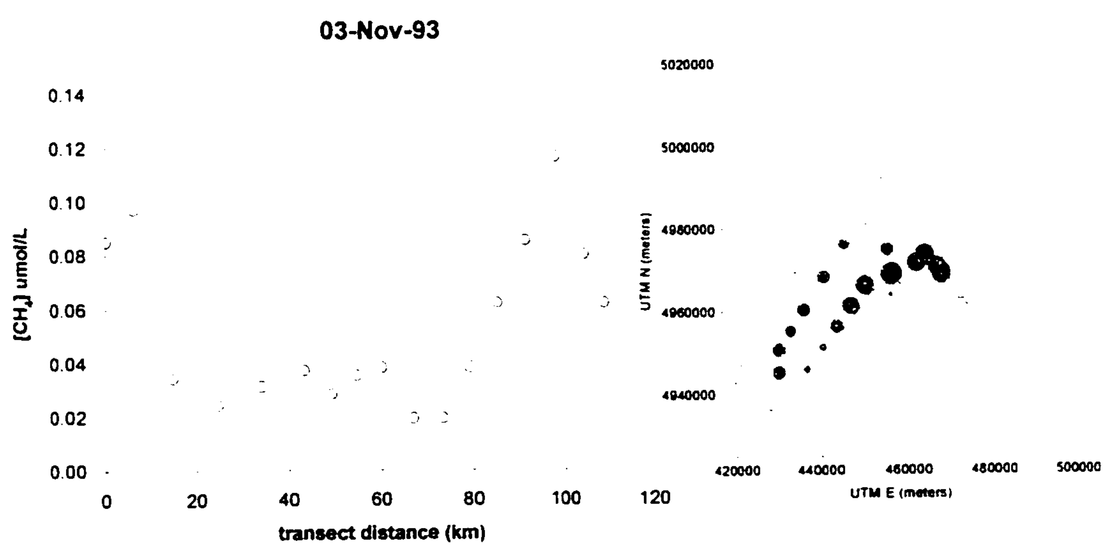
Surface water methane

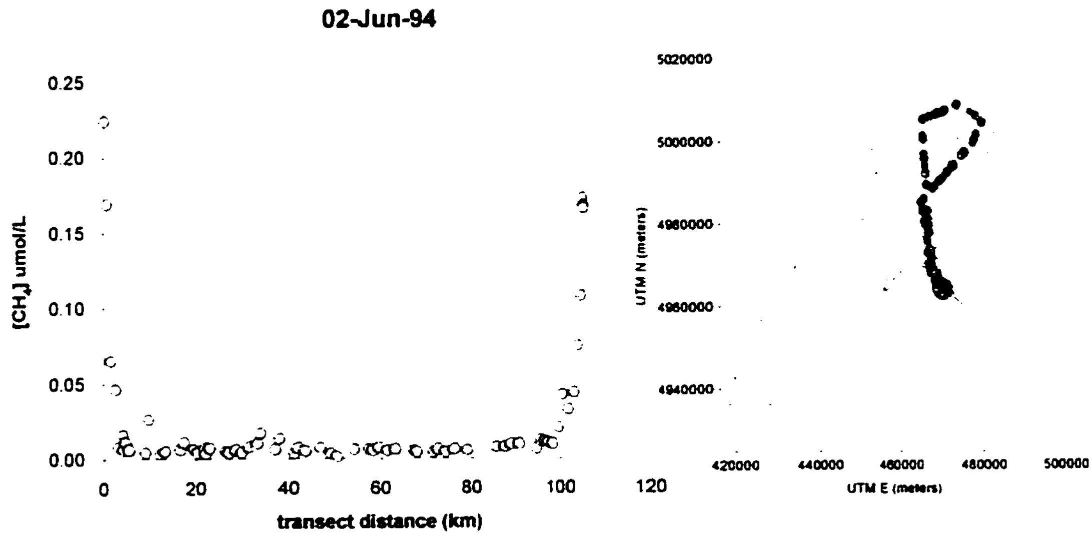
Nearly 1700 surface water samples were measured for methane during the open water transects of 1993, 1994 and 1995. Surface water methane concentrations and sampling sites are shown in Figure 4-2. Each of the measurements, their coordinates, and the physical parameters relevant to calculating each concentration are also given in Appendix 3.

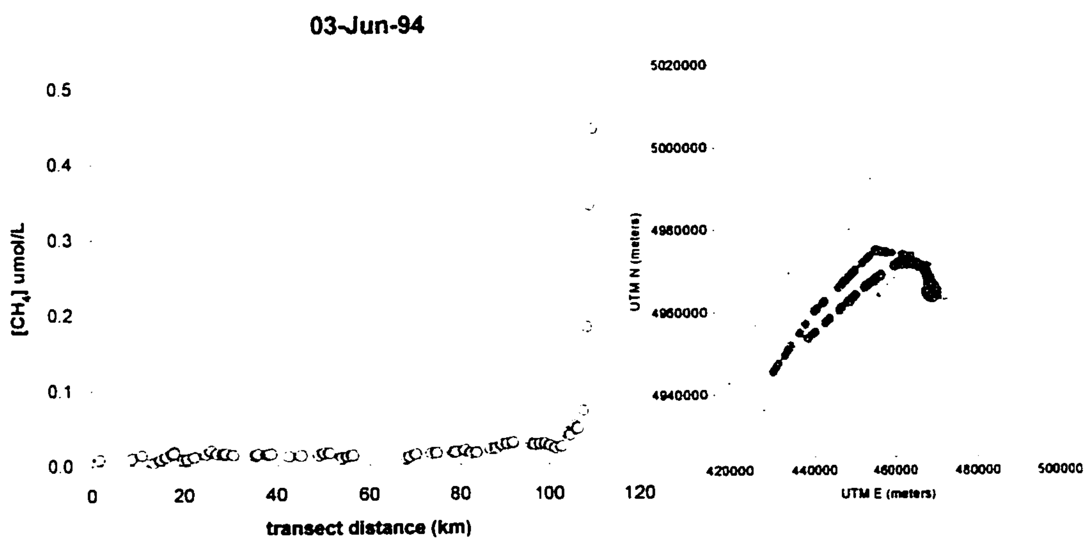
Surface water methane concentrations ranged from 0.003 μM (~ atmospheric equilibrium) to greater than 4.8 μM and averaged ~ 0.06 μM over southern Green Bay. The mean surface water methane concentration in each of the seven zones of the study site

Figure 4-2. Green Bay surface water methane concentrations measured during transect cruises of 1993, 1994 and 1995. The axis range is adjusted to the highest observed concentration for each day's cruise. The transect distance represents the cumulative distance traveled in kilometers. The location of each sample point is plotted with a circle. The area of each circle is proportional to the concentration of methane.

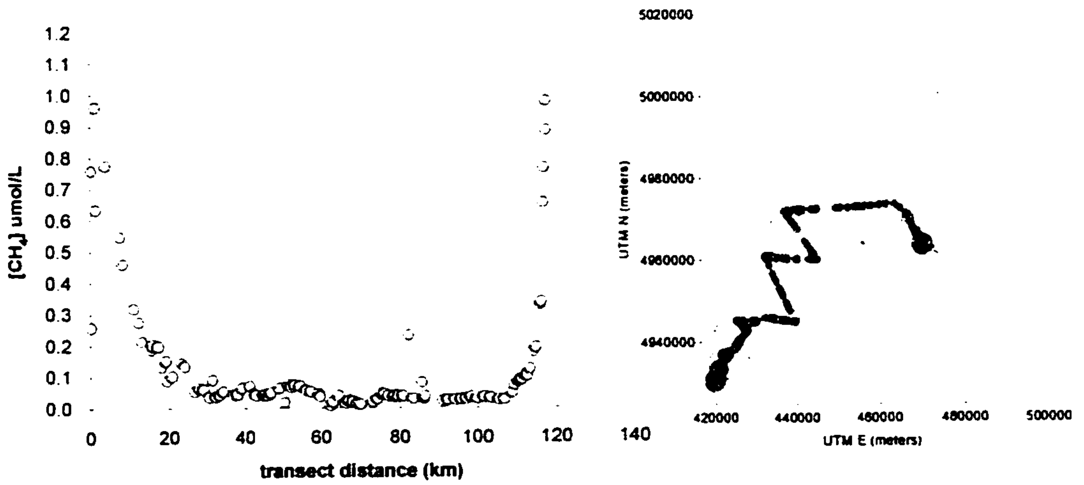

02-Nov-93
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
[CH$_4$] umol/L
0
20
40
60
80
100
120
140
160
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


03-Nov-93
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
[CH$_4$] umol/L
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)

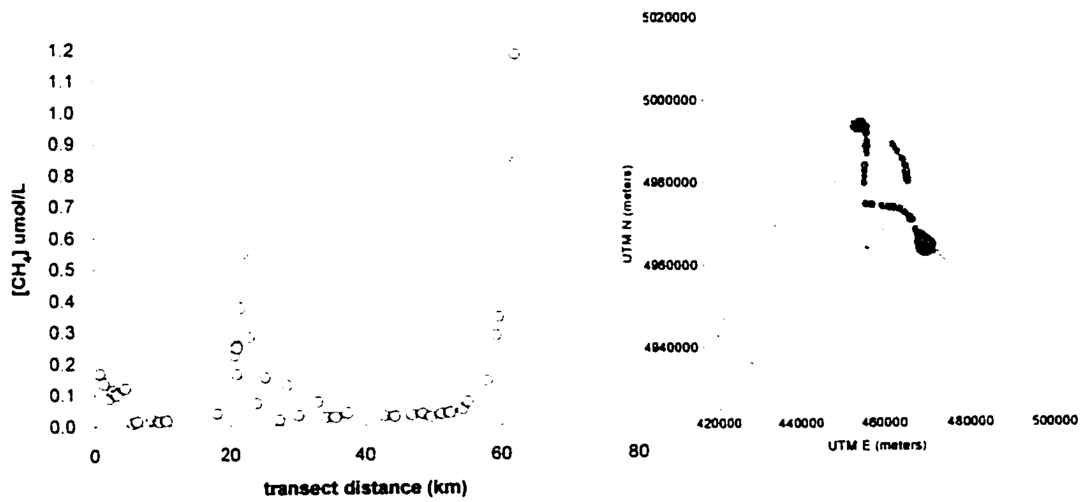

02-Jun-94
0.25
0.20
0.15
0.10
0.05
0.00
[CH4] umol/L
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


03-Jun-94
0.5
0.4
0.3
0.2
0.1
0.0
[CH4] umol/L
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)

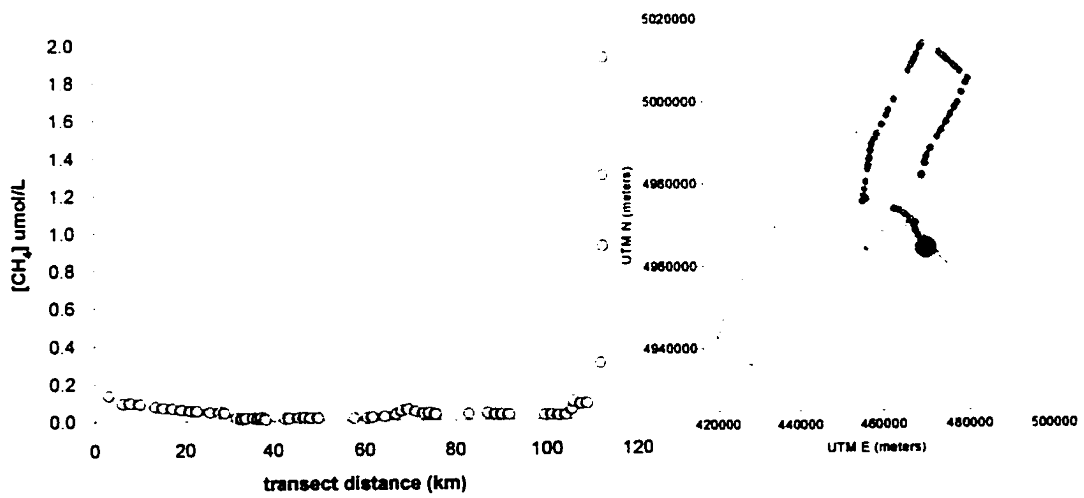
13-Jul-94



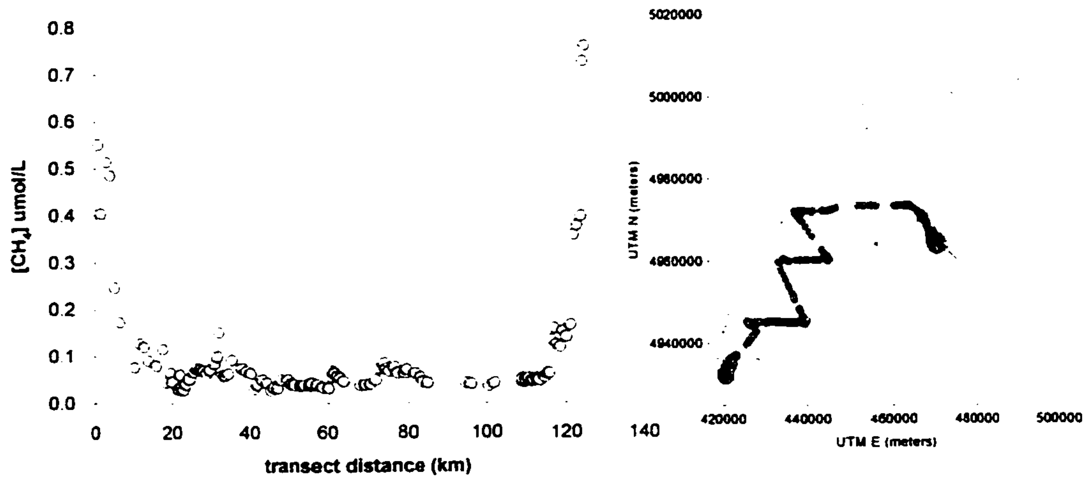
14-Jul-94



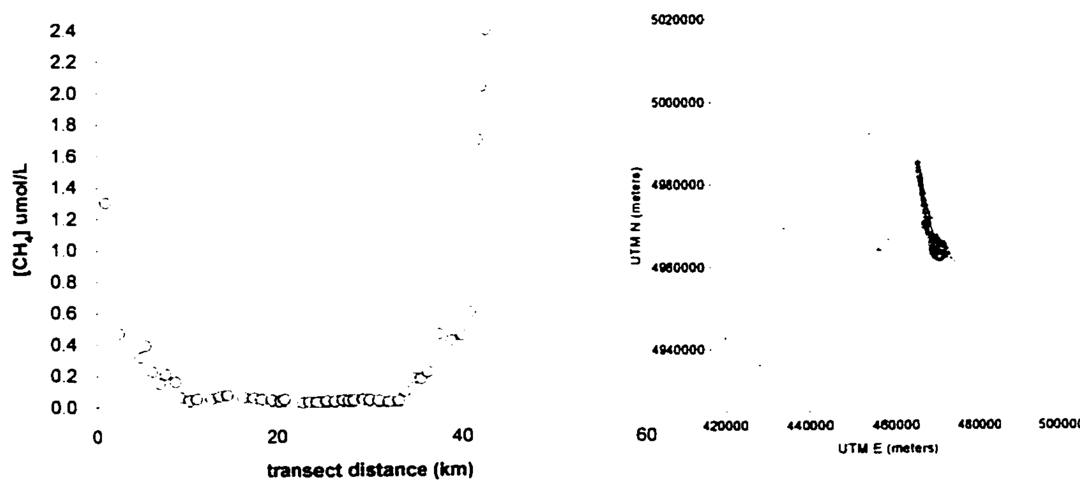
15-Jul-94

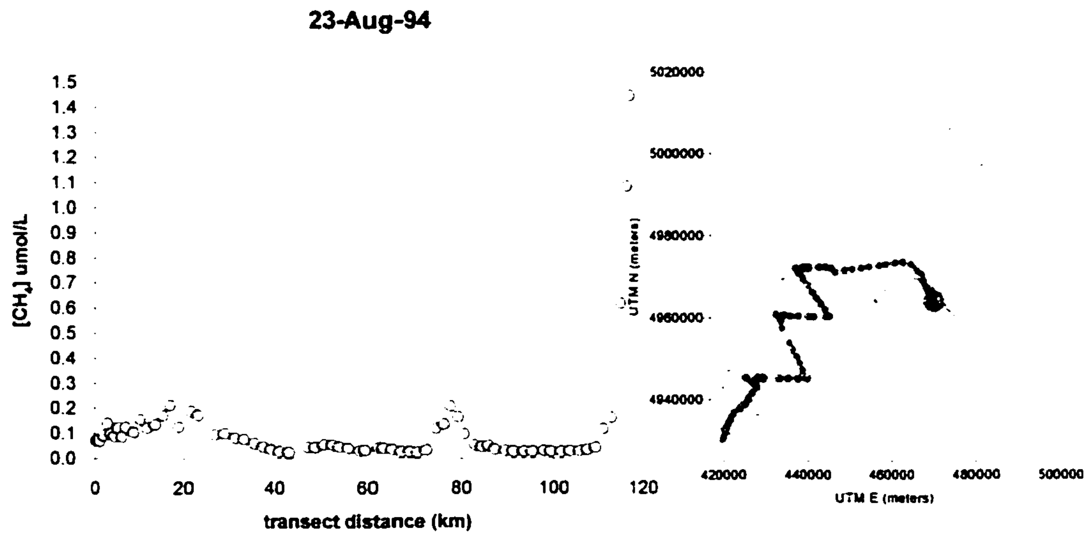


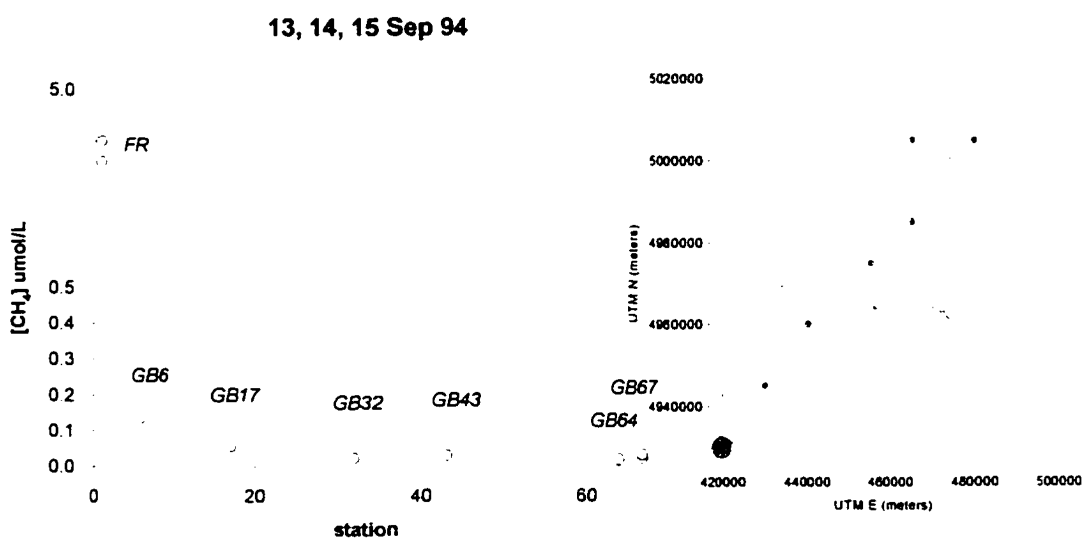
02-Aug-94



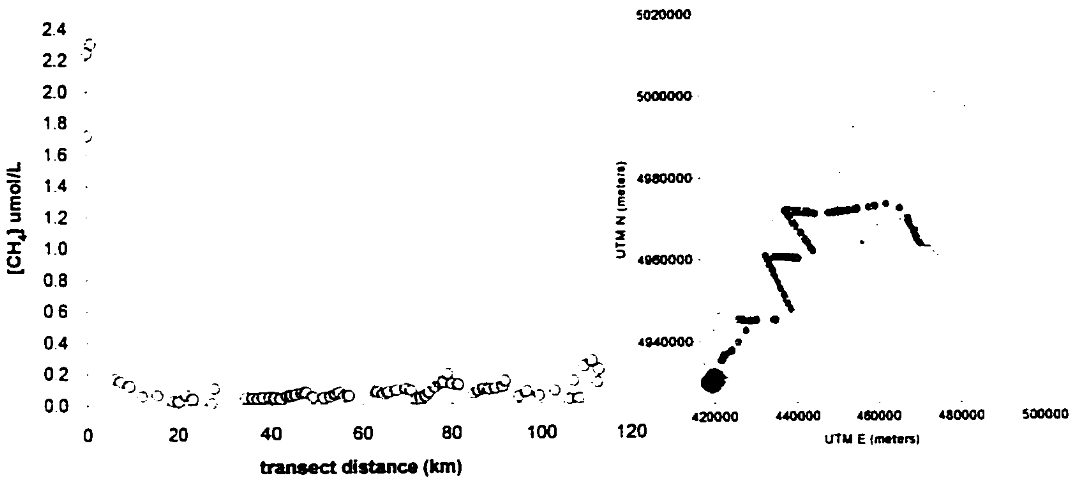
03-Aug-94



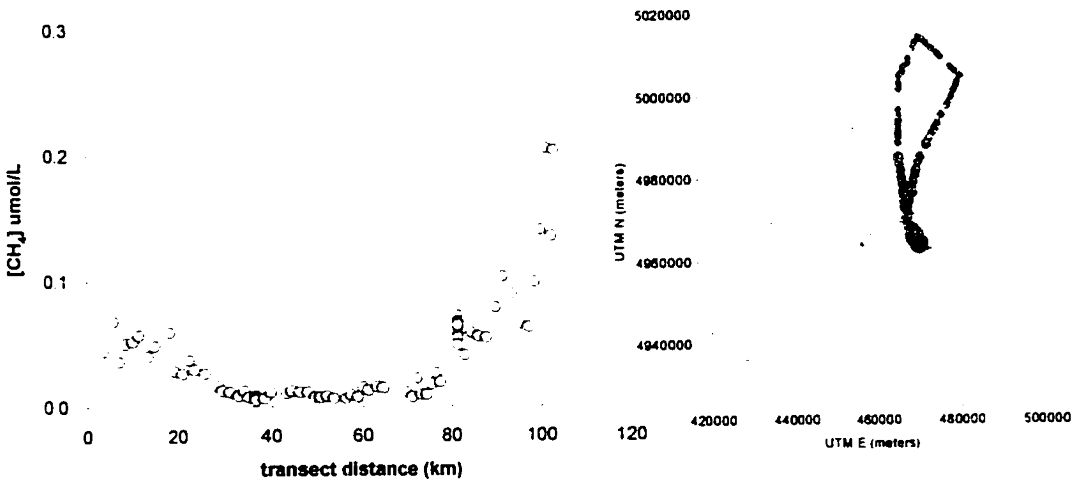

23-Aug-94
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
[CH4] umol/L
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


13, 14, 15 Sep 94
5.0
FR
0.5
0.4
0.3
0.2
0.1
0.0
[CH4] umol/L
GB6
GB17
GB32
GB43
GB67
GB64
0
20
40
60
station
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)

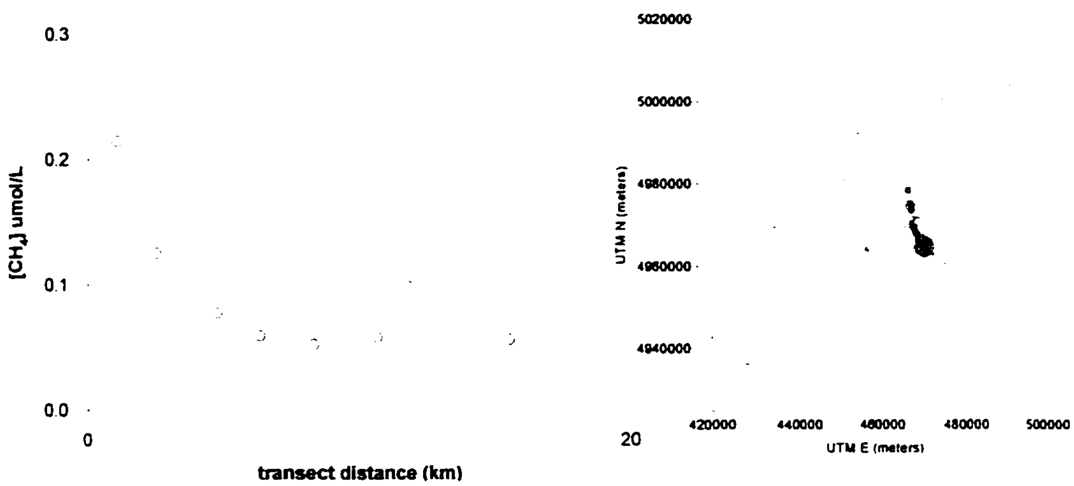
25-Oct-94



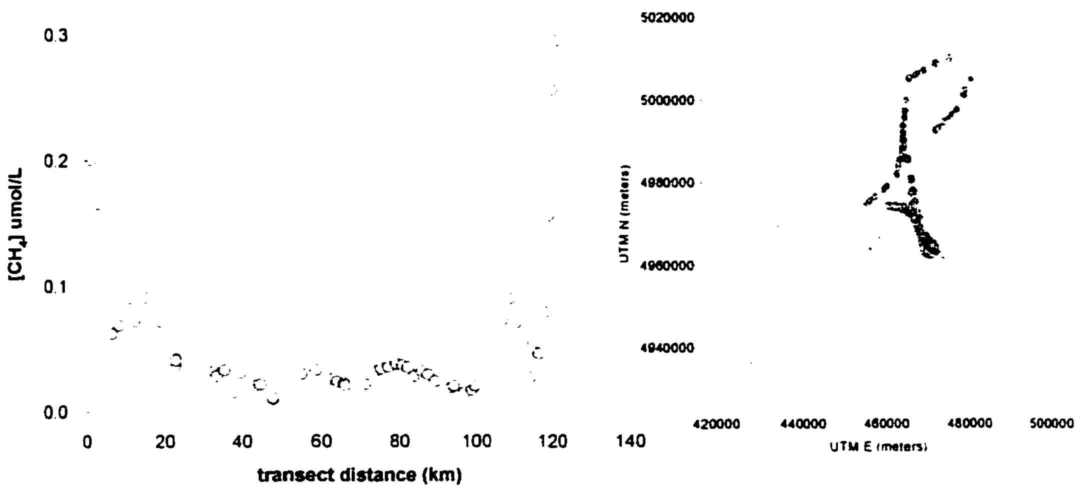
26-Oct-94



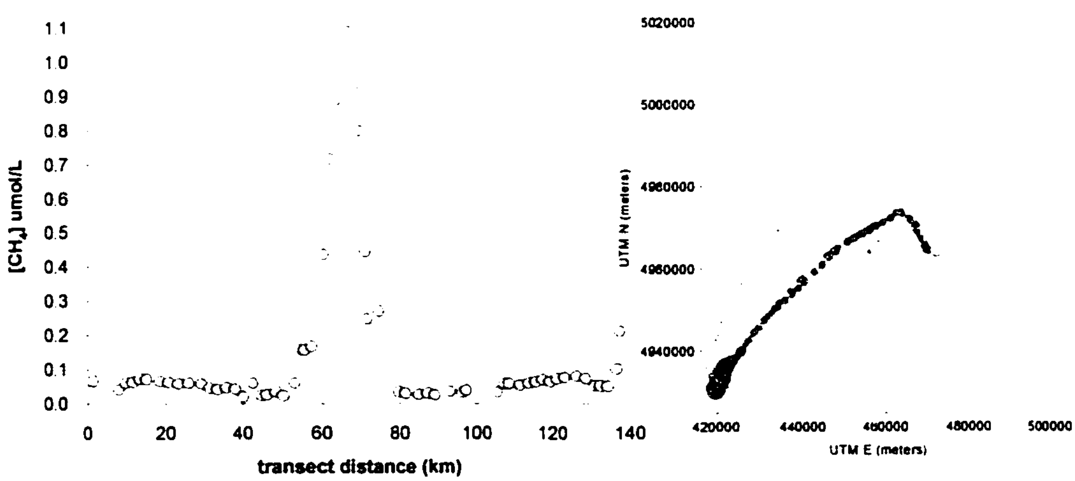
18-Apr-95



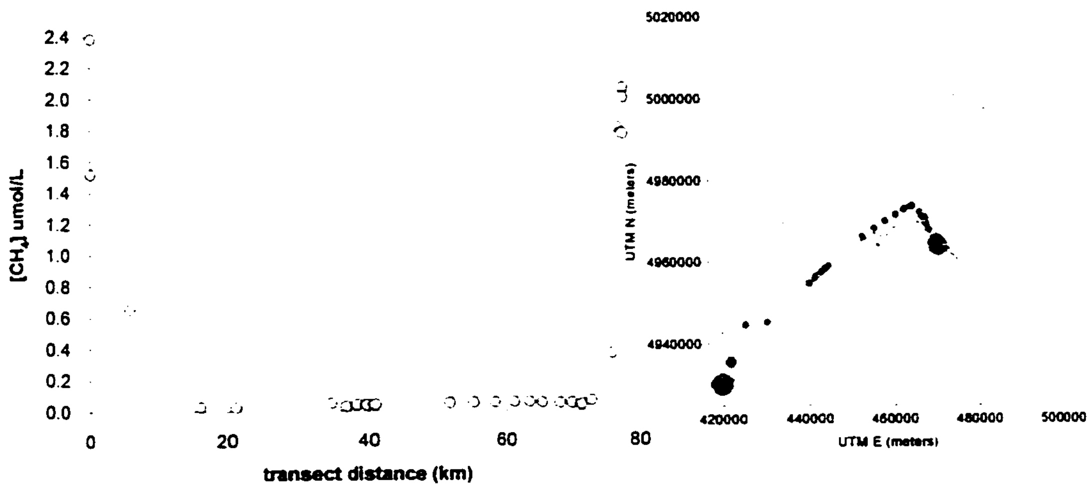
19-Apr-95



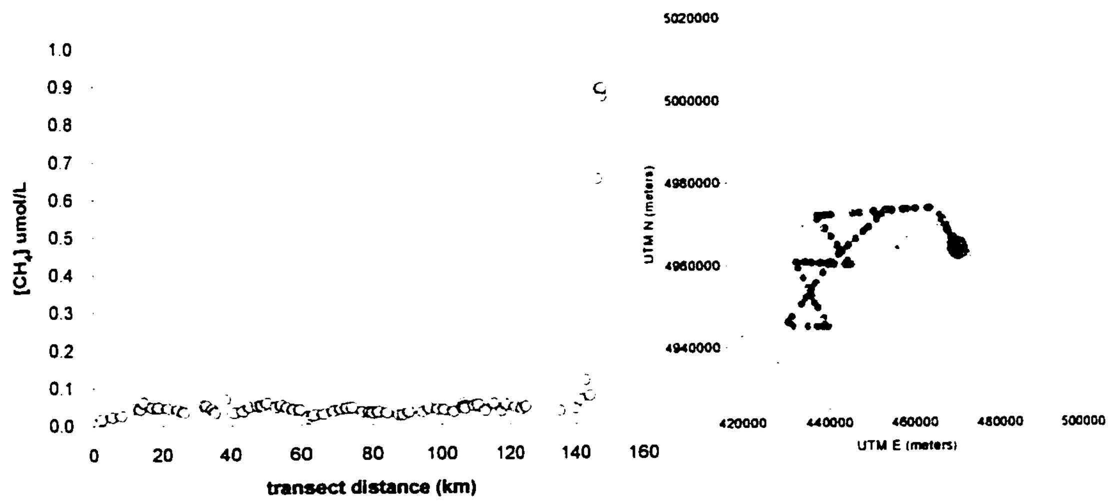
20-Apr-95



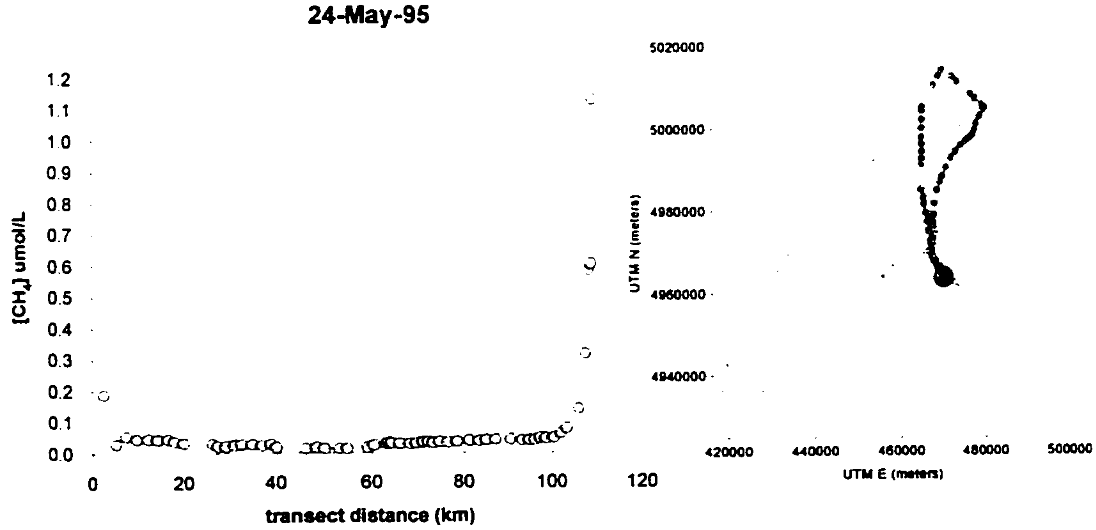
22-May-95



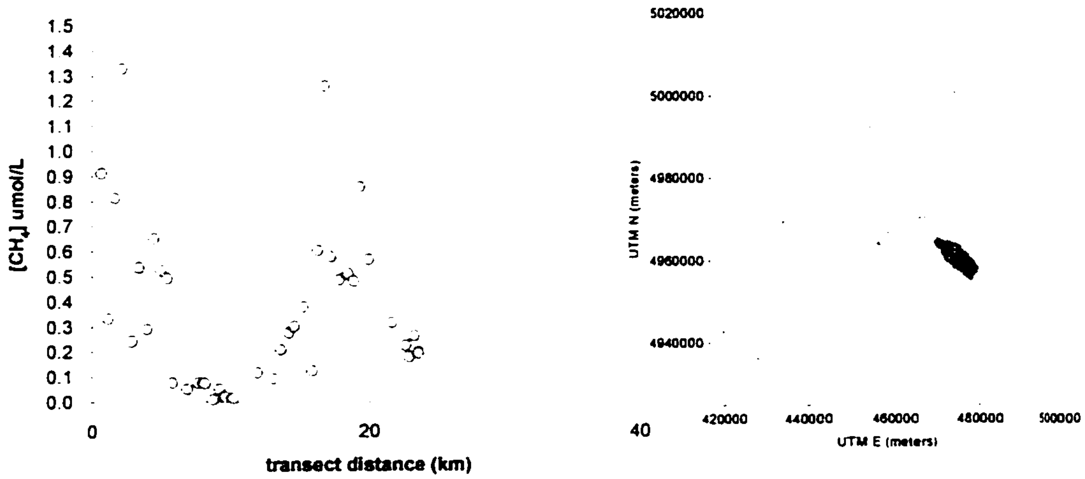
23-May-95



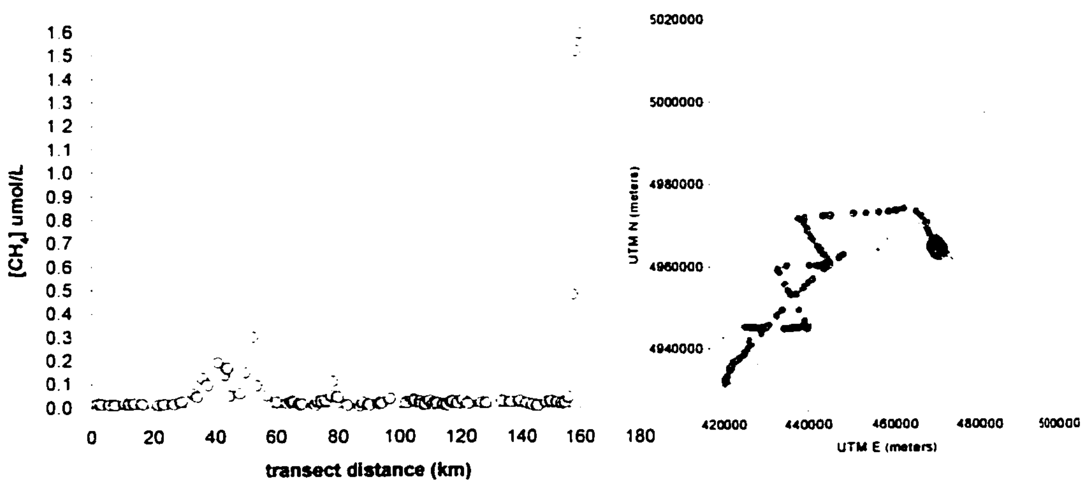
24-May-95



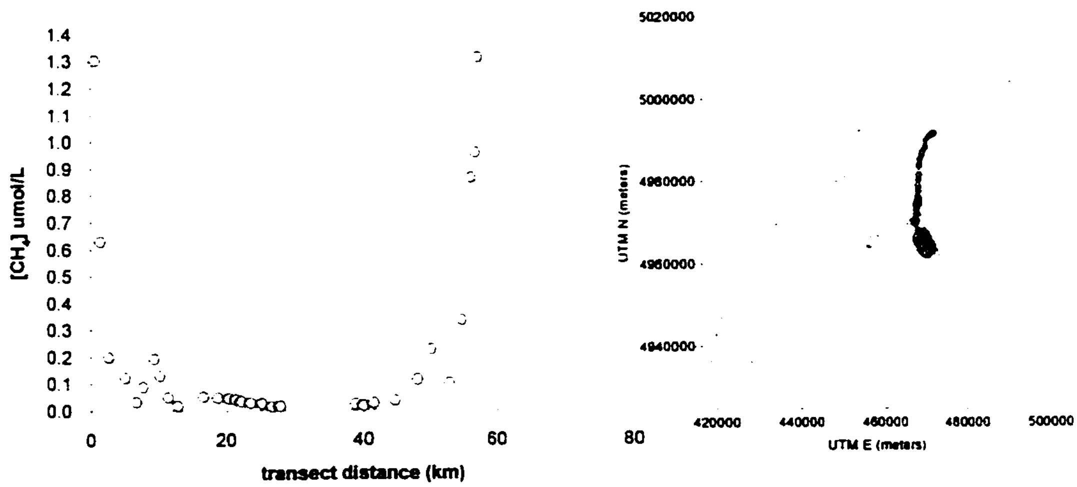
18-Jul-95



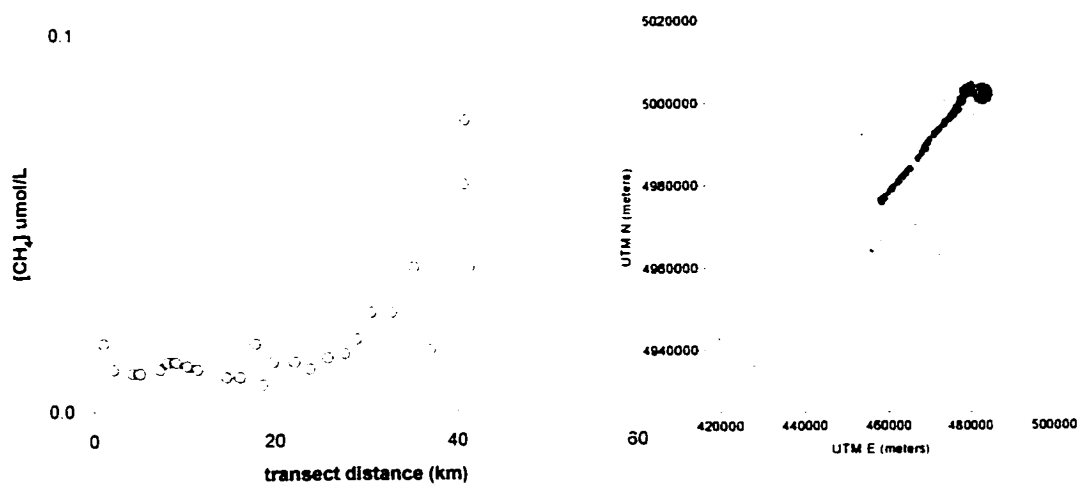
19-Jul-95



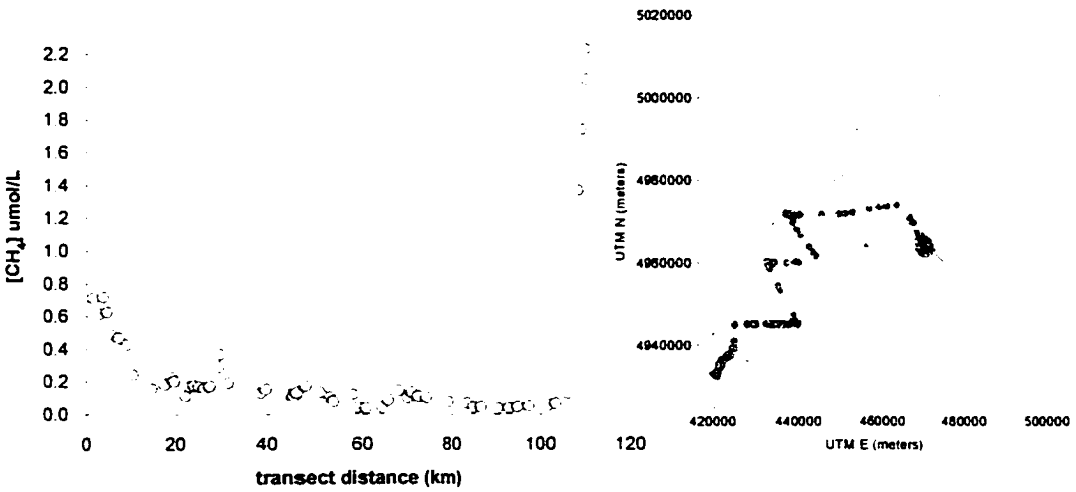
25-Jul-95

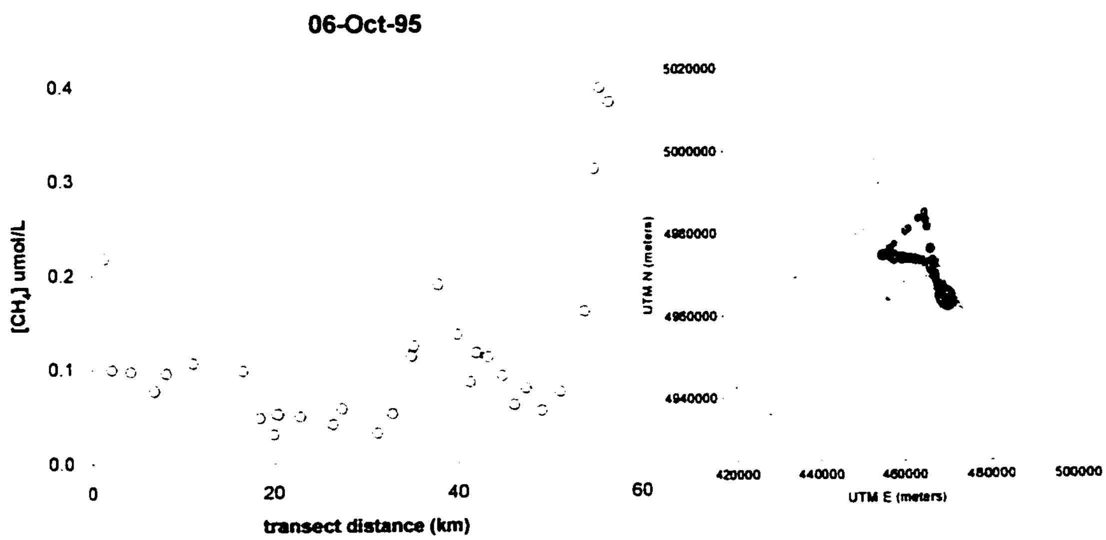


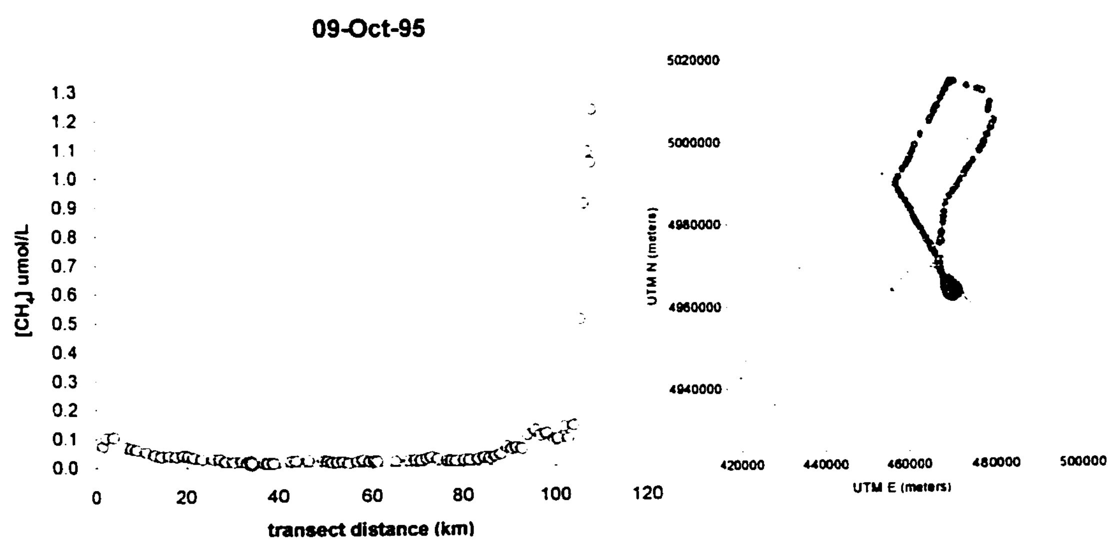
28-Jul-95

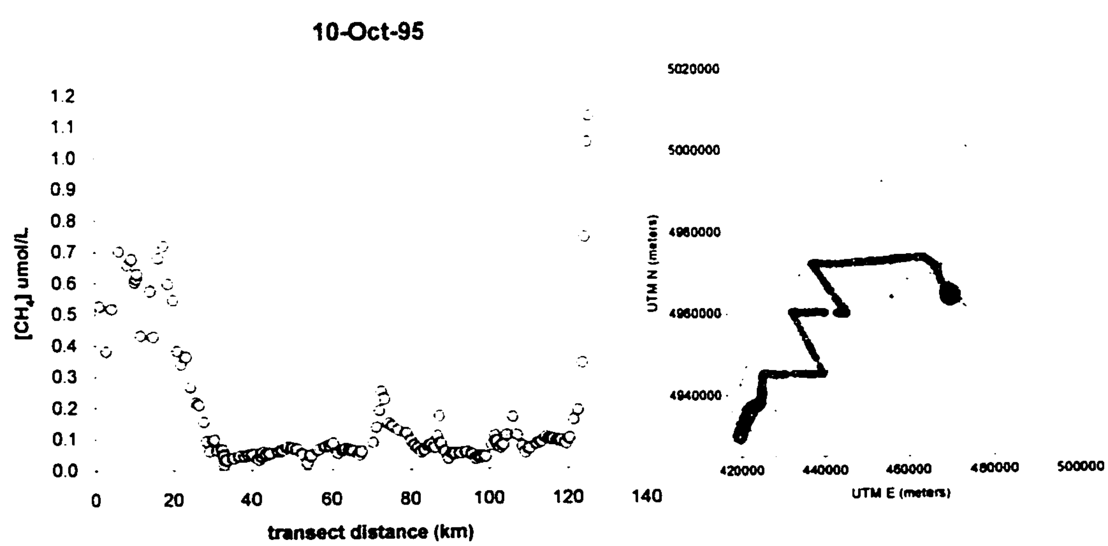


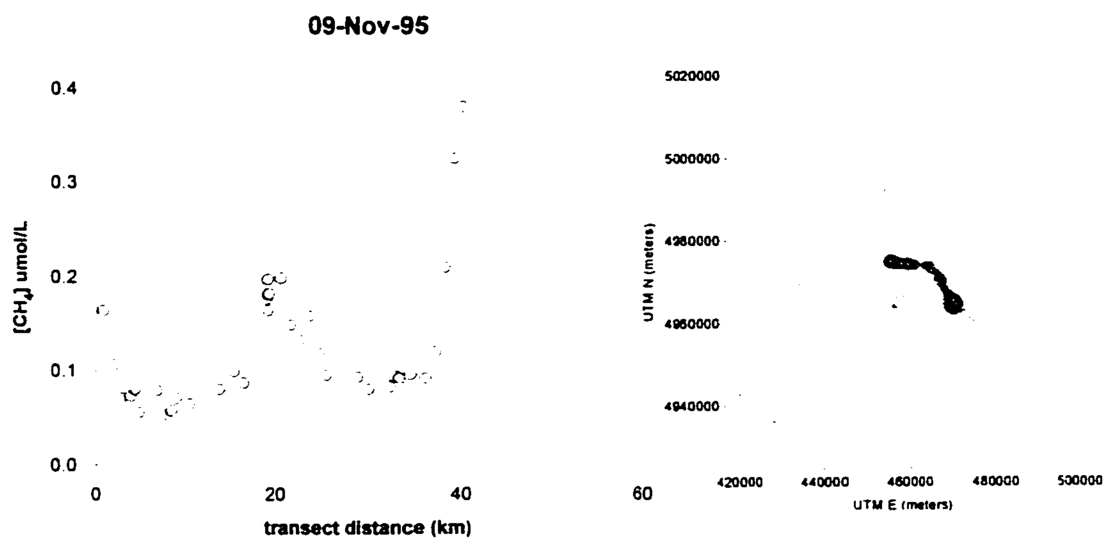
29-Aug-95


2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
[CH4] umol/L
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


06-Oct-95
[CH4] umol/L
0.4
0.3
0.2
0.1
0.0
0
20
40
60
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


09-Oct-95
[CH4] umol/L
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


10-Oct-95
[CH4] umol/L
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
20
40
60
80
100
120
140
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


09-Nov-95
[CH4] umol/L
0.4
0.3
0.2
0.1
0.0
0
20
40
60
transect distance (km)
UTM N (meters)
5020000
5000000
4980000
4960000
4940000
420000
440000
460000
480000
500000
UTM E (meters)

tended to decrease as the average water column depth of each zone increased (Figure 4-3). The reason for this ultimately relates to temperature and is discussed at length below.

The highest concentrations of methane were always found in Sturgeon Bay and the Fox River. At the beginning of this study, I assumed that methane originated in the sediment from biological sources (planktonic sources were assumed negligible (Schmidt and Conrad 1993)). When it was discovered that submerged natural gas pipelines ran under both areas, the possibility existed that a natural gas leak could account for the high concentrations of methane. To test this theory, surface water radon and methane were measured along a transect across Green Bay and into Sturgeon Bay, terminating over the pipeline (Figure 4-4). Since natural gas should not contain radon, an increase in only methane would have suggested that the pipeline might be leaking. Clearly, this was not observed. The concentration of both gases rose in tandem as the water column depth decreased in Sturgeon Bay. This strongly suggested that the methane originated from the sediment and that the high concentrations of methane were a result of relatively warm sediment temperatures and turbulent mixing in a shallow unstratified water column.

To simplify flux calculations and interpretations of large scale changes over space and time, methane concentrations measured over an entire cruise (~ 3 days) were spatially weight averaged in each of the seven zones of the study site. This was accomplished by interpolating the data over a grid of each zone using an exact inverse distance method (equation 2-19). Each grid was then integrated and divided by its base area. Grid nodes were spaced at 100 meter intervals in zone 5, 250 meter intervals in zone 1, and 500 meter intervals in zones 2, 3, 4, 6, and 7. The data set for each particular zone only included measurements from within the zone; measurements made outside of the zone were

Figure 4-3. The mean concentration of methane (± 1 S. D.) for all cruises in zones 1-7 versus water column depth.

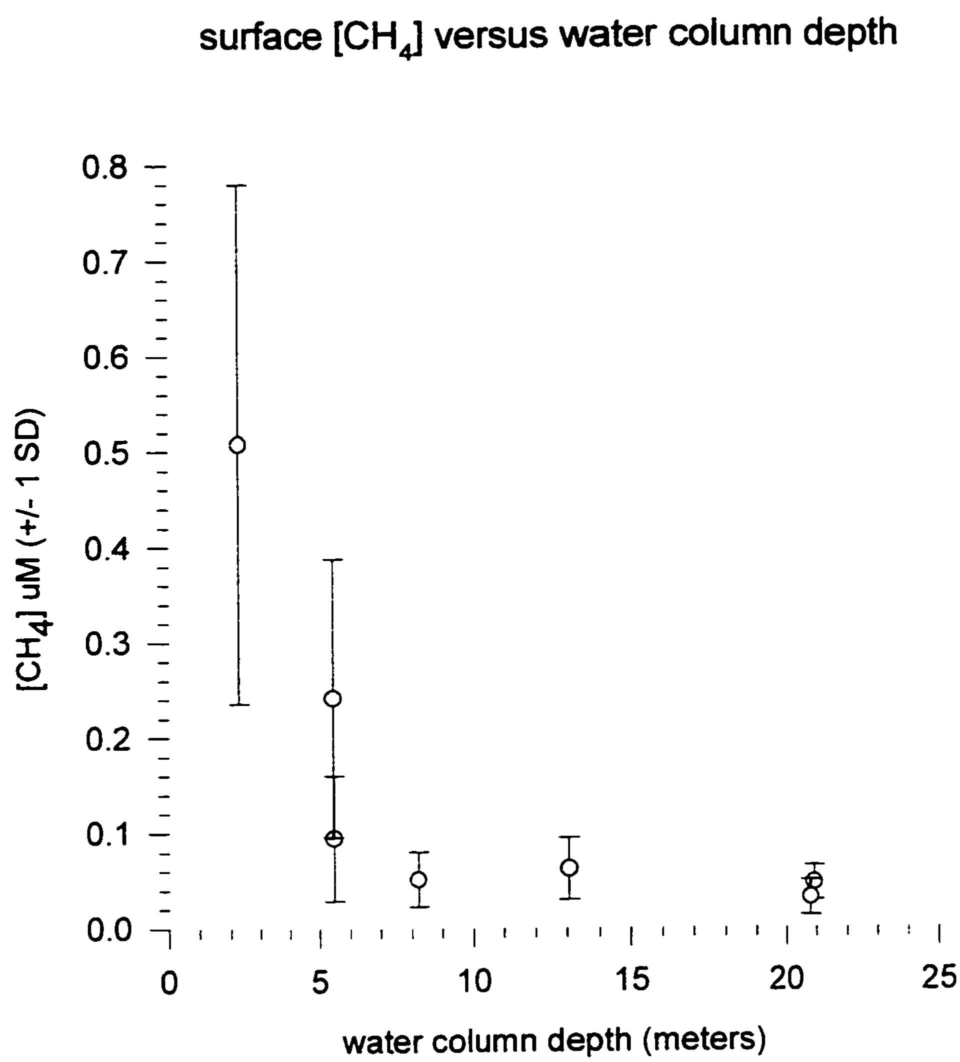
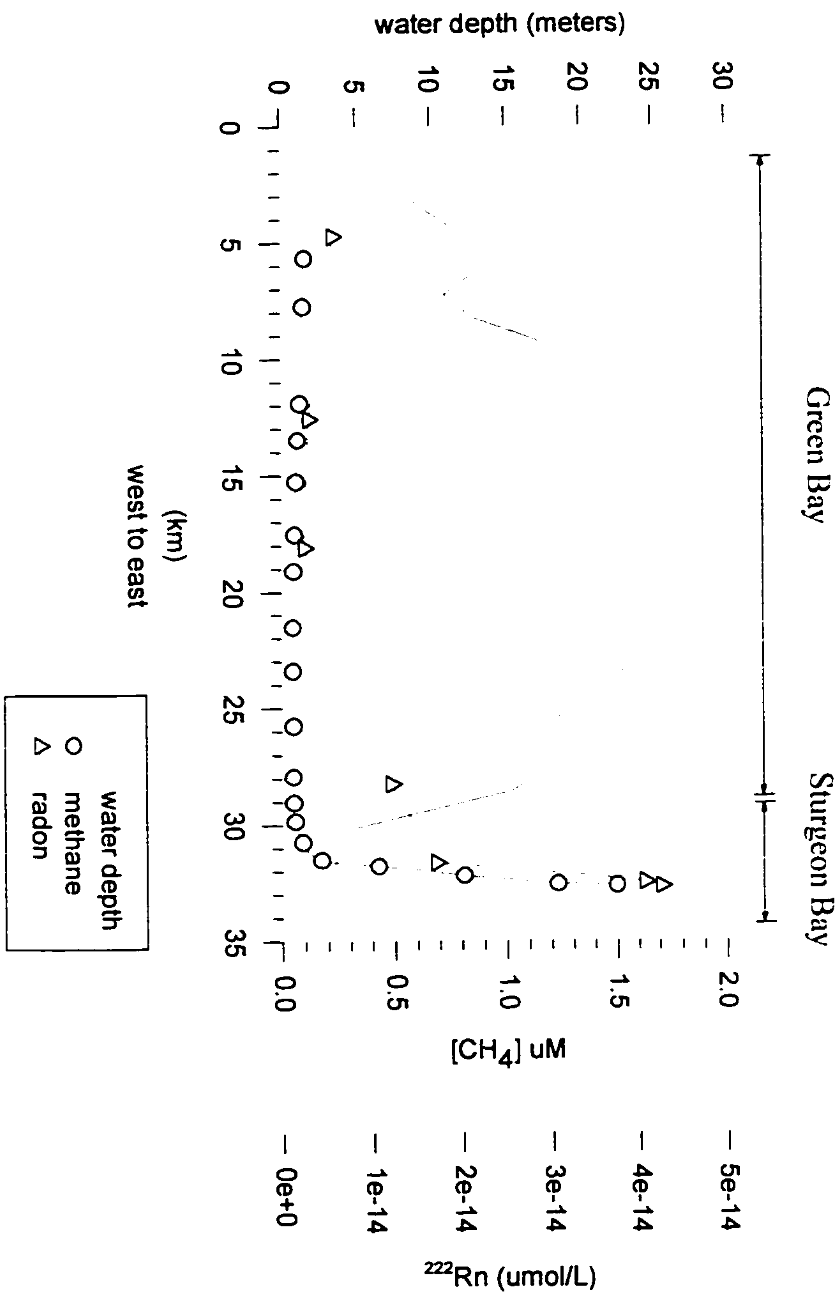

surface [CH4] versus water column depth
[CH4] uM (+/- 1 SD)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
water column depth (meters)

Figure 4-4. Surface water methane and radon measured along a transect across Green Bay and into Sturgeon Bay. High concentrations of methane occurred over a submerged natural gas pipeline running across Sturgeon Bay. The increase in both radon and methane in Sturgeon Bay suggests that the methane originated from the sediments. The values reported here are raw. Neither methane nor radon concentrations were corrected for a lag in response to equilibration. Quenching effects on the radon activity caused by gases other than helium in the counting cell were ignored.



water depth (meters)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
(km)
west to east
Green Bay
Sturgeon Bay
0.0
0.5
1.0
1.5
2.0
[CH4] uM
0e+0
1e-14
2e-14
3e-14
4e-14
5e-14
222Rn (umol/L)
water depth
methane
radon

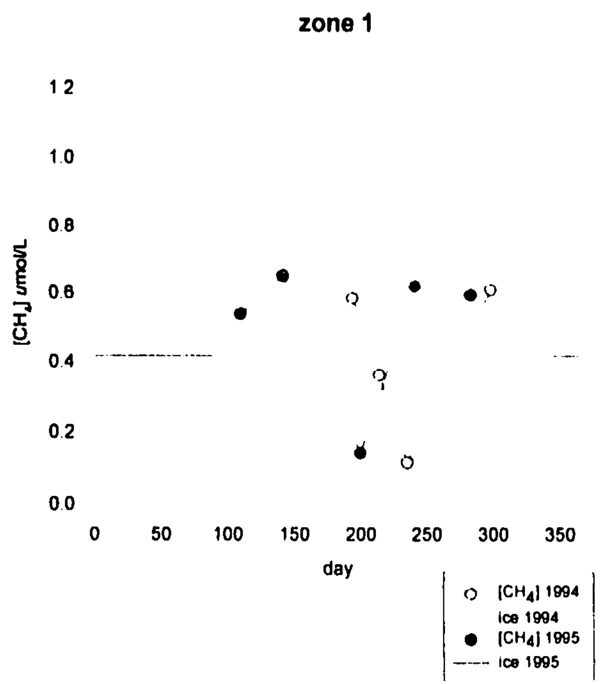
blanked. If no (or insufficient) measurements were made in a zone, the zone was excluded from consideration.

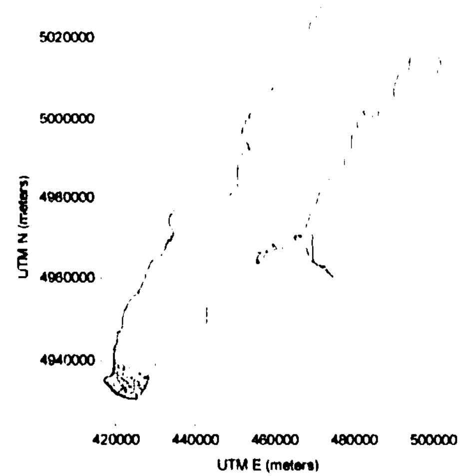
The temporal variations in spatially weighted average surface water methane concentrations are presented in Figure 4-5. The extent to which these concentrations were affected by the physical scalars shown in Figure 4-1 is explored below.

Temperature

Laboratory studies have shown that the rate of methanogenesis is strongly dependent on temperature. Sediment cores taken from the field and incubated in the laboratory have shown a 2.8 to 4.3 fold increase in methane production for every 10° C increase in temperature between 5 and 30°C (Koyama 1963, Klump and Martens 1989, Kiene 1991, Thebrath et al. 1993) The variation in Q_{10} (i.e. change in production over 10 °C) probably relates to the quality or quantity of organic substrate available to the methanogens. In the examples mentioned above, the Q_{10} of 2.8 was observed in sediments obtained from the littoral regions of Lake Constance (Thebrath et al. 1993) while the high value (4.3) was measured in rice paddy soils (Koyama 1963). Incubation experiments conducted on sediment obtained from an organic rich region of Green Bay (GB32) showed a Q_{10} of ~ 3.5 (J. V. Klump, unpublished data). If sediment temperatures increase and the ratio of methane production to methane oxidation remains greater than one, then an increase in water column methane and/or methane flux should be observed. Surprisingly, this has rarely been shown. To my knowledge, only one study has found a positive correlation between the flux of methane across the air-water interface and temperature (Baker-Blocker et al. 1977).

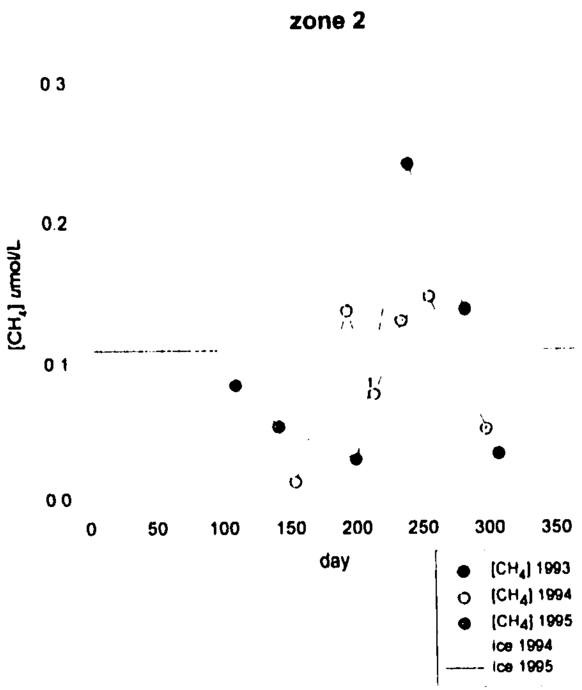
Figure 4-5. The temporal variation of spatially weight-averaged surface water methane concentrations in zones 1-7 of southern Green Bay. The zones are reproduced here for convenience and appear as shaded areas within the Green Bay shoreline. Concentrations measured during the 1994 transects appear as light gray circles; 1995 values are plotted as dark gray circles. Ice cover is plotted as a line using the same color scheme. Note the change of scale on the Y axis in each zone. All relevant data is tabulated below each figure. See text for description of interpolation methods.

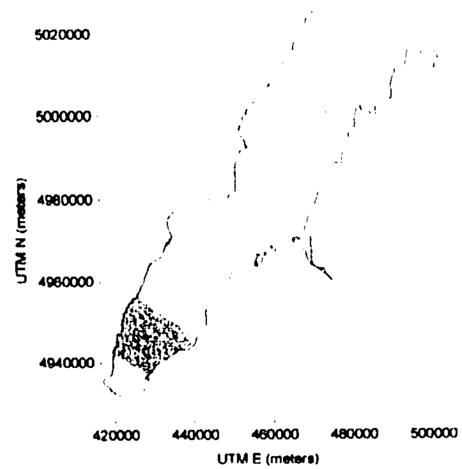




ZONE 1

DATE	**13-Jul-94**	**02-Aug-94**	**23-Aug-94**	**25-Oct-94**	**20-Apr-95**	**22-May-95**	**19-Jul-95**	**29-Aug-95**	**10-Oct-95**
day	194	214	235	298	110	142	200	241	283
[CH4] uM	0 584	0 362	0 115	0 609	0 539	0.650	0 142	0 619	0 594

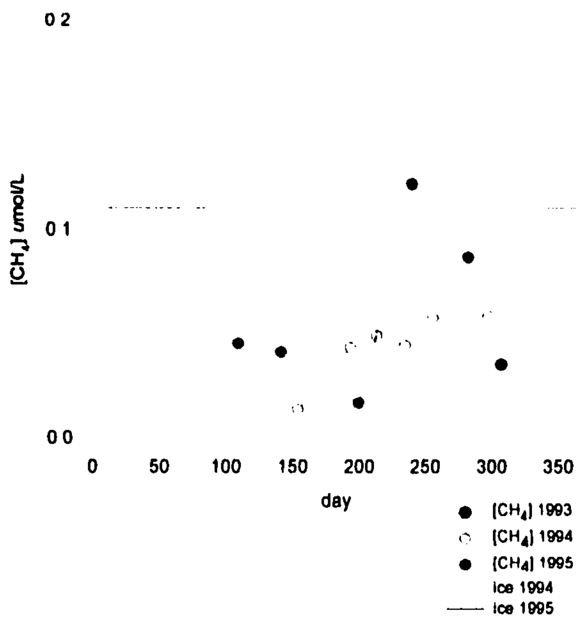


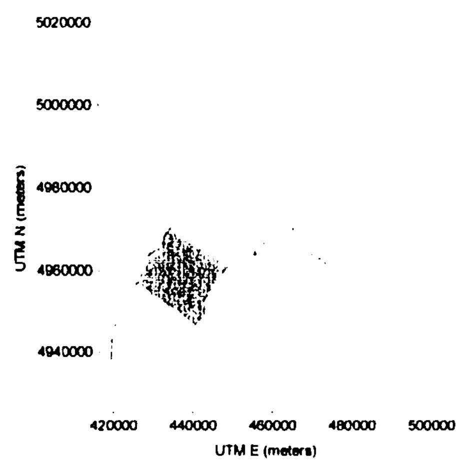


ZONE 2

DATE	**03-Nov-93**	**03-Jun-94**	**13-Jul-94**	**02-Aug-94**	**23-Aug-94**	**13-Sep-94**	**25-Oct-94**	**20-Apr-95**	**22-May-95**	**19-Jul-95**	**29-Aug-95**	**10-Oct-95**
day	307	154	194	214	235	256	298	110	142	200	241	283
[CH4] uM	0 034	0 013	0 137	0 077	0 130	0.147	0 052	0 084	0 054	0 030	0 241	0 138

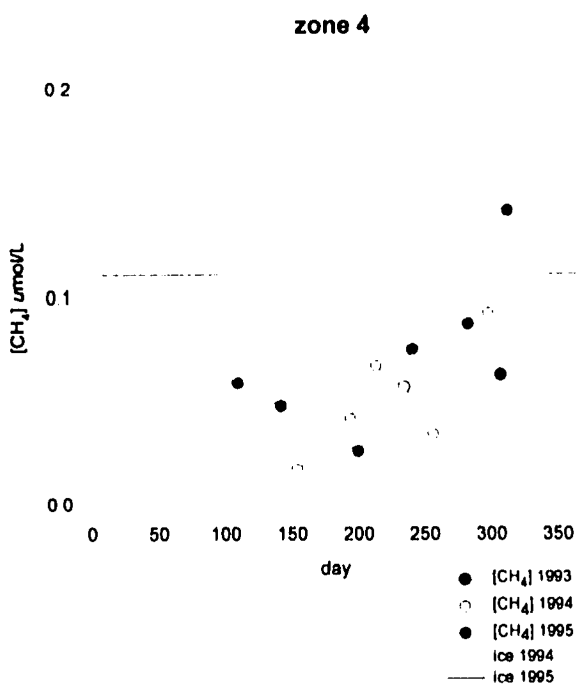
zone 3

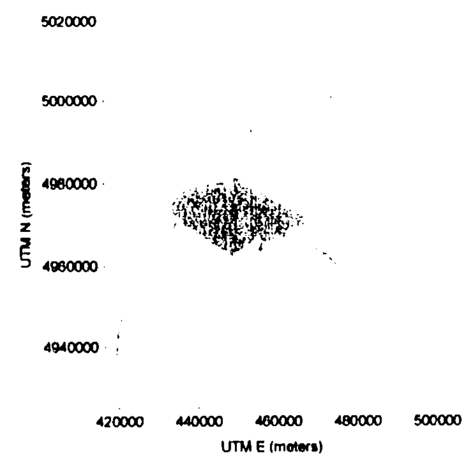




ZONE 3

DATE	03-Nov-93	03-Jun-94	13-Jul-94	02-Aug-94	23-Aug-94	13-Sep-94	25-Oct-94	20-Apr-95	22-May-95	19-Jul-95	29-Aug-95	10-Oct-95
day	307	154	194	214	235	256	298	110	142	200	241	283
[CH4] uM	0 036	0 014	0 044	0 050	0 045	0 058	0 059	0 046	0 042	0 017	0 121	0 087

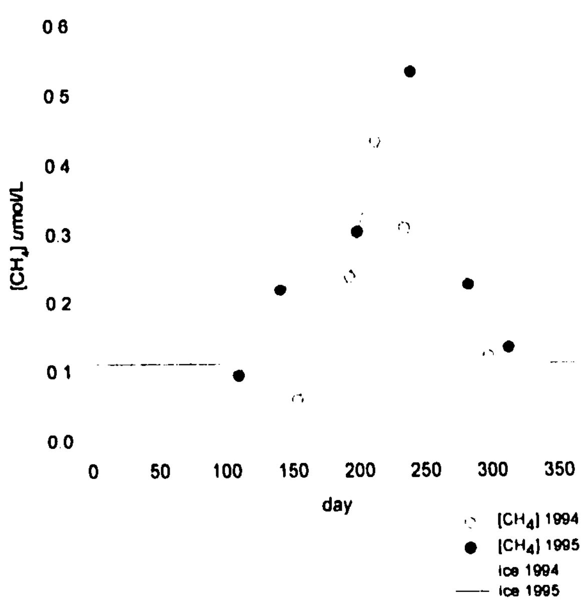


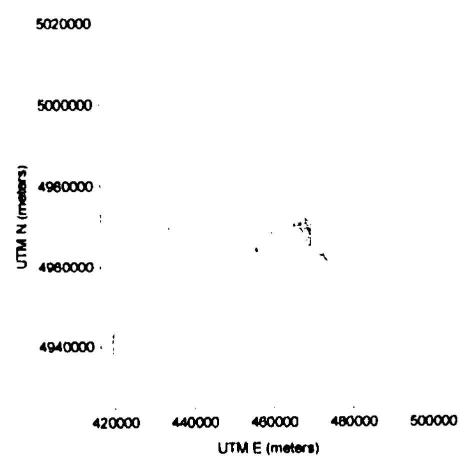


ZONE 4

DATE	03-Nov-93	03-Jun-94	13-Jul-94	02-Aug-94	23-Aug-94	13-Sep-94	25-Oct-94	20-Apr-95	22-May-95	19-Jul-95	29-Aug-95	10-Oct-95	09-Nov-95
day	307	154	194	214	235	256	298	110	142	200	241	283	313
[CH4] uM	0 063	0 017	0 042	0 067	0 057	0 034	0 092	0 059	0 048	0 026	0 075	0 087	0 140

zone 5

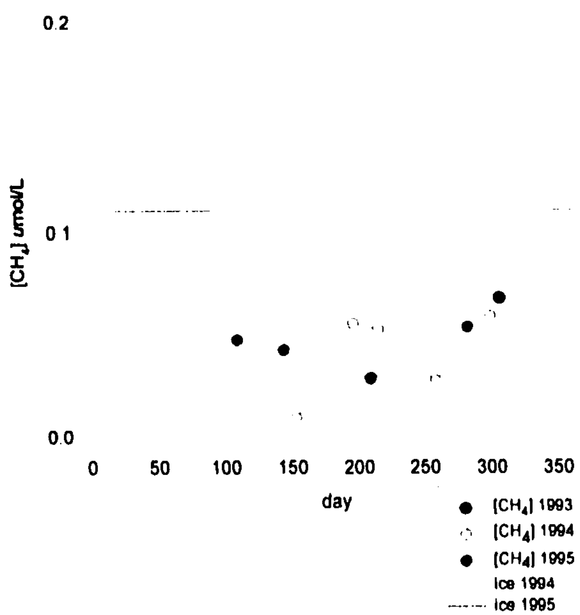


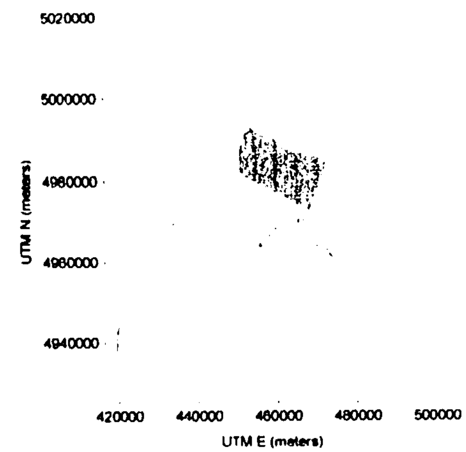


ZONE 5

DATE	*03-Jun-94*	*13-Jul-94*	*02-Aug-94*	*23-Aug-94*	*25-Oct-94*	*20-Apr-95*	*22-May-95*	*19-Jul-95*	*29-Aug-95*	*10-Oct-95*	*09-Nov-95*
day	154	194	214	235	298	110	142	200	241	283	313
[CH4] uM	0 057	0 238	0 432	0 307	0 120	0 093	0 219	0 303	0 533	0 226	0 133

zone 6

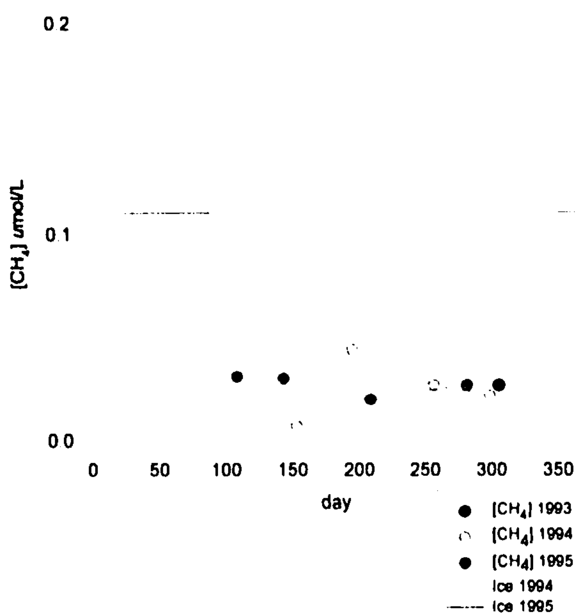


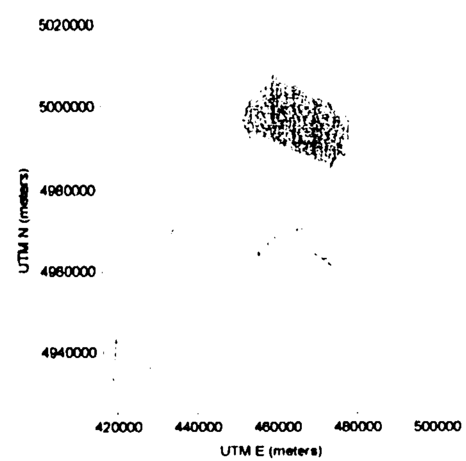


ZONE 6

DATE	**02-Nov-93**	**02-Jun-94**	**15-Jul-94**	**03-Aug-94**	**15-Sep-94**	**26-Oct-94**	**19-Apr-95**	**24-May-95**	**25-Jul-95**	**09-Oct-95**
day	306	153	196	215	258	299	109	144	209	282
[CH4] uM	0 068	0 009	0 056	0 053	0 028	0 059	0 048	0 043	0 029	0 054

zone 7





ZONE 7

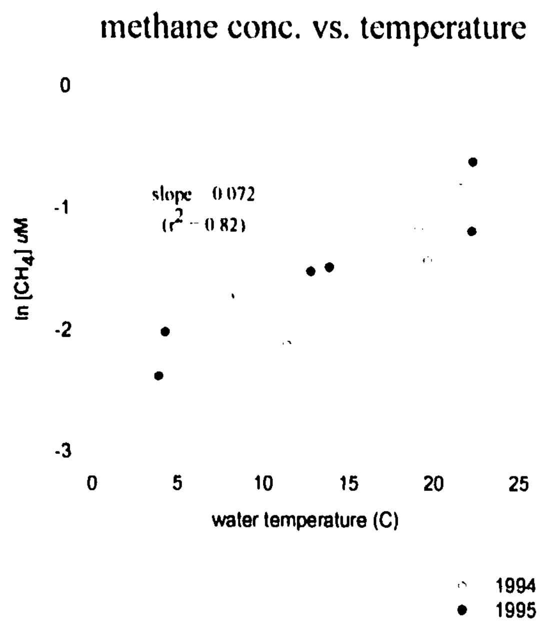
DATE	02-Nov-93	02-Jun-94	15-Jul-94	14-Sep-94	26-Oct-94	19-Apr-95	24-May-95	25-Jul-95	09-Oct-95
day	306	153	196	257	299	109	144	209	282
[CH4] uM	0.027	0.007	0.044	0.027	0.022	0.031	0.030	0.020	0.027

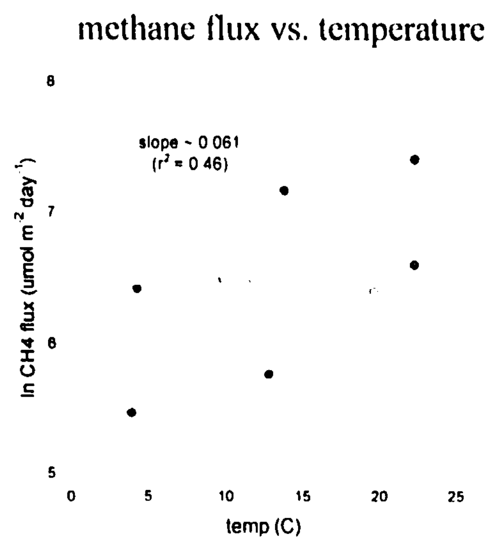
For the data presented in Figure 4-5, only one of the seven zones defined in southern Green Bay show a pronounced seasonal cycle. In zone 5 (Sturgeon Bay), surface water methane concentrations clearly rose from spring to summer and decreased again in autumn. The concentrations are plotted against the spatially weighted average surface temperatures in Figure 4-6a. The temperatures were weight averaged using the same (inverse distance) interpolation method described for methane. The slope of the relationship shows that for every 10°C increase in temperature, surface water methane concentrations rose by a factor of ~ 2.1. This could be used to back-calculate the minimum methane production rate if two assumptions are made. First, I assumed that sediment temperatures were within ~ ± 1°C of the surface water temperatures and isothermal to a depth of at least ~ 30 cm (Klump and Martens 1989, Birge et al. 1928). This assumption was based on the fact that Sturgeon Bay (zone 5) is shallow with a mean depth of 5.4 meters. Based on the temperature profiles shown in Appendix 4, the water column was usually isothermal (the exception occurred during the June 1994 cruise when stratification was just setting up and the thermocline occurred at a depth of ~ 3 meters). To a first approximation, I also assumed that the wind velocity over Sturgeon Bay was relatively constant. Sturgeon Bay is unique among the seven zones in that it lays perpendicular to the predominant wind direction in a narrow strip between hills that rise nearly 70 meters on both sides.

Using a simple one dimensional model derived from Newton's law of cooling,

$$[CH_4]_{water\ column} \cong (J_{sed}/K) + Ce^{-(K/d)t}, \qquad (4\text{-}2)$$

Figure 4-6. The relationship between surface water temperature and methane in Sturgeon Bay (zone 5). All values shown in figure 4-5 (zone 5) are presented here with the exception of measurements made during June 1994. a) Methane concentration versus temperature. With constant wind speeds, and the assumptions implied in equation 4-2, a 10 °C increase in temperature would result in a 2.7 fold increase in methane flux to the atmosphere. b) Methane flux versus temperature. Based on the observed (1989-1993) average monthly wind speeds at buoy #45002, methane flux to the atmosphere increased by a factor of 1.8 for a temperature increase of 10 °C.





$[CH_4]_{wc} = (J_{sed}/K) + Ce^{-(K \cdot d)t}$

for constant WS and ΔT = 10C
ΔJ = 2.7

a

$J_{aw} = J_{sw}$

for obs WS and ΔT = 10C
ΔJ = 1.8

b

J_{sed} = the flux of methane from the sediments, K = the transfer coefficient across the air-water interface, C is a constant of integration, d is the water column depth, and *t* is time. It follows that at steady state, the last term in equation 4-1 goes to zero and the concentration of surface water methane is approximately equal to J_{sed}/K. The term J_{sed}/K is actually equal to the concentration difference between water column methane and water in equilibrium with atmospheric CH_4 (i.e. ΔC in equation 3-1) but the latter term in this instance is insignificant. If the water temperature rises 10°, not only does the concentration of methane increase by a factor of 2.1, but the transfer coefficient also increases by a factor of 1.3 since K is in part determined by the molecular diffusion coefficient of methane which increases by a factor of ~ 1.3 over 10 °C (Jähne et al. 1987a). For the system to remain at steady state then, methane flux from the sediment must increase by a factor of ~ 2.7. If the inventory of methane in the sediments is to remain constant, then methane production must also increase by a factor of 2.7. This is very close to the Q_{10} value of 2.8 obtained from the iittoral sediments of Lake Constance. If the Q_{10} for zone 5 is indeed higher, then either the inventory of sediment methane must increase, the ratio of methane production to oxidation must decrease, or direct venting to the atmosphere must occur through ebullition. Since ebullition has never been observed at the surface of Green Bay or during benthic chamber studies, the first scenario seems most plausible.

In reality, average wind speeds over Sturgeon Bay probably varied from month to month. Using the average monthly wind speeds recorded at buoy #45002 during 1989 to 1993 (see Table 3-1), methane flux estimates from Sturgeon Bay were calculated using equation 3-1. Flux estimates plotted against the spatially weighted average surface temperatures in Figure 4-6b show methane flux to the atmosphere increased by a factor of only 1.8 for a 10 °C rise in sediment temperature.

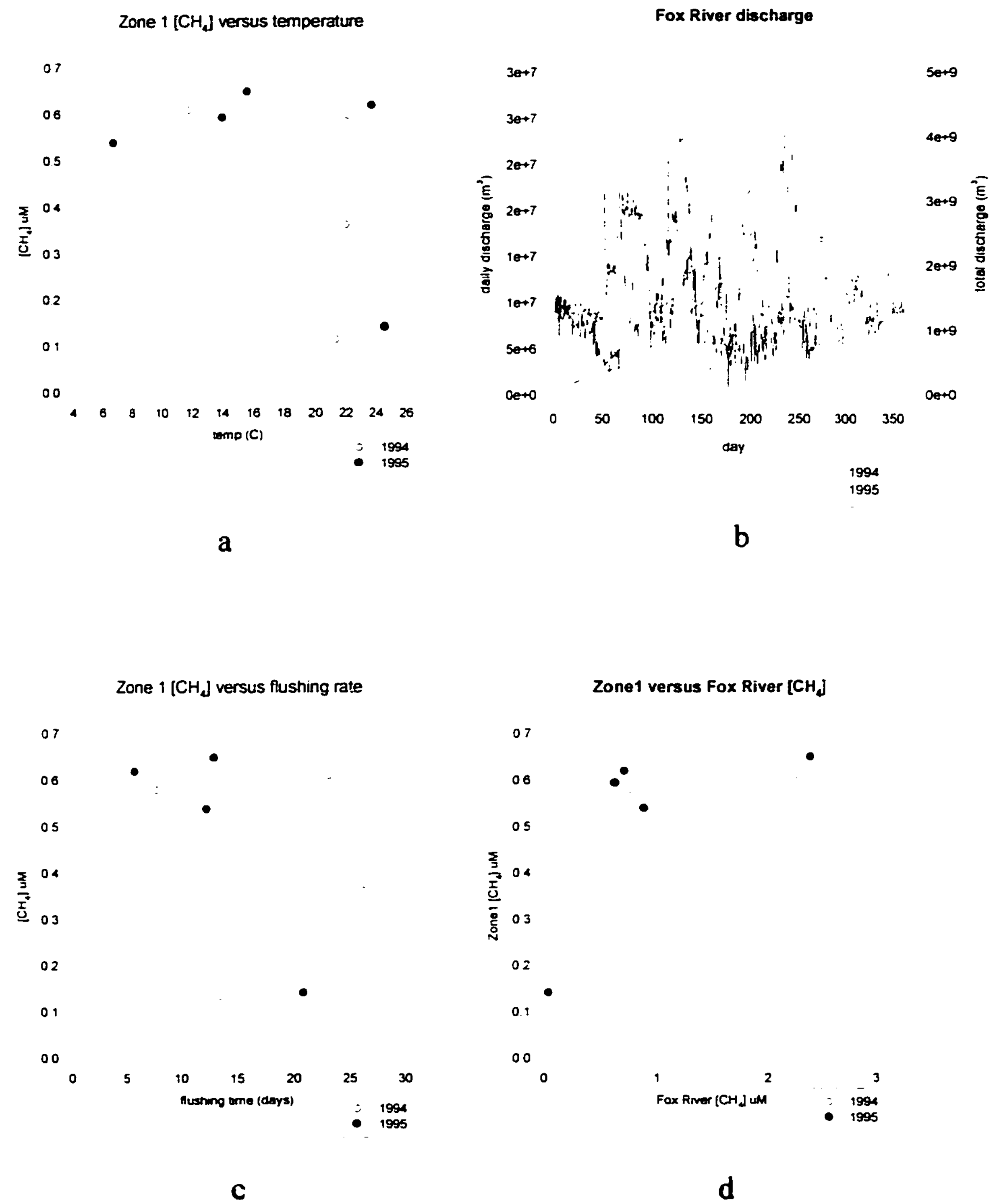
Riverine Input

Although zone 1 is also shallow with a mean depth of ~2.3 meters, no correlation between methane and water temperature was observed. In fact, the concentration of methane actually appeared to decrease as temperatures rose (Figure 4-7a). No explanation for this can be offered at this time except that the same patterns were observed in the lower Fox River.

The possibility that fluctuations in methane concentration might simply reflect a dilution rate was explored by obtaining USGS metered flow rates from the lower Fox River into Green Bay (Figure 4-7b). In spite of a substantial range in flushing rates (defined as the number of days required to fill zone 1 based on the flow rate of water from the Fox River measured during the day of the cruise), the concentration of methane in zone 1 was not effected by the flow rate of Fox River (Figure 4-7c).

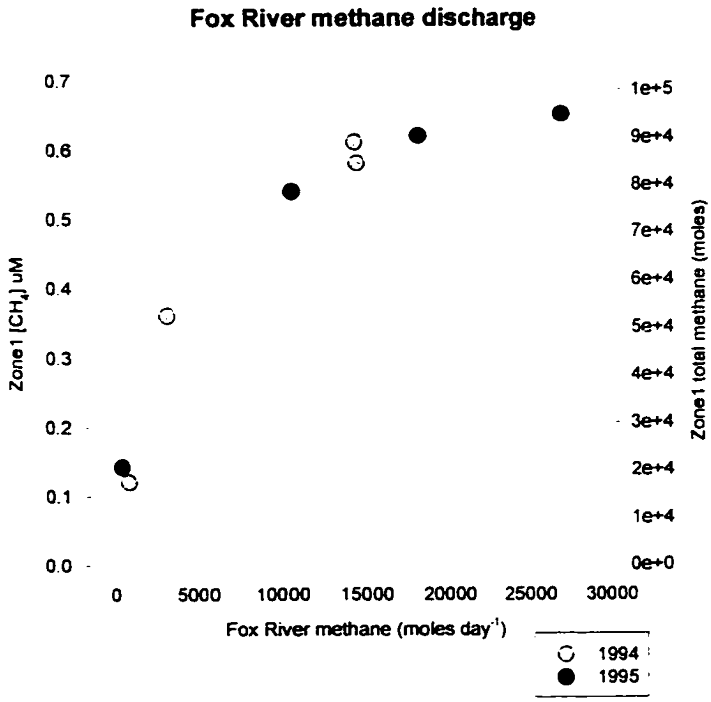
As mentioned above, the concentration of methane in zone 1 did appear to be correlated with that of the Fox River, but the relationship was weak (Figure 4-7d). However, if the mass (i.e. concentration x flow rate) of methane flowing out of the Fox River was plotted against the concentration of methane in zone 1, the relationship was striking (Figure 4-8, top). An exponential fit of the data shows the concentration of methane in zone 1 rising to an apparent maximum of ~ 0.637 μM. Beyond this point, increases in methane flux from the Fox River are matched by a concomitant flux of methane out of zone 1 to either the atmosphere or zone 2. At the other end of the

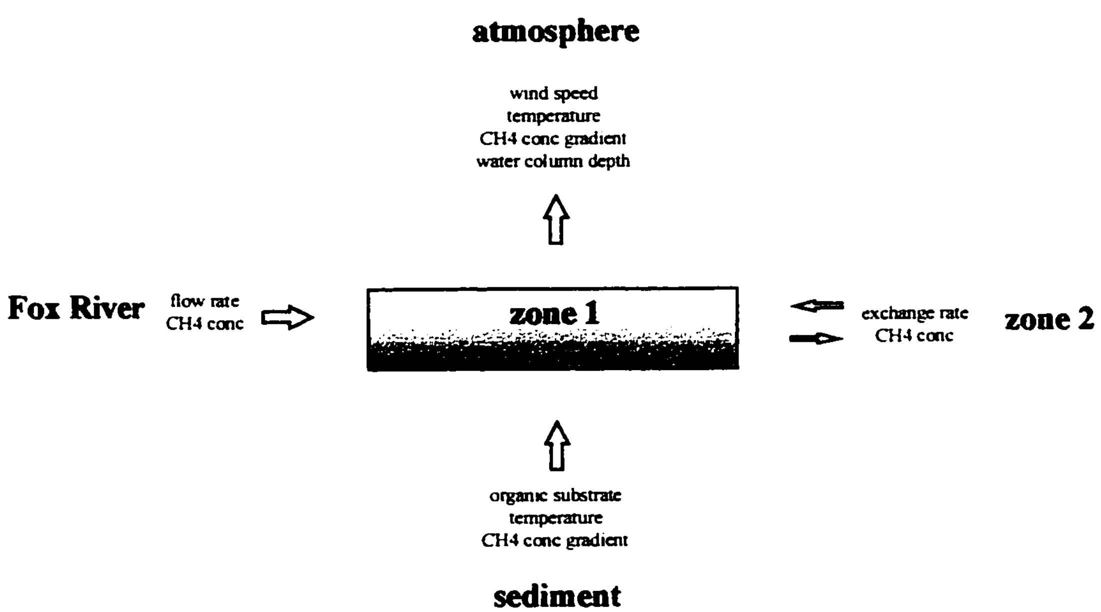
Figure 4-7. The influence of temperature and flow rate on the methane concentrations in Fox River and zone 1. a) Zone 1 methane versus zone 1 temperature. b) The flow rate of water out of Fox River and into zone 1 as determined by the U. S. Geological Survey. Archived data for 1995 were only available to September 30th. c) Zone 1 methane versus the flushing rate of zone 1. Flushing rates were calculated as the time required to fill zone 1 (~ 0.146 km^3) with water flowing from the Fox River based on the flow rate measured during the day of the cruise. d) The spatially weight averaged concentration of methane measured in zone 1 versus the average concentration of methane measured in the Fox River (approximately 3 km upstream).



Zone 1 [CH4] versus temperature
[CH4] uM
0 7
0 6
0 5
0 4
0 3
0 2
0 1
0 0
4 6 8 10 12 14 16 18 20 22 24 26
temp (C)
1994
1995
a
Fox River discharge
daily discharge (m3)
total discharge (m3)
3e+7
3e+7
2e+7
2e+7
1e+7
1e+7
5e+6
0e+0
5e+9
4e+9
3e+9
2e+9
1e+9
0e+0
0 50 100 150 200 250 300 350
day
1994
1995
b
Zone 1 [CH4] versus flushing rate
[CH4] uM
0 7
0 6
0 5
0 4
0 3
0 2
0 1
0 0
0 5 10 15 20 25 30
flushing time (days)
1994
1995
c
Zone1 versus Fox River [CH4]
Zone1 [CH4] uM
0 7
0 6
0 5
0 4
0 3
0 2
0.1
0 0
0 1 2 3
Fox River [CH4] uM
1994
1995
d

Figure 4-8. The discharge of methane from the Fox River. Top) The efflux of methane from the Fox River versus the weight averaged concentration of methane in zone 1 (left axis) and the total mass of methane in zone 1 (right axis). The flux of riverine methane was calculated as the product of the measured concentration and water flow rate. Bottom) A diagram of the other processes affecting the concentration of methane in zone 1.


Fox River methane discharge
Zone1 [CH4] uM
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1e+5
9e+4
8e+4
7e+4
6e+4
5e+4
4e+4
3e+4
2e+4
1e+4
0e+0
Zone1 total methane (moles)
0
5000
10000
15000
20000
25000
30000
Fox River methane (moles day-1)
1994
1995


atmosphere
wind speed
temperature
CH4 conc gradient
water column depth
Fox River
flow rate
CH4 conc
zone 1
exchange rate
CH4 conc
zone 2
organic substrate
temperature
CH4 conc gradient
sediment

spectrum, the exponential curve intersects the Y axis at a concentration of 0.085 μM. This is very close to the average methane concentration of 0.100 μM observed in zone 2.

The full significance of the exponential response is not yet understood. As shown in the bottom of Figure 4-8, there are several unknown sources and sinks influencing the mass balance of methane in zone 1 and each of them would influence the concentration of methane in an exponential fashion as well. What is apparent is that the residence time for methane in zone 1 is extremely short. The principle sink must be the atmosphere. Using equation 4-2, it can be shown that based on air-water transport alone, the half-life for methane in the water column is only ~ 19 hours for a moderate piston velocity of 2 meters per day and decreases to ~ 4 hours for a piston velocity of 9 meters per day (which was the theoretically calculated velocity observed on the 25 October 1994 cruise). If one takes into account the advective and diffusive exchange of methane with zone 2 of Green Bay, the residence time is shortened even further (Mortimer 1978, Modlin and Beeton 1970). The values used to generate Figures 4-7 and 8 are presented in Table 4-1.

Water column depth and the thermocline

The depth of the water column influences the concentration of surface water methane in both direct and indirect ways. In a direct sense, the water column itself acts like a capacitor. In shallow water, variations in methane supply or removal quickly alter the total amount of methane on an areal basis. As a result, repeated measurements of methane over sufficiently long time scales should show considerable variability. As the water column increases in depth, similar forces acting to add or remove methane from the water column affect the areal mass of methane to a lesser degree. Accordingly, surface water measurements of methane over deep water should appear relatively stable over time.

Table 4-1. Fox River temperature, discharge and methane concentrations as measured during the transect cruises of 1994 and 1995.

day	date	FOX RIVER temp (C)	FOX RIVER discharge m3/day	FOX RIVER [CH4] uM	ZONE 1 temp (C)	ZONE 1 [CH4] uM
1994						
194	13-Jul	23.6	1.90E+07	0.76	21.9	0.58
214	02-Aug	24.6	5.58E+06	0.55	21.9	0.36
235	23-Aug	23.1	1.08E+07	0.07	21.3	0.12
298	25-Oct	11.9	6.34E+06	2.25	11.6	0.61
1995						
110	20-Apr	8.3	1.19E+07	0.89	6.6	0.54
142	22-May	17.5	1.13E+07	2.38	15.5	0.65
200	19-Jul	26.3	7.00E+06	0.05	24.5	0.14
241	29-Aug	24.3	2.54E+07	0.71	23.6	0.62
283	10-Oct	14.0	*	0.63	13.9	0.59

area zone 1 = 6.4E+07 m2
volume zone 1 = 15E+07 m3

This is shown in Figure 4-3 where the error bars bracketing the mean concentration observed in each of the seven zones decrease with depth.

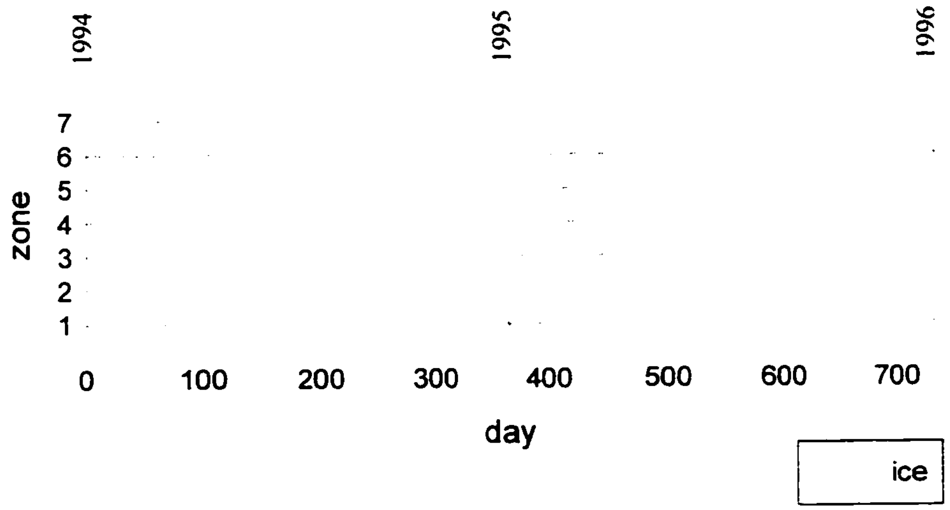
The exponential decrease in surface water methane with depth in Figure 4-3 is only indirectly related to the water column depth. The situation is complicated by the effects of temperature on the water column and the rate of methanogenesis itself. In Green Bay, surface waters warm and stratify in June. As the stratification intensifies over summer, the density gradient across the thermocline intensifies. This reduces the amount of eddy diffusion between the layers of water and consequently further limits the transfer of heat to deeper waters. The temperature profiles shown in Appendix 4 bear this out. In the summer, sediment temperatures at GB6 were probably close to 25°C while further north in 30 meters of water, the sediment temperatures were ~ 8°C. If the relationship between sediment temperature and methane production observed in zone 5 hold here, then a ~ 3 to 5 fold difference in methane production potential occurs between the two sites based upon temperature alone. The difference in surface water methane is further amplified since methane diffusing up from deep sediments encounters the same density barrier that keeps heat from diffusing downwards. This can result in an increase in methane in the hypolimnion and a temporary disparity between sediment-water, thermocline and air-water methane fluxes. Of course, a variety of other factors are influencing surface water methane concentrations at the same time. Teasing apart the effect of the thermocline on "steady state" conditions and temperature on methane production may not be possible. It is intriguing, however, that the lowest concentrations of surface water methane were observed in June when the thermocline was just getting established at a depth of 3 meters.

Ice cover

Ice covers Green Bay for 3 to 4 months of each year (Figure 4-9). During that time, gas exchange between the bay and troposphere decreases to an insignificant level. Advective transport between each of the zones and Lake Michigan also declines to the point where the flow of water out of Green Bay matches the rate of riverine input. For Green Bay south of Chambers Island, this translates to an increase the residence time of water from ~ 8 months to approximately 3 years (Mortimer 1978, Miller and Saylor 1993). The dominant oscillatory currents during this period are caused by the lunar semi-diurnal tide (Gottlieb et al. 1990). Since the major sink for water column methane (i.e. ventilation to the atmosphere) effectively shrinks to zero, methane released from the sediments over this period will tend to accumulate and the concentration of methane should rise. Unfortunately, the rate of methane increase was not measured. However, single time point measurements suggest that the flux of methane from the sediment during winter is low.

In Figure 4-10, the spatially weighted average concentrations of zone 3 methane measured during the last cruise of 1994 (October 25) and the first cruise of 1995 (April 20) are compared with the concentration of methane measured directly under the ice on February 25th, 1997 at station GB21 (also in zone 3). The arrows accompanying each concentration point indicate the probable trend in methane concentration (they do not represent actual concentrations). Beginning in autumn, as surface temperatures gradually decrease, the water column destabilizes and mixes. Methane that had been accumulating in the hypolimnion over the summer months now mixes throughout the water column, raising the surface water concentration. Since the increase in methane is not supported by an

Figure 4-9. Green Bay ice cover during 1994 and 1995. The date of ice in and ice out for each of the seven surface area zones were determined using ice charts obtained from the NOAA/NAVY Ice Center (see methods section in Chapter 2).

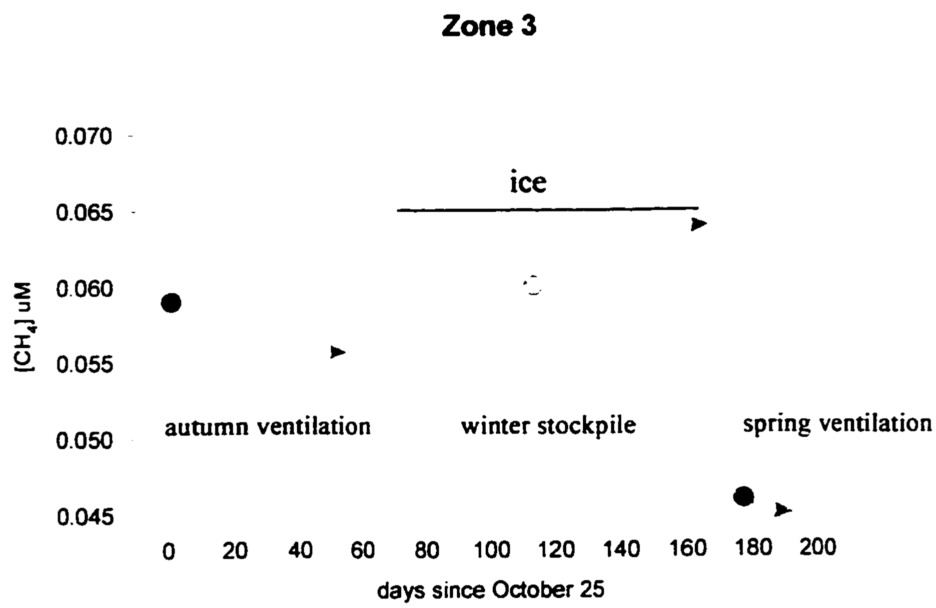


ICE DATA FOR GREEN BAY

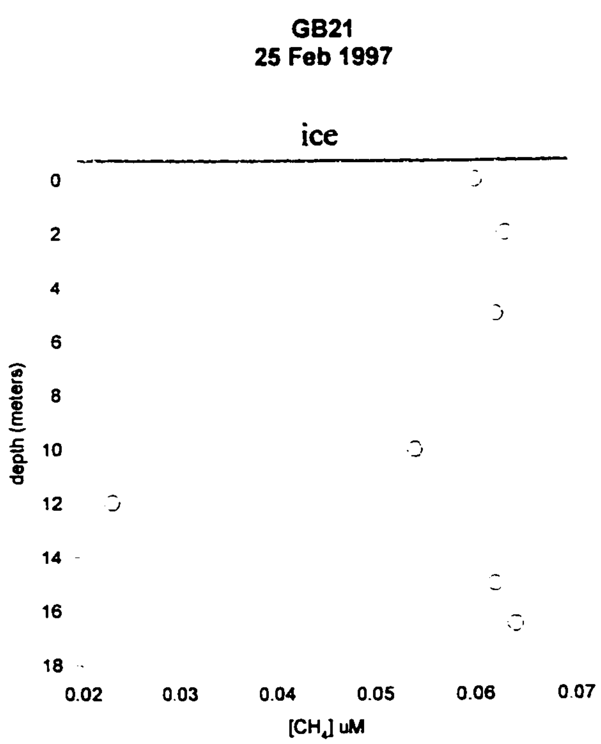
ZONE	I	II	III	IV	V	VI	VII
ICE IN 93/94*	01 JAN	01 JAN	01 JAN	01 JAN	01 JAN	01 JAN	01 JAN
ICE OUT 94	11 APR	11APR	11APR	12 APR	12 APR	15 APR	15 APR
ICE IN 94/95	19 DEC	4 JAN	4 JAN	6 JAN	6 JAN	18 JAN	20 JAN
ICE OUT 95	29 MAR	6 APR	6 APR	6 APR	6 APR	03 APR	31 MAR
ICE IN 95/96	6 DEC	8 DEC	8 DEC	10 DEC	10 DEC	12 DEC	18 DEC

**all regions +90% covered by 03 Jan*

Figure 4-10. The effect of ice cover on methane concentrations in Green Bay. a) The dark gray circles represent the weight averaged concentrations of methane measured in zone 3 on October 25th, 1994 and April 20th, 1995. The gray bar indicates ice cover. The light gray circle represents the concentration of methane measured directly under the ice at station GB21 (in zone 3) on February 25th, 1997. All events are plotted against a calendar year beginning on October 25th. See text for further explanation. b) The methane concentration versus depth at station GB21 on February 25th, 1997.


Zone 3
ice
autumn ventilation
winter stockpile
spring ventilation
[CH4] uM
0.070
0.065
0.060
0.055
0.050
0.045
0
20
40
60
80
100
120
140
160
180
200
days since October 25

a


GB21
25 Feb 1997
ice
depth (meters)
0
2
4
6
8
10
12
14
16
18
0.02
0.03
0.04
0.05
0.06
0.07
[CH4] uM

b

increase in methanogenesis, concentrations fall off to a new "steady state" where the flux of methane from the sediment approximately equals the flux of methane to the atmosphere. As mentioned above, once ice forms, the concentrations of methane will increase until spring ice melt. Assuming that conditions under the ice are approximately equal on an inter-annual basis, then the concentration of 0.060 µM methane measured on February 25th after ~ 40 days of ice cover strongly suggested that the net rate of methane production under ice was low.

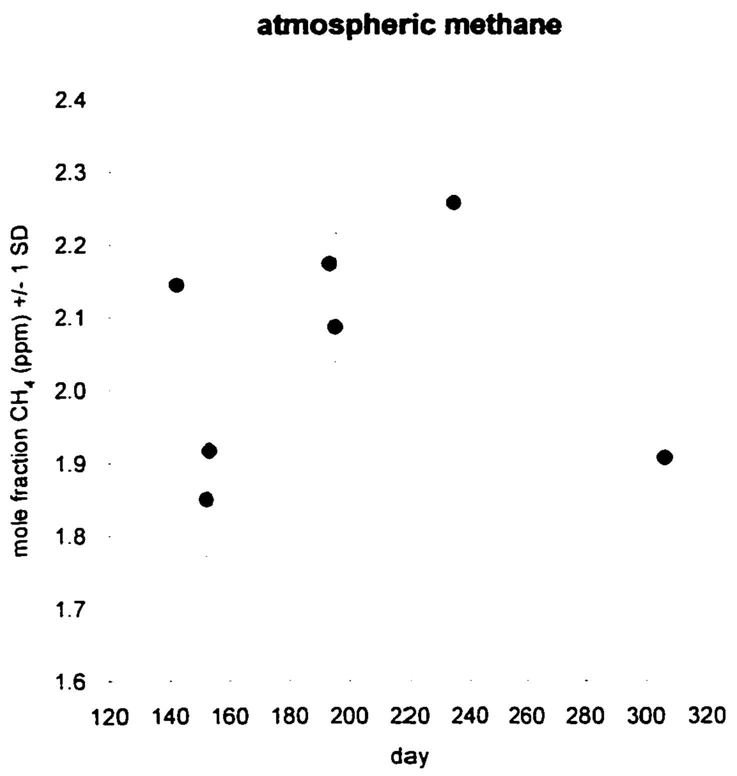
After the ice breaks up, the same process that occurred in late fall occurs again as methane not supported by the rate of production gets vented to the atmosphere. Estimating the flux of methane to the atmosphere during this period is difficult since measurements of methane under the ice just before spring melt are difficult to obtain. Taking advantage of the slow response time of deep water, it is possible to back calculate a rough estimate of the methane concentration just before ice-out. In 1995, zone 7 was considered ice-free on March 31st. Nineteen days later, the average concentration of methane was measured at 0.031 µM. Based on an average water column depth of 20.8 meters and an assumed (moderate) piston velocity of 2 meters per day, the half life of methane in the water column was 20.8 / 2 * 0.693 or ~ 7.2 days. If the flux of methane from the sediment was set to zero during this period, then the maximum water column concentration possible at ice-out would have been approximately 0.031 * $2^{2.64}$ or ~ 0.190 µM. If the flux of methane from the sediment is considered, the maximum concentration drops considerably. Taking the difference between the maximum concentration at ice out and the observed concentration on March 31st and multiplying by the volume of water in southern Green Bay gave an upper flux estimate of ~0.16 µM * 22.5 km^3 or ~ 0.4 x 10^7

moles CH_4 over the 19 day period. This would only amount to ~ 3% of the expected annual flux of methane across the air-water interface based on the sediment-water flux estimates of Klump and Fitzgerald (1998). Therefore, in terms of an annual estimate of methane flux across the air-water interface, the possible error associated with missing a major flux event just after ice-out is small.

Atmospheric Exchange

Daily estimates of methane flux across the air-water interface in each of the seven zones of southern Green Bay were calculated using equation 3-1, where K = the transfer coefficients derived in Chapter 3 (Figure 3-7), and $\Delta C = C_w - C_a$, where C_w = the dissolved methane concentrations of the mixed layer (epilimnion) and C_a = the concentration of methane in the surface water micro-layer which was assumed to be in equilibrium with atmospheric methane. The concentration of methane in the air over Green Bay was measured throughout the study and interpolated over a year to give a mean mole fraction of 1.96 ppm (Figure 4-11). The partial pressure of methane was taken as the product of the mole fraction and the average atmospheric pressure (992 hPa) to give 1.92 μatm. The molarity of methane in equilibrium with atmospheric methane (C_a) was calculated as the product of the partial pressure of methane and its solubility coefficient (see equations 2-1 and 2-2) which was calculated using the surface temperatures derived in Chapter 3 (Figure 3-5). Daily estimates of C_w in each of the 7 zones of southern Green Bay were based on linear interpolations between the spatially averaged concentrations measured during each of the transect cruises shown in Figure 4-5. The concentrations of methane just prior to and after ice cover were taken as the mean of the last and first concentrations measured during 1994 and 1995 respectively.

Figure 4-11. Atmospheric methane mole fractions measured over Green Bay during 1993, 1994, and 1995. The mean concentration for the samples shown (n = 59) is 2.05 ppm. Interpolation over the entire year gave an average concentration of 1.96 ppm.


atmospheric methane
mole fraction CH_4 (ppm) +/- 1 SD
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
120
140
160
180
200
220
240
260
280
300
320
day

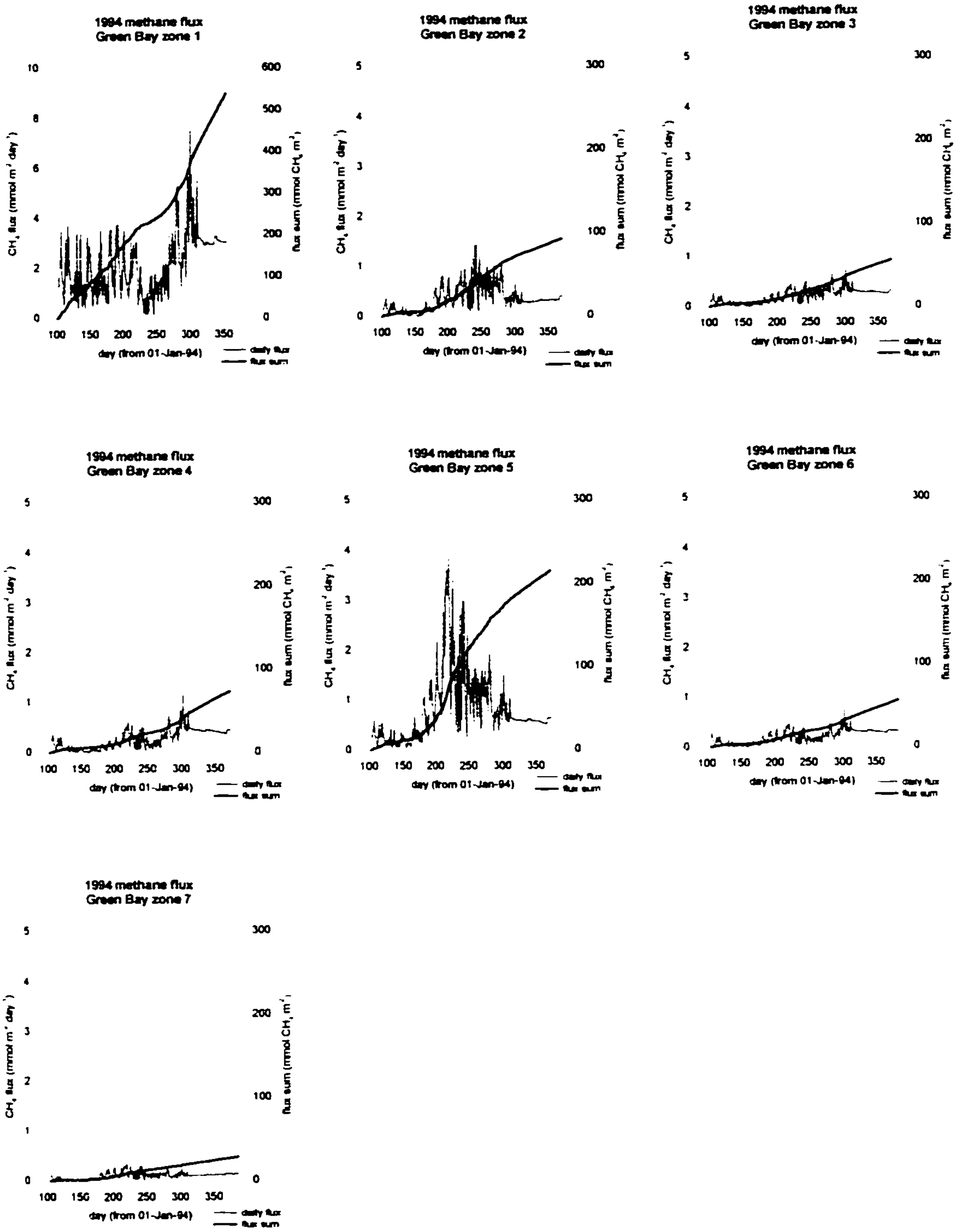
The net flux of methane from Green Bay to the atmosphere is shown together with daily flux estimates in Figure 4-12a (1994) and 4-12b (1995). Average daily flux estimates from Green Bay to the atmosphere are given for each year. month and zone in Table 4-2. The annual flux of methane from each zone is given in Figure 4-13. Flux estimates from the first few days of January 1995 (before the onset of ice cover). were included in the 1994 flux estimate. Based on the air column stability-corrected U/ K relationships of Broecker et al. (1978). ~ 13 x 10^7 moles of methane were vented to the atmosphere from southern Green Bay in 1994. In 1995. the value increased to ~ 16 x 10^7 moles.

Inter-annual variability

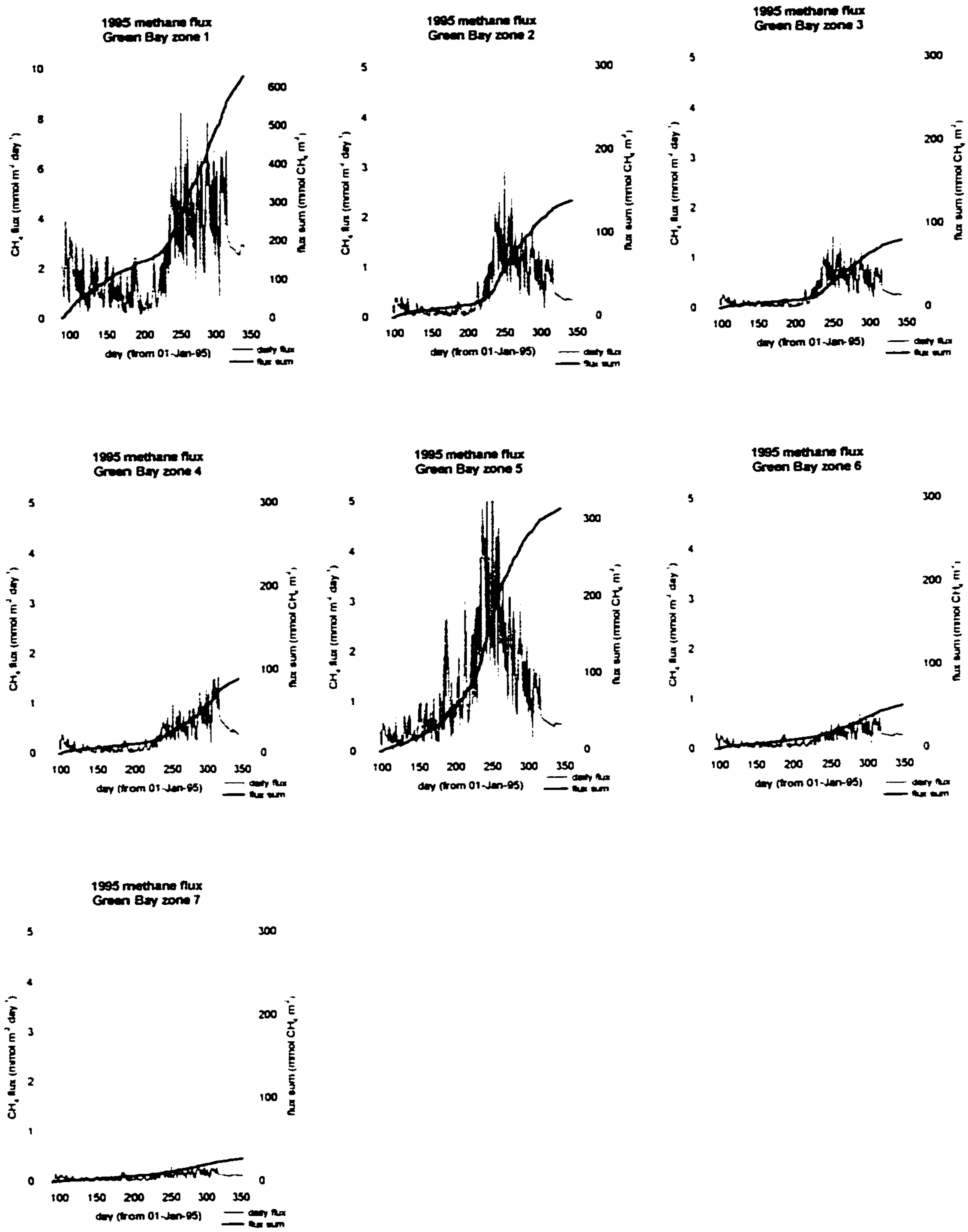
The flux of methane to the atmosphere varied considerably on both an intra- and inter-annual basis. While much of the variability due to seasonality was understandable. the differences observed between 1994 and 1995 were intriguing. In zones 2 and 3 for instance, methane flux to the atmosphere increased ~ 50% from 1994 to 1995.

An intriguing explanation for this may have to due with the dramatic difference in wind directions that occurred in 1994 and 1995. Hourly wind velocities recorded at buoy #45002 were broken down into their u (east) and v (north) component vectors and summed. The results are shown in Figure 4-14a. The vectors both begin at the origin on April 1st and run in the direction that the wind came from. The first of each month is indicated with a circle. the numeral above each circle indicates the month. In 1994. the wind blew fairly consistently from the southwest, straight up the major axis of the bay. In 1995 however. the wind tended to come from the southeast and blow across the minor axis of the bay. Only during September and October of 1995 did the average direction veer southwest.

Figure 4-12. Methane flux from Green Bay to the atmosphere based on air column stability-corrected wind speeds from buoy #45002, the U / K relationship of Broecker et al. (1978) and air-water methane concentration gradients derived in this chapter. a) 1994 flux estimates for Green Bay zones 1-7. b) 1995 flux estimates for Green Bay zones 1-7. Gray lines show daily flux estimates. Black lines show the accumulative flux over time.


1994 methane flux
Green Bay zone 1
1994 methane flux
Green Bay zone 2
1994 methane flux
Green Bay zone 3
1994 methane flux
Green Bay zone 4
1994 methane flux
Green Bay zone 5
1994 methane flux
Green Bay zone 6
1994 methane flux
Green Bay zone 7
CH4 flux (mmol m-2 day-1)
flux sum (mmol CH4 m-2)
day (from 01-Jan-94)
daily flux
flux sum

a


1995 methane flux
Green Bay zone 1
1995 methane flux
Green Bay zone 2
1995 methane flux
Green Bay zone 3
1995 methane flux
Green Bay zone 4
1995 methane flux
Green Bay zone 5
1995 methane flux
Green Bay zone 6
1995 methane flux
Green Bay zone 7
day (from 01-Jan-95)
daily flux
flux sum

b

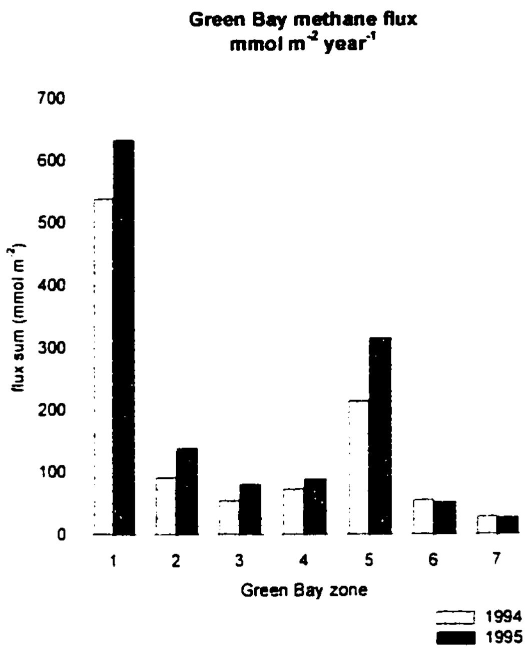
Table 4-2. Average daily methane flux estimates from Green Bay to the atmosphere. Values are given for each year, month and zone. Asterisks denote months when ice covered a particular zone for the entire month. Values given for January, March, April and December reflect the average flux for ice free periods. See Figure 4-9 for specific ice cover dates.

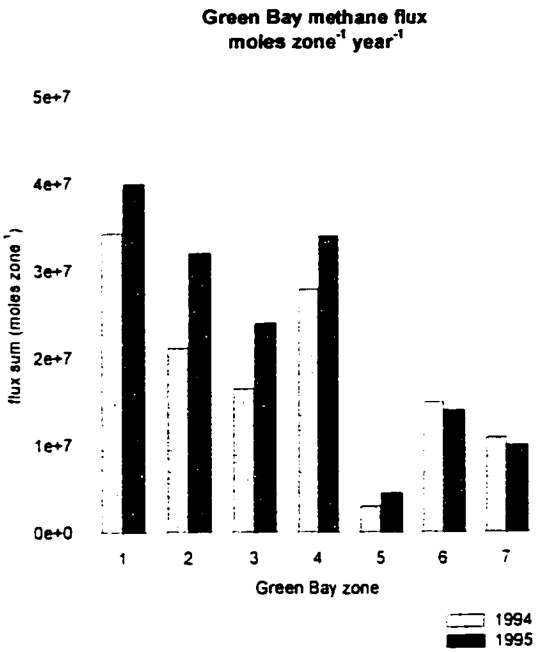
Green Bay
methane efflux to atmosphere
mmol m^{-2} day^{-1}

ZONE	z1	z2	z3	z4	z5	z6	z7
1994							
1	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*
3	*	*	*	*	*	*	*
4	2.02	0.18	0.14	0.21	0.33	0.15	0.06
5	1.51	0.06	0.05	0.07	0.17	0.04	0.02
6	1.53	0.14	0.05	0.06	0.31	0.05	0.04
7	1.99	0.42	0.15	0.16	1.06	0.18	0.13
8	1.27	0.58	0.24	0.30	1.92	0.23	0.17
9	1.43	0.60	0.25	0.19	1.08	0.14	0.11
10	3.49	0.46	0.37	0.50	0.95	0.32	0.13
11	3.18	0.29	0.30	0.47	0.62	0.31	0.11
12	3.09	0.31	0.27	0.42	0.56	0.28	0.11
1995							
1	*	0.39	0.30	0.44	0.63	0.30	0.13
2	*	*	*	*	*	*	*
3	1.79	*	*	*	*	*	0.04
4	1.94	0.24	0.15	0.20	0.34	0.16	0.08
5	1.29	0.12	0.08	0.09	0.40	0.07	0.05
6	0.95	0.09	0.06	0.07	0.55	0.07	0.05
7	0.94	0.18	0.09	0.11	1.23	0.11	0.07
8	2.65	0.98	0.49	0.32	2.50	0.18	0.10
9	4.13	1.33	0.71	0.52	2.74	0.29	0.15
10	4.39	0.98	0.61	0.72	1.60	0.38	0.18
11	3.73	0.60	0.41	0.80	0.83	0.34	0.15
12	2.94	0.34	0.25	0.42	0.53	0.26	0.11

*ice

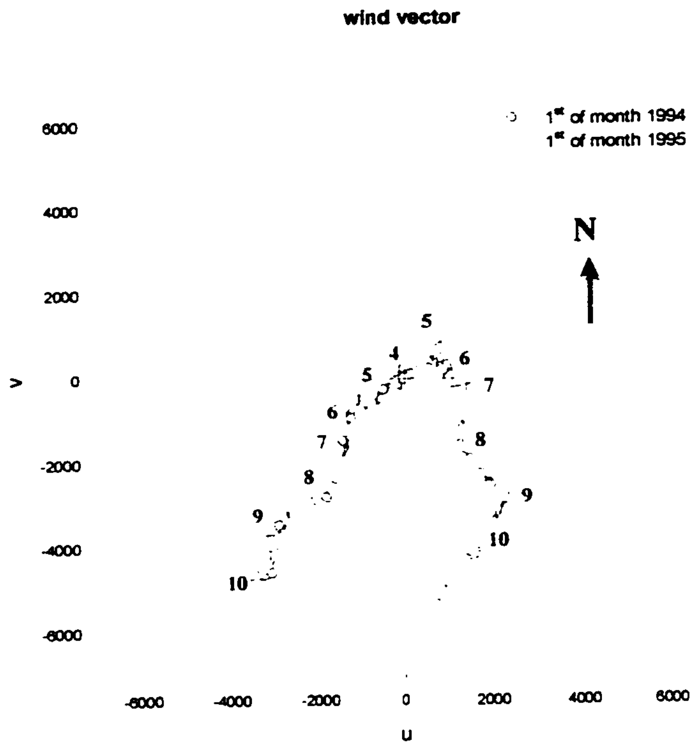
Figure 4-13. Methane flux sums from southern Green Bay (zones 1-7) to the atmosphere in 1994 and 1995. Top left) Annual methane flux per square meter of zones 1-7. Top right) Annual methane flux per zone. Bottom) Tabulated methane flux sums from southern Green Bay to the atmosphere.



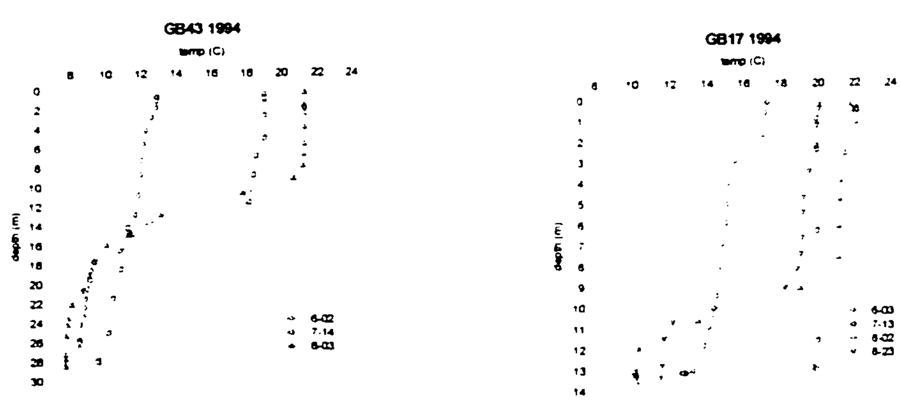


zone	1	2	3	4	5	6	7
area (m2)	6.4E+07	2.3E+08	3E+08	3.8E+08	1.4E+07	2.7E+08	3.8E+08
1994							
sum mmol/m2	539	93	55	73	215	55	29
moles/zone	3.4E+07	2.1E+07	1.6E+07	2.8E+07	3074572	1.5E+07	1.1E+07
TOTAL moles CH4	1.3E+08						
1995							
sum mmol/m2	633	139	80	89	315	51	27
moles/zone	4.0E+07	3.2E+07	2.4E+07	3.4E+07	4.5E+06	1.4E+07	1.0E+07
TOTAL moles CH4	1.6E+08						

Figure 4-14. Inter-annual variability in wind direction and water column temperatures. a) Wind vectors for 1994 (gray circles) and 1995 (open circles) based on hourly wind velocities measured at buoy # 45002. The vectors begin at the origin on April 1st and run toward the direction the wind is coming from till October 31st. b) Temperature profiles showing intrusion of cold Lake Michigan water into the hypolimnion of Green Bay at station GB43 (zone 6) and station GB17 (zone 3).


wind vector
1st of month 1994
1st of month 1995
N
v
u

a


GB43 1994
temp (C)
depth (m)
6-02
7-14
8-03
GB17 1994
temp (C)
depth (m)
6-03
7-13
8-02
8-23

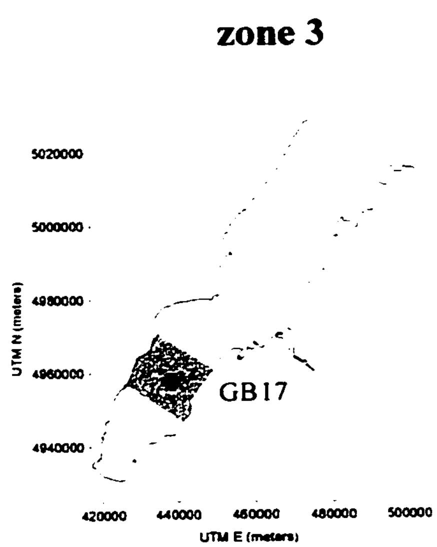
b

Because of the morphology and hydrodynamic properties of the bay. the circulation patterns must have been different in 1994 and 1995. In Green Bay, wind induced water currents tend to travel 0-40° to the right of the prevailing wind direction due to the Coriolis force (Mortimer 1978). The degree of deflection between surface winds and the net direction of water influenced by surface wind (i.e. the Ekman layer) depends primarily on water depth and wind speed. For a wind speed of 5 m/s, the theoretical depth of the Ekman layer is approximately 30 meters (Pond and Pickard 1978). If the water column is shallow enough, the currents generated by surface winds encounter the bottom sediments. When this happens, friction with the bottom overcomes the Coriolis force and the water mass appears to deflect to the left (when viewed relative to the surface current). The net direction of the movement of the water mass then falls closer to the direction of wind. When the water column depth decreases to approximately 10% of the Ekman layer depth, the net direction of water flow is essentially equal to that of surface winds (Pond and Pickard 1978). As wind speeds increase, the depth of the Ekman layer increases and hence, the probability that friction with the bottom will cause a decrease in the net deflection between wind and water currents. As water begins to move in response to the friction caused by wind, conservation of mass dictates that an equal mass of water replaces that which was moved. For a southerly wind over Green Bay, water will tend to move northeastward along the major axis of the bay. If the surface behaves as one sheet, then bottom water must replace the mass of water displaced to the north. This sets up a "conveyor belt" of water motion that has been observed in many estuarine environments including Green Bay (Miller and Saylor 1993). The description is oversimplified, but it suffices for the following argument.

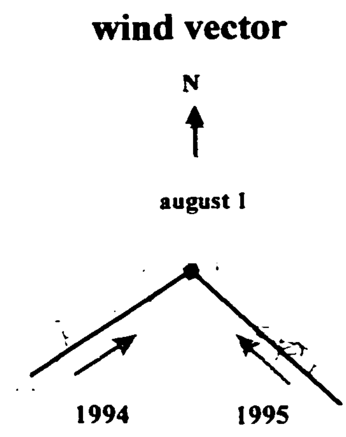
Specifically, the northeastward flow of surface water in 1994 probably exceeded that of 1995, resulting in a greater upwelling of hypolimnetic water in the southern bay and intrusion of bottom water from the north. The temperature profiles in Figure 4-14b confirm this. In August of 1994, bottom water temperatures at station GB43 were actually colder than those measured in June. This could only have occurred through an intrusion of cold Lake Michigan water. The temperature profiles at station GB17 show this to an even greater extent. A concomitant decrease in surface sediment temperature would have dramatically reduced the rate of methane production based on the temperature/methane flux relationship observed in zone 5 (Figure 4-6).

The effect of temperature on the observed differences in methane flux can be modeled, in part, for the month of August in zone 3 (Figure 4-15a). The average wind direction in August1995 was perpendicular to that of 1994 (Figure 4-15b). Average wind speeds differed by only 0.5 m/sec (1994, 5.9 m/sec; 1995, 5.4 m/sec) and yet the average flux of methane doubled from 0.24 mmol m^{-2} day^{-1} in 1994 to 0.49 mmol m^{-2} day^{-1} in 1995 (Table 4-2). Temperature profiles of the water column at GB 17 showed that while surface temperatures differed by only ~ 2 °C, bottom water and (presumably) surface sediment temperatures were ~ 12 °C warmer in 1995 (Figure 4-15c). Based on the slope of the methane flux/temperature correlation shown in Figure 4-6b, the flux of methane to the atmosphere should have increased by a factor of $e^{(0.06 * 12)}$ or 2.05 in 1995. This closely agrees with the observed factor of 2.04 (Figure 4-15d). Thus, it stands to reason that a significant fraction of the observed inter-annual difference in methane flux to the atmosphere can be explained by differences in sediment temperature that occurred during the two field seasons.

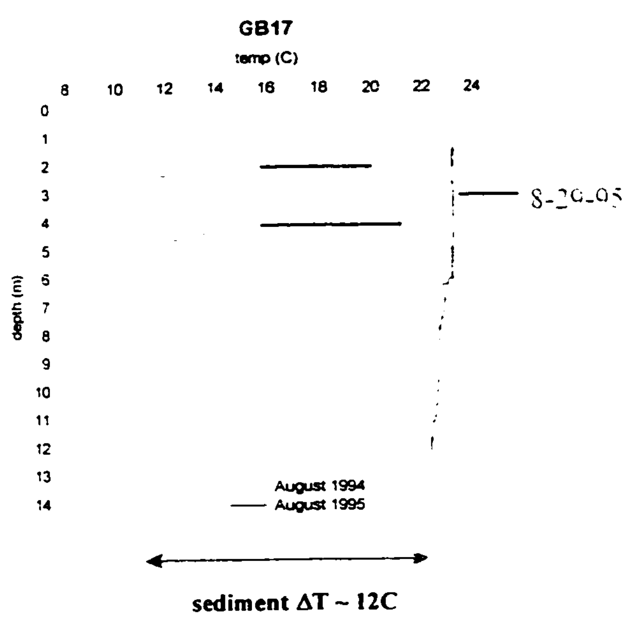
Figure 4-15. August wind directions and the inter-annual variability of surface water methane in zone 3. a) Location of station GB 17 in zone 3. b) Wind vectors for August 1994 (gray circles) and 1995 (open circles) based on hourly wind velocities measured at buoy # 45002. The vectors begin at the origin on August 1st and run toward the direction the wind is coming from till August 31st. c) Temperature profiles showing intrusion of cold Lake Michigan water into the hypolimnion of zone 3 in August of 1994 and the absence of an intrusion in August of 1995. d) Calculation of expected increase in methane flux based on a 12 °C temperature increase and the temperature / methane flux correlation observed in zone 5.



a



b



c

august average		*1994*	*1995*
CH4 flux	mmol/m2 day	0.24	0.49
wind speed	m/sec	5.9	5.4
surface temp	C	21	23

CH4 flux increase	*formula*	*flux ratio*
observed	0.49 / 0.24	2.04
predicted	exp(0.06*12)	2.05

d

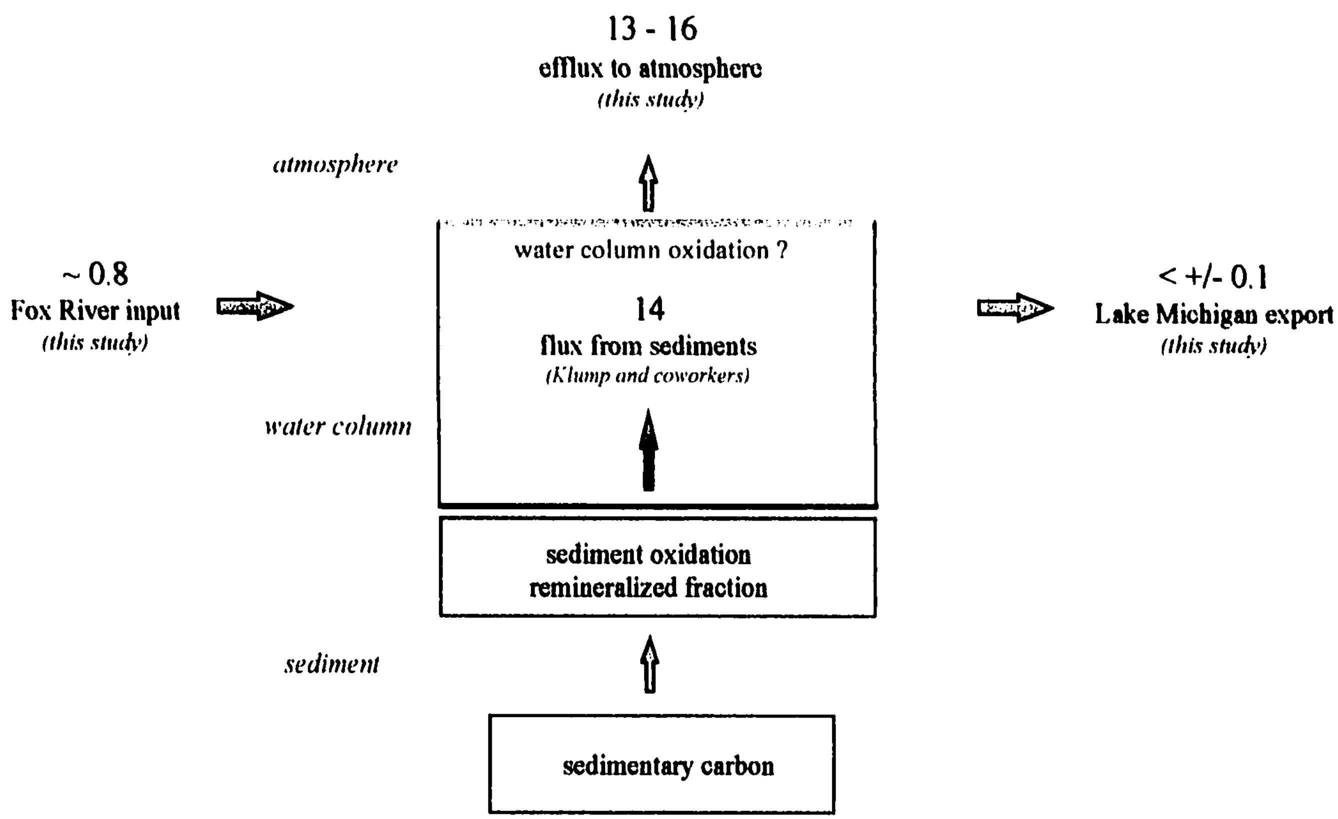
Southern Green Bay Methane Budget

Klump and Fitzgerald (1998) have estimated that approximately 14 x 10^7 moles of CH_4 flux from the sediments to the water column in southern Green Bay each year (Figure 4-16). The Fox River contributes an additional 0.8 x 10^7 moles of CH_4 based on an average surface water (~2m) concentration of ~ 2 µM CH_4 and the total Fox River flow measured during 1994 (4 x 10^9 m^3). Methane contributions from other rivers entering southern Green Bay were ignored based on the rapid attenuation in methane concentrations observed on July 14th, 1994 when the sampling transect ran into and out of the mouth of the Menominee River (see Figure 4-2). The net advective flux of methane to northern Green Bay (past Chambers Island) was estimated to be less than ± 0.1 x 10^7 moles per year. A maximum positive flux was calculated by assuming the entire water mass of southern Green Bay exchanged with water from the northern end of the bay in 0.8 years. If the methane concentration in northern Green Bay was taken as 0, then the average surface water methane concentration of 30 nM in zone 7 multiplied by the volume of southern Green Bay (22.5 km^3) times the annual exchange rate (1.25) gave a positive flux of 0.084 x 10^7 moles CH_4 per year. In reality, there was probably a small influx of methane from the northern portion of the bay. The maximum vertical gradient in methane concentration at station GB67 was assumed to occur at the end of summer. On September 14th, 1994, the hypolimnetic methane concentration was only ~ 10 nM greater than that of surface waters. Taking the product of the concentration difference and flushing volume gave an influx of 0.028 x 10^7 moles CH_4 to southern Green Bay. In either case, the fluxes were insignificant in terms of the overall methane budget.

Figure 4-16. Methane budget for southern Green Bay (zones 1-7).

southern Green Bay methane budget

units = 10^7 moles year^{-1}



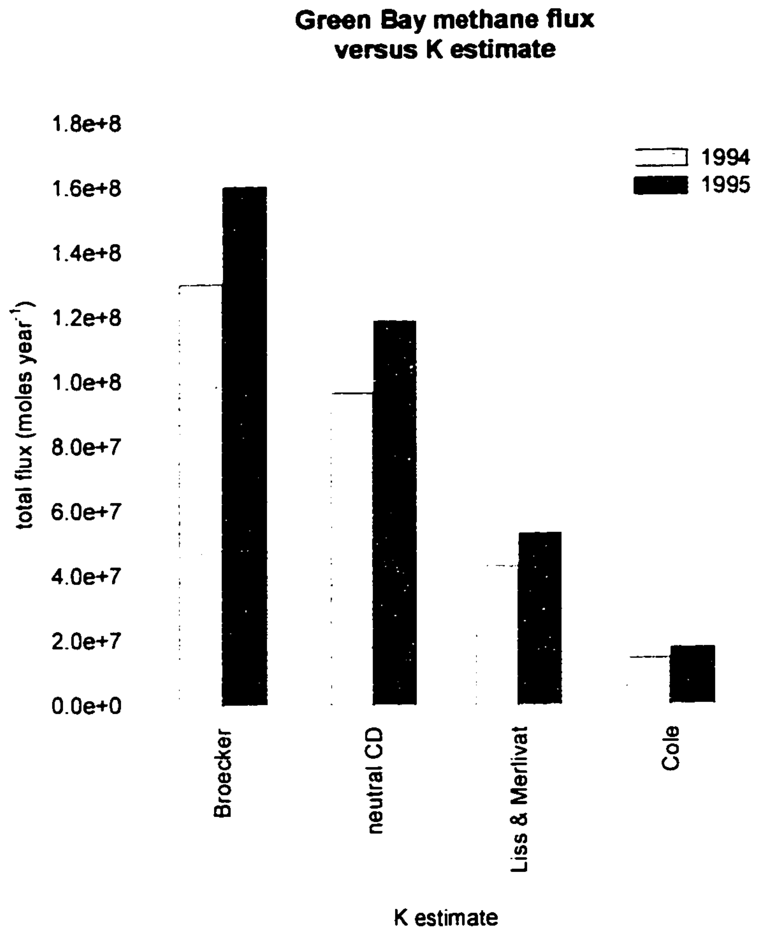
Using the mass balance approach (equation 4-1), the expected annual flux of methane across the air-water interface was equal to $J_{sw} + I - E$ or

$$(14 + 0.8 \pm 0.1) \times 10^7 \cong 14.8 \times 10^7 \text{ moles } CH_4.$$

Estimates of methane flux to the atmosphere based on Fick's first law (equation 3-1) ranged from an average of ~ 14.5 x 10^7 moles per year to ~ 1.5 x 10^7 moles per year depending on the choice of transfer coefficients (see Figure 3-9). The highest fluxes of methane (~ 14.5 x 10^7 moles CH_4 $year^{-1}$) were generated using the air column stability-corrected transfer coefficients of Broecker et al. (1978) (Figure 4-17). If a neutral drag coefficient of 1.3 x 10^{-3} was used throughout the year to estimate the wind speed at 0.6 m from data recorded at 5 m (i.e. the $U_{0.6}$:$U_{5.0}$ factor), estimates of the annual flux of methane from Green Bay were reduced by ~ 25% to ~ 11 x 10^7 moles. Using the Liss and Merlivat (1986) relationship to calculate the transfer coefficient (K) resulted in a flux estimate reduction of ~ 67% to ~ 5 x 10^7 moles CH_4. For a constant K value of 50 cm day^{-1} (Cole et al. 1994), methane flux estimates decreased ~ 90% to ~ 1.5 x 10^7 moles CH_4.

Correspondingly, the amount of (water column) methane oxidation required to balance the methane budget ranged from ~ 0 to 90% of the methane flux from the sediments. In light of the fact that significant methane oxidation has not been observed in oxygenated water columns (Lidstrom and Somers 1984, Heyer and Babenzien 1985, Kuivila 1988, Schmidt and Conrad 1993, Scranton et al. 1993, Thebrath et al. 1993), flux estimates based on shear corrected wind speeds and the U / K relationship of Broecker et al. (1978) seemed most appropriate.

Figure 4-17. Total flux of methane from southern Green Bay (zones 1-7) and its dependence on the wind speed / transfer coefficient relationship. "Broecker" refers to the U / K relationship determined by Broecker et al. (1978) where the wind speed (U) is corrected for the air-water temperature gradient and its affect on shear in the air column. "Neutral CD" refers to Broecker's U / K relationship assuming a constant drag coefficient of 1.3×10^{-3}. "Liss and Merlivat" refers to the U / K relationship given by Liss and Merlivat (1986). "Cole" refers to a constant K value of 50 cm day^{-1} (Cole et al. 1994).


Green Bay methane flux
versus K estimate
1.8e+8
1.6e+8
1.4e+8
1.2e+8
1.0e+8
8.0e+7
6.0e+7
4.0e+7
2.0e+7
0.0e+0
total flux (moles year-1)
1994
1995
Broecker
neutral CD
Liss & Merlivat
Cole
K estimate

Using similar values of $U_{0.6}$, the Broecker et al. (1978) transfer coefficients resulted in methane flux estimates which were 2.2 times higher than those of Liss and Merlivat (1986). A recent study by Keeling et al. (1998) corroborates this finding. Based on seasonal variations in the ratio of atmospheric oxygen to nitrogen in the northern hemisphere, the Liss and Merlivat (1986) relationship underestimated the rate of air-water gas exchange required to support the observed atmospheric cycles by a factor of 2.47. The implications of these finding are significant because the U / K relationship of Liss and Merlivat (1986) has been used extensively over the past decade to estimate air-water gas transfer (Wanninkhof 1992).

The accumulative error associated with my methane flux estimates is probably less than ± 20%. Annual flux estimates for 1994 and 1995 agreed to within 20% in spite of the fact that surface water methane concentrations were measured over different dates and transect routes. In addition, much of inter-annual discrepancy was shown to be due to differences in wind direction which resulted in warmer sediment temperatures and a higher methane production rate in 1995.

The average air-water flux of methane (14.5×10^7 moles year^{-1}) calculated from Fick's first law (equation 3-1) agreed to within 2% of the mass balance calculation (equation 4-1). However, the strength of this correlation rests on the assumption that methane oxidation in the water column of Green Bay is negligible. This needs to be confirmed directly.

Conclusions

The methane data presented here represent one of the larger surveys of methane ever undertaken and the first to incorporate the use of a disk equilibrator. The equilibrator showed a considerable lag in equilibrating with *in situ* methane concentrations with an e-folding time of ~ 14 minutes, but this could be corrected for if the flow rate of water passing through the equilibrator and volume of air in the equilibrator headspace was known.

Surface water methane concentrations varied considerably over both temporal and spatial scales. The lowest concentrations of methane generally occurred in deep water near Chambers Island and did not differ significantly from water in equilibrium with atmospheric methane (~ 3 nM). The highest concentration of methane was measured in the Fox River (4.86 μM). In order to isolate specific factors that might have had an influence on surface water methane concentrations, the 1635 km^2 study site was divided into seven zones ranging in size from 14 to 380 km^2. When the methane values measured during each cruise were spatially weight averaged over the seven zones, several striking patterns emerged. In the area south of Long Tail Point (defined as zone 1), methane concentrations were closely linked to the outflow of methane from the Fox River. In Sturgeon Bay (zone 5), methane correlated strongly with temperature. Concentrations doubled for every 10°C increase in temperature. Using average monthly wind speeds, methane flux to the atmosphere increased by a factor of 1.8 for every 10 °C increase in temperature.

Estimates of methane flux from southern Green Bay to the atmosphere based on air-water concentration gradients, shear corrected wind speeds and the U / K relationship of Broecker et al. (1978) resulted in annual fluxes of 13 x 10^7 moles CH_4 yr^{-1} in 1994 and 16 x 10^7 moles CH_4 yr^{-1} in 1995. Inter-annual differences in methane flux were shown to be largely due to dramatic differences in wind direction—which altered the hydrodynamics of the bay and ultimately, sediment temperatures.

The two-year average annual flux of methane to the atmosphere agreed to within 2% of the estimate of methane influx from sediments and rivers to southern Green Bay (14.8×10^7 moles CH_4 yr^{-1}; Klump and Fitzgerald (1998) and this study). The implied support for the U / K relationship of Broecker et al. (1978) suggests that the kinetics of air-water gas exchange are 2.2 times higher than that predicted by the frequently used U / K relationship of Liss and Merlivat (1986).

Chapter 5

The Dynamics of Surface Water Carbon Dioxide in Green Bay

Introduction

Carbon is arguably the keystone element in an ecosystem and an understanding of the carbon cycle is essential to understanding how an ecosystem functions. However, the chemistry of both organic and inorganic carbon is complex and the flux of carbon within and between biological and non-biological compartments can be rapid.

The situation is somewhat simplified as CO_2 is often the primary medium of exchange. In aquatic environments, photosynthetic autotrophs take up CO_2 during the day (and respire it at night) while heterotrophic organisms consume organic carbon and respire CO_2. Dead organisms fall to the sediment where the organic carbon is either buried permanently or respired to (predominantly) CO_2.

If the rate of photosynthesis (P) differs from respiration (R), then the concentration of CO_2 either increases (for $P/R < 1$) or decreases (for $P/R > 1$). However, physical processes simultaneously drive the CO_2 concentration back to thermodynamic equilibrium—either through air-water gas exchange or carbonate precipitation or dissolution. Therefore, the concentration of CO_2 at any given time gives an integrated history of the kinetics of individual processes affecting the CO_2 concentration. If the dynamics of CO_2 are measured across various temporal and spatial scales, then one can begin to understand which processes play an important role in the carbon cycle.

This study was conducted in part to determine whether or not southern Green Bay acts as a net sink or source for atmospheric CO_2. A net import of CO_2 to Green Bay would imply a P/R ratio of greater than one and a system dominated by autotrophic organisms. If Green Bay was a closed system—without external imputs—autotrophy should dominate just as it does on Earth as a whole (in the sense that some organic carbon is buried). However, the influx and subsequent respiration of allochthonous organic carbon could shift the apparent P/R ratio to values less than one.

A recent survey by Cole et al. (1994) found that an overwhelming majority (87%) of 1835 lakes were supersaturated with CO_2 with respect to the atmosphere. This suggests that inputs of terrestrially derived organic carbon play a substantial and dominant role in the apparent balance between heterotrophy and autotrophy in lakes in general (del Giorgio and Peters 1993, del Giorgio et al. 1997). Whether or not this is true in Green Bay can be determined by measuring the concentration gradient of CO_2 across the air-water interface over time. Using Fick's first law (equation 3-1), the flux of CO_2 from Green Bay to the atmosphere (J_{aw}) can then be determined as the product of the air-water CO_2 gradient and the transfer coefficients that were derived in Chapter 3.

Reasonable estimates of the P/R ratio can also be calculated using published estimates of areal primary productivity (i.e. P) in Green Bay (Sager and Richman 1990, 1991). Temporarily ignoring the effects of carbonate precipitation and advective (non-atmospheric) CO_2 exchange, the ratio of photosynthesis to respiration can be taken as

$$P/R \cong P / (P + J_{aw}), \qquad (5\text{-}1)$$

where all terms are expressed in units of moles C area^{-1} time^{-1} and a positive flux of CO_2 across the air-water interface (J_{aw}) translates to a net loss of CO_2 from the bay to the atmosphere.

Measured rates of primary production span an order of magnitude on a volumetric basis from the hypereutrophic Fox River to the meso-oligotrophic conditions found north of Chambers Island (Sager and Richman 1991). By calculating the P/R ratio in each of the seven zones along this trophic gradient (see Figure 2-11), Green Bay should serve as an excellent model for the effect of terrestrial loading on aquatic systems and the relationship between autotrophy and heterotrophy in coastal systems.

The carbon dioxide system in Green Bay

While a comprehensive description of the carbon dioxide system is beyond the scope of this study (see Butler 1982 and Skirrow 1975), a brief description of some of the terms that will be used are in order. To begin, carbon dioxide differs from most gases in that when it dissolves in water, it hydrates and ionizes to carbonic acid, bicarbonate and carbonate according to the following reactions:

$$CO_2(g) = CO_2(aq) \tag{5-2}$$

$$CO_2(aq) + H_2O = H_2CO_3(aq) \tag{5-3}$$

$$H_2CO_3(aq) = H^+(aq) + HCO_3^-(aq) \tag{5-4}$$

$$HCO_3^-(aq) = H^+(aq) + CO_3^{2-}(aq)\,. \tag{5-5}$$

Since the concentration of carbonic acid at equilibrium is only ~ 10^{-3} times that of [CO_2], the two uncharged species are generally combined. In this study, the two species will simply be referred to as [CO_2].

Using "hybrid" notation (Butler 1982), the concentrations of the various species can be described as:

$$K_0 = [CO_2]/f(CO_2) \quad (5\text{-}6)$$

$$K_1 = 10^{-pH}[HCO_3^-]/[CO_2] \quad (5\text{-}7)$$

$$K_2 = 10^{-pH}[CO_3^{2-}]/[HCO_3], \quad (5\text{-}8)$$

where the fugacity of CO_2 is in atmospheres, the concentrations are expressed on the molality scale, the activity of the hydrogen ion is expressed on the NBS scale (where {H^+} = [H^+] at γ+ = 1) and the activity coefficients for each of the carbon dioxide species (i.e γo, γ- and γ--) are included in the equilibrium constant. Total CO_2 (ΣCO_2 or C_T) is defined as the sum concentration of [CO_2] + [HCO_3^-] + [CO_3^{2-}]. Carbonate alkalinity (A_C) is defined as [HCO_3^-] + 2[CO_3^{2-}] + [OH^-] - [H^+] and, in fresh waters like Green Bay, accounts for approximately 99.7% of the total alkalinity (A_T). Skirrow (1975) gives another definition of carbonate alkalinity (C_A) as [HCO_3^-] + 2[CO_3^{2-}]. At pH values found in Green Bay, $C_A \cong$ 99.8% of A_C. If any two of the four CO_2 parameters (i.e. pH, fCO_2 ,

ΣCO_2, and A_C) are known along with the appropriate equilibrium constants (K_0, K_1, and K_2), then the other two parameters can be calculated using the equations given above.

The value of K_0 is given in Chapter 2 (equation 2-14) and is considered accurate since γo is fairly immune to the ionic strength of the medium (Butler 1982). This is not the case for K_1 and K_2 and a rigorous determination of these equilibrium constants has yet to be made in Green Bay. Weiler (1975) found that the Lyman's (1956) equilibrium constants at zero ionic strength gave the best fit between calculated and measured pCO_2 in Lake Erie and Lake Ontario. The correlation deteriorated when an attempt was made to correct for ionic strength. The reasons for this were not elaborated on. However, based on a very limited data set, the same conclusions were reached in Green Bay during this study. ΣCO_2, pH and fCO_2 were measured while underway on a transect from the Fox River to Sturgeon Bay on August 29th, 1995. Lyman's constants at zero ionic strength as given in Skirrow (1975) were fit to 2nd-order polynomial equations to give

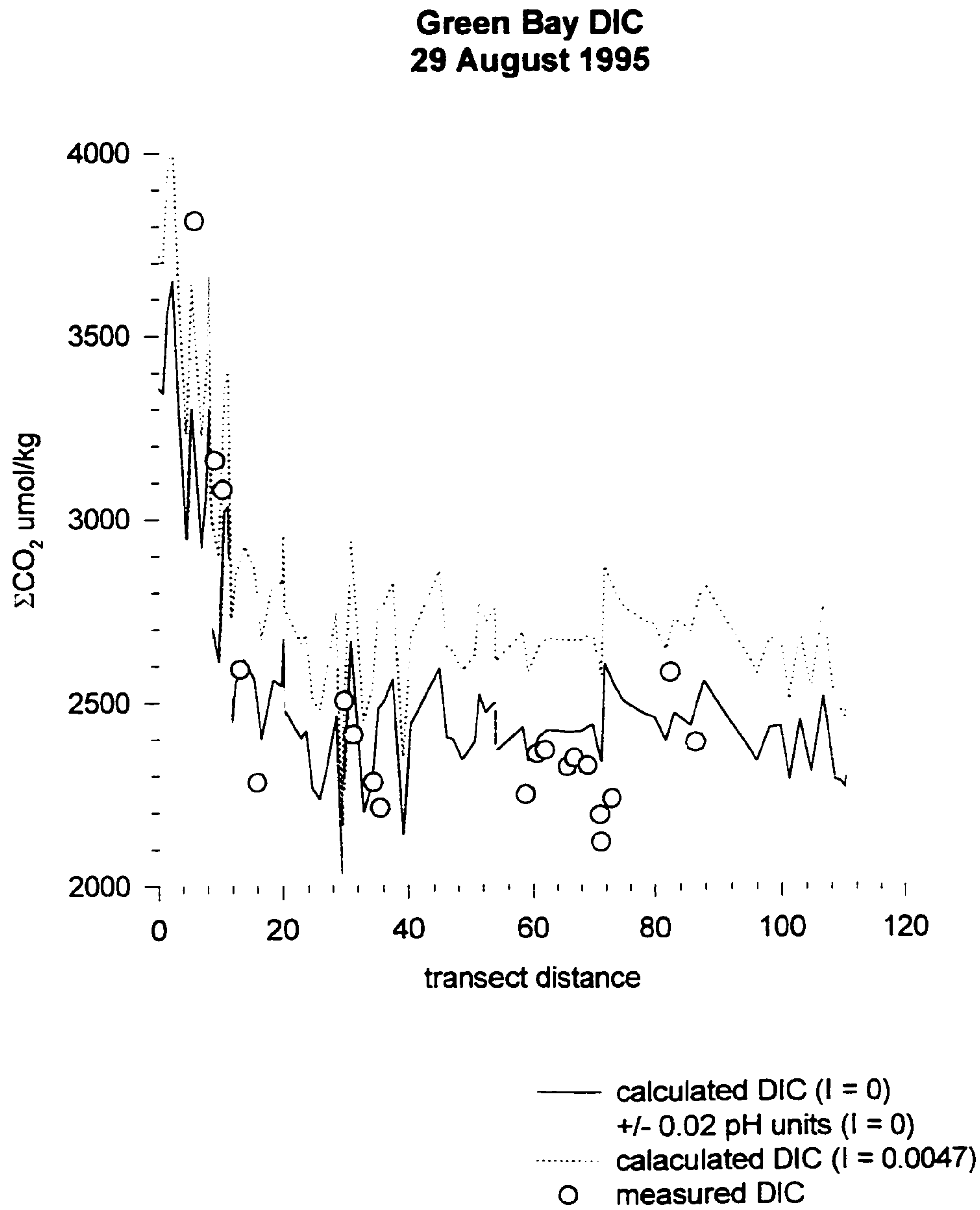
$$pK_1 = 6.58083 - 0.01288t + 0.00015t^2, \qquad (5\text{-}9)$$

and

$$pK_2 = 10.6192 - 0.01402t + 0.00010t^2, \qquad (5\text{-}10)$$

where t = temperature in °C, then used to calculate ΣCO_2 using pH and fCO_2 (Figure 5-1, solid black line). The fit with measured ΣCO_2 (Figure 5-1, gray circles) was reasonable

Figure 5-1. The calculated versus measured ΣCO_2 concentration along a transect from Fox River (0 km) to Sturgeon Bay (110 km). The calculated ΣCO_2 values were determined from pH, fCO_2 and the equilibrium constants of Lyman (1956) at zero ionic strength (solid black line) and the calculated ionic strength (0.0047 M, dotted black line). The gray lines represent calculated ΣCO_2 concentrations at ± 0.02 pH units from the measured pH.


Green Bay DIC
29 August 1995
4000
3500
3000
2500
2000
ΣCO2 umol/kg
0
20
40
60
80
100
120
transect distance
calculated DIC (I = 0)
+/- 0.02 pH units (I = 0)
calaculated DIC (I = 0.0047)
measured DIC

considering the spatial heterogeneity of the system and the accuracy of the pH (~ ±0.02 pH units, gray lines) and ΣCO_2 (~ ±5%, 0.1ml sample size) measurements. If the equilibrium constants were corrected for the average calculated ionic strength of 0.0047 M (Table 5-1), the calculated ΣCO_2 (Figure 5-1, dotted line) appeared to be ~ 10% high.

The average $\gamma-$ calculated for an ionic strength of 0.0047 M was ~ 0.93 (Davies equation). An estimate of the activity coefficient for the hydrogen ion ($\gamma+$) was calculated from Gran titration alkalinity plots (Figure 5-2) that were generated from samples obtained at the Fox River, GB 17, and GB 32. Where

$$\gamma+ = (df1/dV) \times (Va/Ca), \qquad \text{(Butler 1982)} \qquad (5\text{-}11)$$

and

$$f1 = [\,(V + Va) / Va\,] \times 10^{-pH}, \qquad (5\text{-}12)$$

V = volume of the sample, Va = the volume of the titrant (HCl), Ca = the concentration of the titrant, and $\gamma+ \cong 0.96$ (Fox River), 0.98 (GB 17), and 0.99 (GB 32). Assuming $\gamma- \cong \gamma+$, it would appear that the activity coefficients calculated using the Davies equation are somewhat lower than they should be. The discrepancies are consistent with what would

Table 5-1. Approximate charge balance, ionic strength, and activity coefficients for southern Green Bay based on average chemical concentrations given in Torrey (1976).

CHARGE BALANCE

cation

	mg/L	mmol/L	positive charge
Ca	35.000	0.875	1.750
Mg	12.000	0.494	0.988
Na	5.000	0.217	0.217
K	1.000	0.026	0.026
BORON	0.100	0.009	0.028
Σ		1.621	**3.008**

anion

	mg/L	mmol/L	negative charge
HCO3		2.150	2.150
Cl	12.000	0.339	0.339
SO4	20.000	0.208	0.417
CO3		0.040	0.080
NO3	0.200	0.014	0.014
PO4	0.050	0.002	0.005
Σ		2.753	**3.004**

IONIC STRENGTH

I = 0.5 sum(Ciz^2i)

	conc	charge	C*z^2
Ca	0.875	2	3.500
Mg	0.494	2	1.975
Na	0.217	1	0.217
K	0.026	1	0.026
BORON	0.009	3	0.083

	conc	charge	C*z^2
HCO3	2.150	1	2.150
Cl	0.339	1	0.339
SO4	0.208	2	0.833
CO3	0.040	2	0.160
NO3	0.014	1	0.014
PO4	0.002	3	0.015

Σ	cation	5.802
Σ	anion	3.511
Σ		**9.312**
		moles/liter
Ionic strength		**0.0047**

activity coefficients

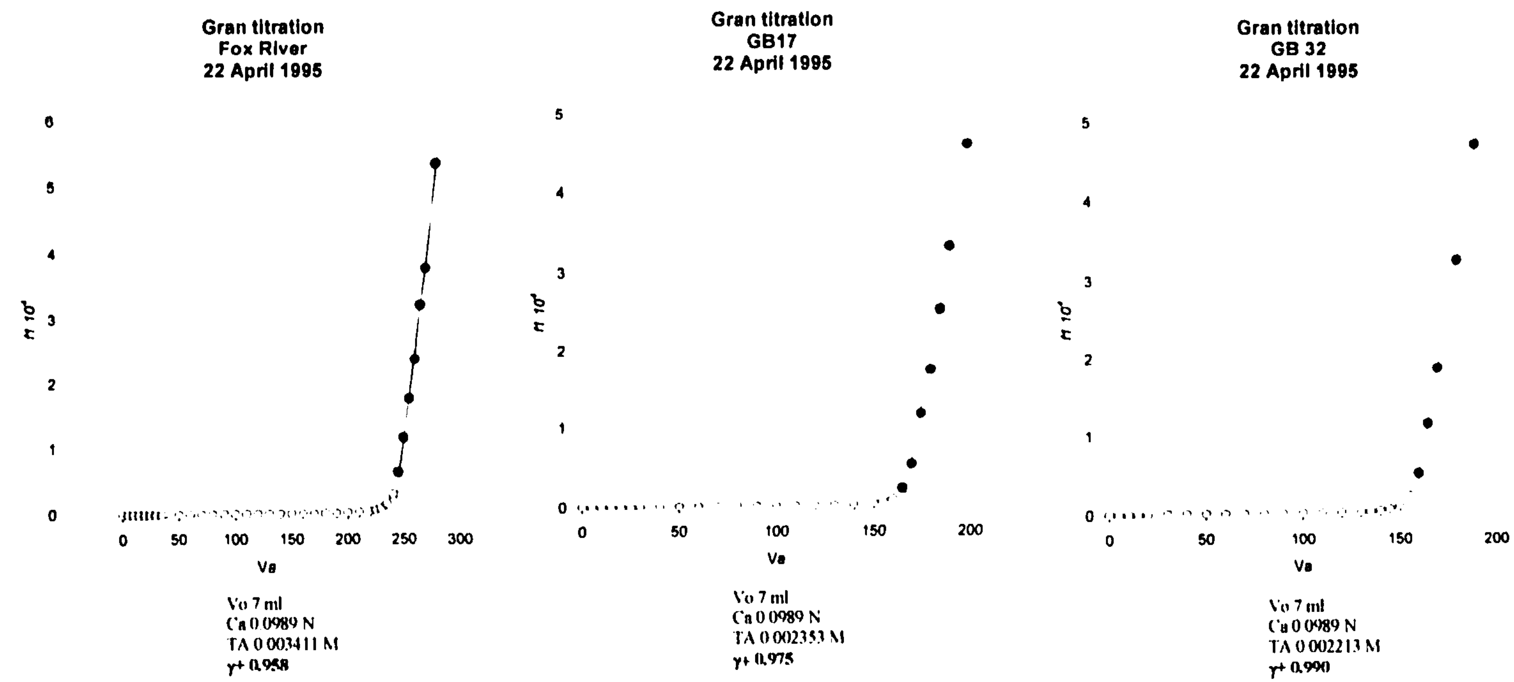
DAVIES EQUATION

log g = -0.5z^2 f(I)

where f(I) = ((I^.5/1+I^.5) - .3I)(298/t+273)^2/3

temp	charge	gamma
15	1	0.929
15	2	0.745
15	3	0.516

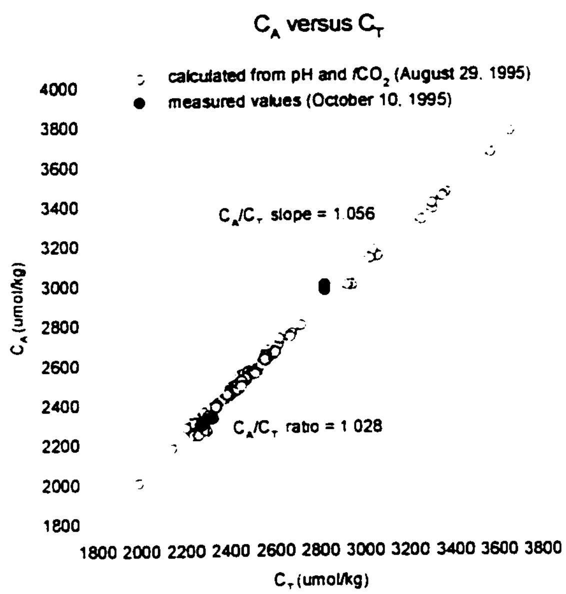
Figure 5-2. Gran titration plots for water samples collected at Fox River, GB17, and GB32. See text for derivation of H^{+} activity coefficient (γ+). Black circles indicate points used to calculate df1/dV. Vo = volume of water sample, Ca = normality of HCl used to titrate sample, TA = total alkalinity and γ+ = calculated activity coefficient for the hydrogen ion (H^{+}).


Gran titration
Fox River
22 April 1995
Va
Vo 7 ml
Ca 0.0989 N
TA 0.003411 M
r² 0.958
Gran titration
GB17
22 April 1995
Va
Vo 7 ml
Ca 0.0989 N
TA 0.002353 M
r² 0.975
Gran titration
GB 32
22 April 1995
Va
Vo 7 ml
Ca 0.0989 N
TA 0.002213 M
r² 0.990

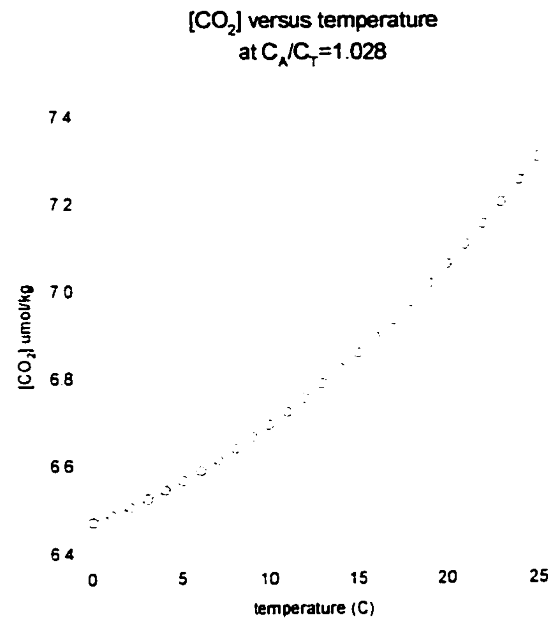
occur if ion-pairing was taking place. Whatever the cause, a more thorough examination is needed. For the time being, Lyman's estimates of K_1 and K_2 (equations 5-9 and 5-10) will be used.

The values of K_0, K_1 and K_2 primarily depend on temperature. Consequentially, the apparent fugacity of CO_2 in water also depends on temperature. As water temperatures fluctuate, the solubility of CO_2 will change as will the equilibrium distribution of the carbonate species. Separating the effects of biology and temperature on CO_2 concentrations, therefore, can be difficult. For this reason, a considerable amount of research has gone into determining the affect of temperature change on fCO_2 in seawater (see Millero 1995). Similar work has not been done in freshwater but a reasonable estimate can be made here using the August 29th, 1995 pH and fCO_2 data (used to generate Figure 5-1) and the equilibrium constants given by equations 2-14, 5-9, and 5-10. To begin, $[CO_2]$, $[HCO_3^-]$, $[CO_3^{2-}]$, C_T, and C_A were calculated from measured values of pH, fCO_2, temperature, and the appropriate equilibrium constants using equations 5-6, 5-7, and 5-8. C_A was plotted against C_T (Figure 5-3a) to give a C_A/C_T slope of 1.056. Based on the average southern Green Bay value of C_T (~ 2.3 mmol/kg, Appendix 5), a C_A/C_T ratio of 1.028 was used to calculate the change in $[CO_2]$ and fCO_2 with temperature. Assuming constant C_T (2300 µmol/kg) and C_A (2363.5 µmol/kg) (i.e. a closed system), $[CO_2]$ was back-calculated for temperatures between 0 - 25°C using the equation (from Skirrow 1975):

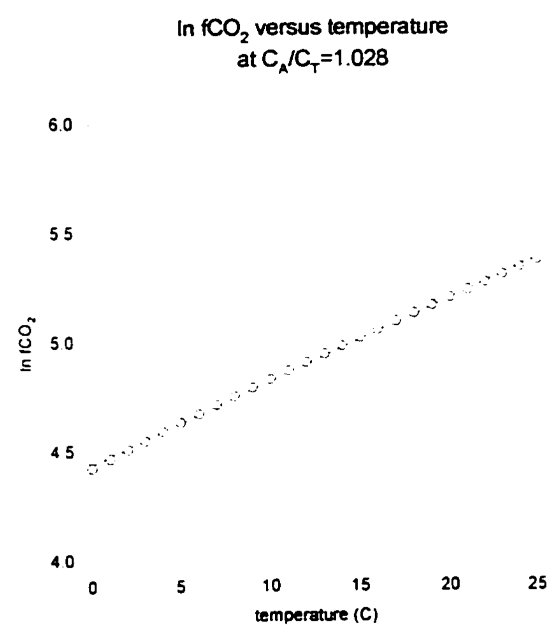
Figure 5-3. Effects of temperature on the concentration of CO_2 in southern Green Bay. a) The relationship between carbonate alkalinity (C_A) and total inorganic carbon (C_T) in Green Bay. Gray circles show values calculated from pH and fCO_2. Black circles show measured values of total alkalinity (A_T) and total inorganic carbon (C_T). Differences between C_A and A_T (< 0.3%) were ignored. b) Response of $[CO_2]$ to temperature at a C_A/C_T ratio of 1.028. c) Response of fCO_2 to temperature at a C_A/C_T ratio of 1.028. d) Change in response of fCO_2 to temperature at a C_A/C_T ratio of 1.028 as a function of temperature.


C_A versus C_T
calculated from pH and fCO_2 (August 29, 1995)
measured values (October 10, 1995)
C_A/C_T slope = 1.056
C_A/C_T ratio = 1.028
C_A (umol/kg)
C_T (umol/kg)
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1800 2000 2200 2400 2600 2800 3000 3200 3400 3600 3800

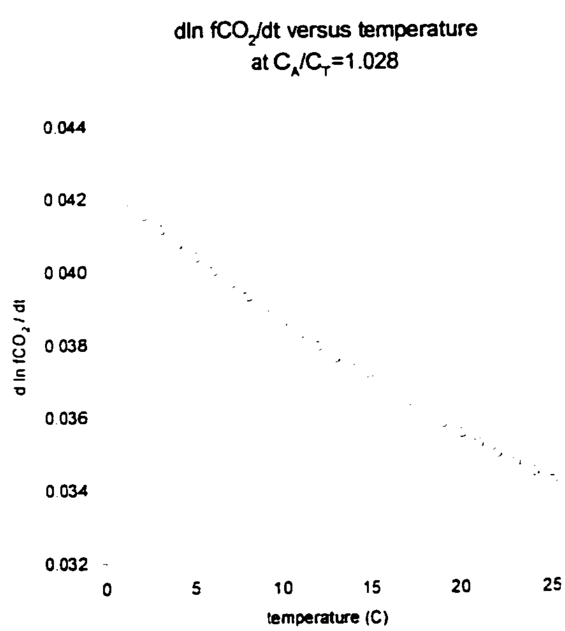
a


$[CO_2]$ versus temperature
at C_A/C_T=1.028
$[CO_2]$ umol/kg
temperature (C)
7.4
7.2
7.0
6.8
6.6
6.4
0 5 10 15 20 25

b


ln fCO_2 versus temperature
at C_A/C_T=1.028
ln fCO_2
temperature (C)
6.0
5.5
5.0
4.5
4.0
0 5 10 15 20 25

c


dln fCO_2/dt versus temperature
at C_A/C_T=1.028
d ln fCO_2 / dt
temperature (C)
0.044
0.042
0.040
0.038
0.036
0.034
0.032
0 5 10 15 20 25

d

$$[CO_2] = C_T - C_A + ((C_A * K_r - C_T * K_r - 4C_A + Z) / 2(K_r - 4) \quad (5\text{-}13)$$

where

$$Z = [(4C_A + C_T * K_r - C_A * K_r)^2 + 4(K_r - 4)C_A^2]^{0.5} \quad (5\text{-}14)$$

and $K_r = K_1/K_2$. The results are plotted in Figure 5-3b, and show a ~ 0.4% increase in $[CO_2]$ for each °C in temperature increase due to shifts in K_1 and K_2. The fugacities for each value of $[CO_2]$ between 0-25°C were calculated using equation 2-14 and plotted in Figure 5-3c. A linear fit of the data gave a slope of $d \ln fCO_2 / dt = 0.0377$. The change in fugacity due to a change in temperature was therefore calculated as:

$$\ln fCO_{2\ \text{NEW TEMP}} = \ln fCO_{2\ \text{OBS TEMP}} + 0.0377dt, \quad (5\text{-}15)$$

where dt = the change in temperature in °C. For example, for an initial fugacity of 350 µatm at 0 °C, a temperature increase of 20 °C would cause the apparent fugacity to increase ~ 112 % to 744 µatm. A closer look at the plot of $d \ln fCO_2 / dt$ versus temperature (Figure 5-3d) revealed the relationship was not quite linear, but the error introduced using the linear assumption was small over the temperature range seen in Green Bay. Scaling the $d \ln fCO_2 / dt$ relationship at $T_A/C_T = 1.028$ up to a ratio of T_A/C_T typical of seawater (~ 1.1), $d \ln fCO_2 / dt \cong 0.042$ which, again, is typical in marine systems (see Millero 1995, Takahashi et al. 1993, Weiss et al. 1982).

Another CO_2 parameter normally associated with marine systems is the Revelle or homogeneous buffer factor. The Revelle factor (B) is defined by Butler (1982) as:

$$B = \Sigma CO_2 / fCO_2 \, (\partial fCO_2 / \partial \Sigma CO_2)_{TA} = (\partial \log fCO_2 / \partial \log \Sigma CO_2)_{TA}, \qquad (5\text{-}16)$$

and describes the percent change in fCO_2 caused by a 1% change in ΣCO_2 at constant alkalinity (Lewis and Wallace 1998). The value of B is sensitive to both temperature and the ratio of total alkalinity to ΣCO_2. In marine systems, B typically ranges from ~ 8 ($A_T/\Sigma CO_2$ ~ 1.20) to 14 ($A_T/\Sigma CO_2$ ~ 1.06) (Takahashi et al. 1993). Interest in the Revelle factor has for the most part been related to estimating the ocean's capacity to buffer anthropogenic increases in atmospheric CO_2. However, for a given change in fCO_2, the Revelle factor can also be used to estimate the change in ΣCO_2 if direct measurements are lacking (Takahashi et al. 1993).

An estimate of the Revelle buffer factor in southern Green Bay was made under the assumption that $A_T \cong A_C \cong C_A$. Under these conditions, B is simply defined as:

$$B = \Sigma CO_2 / [CO_2] + [CO_3^{2-}] \text{ (Butler 1982).} \quad (5\text{-}17)$$

Using the pH, fCO_2, and temperature data collected on August 29th, 1995 and the values of ΣCO_2, $[CO_2]$, and $[CO_3^{2-}]$ that were calculated using equations 2-14, 5-6, 5-7, 5-8, 5-9, and 5-10, estimates of B were calculated using equation 5-17 and plotted in Figure 5-4 (gray circles) in relation to the C_A / C_T ratio observed along the transect route between the Fox River ($C_A/\Sigma CO_2 \sim 1.05$) and Sturgeon Bay ($C_A/\Sigma CO_2 \sim 0.99$). Values of B were also calculated using measured values of fCO_2, A_T, and C_T from October 10th, 1995 (Figure 5-4, black circles) where $[CO_3^{2-}]$ was assumed to be approximately equal to:

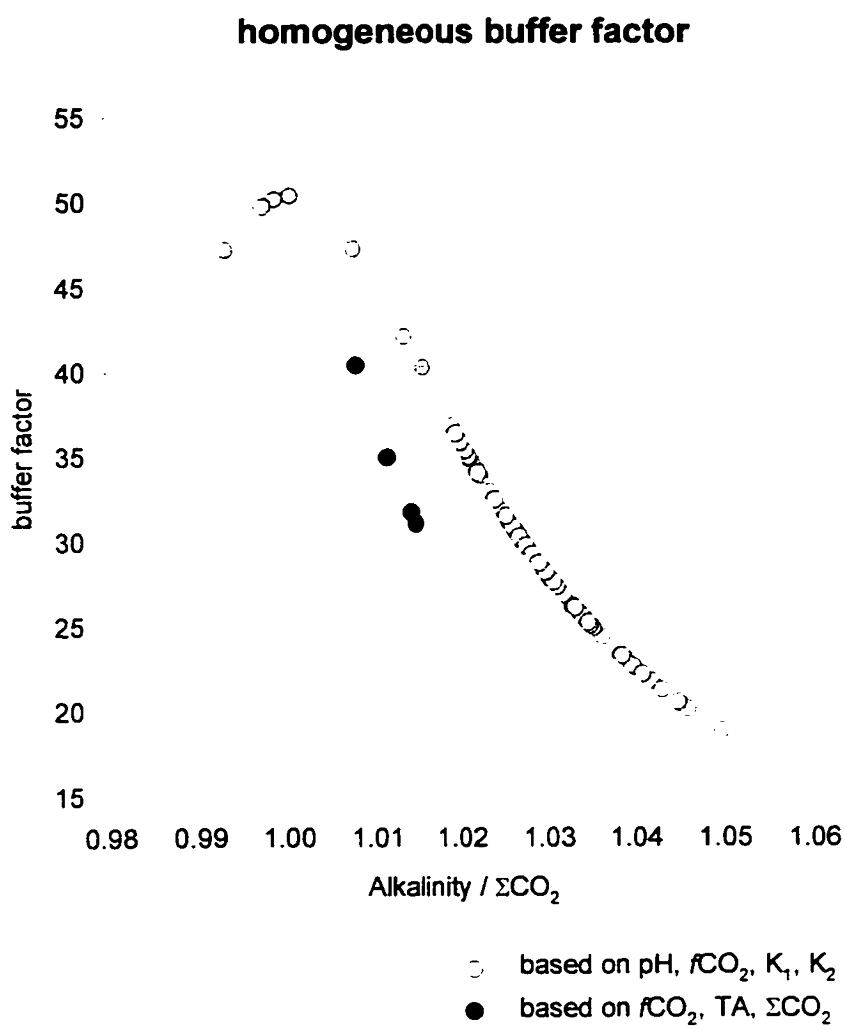
$$[CO_3^{2-}] \cong A_T - C_T - [CO_2]. \quad (5\text{-}18)$$

In both cases, estimates of the Revelle factor for the major basin of Green Bay (outside of Sturgeon Bay and the Fox River) generally fell between 25 and 35—meaning that a 1% change in ΣCO_2 would result in a ~ 30% change in fCO_2.

Surface water carbon dioxide

Over 1800 carbon dioxide measurements were made during the open water transects of 1994 and 1995. The concentrations of CO_2 (expressed as fugacities) and

Figure 5-4. Homogeneous buffer factor as a function of alkalinity/ΣCO_2 in southern Green Bay. Gray circles were calculated from data collected on August 29th, 1995. Black circles were calculated from data collected on October 10th, 1995.



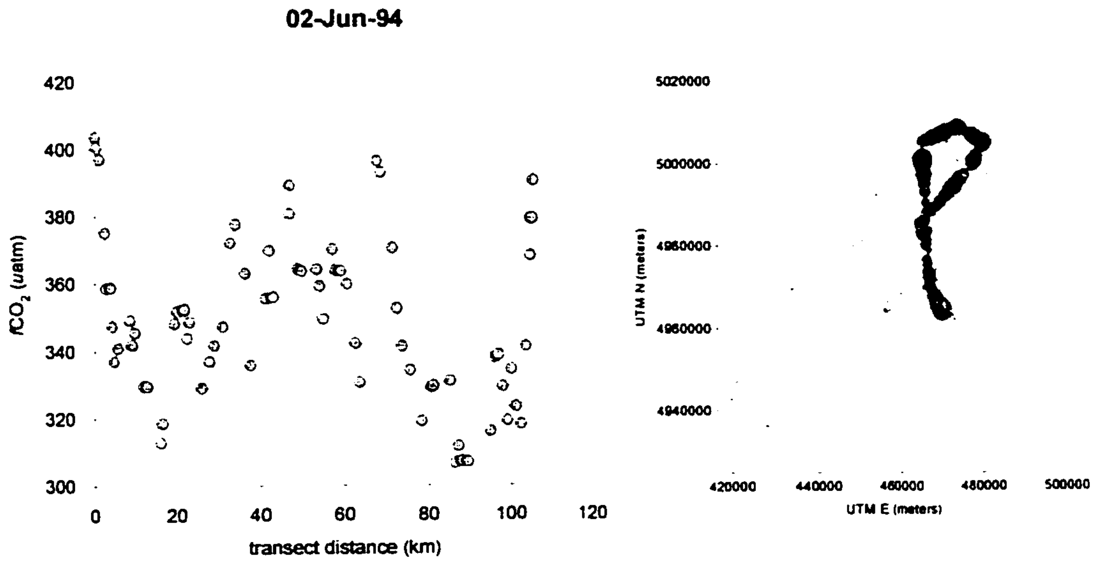
homogeneous buffer factor
55
50
45
40
35
30
25
20
15
buffer factor
0.98
0.99
1.00
1.01
1.02
1.03
1.04
1.05
1.06
Alkalinity / ΣCO2
based on pH, fCO2, K1, K2
based on fCO2, TA, ΣCO2

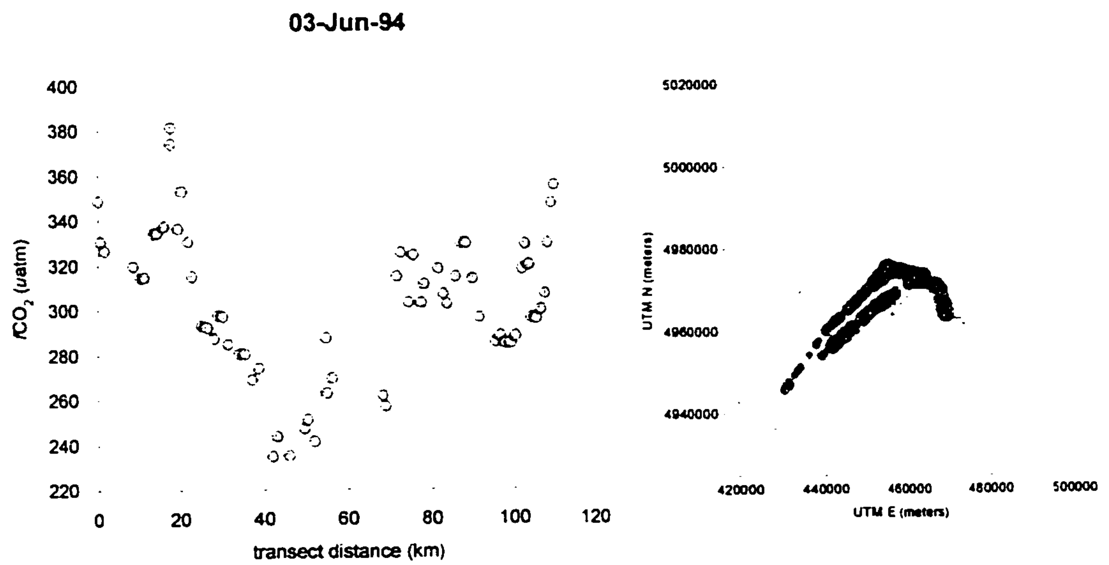
sampling sites are shown in Figure 5-5. Each of the concentrations, their coordinates, and the physical parameters relevant to calculating each concentration are also given in Appendix 3. Variations in fCO_2 in surface waters were large with individual measurements ranging from greater than 900 μatm in the Fox River and Sturgeon Bay to less than 200 μatm over portions of southern Green Bay.

Average surface water fCO_2 values (± 1 SD) in each of the seven zones of southern Green Bay revealed a more interesting spatial trend (Figure 5-6). In zone 1, the average fugacity of CO_2 was ~ 390 μatm. This was slightly higher than the average fugacity of atmospheric CO_2 as shown by the gray dotted line (see below for derivation). North of zone 1, the average surface water fCO_2 dropped below atmospheric equilibrium and remained so till zone 5 (Sturgeon Bay). Though it appeared that zones 2, 3 and 4 would import CO_2 from the atmosphere on an annual basis, while the remaining zones would export CO_2, bias in sampling dates and the coupling between changes in wind speed and surface water fCO_2 preclude this assumption. Concentrations of surface water CO_2 were measured under the ice on February 21 and 22, 1995 (Figure 5-7). While sampling sites were limited due to ice conditions, fCO_2 values tended to be below atmospheric equilibrium and averaged ~ 320 μatm.

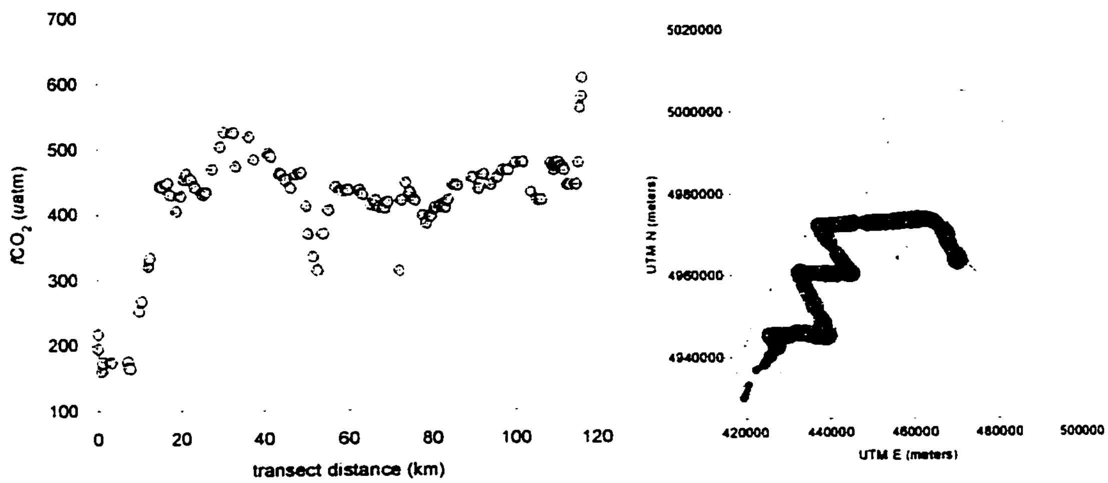
To simplify flux calculations and interpretations of large scale changes over space and time, CO_2 fugacities measured over an entire cruise (~ 3 days) were spatially weight averaged in each of the seven zones of the study site. This was accomplished by interpolating the data over a grid of each zone using an exact inverse distance method (equation 2-19). Each grid was then integrated and divided by its base area. Grid nodes were spaced at 100 meter intervals in zone 5, 250 meter intervals in zone 1, and 500 meter

Figure 5-5. Green Bay surface water fCO_2 values measured during transect cruises of 1994 and 1995. The axis range is adjusted to the highest observed concentration for each day's cruise. The transect distance represents the cumulative distance traveled in kilometers. The location of each sample point is plotted with a circle. The area of each circle is proportional to the concentration of CO_2.

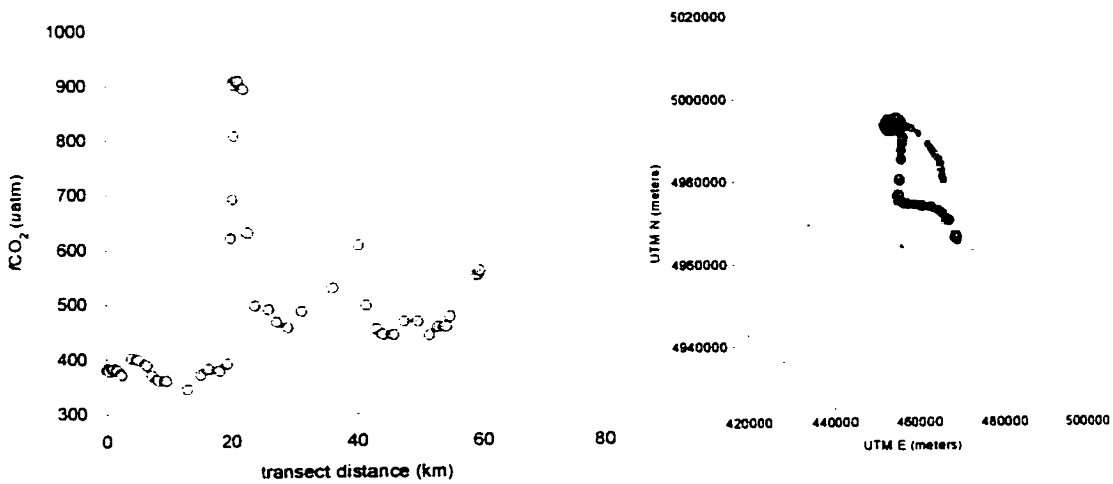

02-Jun-94
420
400
380
360
340
320
300
fCO2 (uatm)
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


03-Jun-94
400
380
360
340
320
300
280
260
240
220
fCO2 (uatm)
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)

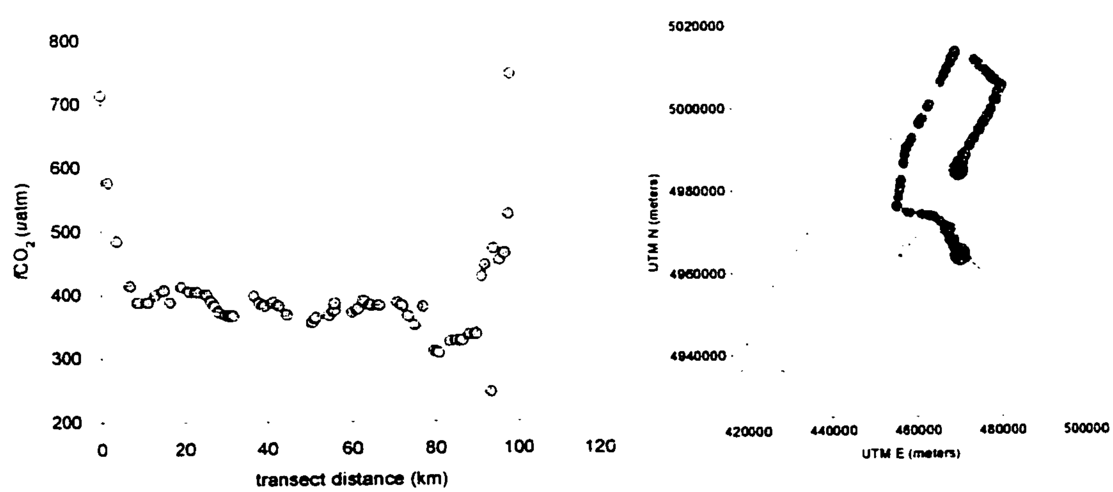
13-Jul-94

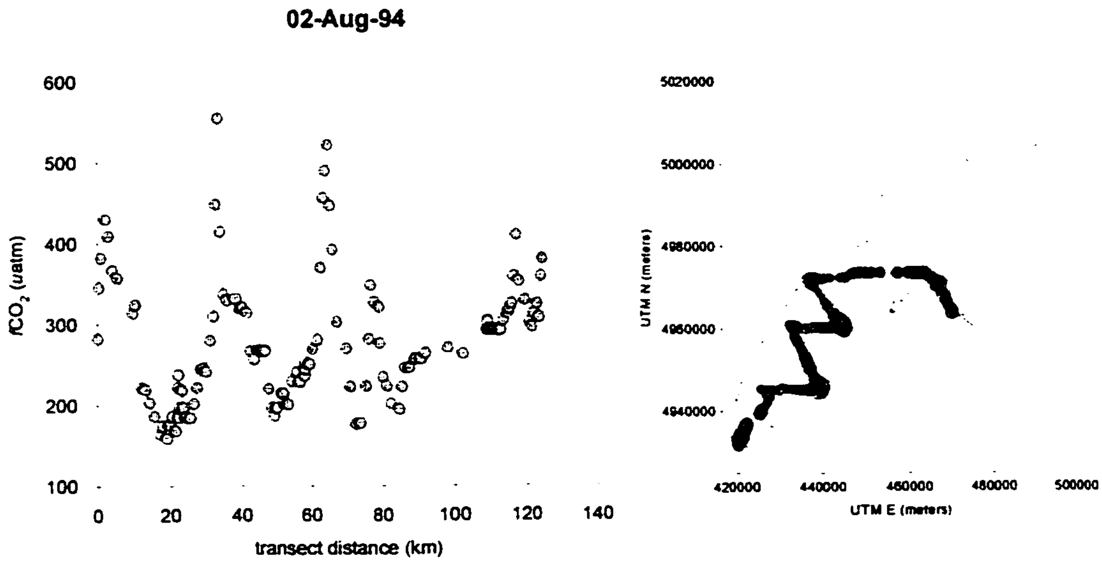


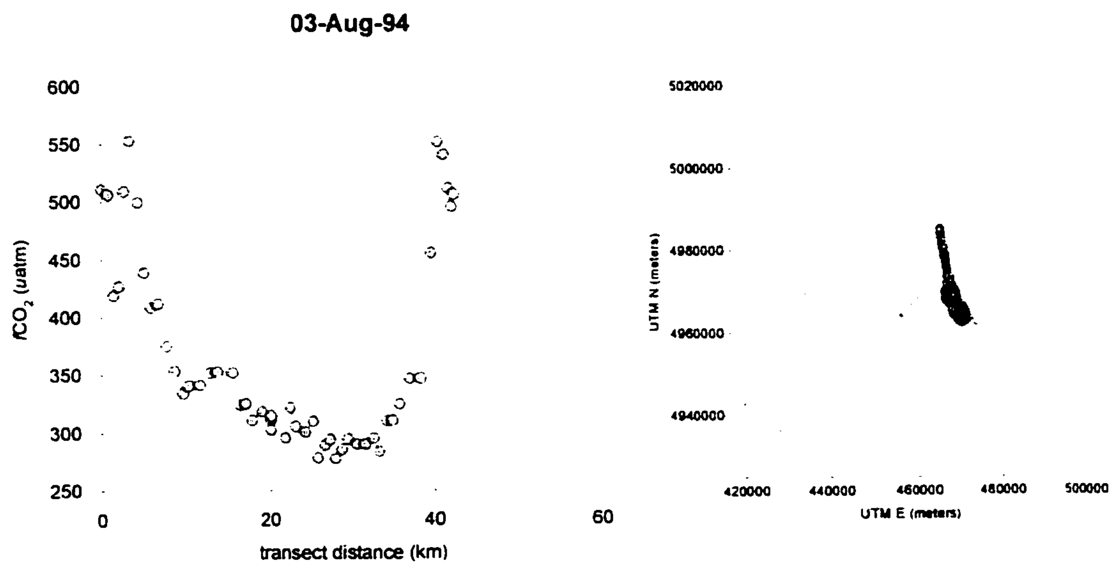
14-Jul-94



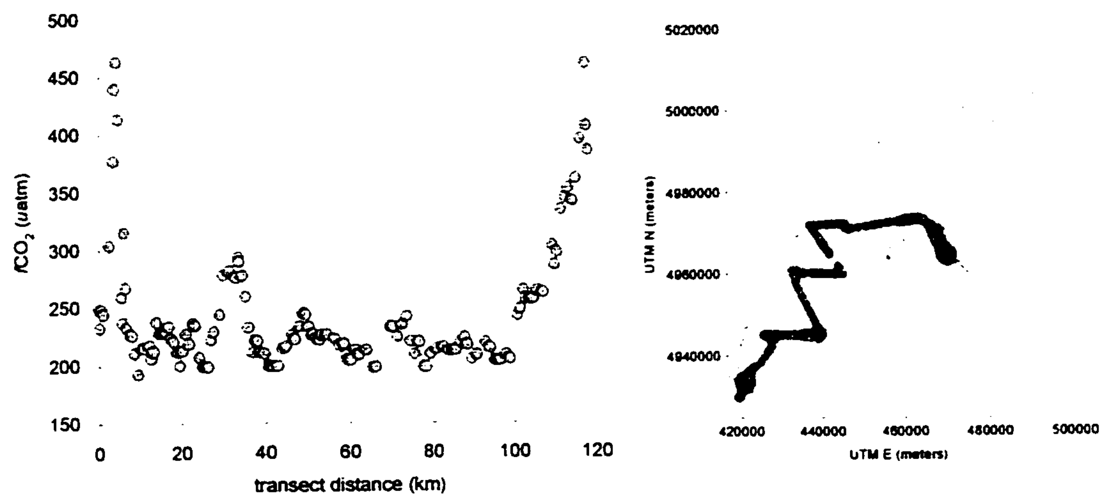
15-Jul-94



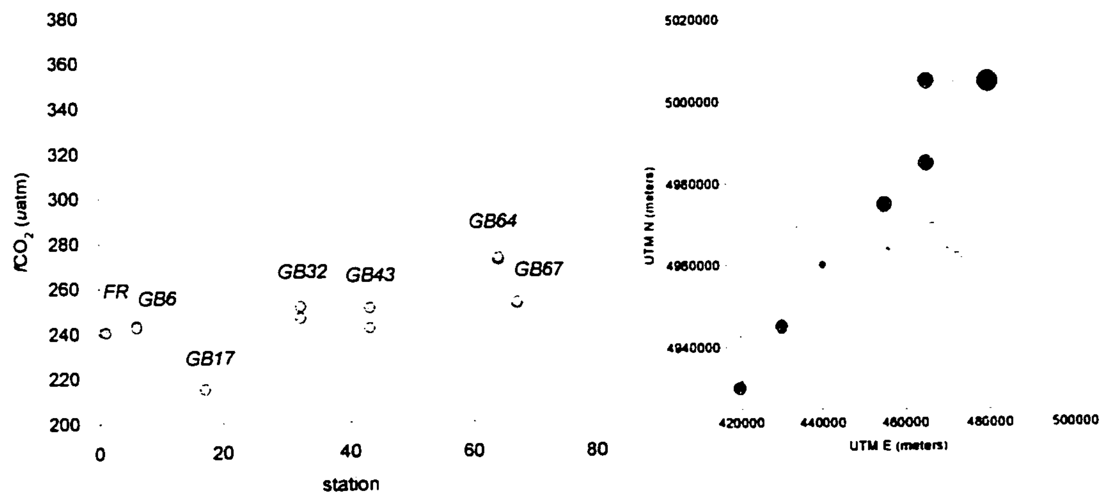

02-Aug-94
fCO2 (uatm)
600
500
400
300
200
100
0
20
40
60
80
100
120
140
transect distance (km)
UTM N (meters)
5020000
5000000
4980000
4960000
4940000
420000
440000
460000
480000
500000
UTM E (meters)


03-Aug-94
fCO2 (uatm)
600
550
500
450
400
350
300
250
0
20
40
60
transect distance (km)
UTM N (meters)
5020000
5000000
4980000
4960000
4940000
420000
440000
460000
480000
500000
UTM E (meters)

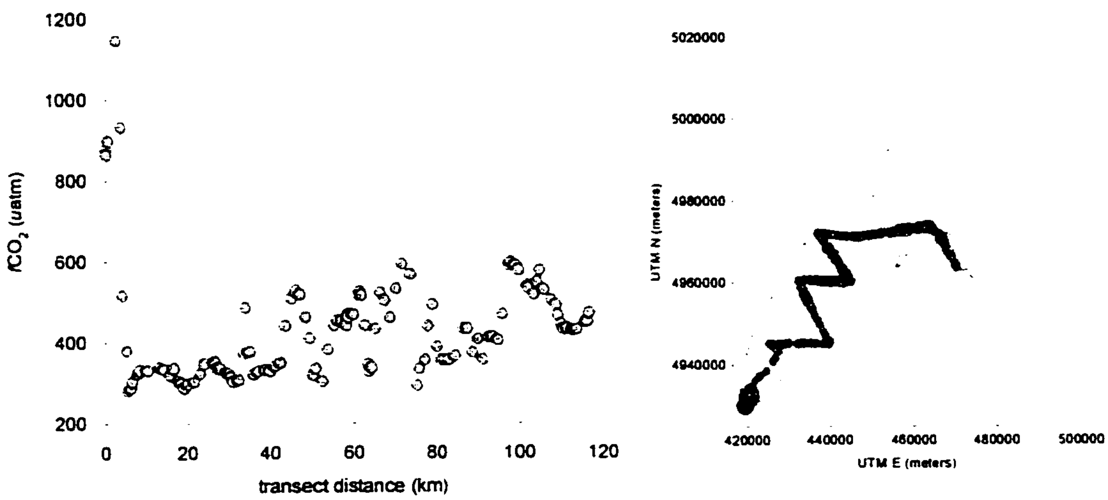
23-Aug-94



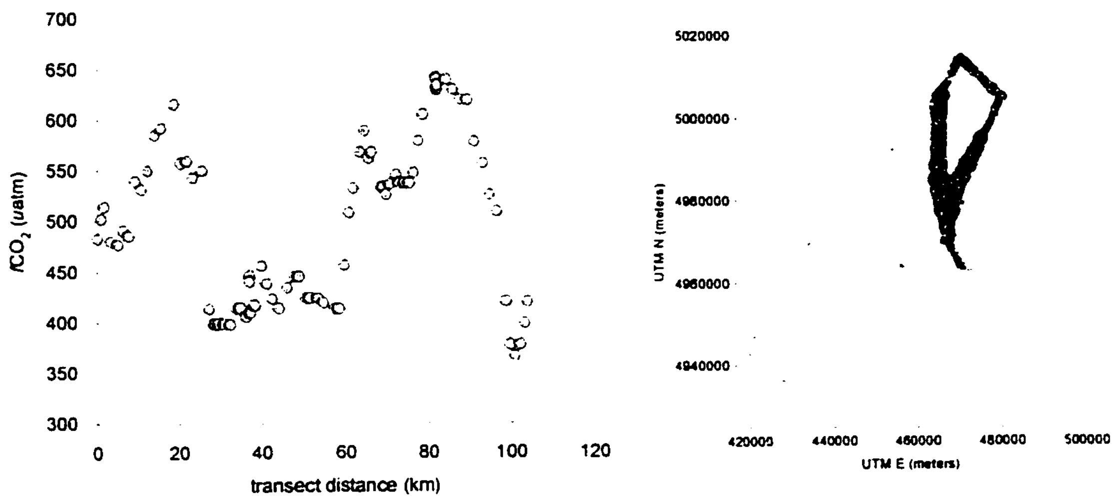
13, 14, 15 Sep 94



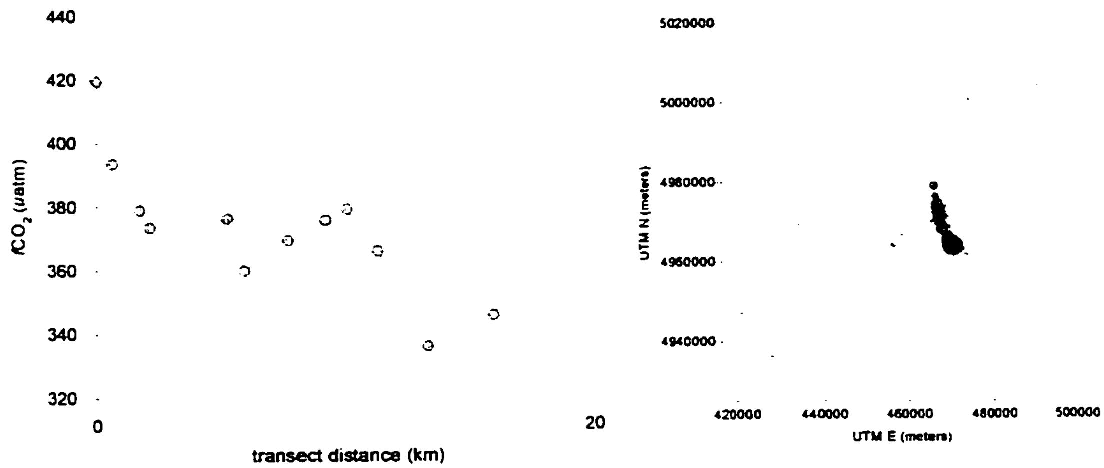
25-Oct-94



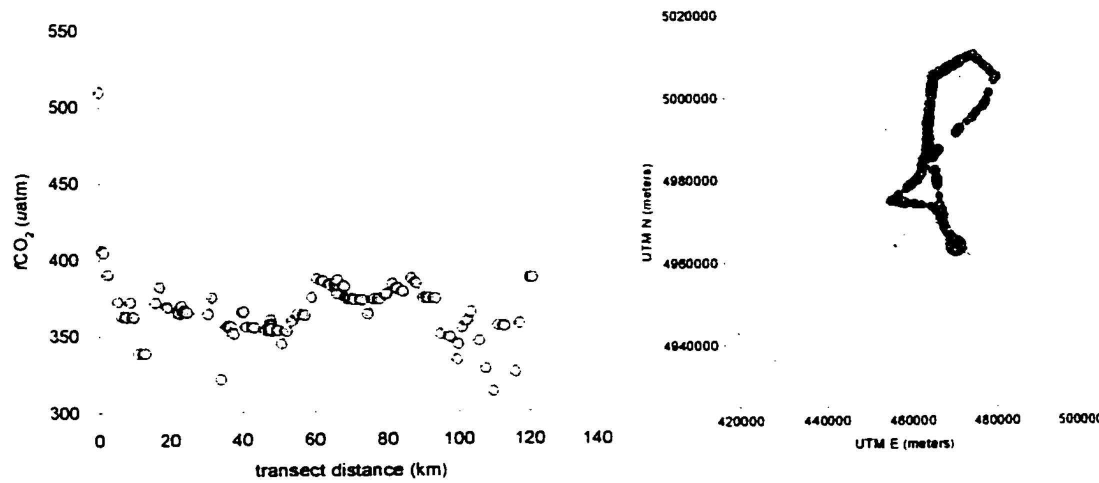
26-Oct-94



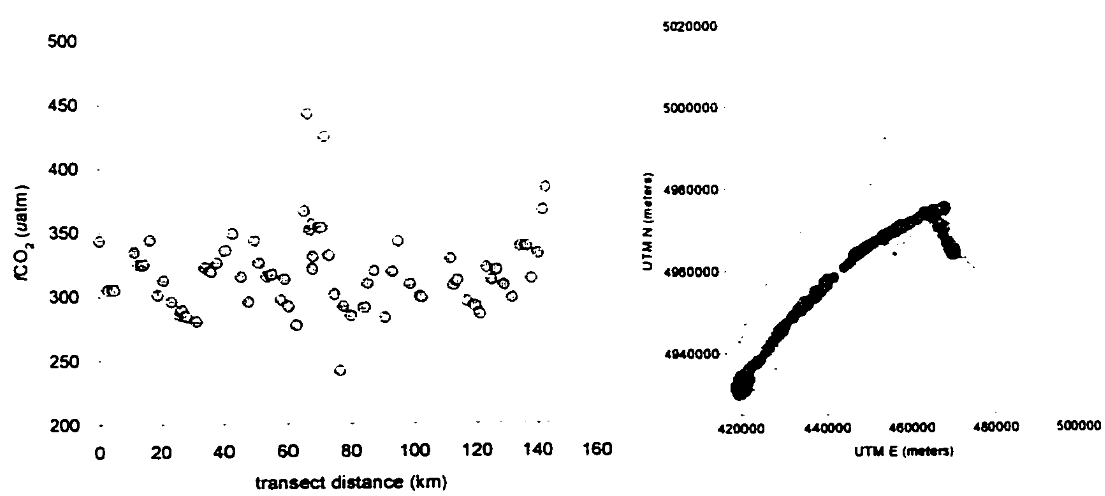
18-Apr-95



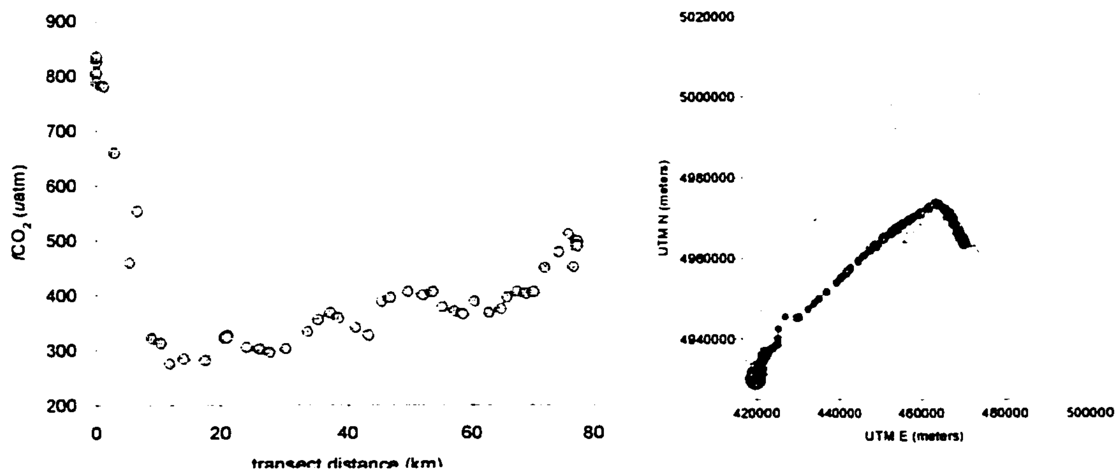
19-Apr-95



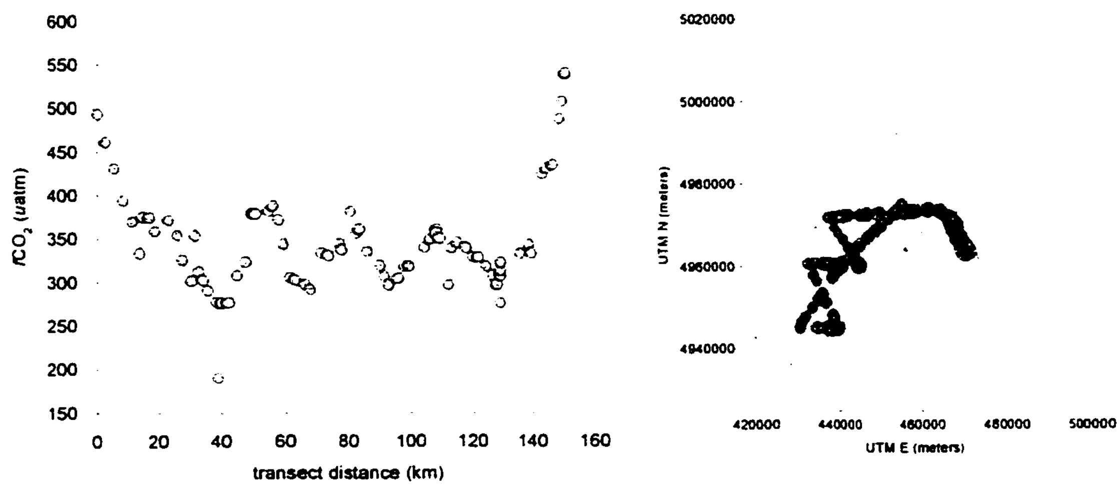
20-Apr-95



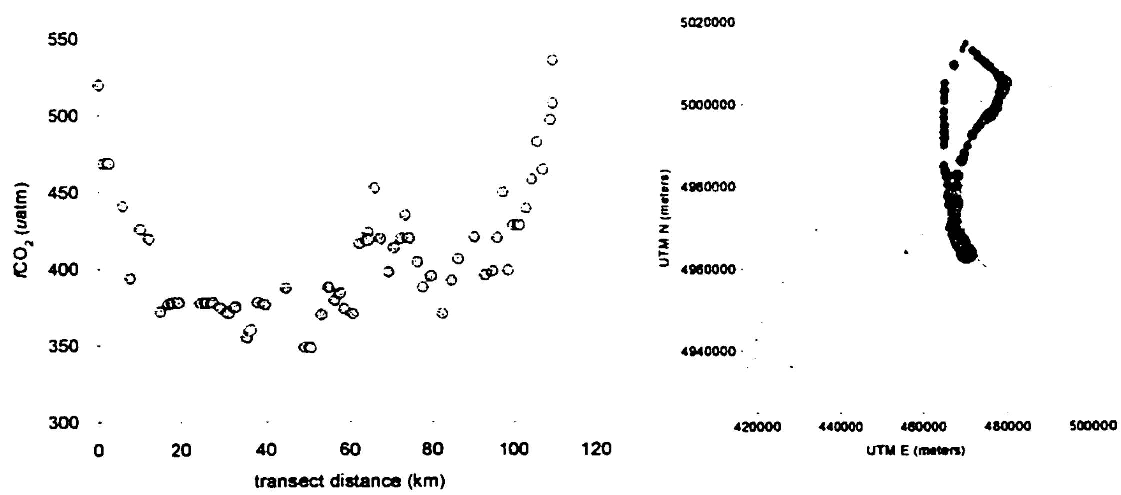
22-May-95



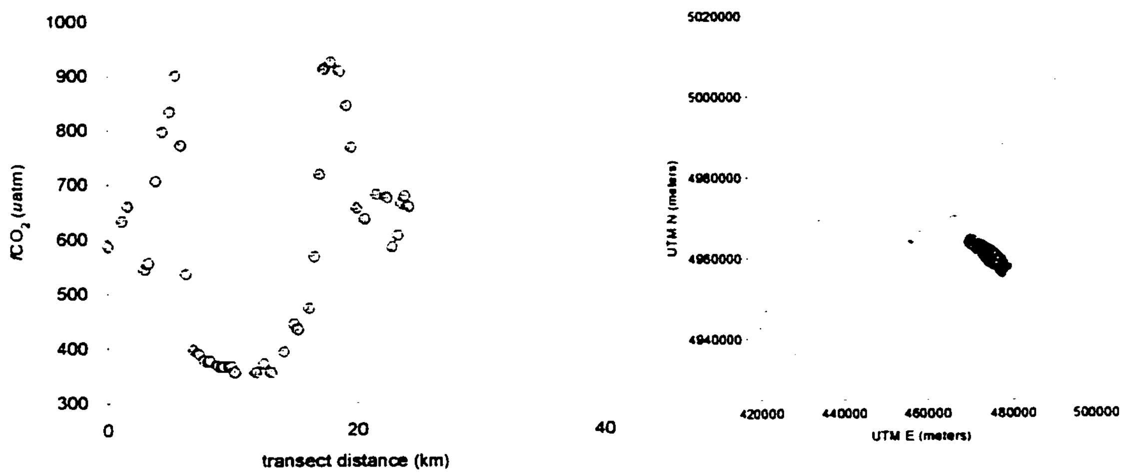
23-May-95



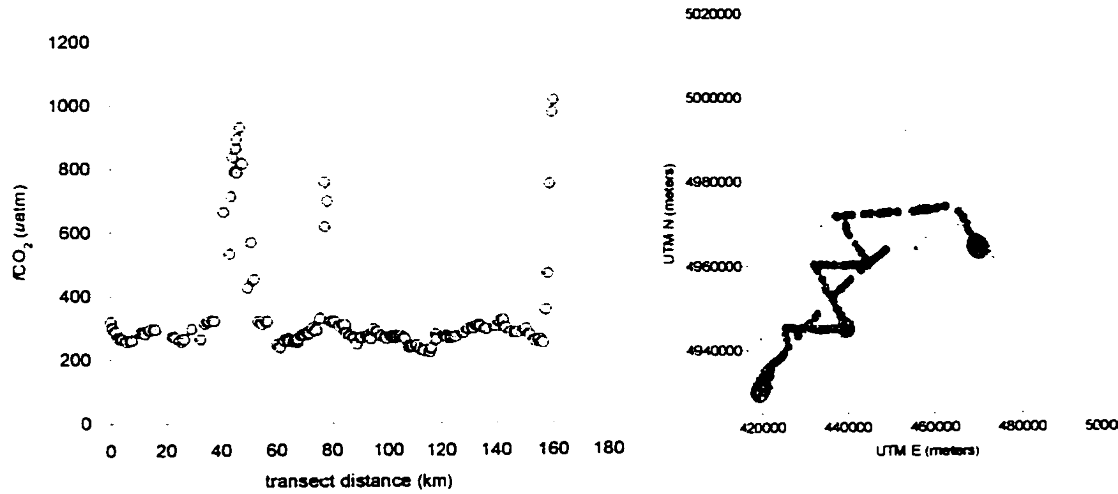
24-May-95



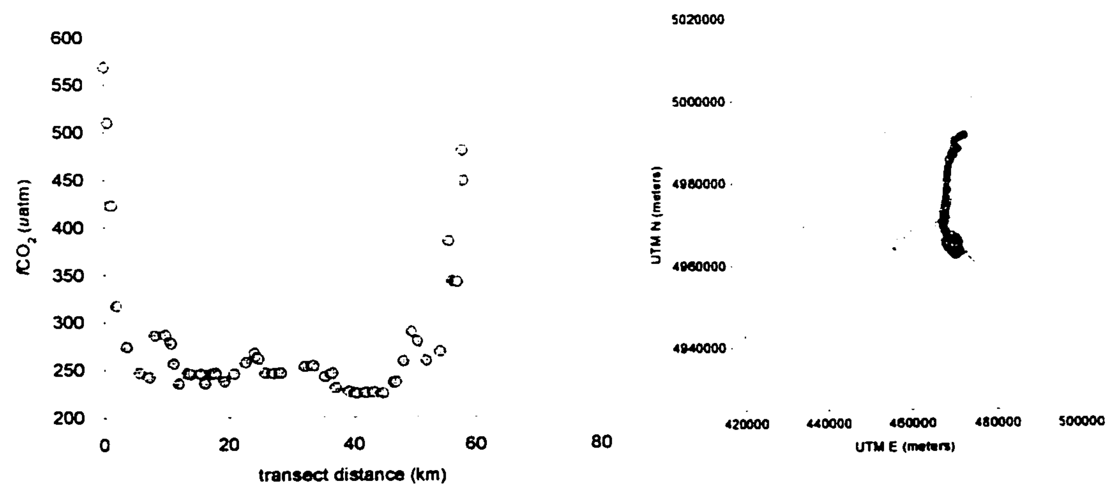
18-Jul-95

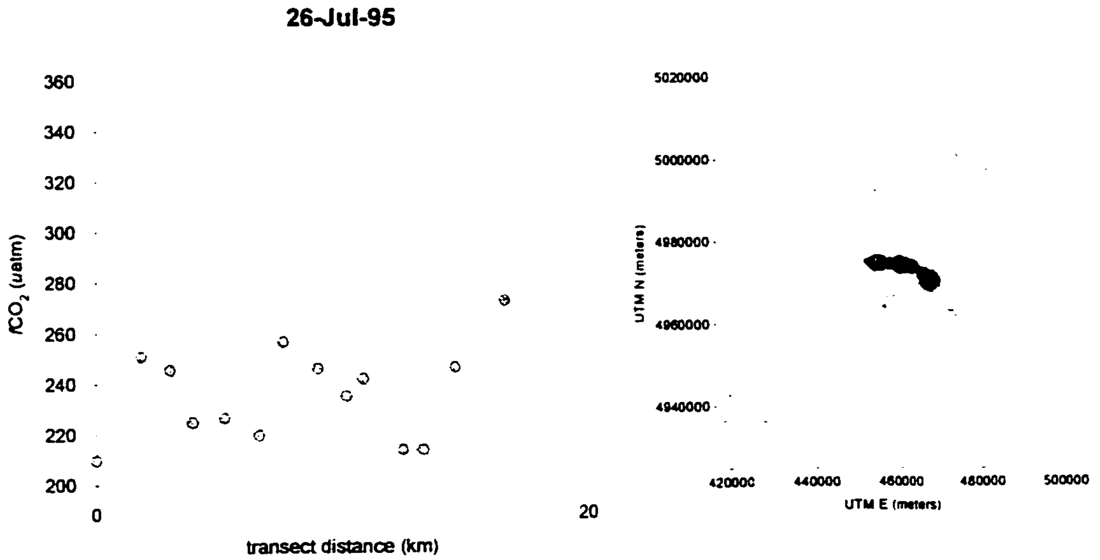


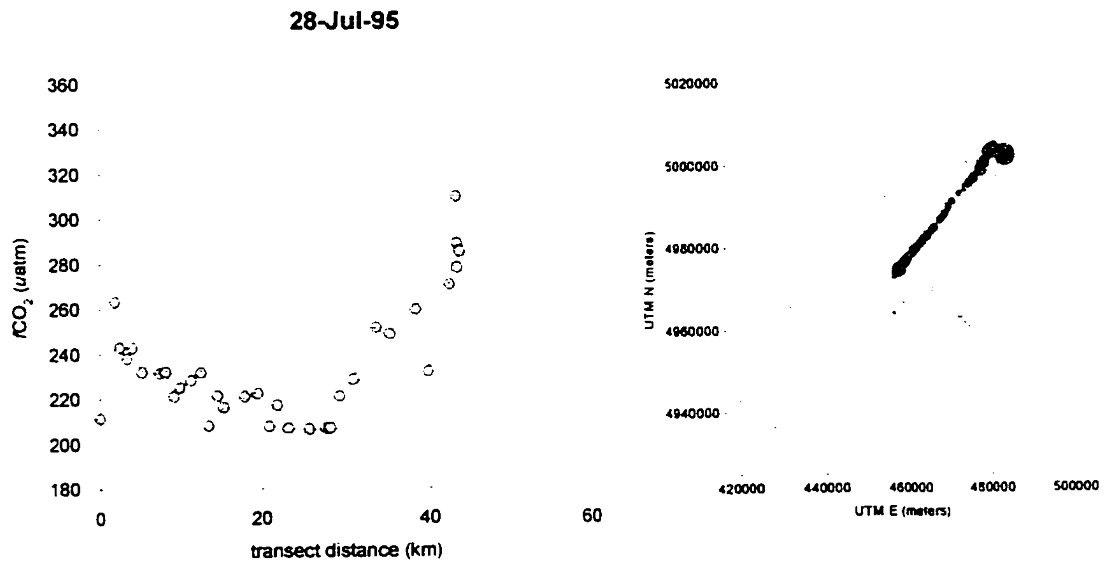
19-Jul-95

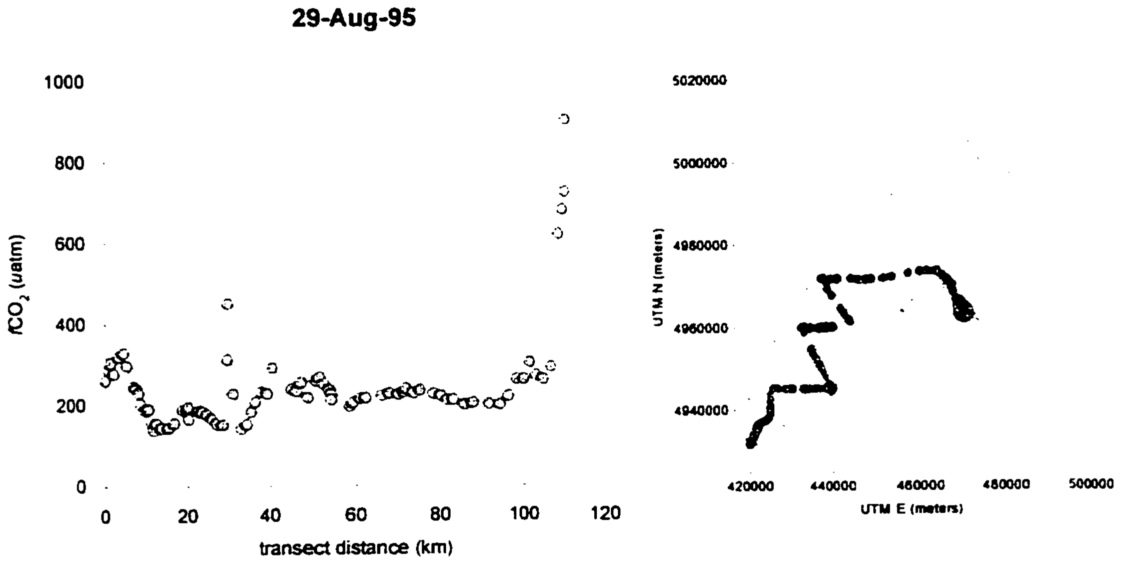


25-Jul-95

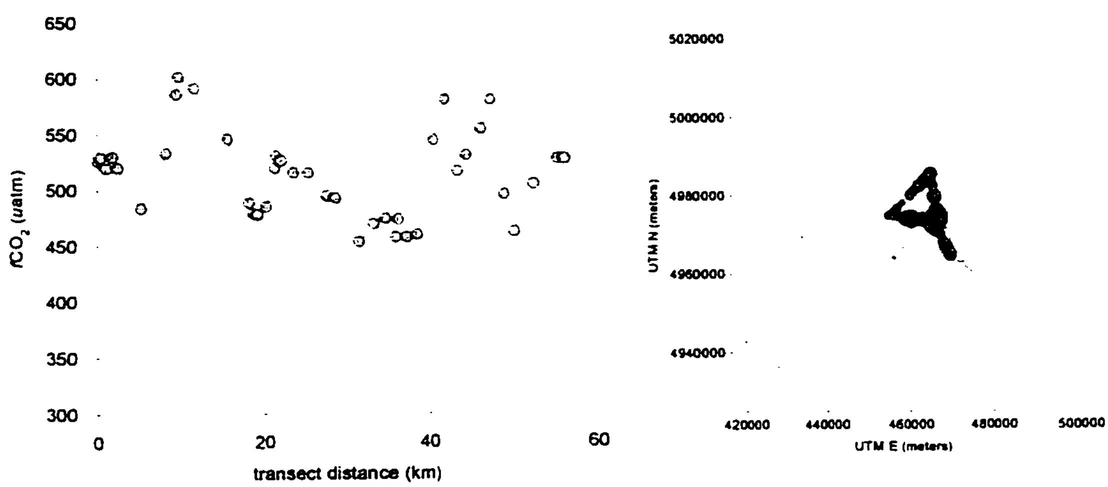



26-Jul-95
360
340
320
300
280
260
240
220
200
fCO_2 (uatm)
0
20
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)

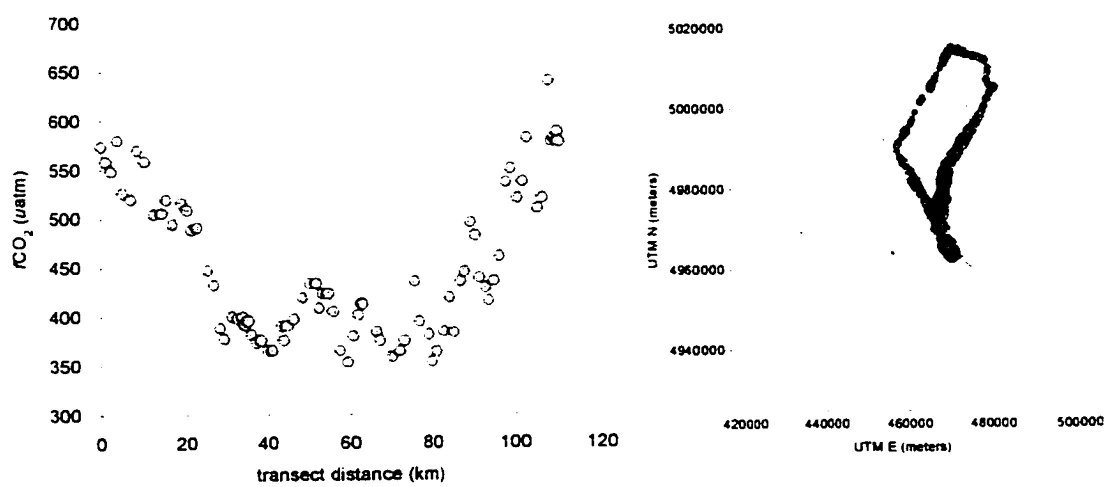

28-Jul-95
360
340
320
300
280
260
240
220
200
180
fCO_2 (uatm)
0
20
40
60
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)


29-Aug-95
1000
800
600
400
200
0
fCO2 (uatm)
0
20
40
60
80
100
120
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)

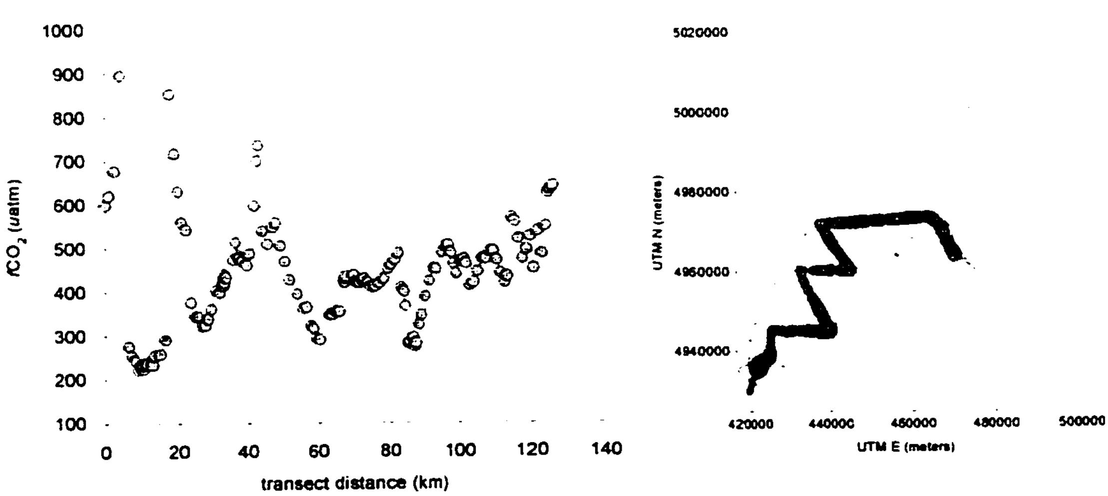
06-Oct-95



09-Oct-95



10-Oct-95



09-Nov-95

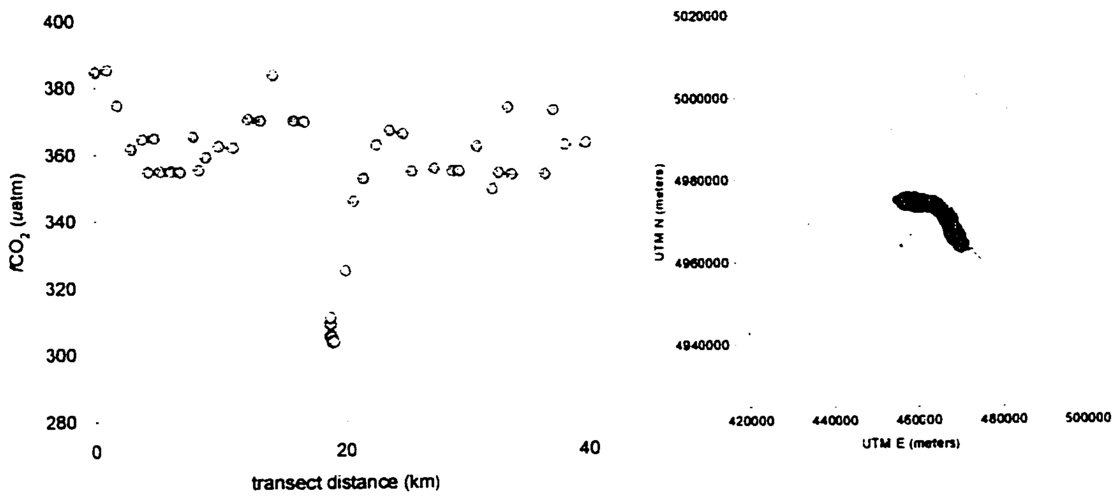
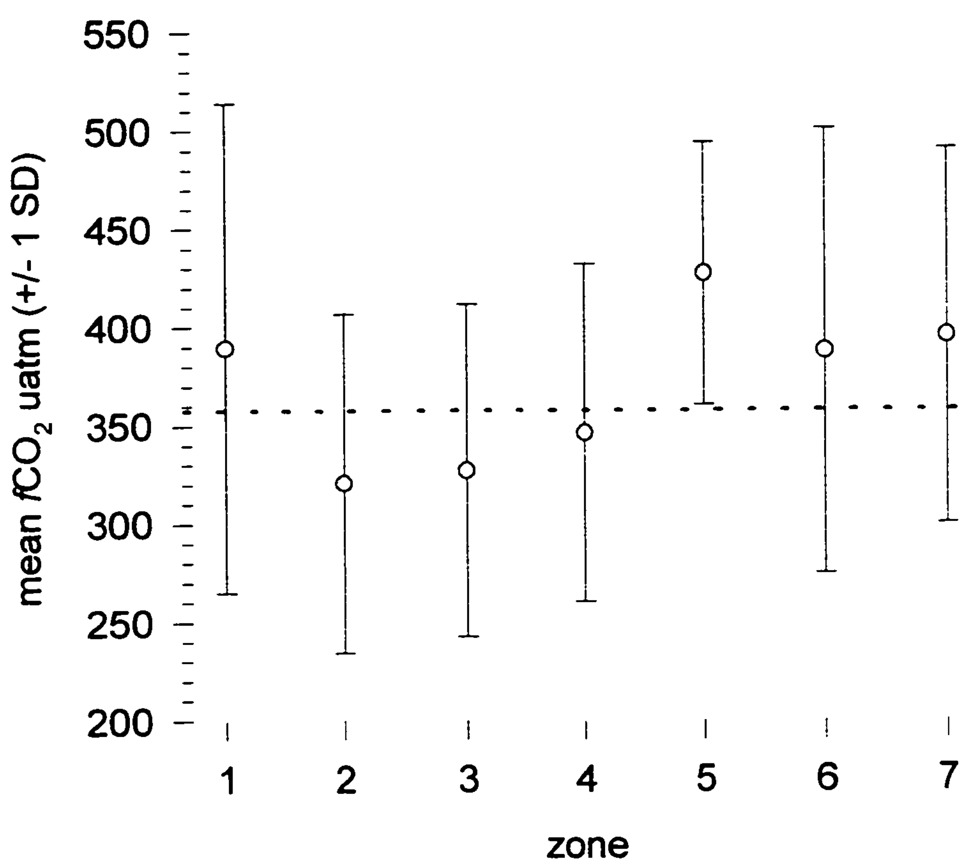

400
380
360
340
320
300
280
fCO2 (µatm)
0
20
40
transect distance (km)
5020000
5000000
4980000
4960000
4940000
UTM N (meters)
420000
440000
460000
480000
500000
UTM E (meters)

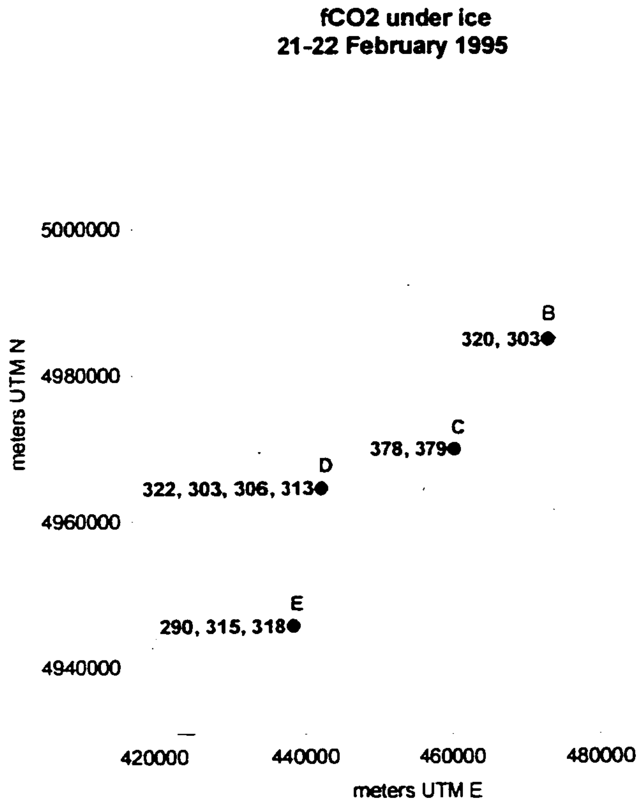
Figure 5-6. The mean fugacity of surface water CO_2 in zones 1-7 (± 1 S.D.). The mean fugacity of atmospheric CO_2 (357 μatm) is shown as a gray dotted line.

mean $fCO2_2$ in surface water
zones 1-7



- - - mean atmospheric fCO_2

Figure 5-7. The fugacity of surface water CO_2 under ice in southern Green Bay. See Appendix 1 for ice station coordinates.

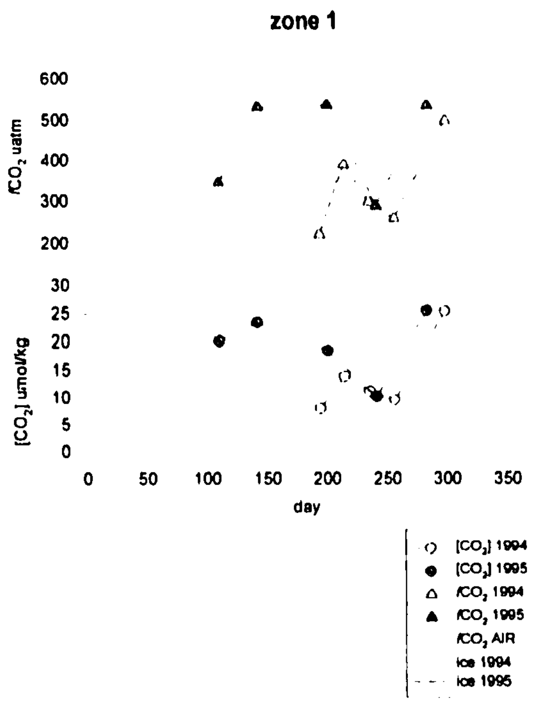

fCO2 under ice
21-22 February 1995
5000000
4980000
4960000
4940000
meters UTM N
B
320, 303
C
378, 379
D
322, 303, 306, 313
E
290, 315, 318
420000
440000
460000
480000
meters UTM E

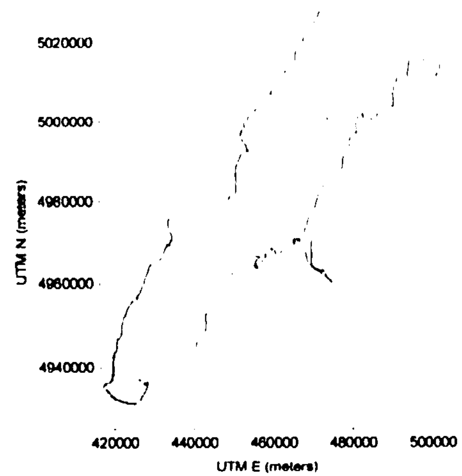
intervals in zones 2, 3, 4, 6, and 7. The data set for each particular zone only included measurements made within the zone; measurements made outside of the zone were blanked. If no (or insufficient) measurements were made in a zone, the zone was excluded from consideration.

The fluctuations in surface water CO_2 over time in each zone are presented in Figure 5-8. Concentrations in CO_2 tended to increase toward the north with minima occurring during the summer and maxima occurring after destratification of the water column in October. While most of the change in aqueous CO_2 was probably due to photo-autotrophic uptake and heterotrophic respiration, changes in temperature and flux across the air-water interface must have significantly dampened the amplitude of fluctuation. On occasion, the effect of temperature may even have overridden the biological affect on CO_2 concentrations. For example, values of fCO_2 may actually have risen due to an increase in temperature in spite of net autotrophic conditions (i.e. a P/R ratio > 1).To determine if this was true, the effects of temperature on fCO_2 in Green Bay were compensated for by normalizing each fugacity (shown in Figure 5-8) to an average surface water temperature of 12.5°C using equation 5-15 (see Takahashi et al. 1993).

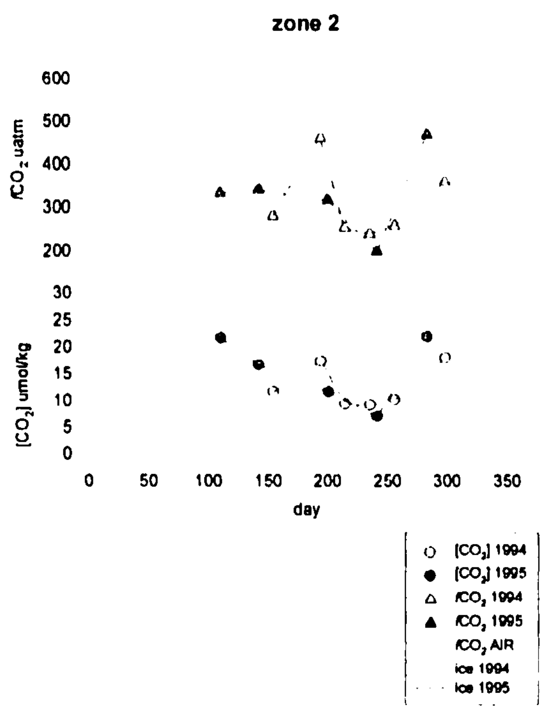
The temperature normalized fugacities are presented along with their *in situ* temperature values (from Figure 5-8) in Table 5-2. Comparing the normalized to *in situ* fugacities reveals the striking effect of temperature change. In zone 4, for example, the observed fCO_2 rose 36% between June and July of 1994 while the normalized fugacities remained essentially unchanged. The fact that the temperature normalized fugacities were stable suggests that the other forces affecting CO_2 concentrations were in balance. In zone

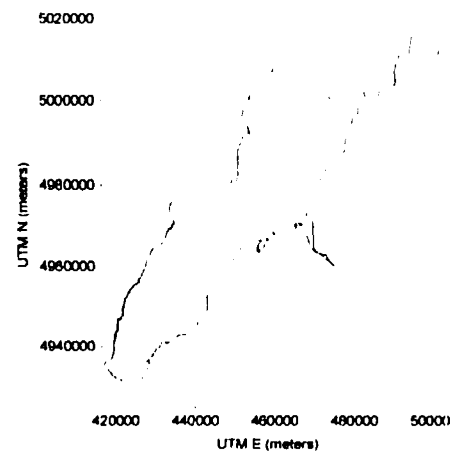
Figure 5-8 (a-g). The temporal variation of spatially weight-averaged surface water CO_2 concentrations in zones 1-7 of southern Green Bay. Zones 1-7 appear as shaded areas within the Green Bay shoreline. Concentrations measured during the 1994 transects appear as light gray symbols; 1995 values are plotted as dark gray symbols. Ice cover is plotted as a thick line using the same color scheme. Atmospheric fCO_2 is plotted as a thin black line. Note the change of scale on the Y axis in each zone. All relevant data is tabulated below each figure.



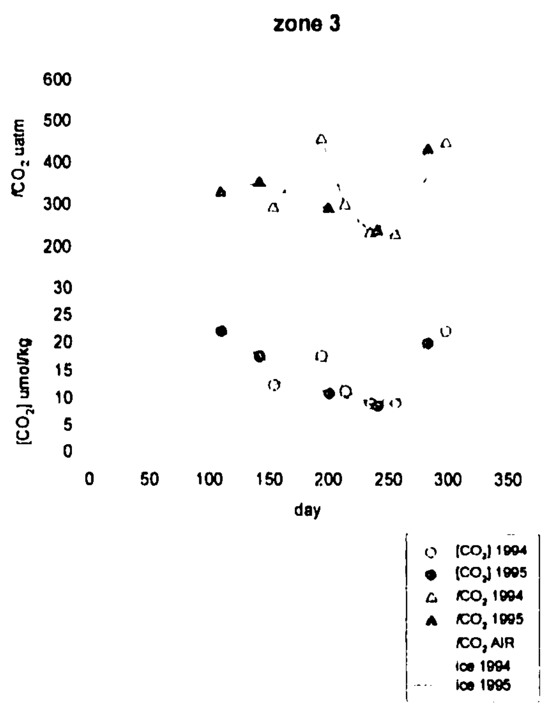


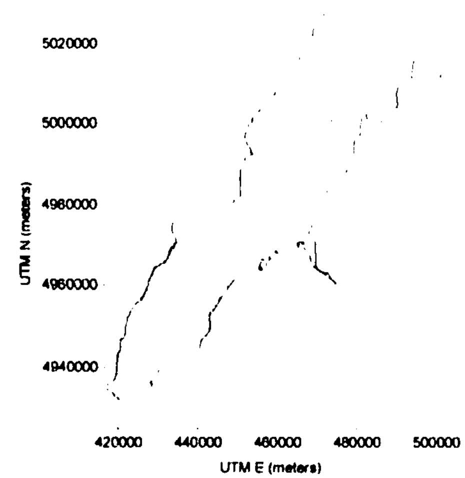
ZONE 1										
DATE	*13-Jul-94*	*02-Aug-94*	*23-Aug-94*	*13-Sep-94*	*25-Oct-94*	*20-Apr-95*	*22-May-95*	*19-Jul-95*	*29-Aug-95*	*10-Oct-95*
day	194	214	235	256	298	110	142	200	241	283
[CO2] uM	8 0	13 8	11 1	9 5	25 3	20 1	23 4	18 4	10 1	25 4
***f*CO2 (uatm)**	221	388	298	258	497	345	530	535	289	534



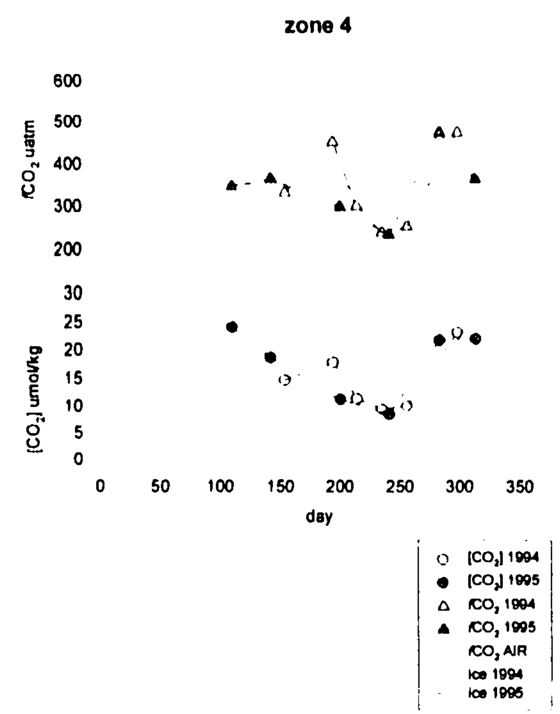


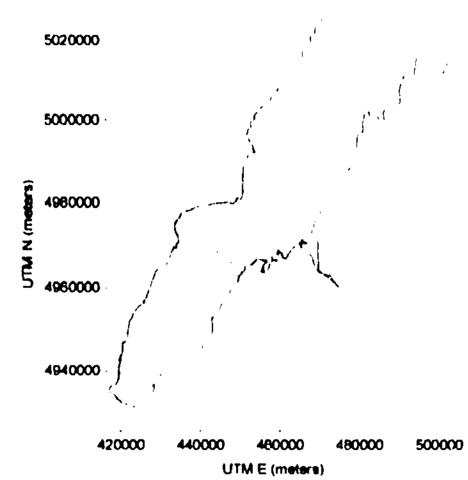
ZONE 2											
DATE	03-Jun-94	13-Jul-94	02-Aug-94	23-Aug-94	13-Sep-94	25-Oct-94	20-Apr-95	22-May-95	19-Jul-95	29-Aug-95	10-Oct-95
day	154	194	214	235	256	298	110	142	200	241	283
[CO2] uM	11.7	17.4	9.4	9.3	10.3	18.1	21.8	18.7	11.7	7.1	22.0
fCO2 (uatm)	282	462	255	242	261	360	334	342	318	201	470



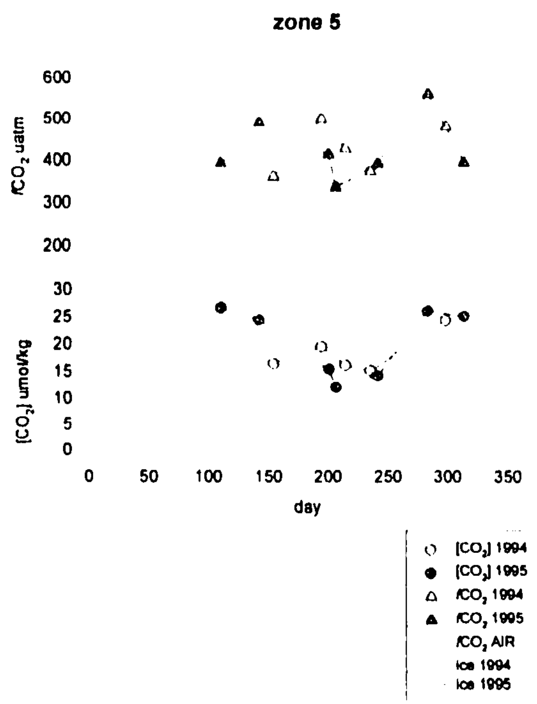


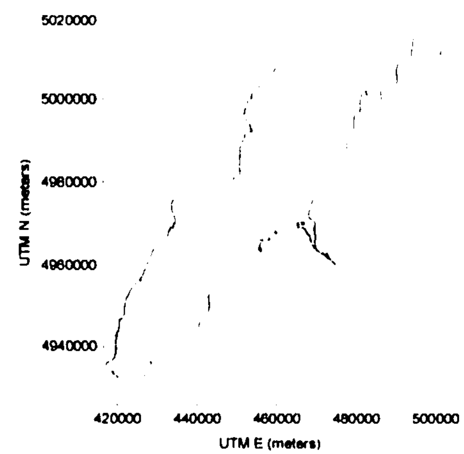
ZONE 3											
DATE	03-Jun-94	13-Jul-94	02-Aug-94	23-Aug-94	13-Sep-94	25-Oct-94	20-Apr-95	22-May-95	19-Jul-95	29-Aug-95	10-Oct-95
day	154	194	214	235	256	298	110	142	200	241	283
[CO2] uM	12 4	17 7	11 3	9 1	9 1	22 1	22 2	17 6	10 9	8 6	20 0
fCO2 (uatm)	293	456	300	233	229	446	329	352	291	239	431





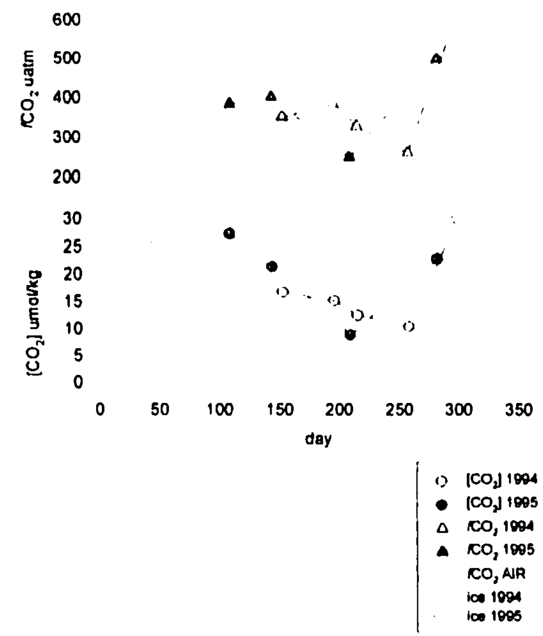
ZONE 4												
DATE	03-Jun-94	13-Jul-94	02-Aug-94	23-Aug-94	13-Sep-94	25-Oct-94	20-Apr-95	22-May-95	19-Jul-95	29-Aug-95	10-Oct-95	09-Nov-95
day	154	194	214	235	256	298	110	142	200	241	283	313
[CO2] uM	14 8	17 9	11 5	9 6	10 2	23 4	24 2	18 8	11 4	8 6	21 9	22 2
fCO2 (uatm)	334	453	302	241	255	475	349	367	301	236	475	367

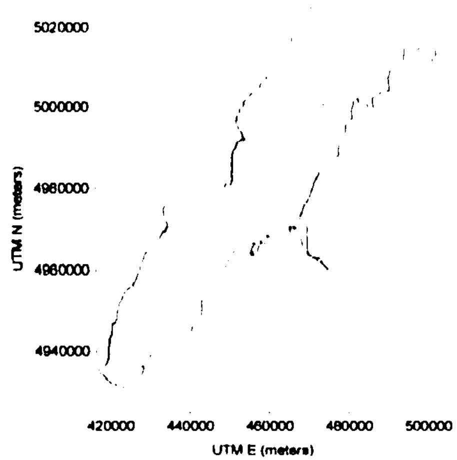




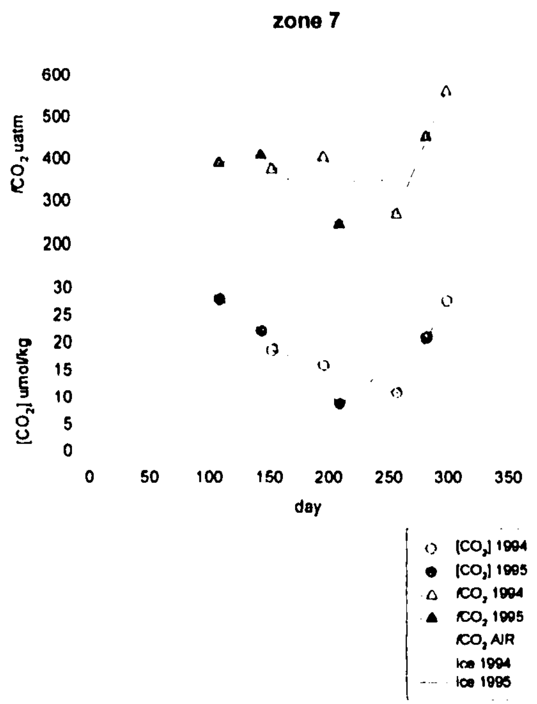
ZONE 5												
DATE	03-Jun-94	13-Jul-94	02-Aug-94	23-Aug-94	25-Oct-94	20-Apr-95	22-May-95	19-Jul-95	25-Jul-95	29-Aug-95	10-Oct-95	09-Nov-95
day	154	194	214	235	298	110	142	200	206	241	283	313
[CO2] uM	16 5	19 6	16 2	15 2	24 4	26 7	24 5	15 5	12 1	14 3	26 2	25 2
fCO2 (uatm)	362	499	428	374	481	393	490	413	337	392	562	394

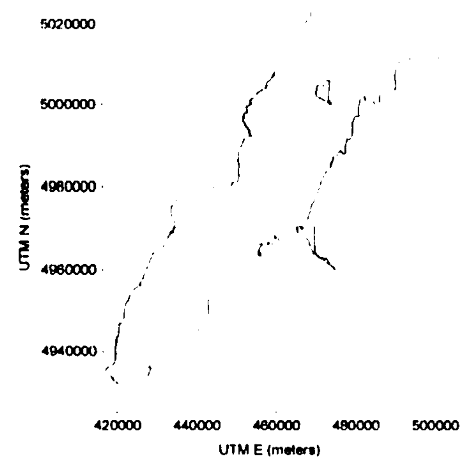
zone 6





ZONE 6									
DATE	02-Jun-94	15-Jul-94	03-Aug-94	15-Sep-94	26-Oct-94	19-Apr-95	24-May-95	25-Jul-95	09-Oct-95
day	153	196	215	258	299	109	144	209	282
[CO2] uM	16 8	15 2	12 6	10 5	30 2	27 4	21 6	9 0	23 0
fCO2 (uatm)	353	387	330	264	614	386	403	252	500





ZONE 7								
DATE	02-Jun-94	15-Jul-94	14-Sep-94	26-Oct-94	19-Apr-95	24-May-95	25-Jul-95	09-Oct-95
day	153	196	257	299	109	144	209	282
[CO2] uM	18 7	15 9	10 9	27 6	27 9	22 2	8 8	21 0
fCO2 (uatm)	375	403	269	561	390	409	246	452

Table 5-2. Surface water CO_2 fugacities at *in situ* water temperatures and their respective fugacities normalized to a mean annual temperature of 12.5°C.

ZONE 1	date	day	temp C	fCO2 (uatm) in situ temp	fCO2 (uatm) 12.5 C
	13-Jul-94	194	24.5	221	141
	02-Aug-94	214	23.4	388	257
	23-Aug-94	235	21.2	298	215
	13-Sep-94	256	18.9	258	203
	25-Oct-94	298	11.1	497	524
	20-Apr-95	110	3.6	345	482
	22-May-95	142	12.9	530	522
	19-Jul-95	200	23.7	535	351
	29-Aug-95	241	22.5	289	198
	10-Oct-95	283	14	534	505

ZONE 2	date	day	temp C	fCO2 (uatm) in situ temp	fCO2 (uatm) 12.5 C
	03-Jun-94	154	17.7	282	232
	13-Jul-94	194	23.7	462	303
	02-Aug-94	214	22.7	255	174
	23-Aug-94	235	20.8	242	177
	13-Sep-94	256	18.5	261	208
	25-Oct-94	298	11.7	360	371
	20-Apr-95	110	3.1	334	477
	22-May-95	142	12	342	348
	19-Jul-95	200	23.2	318	212
	29-Aug-95	241	22.5	201	138
	10-Oct-95	283	14.8	470	431

ZONE 3	date	day	temp C	fCO2 (uatm) in situ temp	fCO2 (uatm) 12.5 C
	03-Jun-94	154	16.5	293	252
	13-Jul-94	194	22.4	456	314
	02-Aug-94	214	21.7	300	212
	23-Aug-94	235	20.2	233	175
	13-Sep-94	256	18.1	229	185
	25-Oct-94	298	12	446	454
	20-Apr-95	110	2.7	329	477
	22-May-95	142	10.8	352	375
	19-Jul-95	200	22.5	291	200
	29-Aug-95	241	22.5	239	164
	10-Oct-95	283	15	431	392

ZONE 4	date	day	temp C	fCO2 (uatm) in situ temp	fCO2 (uatm) 12.5 C
	03-Jun-94	154	14.7	334	308
	13-Jul-94	194	22.1	453	316
	02-Aug-94	214	21.1	302	218
	23-Aug-94	235	19.8	241	183
	13-Sep-94	256	17.8	255	209
	25-Oct-94	298	12.2	475	480
ICE Station D	22-Feb-95	53	0.2	311	494
	20-Apr-95	110	2.2	349	514
	22-May-95	142	9.7	367	408
	19-Jul-95	200	22.3	301	208
	29-Aug-95	241	22.3	236	163
	10-Oct-95	283	15	475	432
	09-Nov-95	313	8.6	367	425

ZONE 5	date	day	temp C	fCO2 (uatm) in situ temp	fCO2 (uatm) 12.5 C
	03-Jun-94	154	17.7	362	298
	13-Jul-94	194	23.7	499	327
	02-Aug-94	214	22.7	428	292
	23-Aug-94	235	20.8	374	274
	25-Oct-94	298	11.7	481	496
	20-Apr-95	110	3.1	393	561
	22-May-95	142	12	490	500
	19-Jul-95	200	23.2	413	276
	25-Jul-95	206	22.9	337	228
	29-Aug-95	241	22.5	392	269
	10-Oct-95	283	14.8	562	516
	09-Nov-95	313	7.8	394	470

ZONE 6	date	day	temp C	fCO2 (uatm) in situ temp	fCO2 (uatm) 12.5 C
	02-Jun-94	153	12.7	353	351
	15-Jul-94	196	21.8	387	273
	03-Aug-94	215	20.7	330	242
	15-Sep-94	258	17.3	264	220
	26-Oct-94	299	12.9	614	605
	19-Apr-95	109	1.9	386	576
	24-May-95	144	9.1	403	458
	25-Jul-95	209	22.3	252	174
	09-Oct-95	282	15.2	500	451

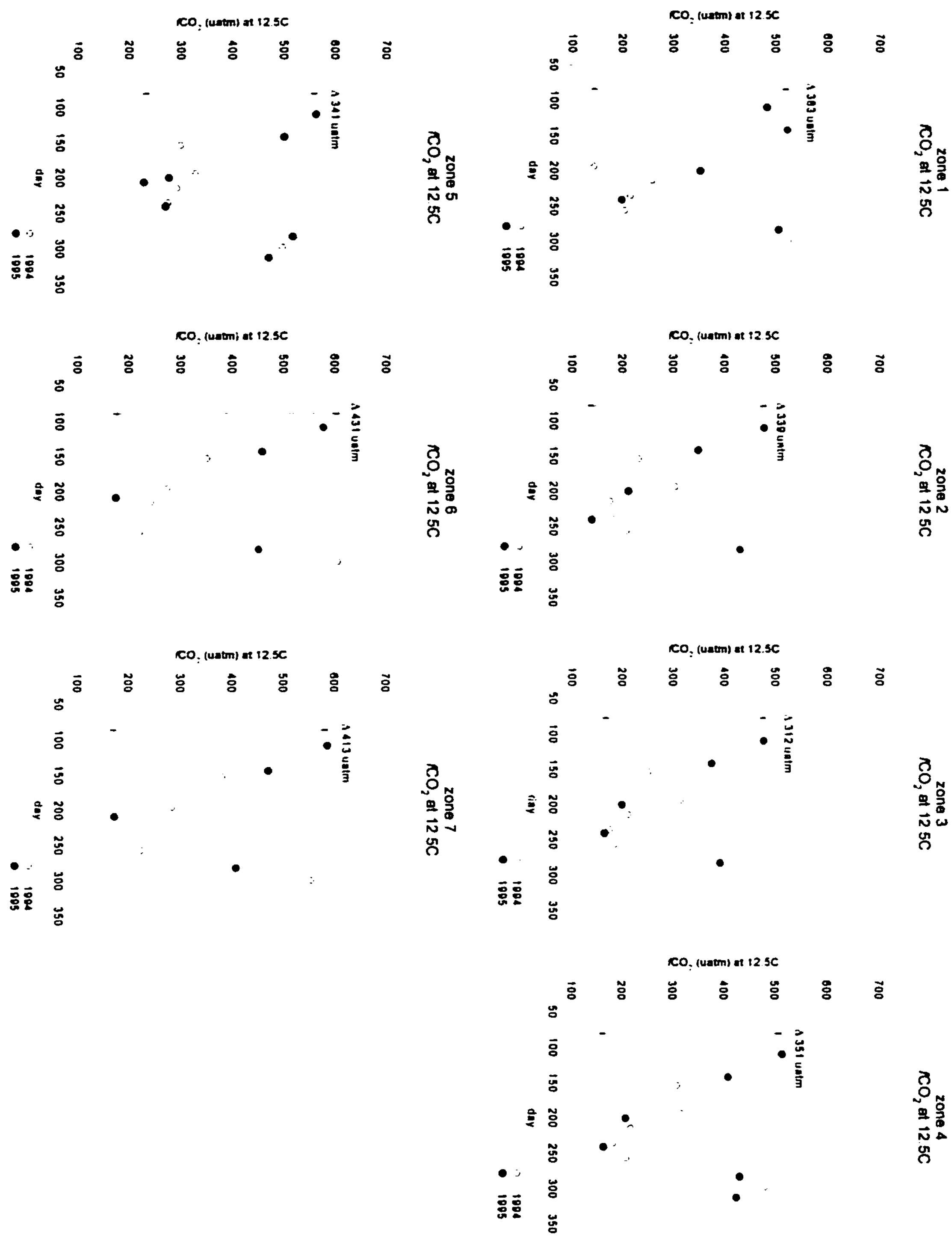
ZONE 7	date	day	temp C	fCO2 (uatm) in situ temp	fCO2 (uatm) 12.5 C
	02-Jun-94	153	12.1	375	381
	15-Jul-94	196	21.8	403	284
	14-Sep-94	257	17.3	269	224
	26-Oct-94	299	12.9	561	553
	19-Apr-95	109	1.7	390	586
	24-May-95	144	8.7	409	471
	25-Jul-95	209	21.8	246	173
	09-Oct-95	282	15.2	452	409

3, however, the observed fugacity rose from 329 µatm on April 20th, 1995 to 352 µatm on May 22nd while the temperature normalized fugacities dropped from 477 µatm to 375 µatm. Since the observed values of fCO_2 were below atmospheric equilibrium (see below), an influx of CO_2 from the atmosphere occurred. Assuming the alkalinity remained essentially constant, a decrease in the normalized fugacities could only have occurred through net autotrophy (i.e. a P/R ratio greater than one).

The fluctuations in fCO_2 observed in all zones between October 1994 and April 1995 were equally interesting. In zone 4, normalized fCO_2 values increased only slightly from October 25th, 1994 to February 22nd, 1995 to April 20th, 1995. Since ice covered the bay during much of that time, either the rates of photosynthesis and respiration decreased to levels that had little effect on the inorganic carbon pool or the P/R ratio was close to one.

When the temperature normalized values of fCO_2 (listed in Table 5-2) were plotted against time (Figure 5-9), one feature common to all zones stood out. The fugacity of CO_2 decreased throughout the summer until autumn when the water column mixed. Some of the decrease in fCO_2 could have been caused by a venting of CO_2 from the bay to the atmosphere. However, because the observed values of fCO_2 in each zone eventually dropped to levels below atmospheric equilibrium, the rate of carbon uptake through photosynthesis must have been higher than carbon release through heterotrophic respiration. In other words, while the water column was stratified, the mixed layer (epilimnion) of southern Green Bay appeared to have a P/R ratio greater than one.

Figure 5-9. The temporal dynamics of dissolved CO_2 in southern Green Bay normalized to 12.5°C.


zone 1
fCO2 at 12.5C
Δ 383 uatm
zone 2
fCO2 at 12.5C
Δ 339 uatm
zone 3
fCO2 at 12.5C
Δ 312 uatm
zone 4
fCO2 at 12.5C
Δ 351 uatm
zone 5
fCO2 at 12.5C
Δ 341 uatm
zone 6
fCO2 at 12.5C
Δ 431 uatm
zone 7
fCO2 at 12.5C
Δ 413 uatm
fCO2 (uatm) at 12.5C
day
1994
1995

Though the epilimnion appeared to have a P/R ratio greater than one, heterotrophic respiration occurring in the hypolimnion and sediment could have resulted in an areal P/R ratio of less than one. Since CO_2 produced through respiration below the mixed layer was essentially "hidden" from my surface water analyses until the water column destratified, estimates of the areal P/R ratio could only be calculated on an annual time scale. Areal estimates of the P/R ratio on an annual time scale required the calculation of air-water CO_2 fluxes.

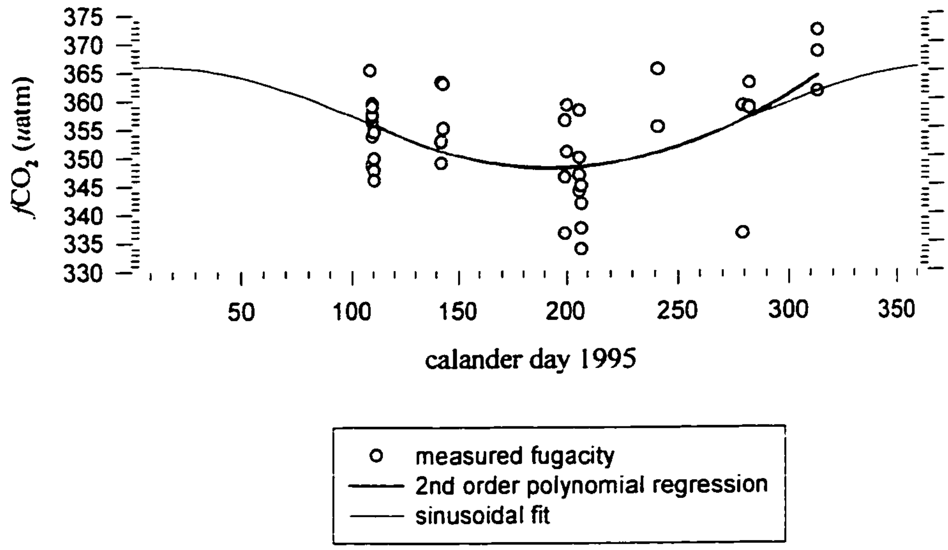
Atmospheric exchange

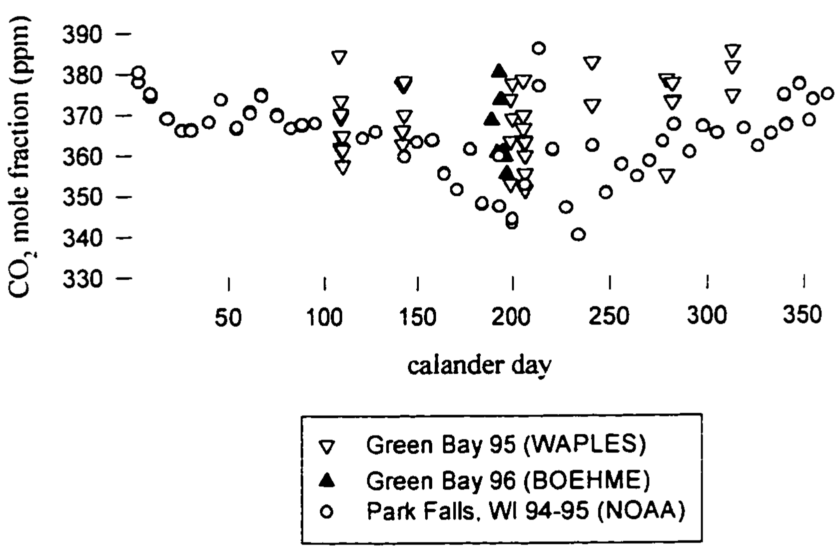
Daily estimates of carbon dioxide flux across the air-water interface in each of the seven zones of southern Green Bay were calculated using equation 3-1, where K equaled the CO_2 specific transfer coefficients derived in Chapter 3 (Figure 3-7), and ΔC equaled C_w - C_a. C_w was equal to the dissolved CO_2 concentrations of the mixed layer (epilimnion) and C_a equaled the concentration of CO_2 in the surface water micro-layer which was assumed to be in equilibrium with atmospheric CO_2.

The atmospheric concentrations of CO_2 over southern Green Bay were measured repeatedly during the field seasons of 1994 and 1995 and showed considerable variability (~ 35 ppm) over very short time scales (Figure 5-10, bottom panel - open triangles). Sue Boehme (Rutgers University) collected and measured atmospheric CO_2 in 1996 and found similar short-term variability in xCO_2 over southern Green Bay (Figure 5-10, bottom panel - black triangles). The 1995 atmospheric CO_2 mole fractions at Park Falls, Wisconsin (45 56'N 90 16'W) were measured by the NOAA Climate Monitoring and Diagnostics Laboratory (CMDL) and also showed considerable variability (Figure 5-10,

Figure 5-10. Annual variation of atmospheric CO_2 over southern Green Bay. Top) Average daily estimates of atmospheric fCO_2 were determined by fitting a sinusoidal curve to a 2^{nd}-order polynomial regression which in turn was fit to the measured fugacities of CO_2 over Green Bay. Bottom) Variability in atmospheric CO_2 over Green Bay appears to be real. The open triangles represent the mole fractions of CO_2 measured in this study during the 1995 field season. The solid triangles show atmospheric xCO_2 values in Green Bay samples that were collected and measured by Susan Boehme at the Lamont Doherty Earth Observatory using CO_2 WMO calibrated standards.

atmospheric carbon dioxide





bottom panel - gray circles). Since no clear pattern describing the daily fluctuations in xCO_2 could be discerned, an average daily estimate of fCO_2 for both 1994 and 1995 was calculated using the measured fugacities of 1995 (Figure 5-10, top panel). A sinusoidal curve was fit to a 2nd-order polynomial regression of the measured fugacities to give:

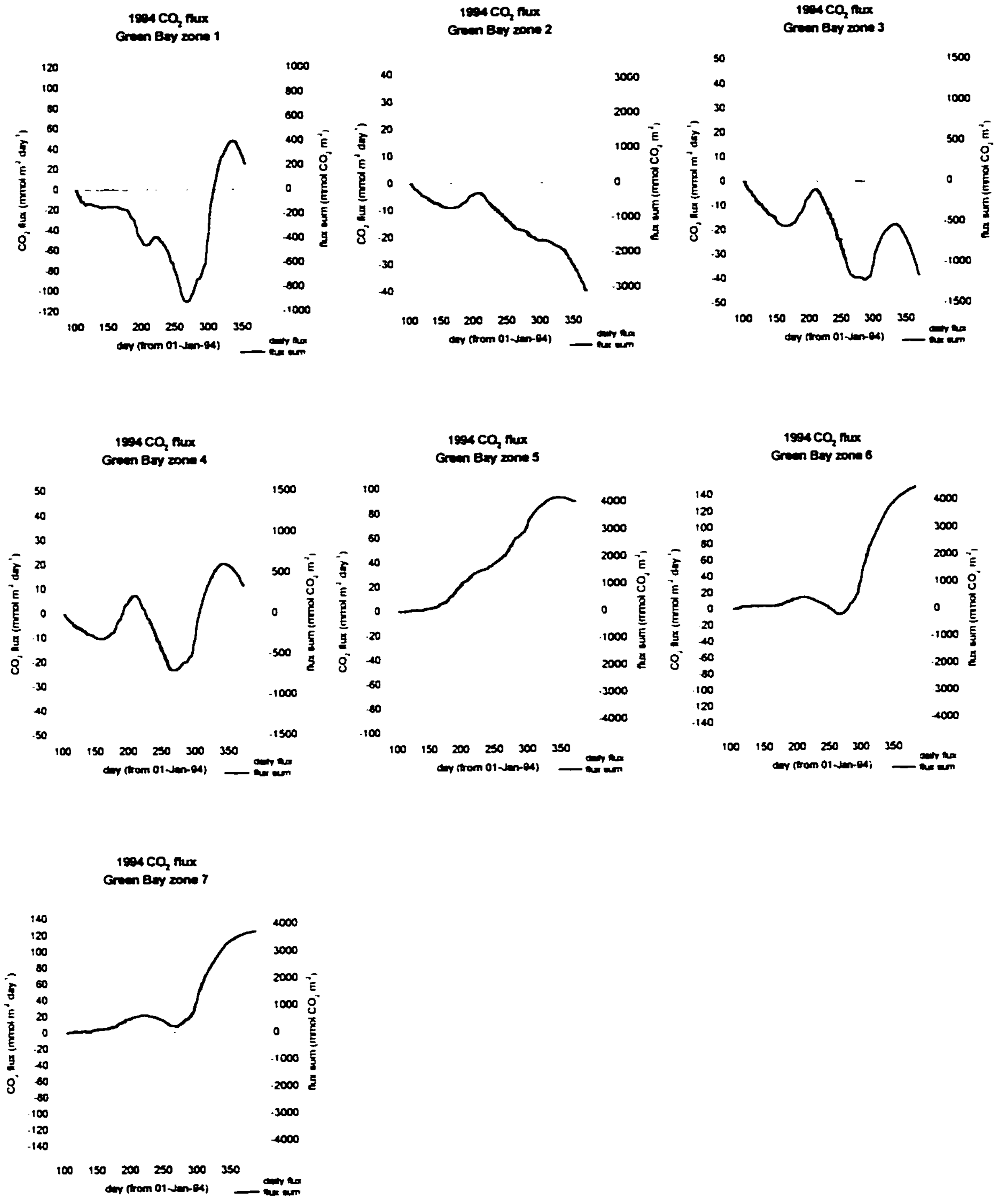
$$fCO_{2\,CD} = 9\cos(2\Pi/365 \times CD) + 1.5\sin(2\Pi/365 \times CD) + 357 \qquad (5\text{-}19)$$

where CD = calendar day.

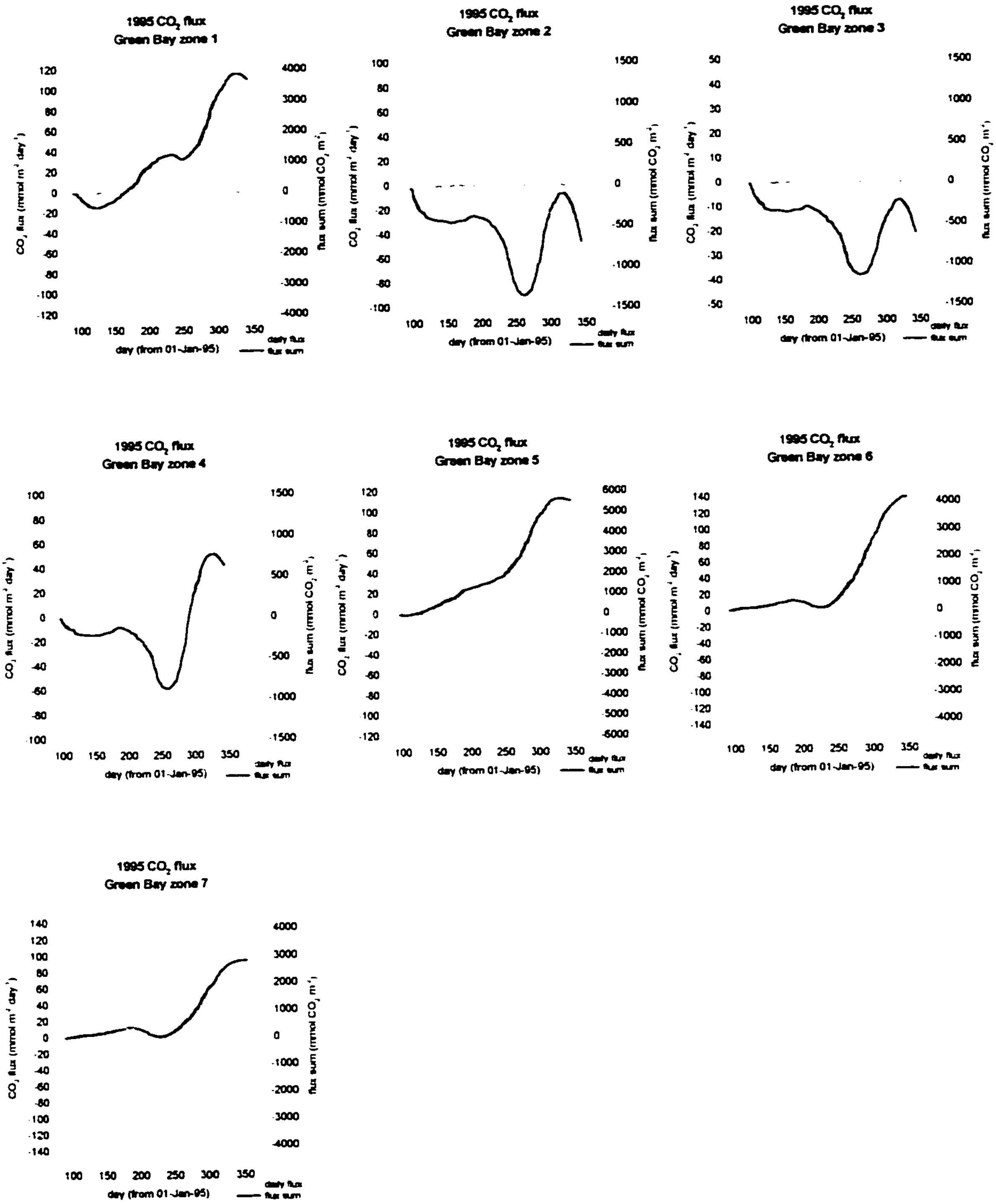
The molarity (≅ molality) of C_a was taken as the product of the fugacity of CO_2 (equation 5-19) and its solubility coefficient (equation 2-14) which was calculated using the surface temperatures derived in Chapter 3 (see Figure 3-5). Daily estimates of C_w in each of the seven zones of southern Green Bay were based on linear interpolations between the spatially averaged concentrations measured during each of the transect cruises shown in Figure 5-8. The concentration of dissolved CO_2 just prior to and after ice cover was taken as the mean of the last and first concentration measured during 1994 and 1995 respectively.

The net exchange of CO_2 between each zone of southern Green Bay and the atmosphere is shown together with daily flux estimates of CO_2 across the air-water interface in Figure 5-11a (1994) and 5-11b (1995) where negative values indicate CO_2 uptake by the bay. An "M" shaped pattern in daily flux estimates appeared in many of the zones. The initial increase in CO_2 flux to the atmosphere occurred due to rising surface water temperatures. As the rate of temperature increase slowed, the rate of photosynthetic

Figure 5-11. Carbon dioxide flux from Green Bay to the atmosphere based on the air column stability corrected transfer coefficients derived in Chapter 3 and air-water CO_2 concentration gradients derived in this chapter. a) 1994 flux estimates for southern Green Bay zones 1-7. b) 1995 flux estimates for southern Green Bay zones 1-7.


1994 CO_2 flux
Green Bay zone 1
1994 CO_2 flux
Green Bay zone 2
1994 CO_2 flux
Green Bay zone 3
1994 CO_2 flux
Green Bay zone 4
1994 CO_2 flux
Green Bay zone 5
1994 CO_2 flux
Green Bay zone 6
1994 CO_2 flux
Green Bay zone 7
CO_2 flux (mmol m^{-2} day^{-1})
flux sum (mmol CO_2 m^{-2})
day (from 01-Jan-94)
daily flux
flux sum

a


1995 CO_2 flux
Green Bay zone 1
1995 CO_2 flux
Green Bay zone 2
1995 CO_2 flux
Green Bay zone 3
1995 CO_2 flux
Green Bay zone 4
1995 CO_2 flux
Green Bay zone 5
1995 CO_2 flux
Green Bay zone 6
1995 CO_2 flux
Green Bay zone 7
CO_2 flux (mmol m^{-2} day^{-1})
flux sum (mmol CO_2 m^{-2})
day (from 01-Jan-95)
daily flux
flux sum

b

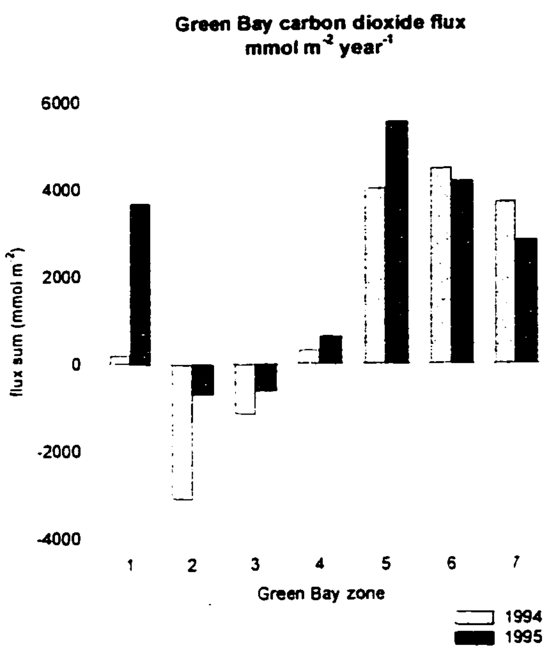
uptake of CO_2 overcame the rate of increase in fCO_2 due to temperature change and respiration. This resulted in a decrease and (in some instances) sign change in air-water flux. In autumn, surface water temperatures cooled and the water column destratified. CO_2 that had been produced through heterotrophic respiration below the surface layer mixed throughout the water column. In most instances, CO_2 fluxes changed sign and the bay vented CO_2 to the atmosphere. Finally, as surface water temperatures continued to fall, the resultant decrease in surface water fCO_2 quickly reduced the positive flux of CO_2 to the point where, just before ice cover, CO_2 fluxes again changed sign.

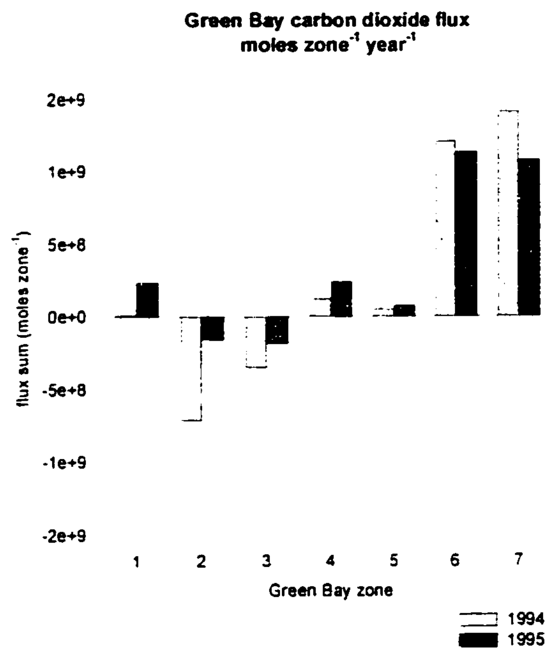
The annual flux of CO_2 across the air-water interface is given for each zone in southern Green Bay in Figure 5-12. Flux estimates from the first few days of 1995 (before the onset of ice cover) were included in the 1994 flux estimates. In 1994, approximately 180×10^7 moles of CO_2 were vented to the atmosphere from southern Green Bay (zones 1-7) in spite of the fact that the southern most portion of the bay (~ 1000 km^2) actually imported CO_2 from the atmosphere. In 1995, the net flux of CO_2 to the atmosphere increased to 240×10^7 moles with most of the increase coming from the southern most portion of the bay (zones 1-4). The proportional increase in CO_2 flux to the atmosphere in 1995 was quite similar to the proportional increase in methane flux observed in 1995 over 1994—thus strengthening the argument that wind direction significantly affected the rate of benthic bacterial respiration by altering the hydrodynamics of the bay and sediment temperatures (see Chapter 4).

<u>P/R ratios</u>

To a first approximation, the sign (or direction) of the annual flux of CO_2 across the air-water interface (Figure 5-12, top left) indicated whether the areal P/R ratio in each

Figure 5-12. Carbon dioxide flux sums for Green Bay zones 1-7. Positive values indicate a net efflux of CO_2 from Green Bay to the atmosphere. Negative values indicate a net influx of CO_2 from the atmosphere to the bay. Top left) Annual CO_2 flux sums in units of mmol m^{-2} yr^{-1}. Top right) Annual CO_2 flux sums from each zone. Bottom) Tabulated CO_2 flux sums for southern Green Bay zones 1-7 including area of each zone.





zone	1	2	3	4	5	6	7
area (m2)	6.4E+07	2.3E+08	3E+08	3.8E+08	1.4E+07	2.7E+08	3.8E+08
1994							
sum mmol/m2	211	-3102	-1157	330	4029	4488	3719
moles/zone	1.3E+07	-7.1E+08	-3.5E+08	1.3E+08	5.6E+07	1.2E+09	1.4E+09
TOTAL moles CO2	1.8E+09						
1995							
sum mmol/m2	3690	-691	-618	630	5557	4187	2827
moles/zone	2.4E+08	-1.6E+08	-1.8E+08	2.4E+08	7.9E+07	1.1E+09	1.1E+09
TOTAL moles CO2	2.4E+09						

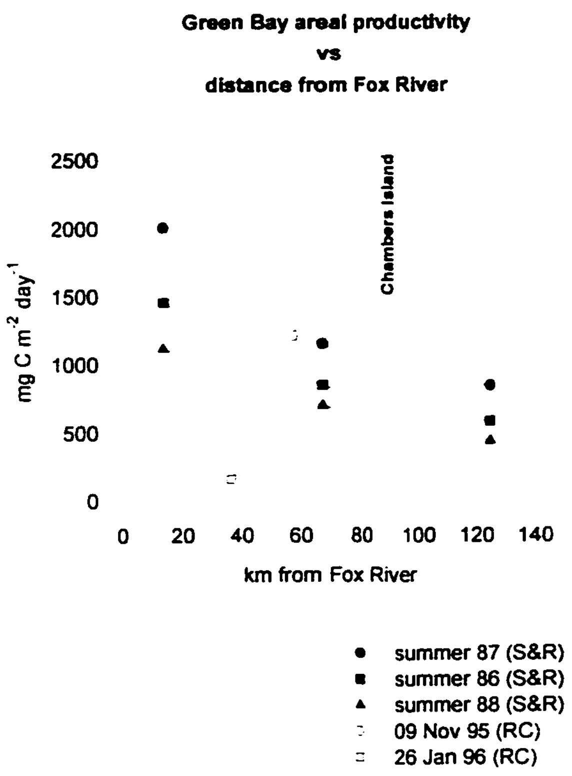
of the seven zones of the study site was greater or less than one. An annual flux of CO_2 out of the bay and into the atmosphere in zones 1, 4, 5, 6 and 7 suggested that these areas had an areal P/R ratio less than one. Zones 2 and 3, however, imported CO_2 from the atmosphere and thus appeared to have areal P/R ratios greater than one.

Specific P/R ratios were calculated from annual air-water CO_2 fluxes and measured rates of areal primary productivity (Sager and Richman 1990, 1991; Russell Cuhel, unpublished data). Sager and Richman (1990, 1991) measured primary production in Green Bay during the summers of 1986, 1987 and 1988. Their average summertime productivity rates for each year and station were plotted against distance from the Fox River in Figure 5-13 (top, black symbols). Standard errors for each summertime average (n = 4) were approximately ± 50% (not shown). Two measurements made by Russell Cuhel (University of Wisconsin - Milwaukee) were included to show that primary productivity was still significant in late autumn (November 1995, gray circle) but decreased to approximately 10% of summertime values when ice covered the bay (January 1996, gray square).

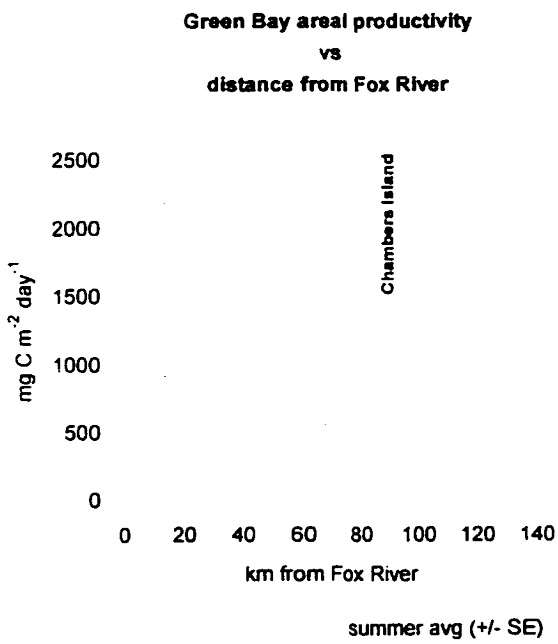
A conservative estimate of the annual areal primary productivity was calculated using the 3-year summertime averages of productivity given by Sager and Richman (1990) (Figure 5-13, bottom) and the under-ice value measured by Cuhel. A second-order polynomial regression was fit to the summertime data as a function of distance from the Fox River to give

$$P_{summer} = 1762.0 - 17.3X + 0.1X^2.$$

Figure 5-13. Areal primary production rates in Green Bay. Top) Average summertime primary productivity rates measured by Sager and Richman (1990, 1991) during the summers of 1986, 1987 and 1988 (black symbols). Productivity was measured at three stations located approximately 13, 66 and 120 kilometers from the mouth of the Fox River. Sampling consisted of four cruises per summer spaced at ~ 2 week intervals. Gray symbols represent additional productivity measurements (unpublished) made by Russell Cuhel from the University of Wisconsin - Milwaukee during November of 1995 and January of 1996. All productivity measurements were based on the ^{14}C method. Bottom) Average of all summertime productivity measurements made by Sager and Richman (1990).


Green Bay areal productivity
vs
distance from Fox River
2500
2000
1500
1000
500
0
mg C m^{-2} day^{-1}
Chambers Island
0
20
40
60
80
100
120
140
km from Fox River
summer 87 (S&R)
summer 86 (S&R)
summer 88 (S&R)
09 Nov 95 (RC)
26 Jan 96 (RC)

a


Green Bay areal productivity
vs
distance from Fox River
2500
2000
1500
1000
500
0
mg C m^{-2} day^{-1}
Chambers Island
0
20
40
60
80
100
120
140
km from Fox River
summer avg (+/- SE)

b

where X = distance from the Fox River in kilometers and P_{summer} = photosynthetic uptake of carbon in units of mg C m^{-2} day^{-1}. Summertime productivity rates were applied to 265 days of the year—the remaining 100 days were assigned a value of one tenth of P_{summer}. Annual estimates of productivity were therefore taken as

$$P = (265 * P_{summer} + 100 * (P_{summer} / 10)) / 1200,$$

where P was equal to mol C m^{-2} yr^{-1}. Using equation 5-1, relative estimates of annual areal respiration (R) were calculated as

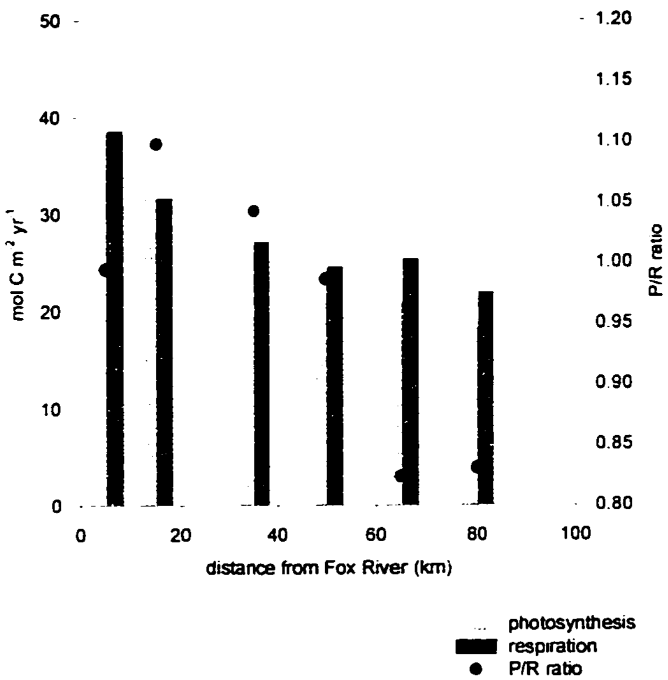
$$R = P + J_{aw},$$

where J_{aw} = the annual flux of CO_2 to the atmosphere in units of mol C m^{-2} yr^{-1} (Figure 5-12). Estimates of P and R and their ratio were plotted for each of the six zones in southern Green Bay in terms of distance from the mouth of the Fox River in Figure 5-14 (zone 5 was excluded from consideration).

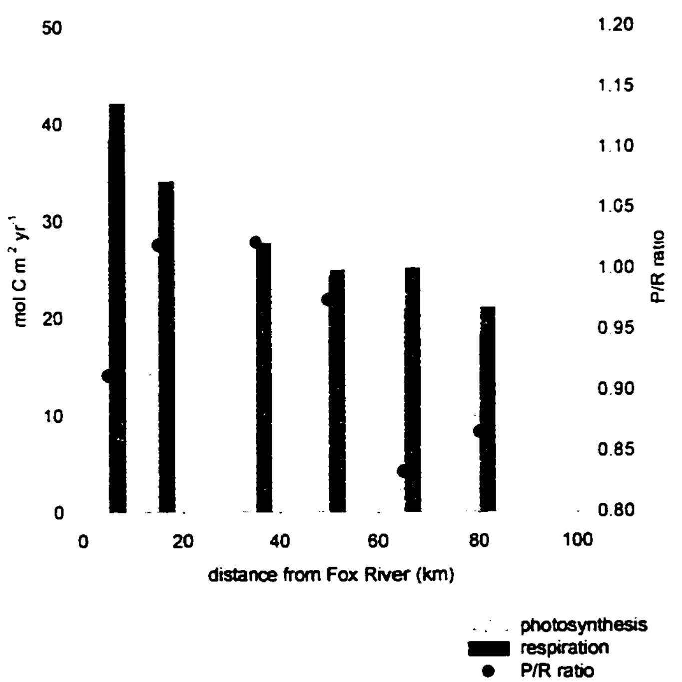
For much of the bay, photosynthesis and respiration were essentially in balance. In 1994, P/R ratios measured 0.99, 1.10, 1.04, 0.99, 0.82 and 0.83 in zones 1, 2, 3, 4, 6 and 7 respectively. In 1995, P/R ratios measured 0.91, 1.02, 1.02, 0.97, 0.83 and 0.87 in the same order. While gradients in the concentration of CO_2 across the air-water interface were often large and easy to measure, annual fluxes between the bay and atmosphere appeared insignificant compared to biological exchange. In zone 1 for instance, the mass

Figure 5-14. Estimates of annual areal primary productivity (light gray bars) and heterotrophic respiration (dark gray bars), and their (P/R) ratio (black circles) as a function of distance from the mouth of the Fox River. From left to right, each set of points correspond to conditions found in zones 1, 2, 3, 4, 6 and 7 (zone 5 excluded).

Green Bay P/R ratios
1994



Green Bay P/R ratios
1995



of total inorganic carbon (ΣCO_2) in the water column was only ~ 5.5 mol C m^{-2}. Based on the rates of P shown in Figure 5-14, the biological turnover time for ΣCO_2 was on the order of ~ 50 days. For the entire study site, the biological turnover time for ΣCO_2 equaled ~ 430 days.

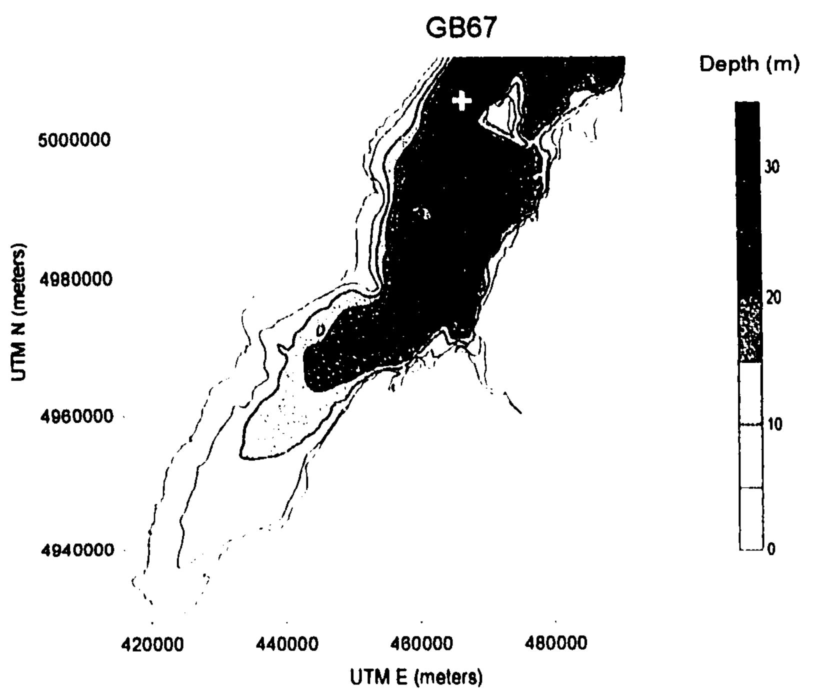
The pattern of rising then falling P/R ratios may have been due to differences in light or nutrient limitation on primary productivity as well as differences in zooplankton grazing rates and bacterial respiration (Sager et al. 1984; Sager and Richman 1990, 1991; del Giorgio et al. 1997). The production of organic carbon in one zone followed by advection and respiration in another zone could have also influenced the observed ratios. If so, then estuaries, lakes and even the ocean may display patterns of rising and falling P/R ratios much like those observed in lotic (river) systems (Cole 1983). These "ripples", over both time and space, could have varying amplitudes as well as wavelengths unique to each system. Inadequate temporal or spatial sampling could therefore lead to inaccurate estimates of the overall P/R ratio.

There was also the possibility that CO_2—in excess of the fugacity of atmospheric CO_2—flowed into the study site where it eventually vented to the atmosphere. This "excess" CO_2 would have been indistinguishable from CO_2 respired inside of the study site and thus would have "artificially" lowered the P/R ratio in the sense that the P/R ratio would not have reflected *in situ* activity.

This last scenario may explain the relatively high CO_2 fluxes (and low P/R ratios) observed in zones 6 and 7. The largest contribution of excess CO_2 from outside the study site was assumed to come from northern Green Bay. Based on current meter studies during the stratified season, water from the north flows into the hypolimnion of the southern bay through the channel west of Chambers Island at a rate of 900 m^3 sec^{-1} (Miller and Saylor 1993). This translates to a total inflow volume of 9.3 km^3 over 4 months. A profile of fCO_2 values measured at station GB67 during late summer (14 September 1994) showed that the potential contribution of excess CO_2 was large (Figure 5-15). Hypolimnetic fCO_2 values averaged ~ 2000 μatms at ~10°C. If the entire water mass entering the southern bay from the north eventually reached the surface layer and warmed 10°C in the process, then based on equation 5-15, fCO_2 would increase another ~ 900 μatm to ~ 2900 μatm. Bringing this water into equilibrium with the atmosphere would result in a loss of approximately 117 mmol C m^{-3} based on equation 5-16 and a Revelle factor of 30. Taking the product of 117 mmol C m^{-3} and 9.3 km^3 gave a total excess CO_2 contribution of ~110 x 10^7 mol C from northern Green Bay during the summer. Though the uncertainty in this number is large, it succeeds in demonstrating the potential contribution of CO_2 from outside of the study site.

Integrating annual productivity rates over the entire study site gave a total productivity estimate of 4.4 x 10^{10} mol C yr^{-1}. Using the average annual CO_2 flux to the atmosphere (210 x 10^7 mol C yr^{-1}) and equation 5-1, the P/R ratio for all of southern Green Bay equaled 0.95. The sensitivity of this ratio to uncertainties in the terms used to calculate it are given in Table 5-3. To begin, the terms affecting the P/R ratio were sorted into two categories: dampening terms and bias terms. Uncertainty in dampening terms could increase or decrease the P/R ratio to a limit of one. Bias terms on the other hand had no limit. For example, in an autotrophic system with a P/R ratio greater than one, error in a dampening term could increase or decrease the P/R ratio—but only to a limit of one. Error in a bias term, however, could decrease the P/R ratio to values below one. Examples

Figure 5-15. Water column profile of fCO_2 values and temperature at station GB67 on September 14th, 1994.


GB67
Depth (m)
30
20
10
0
UTM N (meters)
5000000
4980000
4960000
4940000
420000
440000
460000
480000
UTM E (meters)

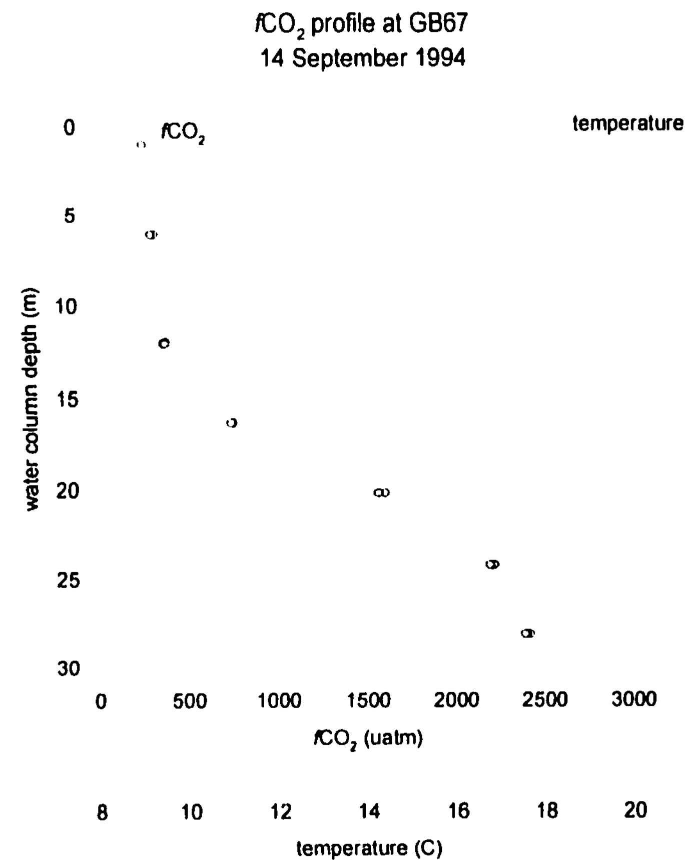

fCO2 profile at GB67
14 September 1994
fCO2
temperature
water column depth (m)
0
5
10
15
20
25
30
0
500
1000
1500
2000
2500
3000
fCO2 (uatm)
8
10
12
14
16
18
20
temperature (C)

Table 5-3. Sensitivity of average P/R ratio for southern Green Bay to uncertainties in the terms used to calculate it. "P" = annual areal primary productivity, "J(aw)" = average annual flux of CO_2 across the air-water interface, "K" = average transfer coefficient, "delta C" = average concentration gradient of CO_2 across the air-water interface, "excess CO_2" = CO_2 respired outside of study site, "carbonate precip" = carbonate precipitation, "chemical uptake" = chemically enhanced CO_2 flux and "sum" = sum of all bias terms.

P/R SENSITIVITY TABLE

	P mol C	**J (aw)** mol C	**P/R** ratio
observed	**4.4E+10**	**2.1E+09**	**0.95**
dampening terms			
2 K	4.4E+10	4.2E+09	**0.91**
0.5 K	4.4E+10	1E+09	**0.98**
2 delta C	4.4E+10	4.2E+09	**0.91**
0.5 delta C	4.4E+10	1E+09	**0.98**
2 P	8.8E+10	2.1E+09	**0.98**
0.5 P	2.2E+10	2.1E+09	**0.91**
bias terms			
excess CO2	4.4E+10	1E+09	**0.98**
carbonate precip	4.4E+10	1.8E+09	**0.96**
chemical uptake	4.4E+10	1.4E+09	**0.97**
sum	4.4E+10	0	**1.00**

of dampening terms include the transfer coefficient (K), the concentration gradient of CO_2 across the air-water interface (ΔC) and the rate of primary productivity (P). Examples of bias terms include the advection of excess CO_2 across the boundary of the study site, carbonate precipitation and chemically enhanced CO_2 flux across the air-water interface. If the sign of ΔC was incorrect, then this too could be considered a bias term, but CO_2 concentration gradients in the bay were usually so large that this was not considered an issue.

Beginning with the dampening terms, an uncertainty in K, ΔC or P would have had little impact on the overall P/R ratio. Doubling or halving K or ΔC would have shifted the P/R ratio ± ~ 3.5% to 0.91 and 0.98 respectively. Doubling or halving P would have increased or lowered the P/R ratio to 0.98 and 0.91 respectively.

The bias terms also had little affect on the overall P/R ratio. However, they all tended to have a positive bias—meaning they all tended to increase the P/R ratio. Using the estimate of excess CO_2 advection from above, an influx of 110 x 10^7 mol C from northern Green Bay would have increased the P/R ratio to a value of 0.98.

Carbonate precipitation would have liberated an equivalent amount of CO_2 and thus decreased the P/R ratio (McConnaughey et al. 1994). The amount of carbonate permanently buried in the sediment of southern Green Bay has been estimated by Klump and Fitzgerald (1998) to be ~ 30 x 10^7 moles per year. A cursory estimate of carbonate loss from southern Green Bay based on the observed decrease in alkalinity from the Fox River northward (see Figure 5-4) gives a similar value of

$$(6\% \times 2.3 \text{ mol } C_A \text{ m}^{-3}) / 2 \times 4 \times 10^9 \text{ m}^3 \cong 28 \times 10^7 \text{ moles } [CO_3^{2-}] \text{ year}^{-1}.$$

where the annual flow of the Fox River during 1994 was measured as 4 x 10^9 m^3 (Figure 4-7b). Subtracting the carbonate burial term from the net flux of CO_2 to the atmosphere increased the P/R ratio slightly from 0.95 to 0.96.

Finally, additional CO_2 could have entered the bay via the air-water interface due to chemical enhancement. Under conditions of low turbulence and high pH values, CO_2 molecules can react with hydroxide ions and water to form bicarbonate ions (Butler 1982). As a result, CO_2 flux due to chemical enhancement can more than double the rate of CO_2 flux based on Fickian diffusion alone (Wanninkhof and Knox 1996). The conditions required for significant chemical enhancement were not generally found in Green Bay. However, the absence of chemical enhancement needs to be confirmed. An upper estimate of enhanced CO_2 flux was made by doubling the flux estimates of CO_2 into the bay in zones 2 and 3. Doubling the uptake of CO_2 in zones 2 and 3 would reduce the overall flux of carbon from the bay to the atmosphere by 70 x 10^7 mol C yr^{-1} which in turn would increase the P/R ratio to 0.97.

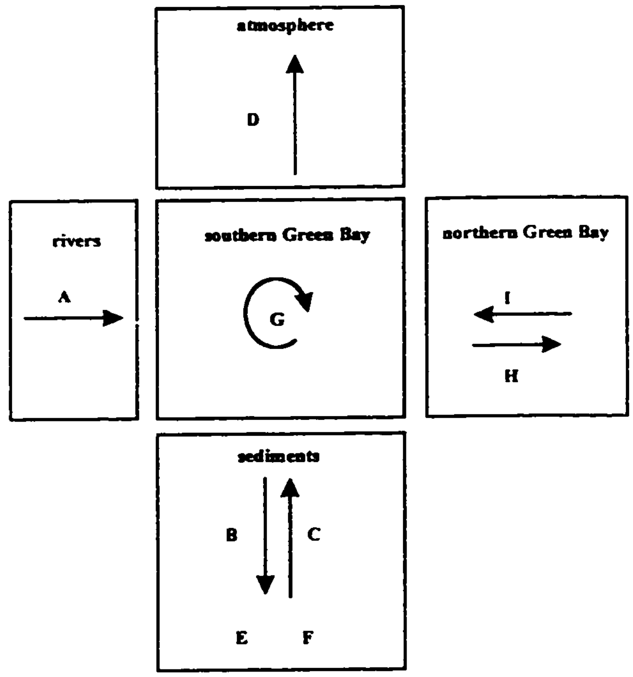
Clearly, none of the factors alone had much influence on the average P/R ratio for southern Green Bay. If all of the bias factors were summed, the P/R ratio would only increase 5% to a value of 1.0. Improving on the accuracy of this estimate would be difficult considering the dynamics of the system observed over two field seasons.

<u>Preliminary allochthonous carbon budget</u>

Though many terms of the carbon budget for southern Green Bay are still unresolved, a suppositional budget for allochthonous carbon is presented in Figure 5-16.

Figure 5-16. Allochthonous carbon budget for southern Green Bay. A preliminary budget for allochthonous carbon entering southern Green Bay based on an assumed input of 360 x 10^7 moles of particulate organic carbon (POC) per year. "Pin" = measured total phosphorus loading to southern Green Bay. C:P = measured stoichiometry of carbon to phosphorus in particulate organic matter (POM) found at the sediment-water interface of Green Bay. See text for definition of other terms. All carbon fluxes are in units of 10^7 moles $year^{-1}$.

southern Green Bay
allochthonous carbon budget



Pin = 2.6 E+07 (800 metric tons) — *Klump et al. 1997*
C:P = 140 (surface sediment POM) — *Klump et al. 1997*

		carbon flux*	formula	source
A	particulate organic C input	360	Pin x C:P	stoichiometry
B	particulate organic C sedimentation	210	measured	Klump and Fitzgerald (1998)
C	remineralized CO2 (sediment)	56	measured	Klump and Fitzgerald (1998)
D	CO2 export to atmosphere	210	measured	this study
E	carbonate burial	30	measured	Klump and Fitzgerald (1998)
F	particulate organic carbon burial	140	measured	Klump and Fitzgerald (1998)
G	remineralized CO2 (water column)	0 - 124	D - C - E - I	mass balance
H	particulate organic C export	150 - 26	A - B - G	mass balance
I	"excess" CO2 import	124 - 0	D - C - E - G	mass balance

check $A = F + G + C + H + 14\ (CH_4) = 360$
check $D = C + E + G + I = 210$

* units = 10^7 moles year^{-1}

An upper estimate of ~ 360 x 10^7 moles of particulate organic carbon (POC) are loaded into southern Green Bay from riverine sources each year based on an annual total phosphorus loading of 2.6 x 10^7 moles and an observed C:P stoichiometry of 141 (~140) for particulate organic matter (POM) at the Green Bay sediment-water interface (Klump et al. 1997).

This estimate of allochthonous POC assumes that all of the phosphorus entering the bay is already fixed in organic matter. It also assumes that the C:P stoichiometry of 141 represents the average C:P stoichiometry of POM entering the bay from riverine sources. In reality, both assumptions may be false. Some of the phosphorous entering the bay may be biologically unavailable. Another unknown fraction of the phosphorus input may stimulate new production within the bay.

Regardless, the fate of allochthonous POC can be constrained to some degree based on measurements of other terms in the carbon budget. To begin, Klump and Fitzgerald (1998) have measured a sedimentation rate of 210 x 10^7 moles of POC per year. Of that amount, approximately 140 x 10^7 moles are permanently buried while the remaining fraction returns to the water column as remineralized inorganic carbon (~ 56 x 10^7 moles of CO_2 and ~14 x 10^7 moles of CH_4) (Klump and Fitzgerald 1998). The amount of carbonate permanently buried each year is estimated to be 30 x 10^7 moles (Klump and Fitzgerald 1998; this study, see above). Finally, the flux of CO_2 from the bay to the atmosphere averages 210 x 10^7 moles per year based on the observations of this study.

Based on an initial loading of 360 x 10^7 moles, a maximum of 58% of the POC settles to the sediments leaving a minimum of 42% of the POC (or 150 x 10^7 moles) unaccounted for. Similarly, the amount of unaccounted for CO_2 leaving the system via the air-water interface is equal to

$$210 \times 10^7 - 56 \times 10^7 \text{ (from sediment)} - 30 \times 10^7 \text{ (carbonate burial)}$$

or 124×10^7 moles CO_2 (i.e. 59% of the air-water CO_2 flux). The subtraction of the carbonate term assumes that the carbonate precipitated within the bay—releasing an equal number of moles of CO_2.

By mass balance, the amount of allochthonous POC exported out of southern Green Bay each year should equal 150×10^7 moles minus the amount respired within the water column of the southern bay. If all of the allochthonous POC is exported back out of the system, then approximately 124×10^7 moles of allochthonous "excess" CO_2 must enter the southern bay in order to balance the flux of CO_2 to the atmosphere. Likewise, a maximum of 124×10^7 moles of allochthonous POC could be respired within the water column of southern Green Bay. The remaining 26×10^7 moles of POC would have to be exported out of the study site in order to achieve mass balance.

If the allochthonous POC input was smaller (e.g. the average C:P stoichiometry of POM was equal to 116), then the export of POC would decrease and could change sign depending on the input of excess CO_2. If some of the phosphorus stimulated new production within the bay, then an increase in the input of excess CO_2 from outside of the system would be required the balance the budget.

Though the uncertainty in many of the terms of this carbon budget are large, it illuminates which terms are important and, on that account, the direction of future research.

Conclusions

Based on over 1800 measurements of surface water fCO_2 and the transfer coefficients derived in Chapter 3, southern Green Bay (south of Chambers Island) exported 180 x 10^7 moles of CO_2 to the atmosphere in 1994 and 240 x 10^7 moles of CO_2 in 1995. While the entire study site exported CO_2 to the atmosphere, the southern most portion of the bay (~ 1000 km^2) imported CO_2 over the year.

Heating of the water column during summer caused a ~ 138% increase in fCO_2 (0°C:320 μatm, 23°C:~762 μatm, equation 5-15) which was moderated to varying degrees throughout the bay by autotrophic CO_2 uptake. Immediately after destratification of the water column, surface water fCO_2 values rose sharply as CO_2 produced through benthic bacterial metabolism spread throughout the water column. Rapidly dropping water temperatures quickly depressed CO_2 fugacities to the point where, by ice cover, the surface waters of Green Bay were slightly below equilibrium with respect to atmospheric CO_2.

The conclusions of this study can neither support nor refute Cole et al. (1994) who conclude that lakes, in general, export CO_2 to the atmosphere. However, the observed spatial and temporal heterogeneity of surface water fCO_2 in southern Green Bay points to the fact that decisions on whether or not a system imports or exports CO_2 to the atmosphere cannot be made from single time or space point measurements. Of the 1835 lakes included in Cole's survey, less than 6% (106) were surveyed over an entire seasonal cycle. Nearly 88% (1612) of the lakes were sampled only once in the autumn when fluctuations in fCO_2 due to falling temperatures and mixing of the water column are at their greatest. An additional ~ 3% (60) of the lakes were only sampled during the summer when substantial increases in fCO_2 caused by thermal effects alone could easily overwhelm the autotrophic depression of fCO_2 in an oligotrophic system.

Estimates of the P/R ratio in each of the six zones along the main axis of Green Bay rose from values below one at the mouth of the Fox River (zone 1) to values higher than one in zones 2 and 3. Further north, P/R ratios again dropped below one in zones 4, 6 and 7. The physiological reasons for this were beyond the scope of this study but probably related to differences in light or nutrient limitation on primary productivity as well as differences in zooplankton grazing rates and bacterial respiration (Sager et al. 1984; Sager and Richman 1990, 1991; del Giorgio et al. 1997). Future research might focus on the relationship between heterotrophy and autotrophy at distances farther from the land-water interface. As the affects of terrestrial loading on community structure and activity should diminish with distance—so should the P/R ratio eventually rise to a value of one or more.

BIBLIOGRAPHY

Anderson, M. P., and C. J. Bowser. 1986. The role of groundwater in delaying acid acidification. Water Resour. Res. 22:1101-1108.

Auer, M. T., R. P. Canale, and J. H. Wiersma. (unpublished) A steady-state mass balance model for chloride, total phosphorus and total organic carbon in Green Bay (Lake Michigan).

Baker-Blocker, A., T. M. Donahue, and K. H. Mancy. 1977. Methane flux from wetland areas. Tellus 29:245-250.

Barber, R. B., R. A. Burke, Jr., and W. M. Sackett. 1988. Diffusive flux of methane from warm wetlands. Global Biogeochem. Cycles 2:411-425.

Bender, M., W. Martin, J. Hess, F. Sayles, L. Ball, and C. Lambert. 1987. A whole-core squeezer for interfacial pore-water sampling. Limnol. Oceanogr. 32:1214-1225.

Benson, B. B., D. Krause, Jr., and M. A. Peterson. 1979. The solubility and isotopic fractionation of gases in dilute aqueous solution: I. Oxygen. J. Solution Chem. 8:655-690.

Birge, E. A., C. Juday, and H. W. March. 1928. The temperature of the bottom deposits of Lake Mendota; a chapter in the heat exchanges in the lake. Trans. Wis. Acad. Sci. Arts Lett. 23:187-231.

Bishop, P. K. 1990. Precipitation of dissolved carbonate species from natural waters for $\delta^{13}C$ analysis - A critical appraisal. Chem. Geol. (Isot. Geosci. Sect.) 80:251-259.

Blair, N. E., C. S. Martens, D. J. Des Marais. 1987. Natural abundances of carbon isotopes in acetate from a coastal marine sediment. Science 236:66-67.

Blake, D. R., and F. S. Rowland. 1988. Continuing worldwide increase in tropospheric methane, 1978 to 1987. Science 239:1129-1131.

Boehme, S. E. 1993. The carbon isotope biogeochemistry of a methanogenic marine sediment. Ph.D. dissertation, North Carolina State Univ., Raleigh.

Bolgrien, D. W. 1993. Delineation of the hydrodynamics of Lake Michigan and Lake Baikal using satellite-derived surface temperatures. Ph.D. dissertation, University of Wisconsin-Milwaukee.

Boone, D. R. 1991. Ecology of methanogenesis, pp. 57-70. In J. E. Rogers and W. B. Whitman [eds.], Microbial Production and Consumption of Greenhouse Gases:

Methane, Nitrogen Oxides, and Halomethanes. American Society for Microbiology. Washington D. C.

Boutin, J., and J. Etcheto. 1997. Long-term variability of the air-sea CO_2 exchange coefficient: Consequences for the CO_2 fluxes in the equatorial Pacific Ocean. Global Biogeochem. Cycles 11:453-470.

Boutton, T. W. 1991. Stable carbon isotope ratios of natural materials: 1. Sample preparation and mass spectrometric analysis. In D. C. Coleman and B. Fry [eds.], Carbon Isotope Techniques. Academic Press.

Broecker, H. C., J. Petermann, and W. Siems. 1978. The influence of wind on CO_2-exchange in a wind-wave tunnel, including the effects of monolayers. J. Marine Res. 36:595-610.

Broecker, W. S. 1966. Radioisotopes and the rate of mixing across the main thermocline of the ocean. J. Geophys. Res. 71:5827-5836.

Broecker, W. S. and T. H. Peng. 1982. Tracers in the Sea. Columbia University. New York.

Broecker, W. S. and T. H. Peng. 1984. Gas exchange measurements in natural systems, pp. 479-493. In W. Brutseart and G. H. Jirka [eds.], Gas transfer at water surfaces. D. Reidel, Dordrecht.

Broecker, W., J. R. Ledwell, T. Takahashi, R. Weiss, L. Merlivat, L. Memery, T. H. Peng, B. Jahne, and K. O. Munnich. 1986. Isotopic versus micrometerologic ocean CO_2 fluxes: A serious conflict. J. Geophys. Res. 91:10517-10527.

Broecker, W. S., and E. Maier-Reimer. 1992. The influence of air and sea exchange on the carbon isotope distribution in the sea. Global Biogeochem. Cycles 6:315-320.

Broecker, W. S., and T. H. Peng. 1992. Interhemispheric transport of carbon dioxide by ocean circulation. Nature 356:587-589.

Brooks, A. S., and D. N. Edgington. 1994. Biogeochemical control of phosphorus cycling and primary production in Lake Michigan. Limnol. Oceanogr. 39:961-968.

Buchholz, L. A., J. V. Klump, M. L. P. Collins, C. A. Brantner, C. C. Remsen. 1995. Activity of methanotrophic bacteria in Green Bay sediments. FEMS Microbiol. Ecol. 16:1-8.

Buesseler, K. O., A. F. Michaels, D. A. Siegel, and A. H. Knap. 1994. A three dimensional time-dependent approach to calibrating sediment trap fluxes. Global Biogeochem. Cycles 8:179-193.

Bunn, S. E., N. R. Loneragan, and M. A. Kempster. 1995. Effects of acid washing on stable isotope ratios of C and N in penaeid shrimp and seagrass: Limnol. Oceanogr. 40:622-625.

Butler, J. N. 1982. Carbon Dioxide Equilibria and Their Applications. Addison-Wesley, Reading, Massachusetts.

Capone, D. G., and R. P. Kiene. 1988. Comparison of microbial dynamics in marine and freshwater sediments: Contrasts in anaerobic carbon catabolism. Limnol. Oceanogr. 4:725-749.

Carmack, E. C., C. B. J. Gray, C. H. Pharo, and R. J. Daley. 1979. Importance of lake-river interaction on seasonal patterns in the general circulation of Kamloops Lake, British Columbia. Limnol. Oceanogr. 24:634-644.

Carpenter, J. H. 1965a. The accuracy of the Winkler method for dissolved oxygen analysis. Limnol. Oceanogr. 10:135-140

Carpenter, J. H. 1965b. The Chesapeake Bay Institute technique for the Winkler dissolved oxygen method. Limnol. Oceanogr. 10:141-143.

Carroll, P., and P. Crill. 1997. Carbon balance of a temperate poor fen. Global Biogeochem. Cycles 11:349-356.

Chanton, J. P., C. S. Martens, and M. B. Goldhaber. 1987. Biogeochemical cycling in an organic-rich coastal marine basin. 8. A sulfur isotopic budget balanced by differential diffusion across the sediment-water interface. Geochim. Cosmochim. Acta 51:1201-1208.

Chanton, J. P., and C. S. Martens. 1988. Seasonal variations in the ebullitive flux and carbon isotopic composition of methane in a tidal freshwater estuary. Global Biogeochem. Cycles 2:289-298.

Chanton, J. P., G. G. Pauley, C. S. Martens, N. E. Blair, and J. W. Dacey. 1988. Carbon isotopic composition of methane in Florida Everglades soils and fractionation during its transport to the troposphere. Global Biogeochem. Cycles 2:245-252.

Chanton, J. P., C. S. Martens, and C. A. Kelly. 1989. Gas transport from methane-saturated, tidal freshwater and wetland sediments. Limnol. Oceanogr. 34:807-819.

Chanton, J. P., and J. W. H. Dacey. 1991. Effects of vegetation on methane flux, reservoirs, and carbon isotopic composition., pp.65-92. In T. D. Sharkey, A. E. Holland, and H. A. Mooney [eds.], Trace gas emissions by plants. Academic, San Diego.

Chavez, F. P., and R. T. Barber. 1987. An estimate of new production in the equatorial Pacific. Deep-Sea Res. 34:1229-1243.

Chen, C. L., and K. K. Lee. 1991. Great Lakes river-estuary hydrodynamic finite element model. J. Hydraulic Engrg. 117:1531-1549.

Chen, R. L., D. R. Keeny, and T. H. McIntosh. 1983. The role of sediments in the nitrogen budget of lower Green Bay, Lake Michigan. J. Great Lakes Res. 9:23-31.

Chipman, D. W., T. Takahashi, S. Rubin, S. C. Sutherland, and M. H. Koshlyakov. 1997. Carbon dioxide, hydrographic, and chemical data obtained during the R/V *Akademik Ioffe* cruise in the South Pacific Ocean (WOCE Section S4P, February-April 1992). ORNL/CDIAC-100, NDP-063. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Cicerone, R. J., J. D. Shetter, and C. C. Delwiche. 1983. Seasonal variation of methane flux from a California rice paddy. J. Geophys. Res. 88:11022-11024.

Cicerone, R. J., and R. S. Oremland. 1988. Biogeochemical aspects of atmospheric methane. Global Biogeochem. Cycles 2:299-327.

Cifuentes, L. A., J. H. Sharp, and M. L. Fogel. 1988. Stable carbon and nitrogen isotope biogeochemistry in the Delaware estuary. Limnol. Oceanogr. 33:1102-1115.

Cloern, J. E., C. Grenz, and L. Vidergas-Lucas. 1995. An empirical model of the phytoplankton chlorophyll: carbon ratio - the conversion factor between productivity and growth rate. Limnol. Oceanogr. 40:1313-1321.

Cole, G. A. 1983. Textbook of Limnology, 3rd edition. Waveland Press; Prospect Heights, Illinois.

Cole, J. J., N. F. Caraco, G. W. Kling, and T. K. Kratz. 1994. Carbon dioxide supersaturation in the surface waters of lakes. Science 265:1568-1570.

Colman, J. A., and D. E. Armstrong. 1987. Vertical eddy diffusivity determined with ^{222}Rn in the benthic boundary layer of ice-covered lakes. Limnol. Oceanogr. 32:577-590.

Conger, P. S. 1943. Ebullition of gases from marsh and lake waters. Pub. 59, Chesapeake Biol. Lab. 42.

Copin-Montégut, C. 1993. Alkalinity and carbon budgets in the Mediterranean Sea. Global Biogeochem. Cycles 7:915-925.

Craig, H., R. A. Wharton, Jr., and C. P. McKay. 1992. Oxygen supersaturation in ice-covered Antarctic lakes: Biological versus physical conditions. Science 255:318-321.

Csanday, G. T. 1975. Physical limnology of Lake Michigan: Part 2. Diffusion and dispersion. Argonne Nat. Lab., "Environ. Status L. Michigan Region", ANL/ES-40, 2:103-121.

D'Avanzo, C., and J. N. Kremer. 1994. Diel oxygen dynamics and anoxic events in an eutrophic estuary of Waquoit Bay, Massachusetts. Estuaries 17:131-139.

Deacon, E. L. 1977. Gas transfer to and across an air-water interface. Tellus 29:363-374.

de Angelis, M. A., and M. D. Lilley. 1987. Methane in surface waters of Oregon estuaries and rivers. Limnol. Oceanogr. 32:716-722.

de Angelis, M. A., and M. I. Scranton. 1993. Fate of methane in the Hudson River and Estuary. Global Biogeochem. Cycles 7:509-523.

Deffeyes, K. S. 1965. Carbonate equilibria: A graphic and algebraic approach. Limnol. Oceanogr. 10:412-426.

del Giorgio, P. A., and R. H. Peters. 1993. Balance between phytoplankton production and plankton respiration in lakes. Can. J. Fish. Aquat. Sci. 50:282-289.

del Giorgio, P. A., J. J. Cole, and A. Cimbleris. 1997. Respiration rates in bacteria exceed phytoplankton production in unproductive aquatic systems. Nature 385:148-151.

Denman, K. L., and A. E. Gargett. 1983. Time and space scales of vertical mixing and advection of phytoplankton in the upper ocean. Limnol. Oceanogr. 28:801-815.

DePinto, J. V., R. Raghunathan, V. J. Bierman, Jr., P. W. Rodgers, T. C. Young, and C. S. Martin. 1994. Analysis of organic carbon sediment-water exchange in Green Bay, Lake Michigan, USA. Wat. Sci. Tech. 28:149-159.

Dobson, F. 1983. Introductory physical oceanography, pp. 53-120. In P. S. Liss and W. G. N. Slinn [eds.], Air-sea exchange of gases and particles. D. Reidel, Dordrecht.

DOE. 1994. Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A. G. Dickson & C. Goyet, eds. (unpublished manuscript).

Driscoll, C. T., S. W. Effler, and S. M. Doerr. 1994. Changes in inorganic carbon chemistry and deposition of Onondaga Lake, New York. Environ. Sci. Technol. 28:1211-1218.

Duchemin, E., M. Lucotte, R. Canuel, and A. Chamberland. 1995. Production of the greenhouse gases CH_4 and CO_2 by hydroelectric reservoirs of the boreal region. Global Biogeochem. Cycles 9:529-540.

Dueñas, C., M. C. Fernandez, and M. De La Torre. 1986. Fluxes and exchange rates of radon and oxygen across an air-sea interface. Geochem. J. 20:61-69.

Dunstall, T. G., et al. 1990. Influence of upwelling, storms, and generating station operation on water chemistry and plankton in the Nanticoke region of Long Point Bay, Lake Erie. Can J. Fish Aquat. Sci. 47:1434-1445.

Duxbury, A. C. 1979. Upwelling and estuary flushing. Limnol. Oceanogr. 24:627-633.

Eadie, B. J., and A. Robertson. 1976. An IFYGL carbon budget for Lake Ontario. J. Great Lakes Res. 2:307-323.

Eadie, B. J., R. L. Chambers, W. S. Gardner, and G. L. Bell. 1984: Sediment trap studies in Lake Michigan: Resuspension and chemical fluxes in the southern basin. J. Great Lakes Res. 10:307-321.

Eadie, B. J., G. L. Bell, and N. Hawley. 1991. Sediment trap study in the Green Bay Mass Balance Program: Mass and organic carbon fluxes, resuspension, and particle settling velocities. NOAA Tech. Memo. ERL GLERL-75.

Eaton, A. D., L. S. Clesceri, and A. E. Greenberg, eds. 1995. Standard methods for the examination of water and wastewater, 19th edition, American Public Health Assoc. Washington D. C.

Effler, S. W. 1984. Carbonate equilibria and the distribution of inorganic carbon in Saginaw Bay. J. Great Lakes Res. 10:3-14.

Ehhalt, D. H. 1974. The atmospheric cycle of methane. Tellus 26:58-70.

Eisenreich, S. J., P. J. Emmling, and A. M. Beeton. 1977. Atmospheric loading of phosphorus and other chemicals to Lake Michigan. J. Great Lakes Res. 3:291-304.

Emerson, S. 1975a. Chemically enhanced CO_2 gas exchange in a eutrophic lake: A general model. Limnol. Oceanogr. 20:743-753.

Emerson, S. 1975b. Gas exchange rates in small Canadian Shield lakes. Limnol. Oceanogr. 20:754-761.

Emerson, S., P. Quay, C. Stump, D. Wilbur, and M. Knox. 1991. O_2, Ar, N_2, and ^{222}Rn in surface waters of the subarctic ocean: Net biological O_2 production. Global Biogeochem. Cycles 5:49-69.

Etcheto, J., and L. Merlivat. 1988. Satellite determination of the carbon dioxide exchange coefficient at the ocean-atmosphere interface: A first step. J. Geophys. Res. 93:15669-15678.

Fahnenstiel, G. L., and D. Scavia. 1987. Dynamics of Lake Michigan phytoplankton: Primary production and growth. Can. J. Fish. Aquat. Sci. 44:499-508.

Fahnenstiel, G. L., J. F. Chandler, H. J. Carrick, and D. Scavia. 1989. Photosynthetic characteristics of phytoplankton communities in Lakes Huron and Michigan: P-I parameters and end-products. J. Great Lakes Res. 15:394-407.

Fallon, R. D., S. Harrits, R. S. Hanson, and T. D. Brock. 1980. The role of methane in internal carbon cycling in Lake Mendota during summer stratification. Limnol. Oceanogr. 25:357-360.

Fallon, R. D., and C. W. Boylen. 1990. Bacterial production in freshwater sediments: Cell specific versus system measures. Microb. Ecol. 19:53-62.

Farmer, D. M., C. L. McNeil, and B. D. Johnson. 1993. Evidence for the importance of bubbles in increasing air-sea gas flux. Nature 361:620-623.

Fee, E. J., R. E. Hecky, G. Regehr, L. L. Hendzel, and P. Wilkinson. 1994. Effects of lake size on nutrient availability in the mixed-layer during summer stratification. Can. J. Fish. Aquat. Sci. 51:2756-2768.

Fitzgerald, S. A. 1989. The biogeochemistry of amino acids in sediments from the Great Lakes. Ph.D. dissertation, University of Wisconsin-Milwaukee.

France, R. L. 1995. Differentiation between littoral and pelagic food webs in lakes using stable carbon isotopes. Limnol. Oceanogr. 40:1310-1313.

France, R. L., and R. H. Peters. 1997. Ecosystem differences in the trophic enrichment of ^{13}C in aquatic food webs. Can. J. Fish. Aquat. Sci. 54:1255-1258.

Frankignoulle, M. 1988. Field measurements of air-sea CO_2 exchange. Limnol. Oceanogr. 33:313-322.

Fry, B. 1991. Stable isotope diagrams of freshwater food webs. Ecology 72:2293-2297.

Fujita, T. T., and R. M. Wakimoto. 1982. Effects of miso- and mesoscale obstructions on PAM winds obtained during Project NIMROD. J. Appl. Meteor. 21:840-858.

Gailani, J., C. K. Ziegler, and W. Lick. 1991. Transport of suspended solids in the lower Fox River. J. Great Lakes Res. 17:479-494.

Gardner, W. S., T. F. Nalepa, and J. M. Malczyk. 1987. Nitrogen mineralization and denitrification in lake Michigan sediments. Limnol. Oceanogr. 32:1226-1238.

Gardner, W. S., B. J. Eadie, J. F. Chandler, C. C. Parrish, and J. M. Malczyk. 1989. Mass flux and "nutritional composition" of settling epilimnetic particles in Lake Michigan. Can. J. Fish. Aquat. Sci. 46:1118-1124.

Gloss, S. P., L. M. Mayer, and D. E. Kidd. 1979. Advective control of nutrient dynamics in the epilimnion of a large reservoir. Limnol. Oceanogr. 25:219-228.

Gottlieb, E. S., J. H. Saylor, and G. S. Miller. 1990. Currents and water temperatures observed in Green Bay, Lake Michigan. NOAA Tech. Memo. ERL GLERL-73.

Graber, E. R., and P. Aharon. 1991. An improved microextraction technique for measuring dissolved inorganic carbon (DIC), $\delta^{13}C_{DIC}$ and $\delta^{18}O_{H2O}$ from milliliter-size water samples. Chem. Geol. (Isot. Geosci. Sect.) 94:137-144.

Granéli, W., M. Lindell, and L. Tranvik. 1996. Photo-oxidative production of dissolved inorganic carbon in lakes of different humic content. Limnol. Oceanogr. 41:698-706.

Hall, P. O. J., and R. C. Aller. 1992. Rapid, small volume, flow injection analysis for ΣCO_2 and NH_4^- in marine and freshwaters. Limnol. Oceanogr. 37:1113-1119.

Hansell, D. A., N. R. Bates, and C. A. Carison. 1997. Predominance of vertical loss of carbon from surface waters of the equatorial Pacific Ocean. Nature 386:59-61.

Harned, H. S. and Davis, R. Jr. 1943. The ionization constant of carbonic acid in water and the solubility of carbon dioxide in water and aqueous salt solutions from 0 to 50°. J. American Chem. Soc. 65:2030-2037, 1943.

Harned, H. S. and S. R. Scholes, Jr. 1941. The ionization constant of HCO3- from 0 to 50°. J. American Chem. Soc. 43:1706-1709.

Harriss, R. C., D. I. Sebacher, K. B. Bartlett, D. S. Bartlett, and P. M. Crill. 1988. Sources of atmospheric methane in the South Florida environment. Global Biogeochem. Cycles 2:231-243.

Harrits, S. M., and R. S. Hanson. 1980. Stratification of aerobic methane oxidizing organisms in Lake Mendota, Madison, Wisconsin. Limnol. Oceanogr. 25:412-421.

Hartman, B., and D. E. Hammond. 1984. Gas exchange rates across the sediment-water and air-water interfaces in south San Francisco Bay. J. Geophys. Res. 89:3593-3603.

Hasse, L. 1983. Introductory meteorology and fluid dynamics, pp. 1-51. In P. S. Liss and W. G. N. Slinn [eds.], Air-sea exchange of gases and particles. D. Reidel, Dordrecht.

Hawley, N., and J. Niester. 1993. Measurement of horizontal sediment transport in Green Bay, May-October, 1989. J. Great Lakes Res. 19:368-378.

Heaps, N. S., C. H. Mortimer, and E. J. Fee. 1982. Numerical Models and observations of water motion in Green Bay, Lake Michigan. Phil. Trans. R. Soc. Lond. A306:371-398.

Herczeg, A. L., and R. H. Hesslein. 1984. Determination of hydrogen ion concentration in softwater lakes using carbon dioxide equilibria. Geochim. Cosmochim. Acta 48:837-845.

Herczeg, A. L. 1987. A stable carbon isotope study of dissolved inorganic carbon cycling in a softwater lake. Biogeochemistry 4:231-263.

Herczeg, A. L., and R. G. Fairbanks. 1987. Anomalous carbon isotope fractionation between atmospheric CO_2 and dissolved inorganic carbon induced by intense photosynthesis. Geochim. Cosmochim. Acta 51:895-899.

Herczeg, A. L. 1988. Early diagenesis of organic matter in lake sediments: A stable carbon isotope study of pore waters. Chem. Geol. (Isot. Geosci. Sect.) 72:199-209.

Hesslein, R., and P. Quay. 1973. Vertical eddy diffusion studies in the thermocline of a small stratified lake. J. Fish. Res. Board Can. 30:1491-1500.

Heyer, J., and H. D. Babenzien. 1985. Untersuchungen des Methankreislaufes in einem oligotrophen See (Stechlinsee). Limnologica (Berlin) 16:267-276.

Himmelblau, D. M. 1964. Diffusion of dissolved gases in liquids. Chem. Rev. 64:527-550.

Holligan, P. M., E. Fernández, J. Aiken, W. M. Balch, P. Boyd, P. H. Burkill, M. Finch, S. B. Groom, G. Malin, K. Muller, D. A. Purdie, C. Robinson, C. C. Trees, S. M. Turner, and P. van der Wal. 1993. A biogeochemical study of the coccolithophore, *Emiliania huxleyi*, in the North Atlantic. Global Biogeochem. Cycles 7:879-900.

Holmen, K., and P. Liss. 1984. Models for air-water gas transfer: an experimental investigation. Tellus 36B:92-100.

Holzapfel-Pschorn, A., R. Conrad, and W. Seiler. 1985. Production, oxidation and emission of methane in rice paddies. FEMS Microbiol. Ecol. 31:343-351.

Howard, D. L., J. I. Frea, and P. M. Pfister. 1971. The potential for methane carbon cycling in Lake Erie. In Proc. 14th Conf. Great Lakes Res. Int. Assoc., Great Lakes Res., pp. 236-240.

Hutchinson, G. E. 1975. A treatise on limnology: Volume 1, Part 1 - Geography and physics of lakes. John Wiley & Sons, New York.

Imboden, D. M., and S. Emerson. 1978. Natural radon and phosphorus as limnologic tracers: Horizontal and vertical eddy diffusion in Greifensee. Limnol. Oceanogr. 23:77-90.

Inoue, H., and Y. Sugimura. 1985. Carbon isotopic fractionation during the CO_2 exchange process between air and sea water under equilibrium and kinetic conditions. Geochim. Cosmochim. Acta 49:2453-2460.

Ivanov-Klokov, V. I., V. V. Lushkin, I. Ya. Sklyarenko, and Yu. P. Shakula. 1975. Variations of atmospheric methane abundance. Atmos. Oceanic Phys. 11:993-998.

Jähne, B., K. O. Munnich, and U. Siegenthaler. 1979. Measurements of gas exchange and momentum transfer in a circular wind-water tunnel. Tellus 31:321-329.

Jähne, B., G. Heinz, and W. Dietrich. 1987a. Measurement of the diffusion coefficients of sparingly soluble gases in water. J. Geophys. Res. 92:10767-10776.

Jähne, B., K. O. Munnich, R. Bosinger, A. Dutzi, W. Huber, and P. Libner. 1987b. On the parameters influencing air-water gas exchange. J. Geophys. Res. 92:1937-1949.

Jahnke, R. A. 1988. A simple, reliable, and inexpensive pore-water sampler. Limnol. Oceanogr. 33:483-486.

Jassby, A., and T. Powell. 1975. Vertical patterns of eddy diffusion during stratification in Castle Lake, California. Limnol. Oceanogr. 20:530-543.

Jenkins, W. J., and J. C. Goldman. 1985. Seasonal oxygen cycling and primary production in the Sargasso Sea. J. Mar. Res. 43:465-491.

Jewell, P. W. 1994. Mass balance models of Ekman transport and nutrient fluxes in coastal upwelling zones. Global Biogeochem. Cycles 8:165-177.

Johnson, K. S., R. M. Pytkowicz, and C. S. Wong. 1979. Biological production and the exchange of oxygen and carbon dioxide across the sea surface in Stuart Channel, British Columbia. Limnol. Oceanogr. 24:474-482.

Jones, J. G. 1980. Some differences in the microbiology of profundal and littoral lake sediments. J. Gen. Microbiol. 117:285-292.

Jørgensen, B. B. 1979. A theoretical model of the stable sulfur isotope distribution in marine sediments. Geochim. Cosmochim. Acta 43:363-374.

Kayanne, H., A. Suzuki, and H. Saito. 1995. Diurnal changes in the partial pressure of carbon dioxide in coral reef water. Science 269:214-216.

Keeling, R. F., B. B. Stephens, R. G. Najjar, S. C. Doney, D. Archer, and M. Heimann. 1998. Seasonal variations in the atmospheric O_2/N_2 ratio in relation to the kinetics of air-sea gas exchange.

Keir, R. S. 1991. The effect of vertical nutrient redistribution on surface ocean $\delta^{13}C$. Global Biogeochem. Cycles 5:351-358.

Kennedy, J. A. 1982. Water-mass structures and exchanges in Green Bay, Lake Michigan. M.Sc. dissertation, University of Wisconsin-Milwaukee.

Key, R. M., R. L. Brewer, J. H. Stockwell, N. L. Guinasso, Jr., and D. R. Schink. 1979. Some improved techniques for measuring radon and radium in marine sediments and in seawater. Mar. Chem. 7:251-264.

Kiene, R. P. 1991. Production and consumption of methane in aquatic systems, pp. 111-145. In J. E. Rogers and W. B. Whitman [eds.], Microbial Production and Consumption of Greenhouse Gases: Methane, Nitrogen Oxides, and Halomethanes. American Society for Microbiology, Washington D. C.

King, F. D., and A. H. Devol. 1979. Estimates of vertical eddy diffusion through the thermocline from phytoplankton nitrate uptake rates in the mixed layer of the eastern tropical Pacific. Limnol. Oceanogr. 24:645-651.

Kipphut, G. W., and C. S. Martens. 1982. Biogeochemical cycling in an organic-rich coastal marine basin- 3. Dissolved gas transport in methane-saturated sediments. Geochim. Cosmochim. Acta 46:2049-2060.

Kling, G. W. 1994. Ecosystem scale experiments in freshwaters: the use of stable isotopes. In L. A. Baker [ed.], Environmental chemistry of lakes and reservoirs. Advances in Chemistry Series 237. American Chemical Society, Washington DC, pp.321-336.

Kling, G. W., A. E. Giblin, B. Fry, and B. J. Peterson. 1991a. The role of seasonal turnover in lake alkalinity dynamics. Limnol. Oceanogr. 36:106-122.

Kling, G. W., G. W. Kipphut, and M. C. Miller. 1991b. Arctic lakes and streams as gas conduits to the atmosphere: Implications for tundra carbon budgets. Science 251:298-301.

Klump, J. V., and C. S. Martens. 1989. The seasonality of nutrient regeneration in an organic-rich coastal sediment: Kinetic modeling of changing pore-water nutrient and sulfate distributions. Limnol. Oceanogr. 34:559-577.

Klump, J. V., D. E. Edgington, P. E. Sager, and D. M. Robertson. 1997. Sedimentary phosphorus cycling and a phosphorus mass balance for the Green Bay (Lake Michigan) ecosystem. Can. J. Fish. Aquat. Sci. 54:10-26.

Klump, J. V., and S. A. Fitzgerald. 1998. Carbon and nitrogen regeneration along a sedimentary gradient in a freshwater bay (in preparation).

Koyama, T. 1963. Gaseous metabolism in lake sediments and paddy soils and the production of atmospheric methane and hydrogen. J. Geophys. Res. 68:3971-3973.

Kraus, E. B., and J. S. Turner. 1967. A one-dimensional model of the seasonal thermocline. Part II. The general theory and its consequences. Tellus 19:98-105.

Kraus, E. B., and J. A. Businger. 1994. Atmosphere-Ocean Interaction. Oxford University Press. New York.

Kuivila, K. M., and J. W. Murray. 1984. Organic matter diagenesis in freshwater sediments: The alkalinity and total CO_2 balance and methane production in the sediments of Lake Washington. Limnol. Oceanogr. 29:1218-1230.

Kuivila, K. M., J. W. Murray, A. H. Devol, M. E. Lidstrom, and C. E. Reimers. 1988. Methane cycling in the sediments of Lake Washington. Limnol. Oceanogr. 33:571-581.

Kullenberg, G. 1971. Vertical diffusion in shallow waters. Tellus 23:129-135.

Kullenberg, G., C. R. Murthy, and H. Westerberg. 1973. An experimental study of diffusion characteristics in the thermocline and hypolimnion regions of Lake Ontario. Proc. 16th Conf. Great Lakes Res. 1973:774-790.

Laird, G. A., and D. Scavia. 1990. Distribution of labile dissolved organic carbon in Lake Michigan. Limnol. Oceanogr. 35:443-447.

Lammers, S., E. Suess, M. N. Mansurov, and V. V. Anikiev. 1995. Variations of atmospheric methane supply from the Sea of Okhotsk induced by the seasonal ice cover. Global Biogeochem. Cycles 9:351-358.

Large, W. G., and S. Pond. 1981. Open ocean momentum flux measurements in moderate to strong winds. J. Phys. Oceanogr. 11:324-336.

Large, W. G., and S. Pond. 1982. Sensible and latent heat flux measurements over the ocean. J. Phys. Oceanogr. 12:464-482.

Lashof, D. A., and D. R. Ahuja. 1990. Relative contributions of greenhouse gas emissions to global warming. Nature 344:529-531.

Lathrop, R. G., Jr., J. R. Vande Castle, and T. M. Lillesand. 1990. Monitoring river plume transport and mesoscale circulation in Green Bay, Lake Michigan, through satellite remote sensing. J. Great Lakes Res. 16:471-484.

Ledwell, J. R. 1984. The variation of the gas transfer coefficient with molecular diffusivity, pp. 293-302. In W. Brutseart and G. H. Jirka [eds.], Gas transfer at water surfaces. D. Reidel, Dordrecht.

Ledwell, J. R., A. J. Watson, and W. S. Broecker. 1986. A deliberate tracer experiment in Santa Monica Basin. Nature 323:322-324.

Ledwell, J. R., A. J. Watson, and C. S. Law. 1993. Evidence for slow mixing across the pycnocline from an open-ocean tracer-release experiment. Nature 364:701-703.

Lerman, A. 1979. Geochemical Processes - Water and Sediment Environments. John Wiley and Sons, New York.

Lesht, B. M. 1988. Nonparametric evaluation of the size of limnological sampling networks: Application to the design of a survey of Green Bay. J. Great Lakes Res. 14:325-337.

Lewis, E. and D. W. R. Wallace. 1998. Program developed for CO2 system calculations. ORNL/CDIAC-105. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U. S. Department of Energy, Oak Ridge, Tennessee.

LI-COR. 1992. LI-6252 CO_2 analyzer operating and service manual. LI-COR, inc. Publications No. 9003-60.

Lidstrom, M. E., and L. Somers. 1984. Seasonal study of methane oxidation in Lake Washington. Appl. Environ. Microbiol. 47:1255-1260.

Liss, P. S. 1983. Gas transfer: experiments and geochemical implications, pp. 241-298. In P. S. Liss and W. G. N. Slinn [eds.], Air-sea exchange of gases and particles. D. Reidel, Dordrecht.

Liss, P. S., and L. Merlivat. 1986. Air-sea gas exchange rates: Introduction and synthesis, pp. 113-127. In P. Buat-Ménard [ed.], The Role of Air-Sea Exchange in Geochemical Cycling. NATO Adv. Sci. Inst. Ser., D. Reidel, Hingham, MA.

Livingstone, D. M. and D. M. Imboden. 1993. The non-linear influence of wind-speed variability on gas transfer in lakes. Tellus 45B:275-295.

Longhurst, A. R. 1991. Role of the marine biosphere in the global carbon cycle. Limnol. Oceanogr. 36:1507-1526.

Lovell, C. R., and A. Konopka. 1985. The effects of temperature on bacterial production in a dimictic eutrophic lake. FEMS Microbiol. Ecol. 31:135-140.

Lyman, J. 1956. Thesis. University of California, Los Angeles.

Lynch-Stieglitz, J., T. F. Stocker, W. S. Broecker, and R. G. Fairbanks. 1995. The influence of air-sea exchange on the isotopic composition of oceanic carbon: Observations and modeling. Global Biogeochem. Cycles 9:653-665.

Marino, R., and R. W. Howarth. 1993. Atmospheric oxygen exchange in the Hudson River: Dome measurements and comparison with other natural waters. Estuaries 16:433-445.

Mariotti, A., C. Lancelot, and G. Billen. Natural isotopic composition of nitrogen as a tracer of origin for suspended organic matter in the Scheldt estuary. Geochim. Cosmochim. Acta 48:549-555.

Martens, C. S., and R. A. Berner. 1977. Interstitial water chemistry of anoxic Long Island Sound sediments. 1. Dissolved gases. Limnol. Oceanogr. 22:10-25.

Martens, C. S., and J. P. Chanton. 1989. Radon as a tracer of biogenic gas equilibration and transport from methane-saturated sediments. J. Geophys. Res. 94:3451-3459.

Mathieu, G. G., P. E. Biscaye, R. A. Lupton, and D. E. Hammond. 1988. System for measurement of ^{222}Rn at low levels in natural waters. Health Physics 55:989-992.

Matthews, E., and I. Fung. 1987. Methane emission from natural wetlands: global distribution, area, and environmental characteristics of sources. Global Biogeochem. Cycles 1:61-86.

McConnaughey, T. A., J. W. LaBaugh, D. O. Rosenberry, R. G. Striegl, M. M. Reddy, P. F. Schuster, and V. Carter. 1994. Carbon budget for a groundwater-fed lake: Calcification supports summer photosynthesis. Limnol. Oceanogr. 39:1319-1332.

McKeown, W., F. Bretherton, H. L. Huang, W. L. Smith, and H. L. Revercomb. 1995. Sounding the skin of water: Sensing air-water interface temperature gradients with interferometry. J. Atmos. Oceanic Technol. 12:1313-1327.

Merlivat, L., and L. Memery. 1983. Gas exchange across an air-water interface: Experimental results and modeling of bubble contribution to transfer. J. Geophys. Res. 88:707-724.

Michaels, A. F., N. R. Bates, K. O. Buesseler, C. A. Carison, and A. H. Knap. 1994. Carbon cycle imbalances in the Sargasso Sea. Nature 372:537-539.

Miller, G. S., and J. H. Saylor. 1985. Currents and temperatures in Green Bay, Lake Michigan. J. Great Lakes Res. 16:471-484.

Miller, G. S., and J. H. Saylor. 1993. Low-frequency water volume transport through the midsection of Green Bay. J. Great Lakes Res. 16:471-484.

Miller, L. G., and R. S. Oremland. 1988. Methane efflux from the pelagic regions of four lakes. Global Biogeochem. Cycles 2:269-277.

Millero, F. J. 1995. Thermodynamics of the carbon dioxide system in the oceans. Geochim. Cosmochim. Acta 59:661-677.

Modlin, R., and A. M. Beeton. 1970. Dispersal of Fox River water in Green Bay, Lake Michigan. Proc. 13th Conf. Great Lakes Res., Int. Assoc. Great Lakes Res., 468-476.

Moore, E. W. 1939. Graphic determination of carbon dioxide and the three forms of alkalinity. J. Amer. Water Works Assoc. 31:51.

Mortimer, C. H. 1941. The exchange of dissolved substances between mud and water in lakes. J. Ecol. 29:280-329.

Mortimer, C. H. 1978. Water movement, mixing and transport in Green Bay, Lake Michigan. In *Research Needs for Green Bay*, pp. 10-56. UW Sea Grant Report WIS-SG-78-234.

Mortimer, C. H. 1981. The oxygen content of air-saturated fresh waters over ranges of temperature and atmospheric pressure of limnological interest. Mitt. int. Ver. Limnol. No. 22.

Murphy, P. P., K. C. Kelly, R. A. Feely, and R. H. Gammon. 1995. Carbon dioxide concentrations in surface water and the atmosphere during 1986-1989 NOAA/PMEL cruises in the Pacific and Indian Oceans. ORNL/CDIAC-75, NDP-

047. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Murray, J. W., R. T. Barber, M. R. Roman, M. P. Bacon, and R. A. Feely. 1994. Physical and biological controls on carbon cycling in the Equatorial Pacific. Science 266:58-65.

Nalepa, T. F. 1989. Estimates of macroinvertebrate biomass in Lake Michigan. J. Great Lakes Res. 15:437-443.

O'Brien, J. J. 1986. An important scientific controversy: Oceanic CO_2 fluxes. J. Geophys. Res. 91:10515.

Ocampo-Torres, F. J., M. A. Donelan, N. Merzi, and F. Jia. 1994. Laboratory measurements of mass transfer of carbon dioxide and water vapour for smooth and rough flow conditions. Tellus 46B:16-32.

O'Leary, M. H. 1980. Carbon isotope fractionation in plants. Phytochemistry 20:553-567.

Oremland, R. S., 1979. Methanogenic activity in plankton samples and fish intestines: A mechanism for in situ methanogenesis in oceanic surface waters. Limnol. Oceanogr. 24:1136-1141.

Oudot, C. 1989. O_2 and CO_2 balances approach for estimating biological production in the mixed layer of the tropical Atlantic Ocean (Guinea Dome area). J. Mar. Res. 47:385-409.

Oxburgh, R., W. S. Broecker, and R. H. Wanninkhof. 1991. The carbon budget of Mono Lake. Global Biogeochem. Cycles 5:359-372.

Peng, T.-H., and W. S. Broecker. 1991. Factors limiting the reduction of atmospheric CO_2 by iron fertilization. Limnol. Oceanogr. 36:1919-1927.

Peterson, D., D. Cayan, J. DiLeo, M. Nobel, and M. Dettinger. 1995. The role of climate in estuarine variability. American Scientist 83:58-67.

Platt, T., and W. G. Harrison. 1985. Biogenic fluxes of carbon and oxygen in the ocean. Nature 318:55-58.

Platt, T., and W. G. Harrison. 1986. Reconciliation of carbon and oxygen fluxes in the upper ocean. Deep-Sea Res. 33:273-276.

Pond, S. and G. L. Pickard. 1978. Introductory Dynamic Oceanography, 1st ed. Pergamon Press, New York.

Quay P. D., S. R. Emerson, B. M. Quay and A. H. Devol. 1986. The carbon cycle for Lake Washington -A stable isotope study. Limnol. Oceanogr. 31:596-611.

Rasmussen, R. A., and M. A. K. Khalil. 1981. Atmospheric methane (CH_4): Trends and seasonal cycles. J. Geophys. Res. 86:9826-9832.

Raven, J. A., and A. M. Johnston. 1991. Mechanisms of inorganic-carbon acquisition in marine phytoplankton and their implications for the use of other resources. Limnol. Oceanogr. 36:1701-1714.

Reeburgh, W. S., and D. T. Heggie. 1977. Microbial methane consumption reactions and their effect on methane distributions in freshwater and marine environments. Limnol. Oceanogr. 22:1-9.

Remsen, C. C., E. C. Minnich, R. S. Stephens, L. Buchholz, and M. E. Lidstrom. 1989. Methane oxidation in Lake Superior sediments. J. Great Lakes Res. 15:141-146.

Resio, D. T., and C. L. Vincent. 1977. Estimation of winds over the Great Lakes. J. Waterway Port Coast. Ocean Div., ASCE 102:265-283.

Richards, R. P. 1990. Measures of flow variability and a new flow-based classification of Great Lakes tributaries. J. Great Lakes Res. 16:53-70.

Richman, S., M. D. Bailiff, L. J. Mackey, and D. Bolgrien. 1984a. Zooplankton standing stock, species composition and size distribution along a trophic gradient in Green Bay, Lake Michigan. Verh. Internat. Verein. Limnol. 22:475-487.

Richman, S., P. Sager, G. Banta, T. Harvey, and B. DeStasio. 1984b. Phytoplankton standing stock, size distribution, species composition and productivity along a trophic gradient in Green Bay, Lake Michigan. Verh. Internat. Verein. Limnol. 22:460-469.

Richman, S., D. K. Branstrator, and M. Huber-Villegas. 1990. The impact of zooplankton grazing on phytoplankton along a trophic gradient, pp. 593-615. In M. M. Tilzer, and C. Serruya [eds.], Ecological structure and function in large lakes. Springer-Verlag, Science Tech Publishers.

Richman, S., and P. E. Sager. 1990. Patterns of phytoplankton-zooplankton interaction along a trophic gradient: II. Biomass and size distribution. Verh. Internat. Verein. Limnol. 24:401-405.

Rivkin, R. B., et. al. 1996. Vertical flux of biogenic carbon in the ocean: Is there food web control? Science 272:1163-1166.

Robertson, J. E., and A. J. Watson. 1992. Thermal skin effect of the surface ocean and its implications for CO_2 uptake. Nature 358:738-740.

Roemmich, D., and J. McGowan. 1995. Climatic warming and the decline of zooplankton in the California current

Rosen, M. R., J. V. Turner, L. Coshell, and V. Gailitis. 1995. The effects of water temperature, stratification, and biological activity on the stable isotopic composition and timing of carbonate precipitation in a hypersaline lake. Geochim. Cosmochim. Acta 59:979-990.

Rossolimo, L. 1935. Die Bodengasausscheidung und das Sauerstoffregime der Seen. Verh. Int. Ver. Limnol. 7:539-561.

Rowe, G. T., G. S. Boland, W. C. Phoel, R. F. Anderson, and P. E. Biscaye. 1994. Deep-sea floor respiration as an indication of lateral input of biogenic detritus from continental margins. Deep-Sea Res. 41:657-668.

Rowland, F. S., N. R. P. Harris, and D. R. Blake. 1990. Methane in cities. Nature 347:

Rudd, J. W. M., A. Furutani, R. J. Flett, and R. D. Hamilton. 1976. Factors controlling methane oxidation in shield lakes: The role of nitrogen fixation and oxygen concentration. Limnol. Oceanogr. 21:357-364.

Rudd, J. W. M., and R. D. Hamilton. 1978. Methane cycling in a eutrophic shield lake and its effects on whole lake metabolism. Limnol. Oceanogr. 23:337-348.

Sabine, C. L., R. M. Key, and J. L. Sarmiento. 1994. The disk equilibrator: A new design for underway pCO_2 systems. EOS 75 (3):195.

Sabine, C. L. 1995. Geochemistry of carbon dioxide in seawater at the Hawaii Ocean Time series station, ALOHA. Global Biogeochem. Cycles 9:637-651.

Sager, P. E., G. Banta, and J. Kirk. 1984. The relation between area and volumetric expressions of C^{14} productivity in Green Bay, Lake Michigan. Verh. Internat. Verein. Limnol. 22:470-474.

Sager, P. E., and S. Richman. 1990. Patterns of phytoplankton-zooplankton interaction along a trophic gradient: I. Production and utilization. Verh. Internat. Verein. Limnol. 24:393-396.

Sager, P. E., and S. Richman. 1991. functional interaction of phytoplankton and zooplankton along the trophic gradient in Green Bay, Lake Michigan. Can. J. Fish. Aquat. Sci. 48:116-122.

Saltzman, E. S., D. B. King, K. Holmen, and C. Leck. 1993. Experimental determination of the diffusion coefficient of dimethylsulfide in water. J. Geophys. Res. 98:16481-16486.

Sambrotto, R. N., G. Savidge, C. Robinson, P. Boyd, T. Takahashi, D. M. Karl, C. Langdon, D. Chipman, J. Marra, and L. Codispoti. 1993. Elevated consumption of carbon relative to nitrogen in the surface ocean. Nature 363:248-250.

Sand-Jenson, K., C. Prahl, and H. Stokholm. 1982. Oxygen release from the roots of submerged aquatic macrophytes. Oikos 38:349-354.

Sansone, F. J., and C. S. Martens. 1978. Methane oxidation in Cape Lookout Bight, North Carolina. Limnol. Oceanogr. 23:349-355.

Sansone, F. J., T. M. Rust, and S. V. Smith. 1997. Methane distribution and cycling in Tomales Bay, California. Estuaries, in press.

Sarmiento, J. L., and P. E. Biscaye. 1986. Radon 222 in the benthic boundary layer. J. Geophys. Res. 91:833-844.

Sarmiento, J. L., and E. T. Sundquist. 1992. Revised budget for the oceanic uptake of anthropogenic carbon dioxide. Nature 356:589-593.

Scavia, D., G. A. Laird, and G. L. Fahnenstiel. 1986. Production of planktonic bacteria in Lake Michigan. Limnol. Oceanogr. 31:612-626.

Scavia, D., and G. A. Laird. 1987. Bacterioplankton in Lake Michigan: Dynamics, controls, and significance to carbon flux. Limnol. Oceanogr. 32:1017-1033.

Scavia, D., G. A. Lang, and J. F. Kitchell. 1988. Dynamics of Lake Michigan plankton: A model evaluation of nutrient loading, competition, and predation. Can. J. Fish. Aquat. Sci. 45:165-177.

Schindler, D. E., S. R. Carpenter, J. J. Cole, J. F. Kitchell, M. L. Pace. 1997. Influence of food web structure on carbon exchange between lakes and the atmosphere. Science 277:248-251.

Schink, D. R., N. L. Guinasso, Jr., R. L. Charnell, and J. J. Sigalove. 1970. Radon profiles in the sea: A measure of air-sea exchange. IEEE Trans. Nucl. Sci. NS-17:184-190.

Schlesinger, W. H. 1997. Biogeochemistry: an analysis of global change, 2nd ed. Academic, San Diego.

Schmidt, U., and R. Conrad. 1993. Hydrogen, carbon monoxide and methane dynamics in Lake Constance. Limnol. Oceanogr. 38:1214-1226.

Schnell, S. and King, G. M. 1995. Stability of methane oxidation capacity to variations in methane and nutrient concentrations. FEMS Microbiol. Ecol. 17:285-294.

Schwab, D. J. 1978. Simulation and forecasting of Lake Erie storm surges. Mon. Wea. Rev. 106:1476-1487.

Schwab, D. J., and J. A. Morton. 1984. Estimation of overlake wind speed from overland wind speed: A comparison of three methods. J. Great Lakes Res. 10:68-72.

Schwab, D. J., G. A. Leshkevich, and G. C. Muhr. 1992. Satellite measurements of surface water temperature in the Great Lakes - Great Lakes CoastWatch. J. Great Lakes Res. 18:247-258.

Scranton, M. I., P. Crill, M. A. de Angelis, P. L. Donaghay, and J. M. Sieburth. 1993. The importance of episodic events in controlling the flux of methane from an anoxic basin. Global Biogeochem. Cycles 7:491-507.

Sellers, P., R. H. Hesslein, and C. A. Kelly. 1995. Continuous measurement of CO_2 for estimation of air-water fluxes in lakes: An *in situ* technique. Limnol. Oceanogr. 40:575-581.

Siegenthaler, U., and J. L. Sarmiento. 1993. Atmospheric carbon dioxide and the ocean. Nature 365:119-125.

Skirrow, G. 1975. The dissolved gases - carbon dioxide, pp. 1-192. In J. P. Riley and G. Skirrow [eds.], Chemical Oceanography, 2. Academic Press, London.

Sloey, W. E. 1970. The limnology of hypereutrophic Lake Butte des Morts, Wisconsin. Proc. 13th Conf. Great Lakes Res. 1970:951-968.

Smethie, W. M., Jr., T. Takahashi, and D. W. Chipman. 1985. Gas exchange and CO_2 flux in the tropical Atlantic Ocean determined from ^{222}Rn and pCO_2 measurements. J. Geophys. Res. 90:7005-7022.

Smith, C. J., R. D. DeLaune, and W. H. Patrick, Jr. 1983. Carbon dioxide emission and carbon accumulation in coastal wetlands. Estuarine, Coastal and Shelf Science 17:21-29.

Smith, S. D., and E. P. Jones. 1986. Isotopic and micrometeorological ocean CO_2 fluxes: Different time and space scales. J. Geophys. Res. 91:10529-10532.

Smith, S. V., K. J. Roy, H. G. Schiesser, G. L. Shepherd, and K. E. Chave. 1971. Flux of suspended calcium carbonate ($CaCO_3$), Fanning Island Lagoon. Pacific Science 25:206-221.

Smith, S. V., W. J. Weibe, J. T. Hollibaugh, S. J. Dollar, S. W. Hager, B. E. Cole, G. W. Tribble, and P. A. Wheeler. 1987. Stoichiometry of C, N, P. and Si fluxes in a temperate-climate embayment. J. Mar. Res. 45:427-460.

Sommaruga, R. 1995. Microbial and classical food webs: A visit to a hypertrophic lake. FEMS Microbiol. Ecol. 17:257-270.

Sommerfeld, R. A., A. R. Mosier, and R. C. Musselman. 1993. CO_2, CH_4, and N_2O flux through a Wyoming snowpack and implications for global budgets. Nature 361:140-142.

Stabel, H.-H. 1986. Calcite precipitation in Lake Constance: Chemical equilibrium, sedimentation, and nucleation by algae. Limnol. Oceanogr. 31:1081-1093.

Stainton, M. P. 1973. A syringe gas-stripping procedure for gas-chromatographic determination of dissolved inorganic and organic carbon in fresh water and carbonates in sediments. J. Fish Res. Board Can. 30:1441-1445.

Stauffer, R. E. 1980. Windpower time series above a temperate lake. Limnol. Oceanogr. 25:513-528.

Stoermer, E. F., J. P. Kociolek, C. L. Schelske, and N. A. Andresen. 1991. Siliceous microfossil succession in the recent history of Green Bay, Lake Michigan. J. Paleolim. 6:123-140.

Strayer, R. F., and J. M. Tiedje. 1978. In situ methane production in a small, hypereutrophic, hard-water lake: Loss of methane from sediments by vertical diffusion and ebullition. Limnol. Oceanogr. 23:1201-1206.

Strong, A. E., and B. J. Eadie. 1978. Satellite observations of calcium carbonate precipitations in the Great Lakes. Limnol. Oceanogr. 23:877-887.

Stumm, W. and J. J. Morgan. 1996. Aquatic Chemistry, 3rd ed. Wiley-Intersci., New York.

Takahashi, T., J. Olafsson, J. G. Goddard, D. W. Chipman, and S. C. Sutherland. 1993. Seasonal variation of CO_2 and nutrients in the high-latitude surface oceans: A comparative study. Global Biogeochem. Cycles 7:843-878.

Tans, P. P., I. Y. Fung, and T. Takahashi. 1990. Observational constraints on the global atmospheric CO_2 budget. Science 247:1431-1438.

Taylor, J. A. G. P. Brasseur, P. R. Zimmerman, and R. J. Cicerone. 1991. A study of the sources and sinks of methane and methyl chloroform using a global three-dimensional Lagrangian tropospheric tracer transport model. J. Geophys. Res. 96:3013-3044.

Thebrath, B., F. Rothfuss, M. J. Whiticar, and R. Conrad. 1993. Methane production in littoral sediment of Lake Constance. FEMS Microbiol. Ecol. 102:279-289.

Thomson, D. J. 1995. The seasons, global termperature, and precession. Science 268:59-68.

Tilzer, M. M. and P. Bossard. 1992. Large lakes and their sustainable development. Aquat. Sci. 54:91-103.

Toggweiler, J. R. 1993. Carbon overconsumption. Nature 363:210-211.

Topp, E., and R. S. Hanson. 1991. Metabolism of radiatively important trace gases by methane-oxidizing bacteria, pp. 71-88. In J. E. Rogers and W. B. Whitman [eds.], Microbial Production and Consumption of Greenhouse Gases: Methane, Nitrogen Oxides, and Halomethanes. American Society for Microbiology. Washington D. C.

Torgersen, T., G. Mathieu, R. H. Hesslein, and W. S. Broecker. 1982. Gas exchange dependency on diffusion coefficient: Direct ^{222}Rn and ^{3}He comparisons in a small lake. J. Geophys. Res. 87:546-556.

Torrey, M. S. 1976. Chemistry of Lake Michigan Vol. 3. Argonne Nat. Lab., "Environ. Status L. Michigan Region", ANL/ES-40.

Tyler, S. C. 1991. The global methane budget, pp. 7-38. In J. E. Rogers and W. B. Whitman [eds.], Microbial Production and Consumption of Greenhouse Gases: Methane, Nitrogen Oxides, and Halomethanes. American Society for Microbiology. Washington D. C.

Tyler, S. C., R. S. Bilek, R. L. Sass, and F. M. Fisher. 1997. Methane oxidation and pathways of production in a Texas paddy field deduced from measurements of flux, δ^{13}C, and δD of CH_4. Global Biogeochem. Cycles 11:323-348.

Tyrrell, T., and A. H. Taylor. 1995. Latitudinal and seasonal variations in carbon dioxide and oxygen in the northeast Atlantic and the effects on *Emiliania huxleyi* and other organisms. Global Biogeochem. Cycles 9:585-604.

Upstill-Goddard, R. C., A. J. Watson, P. S. Liss, and M. I. Liddicoat. 1990. Gas transfer velocities in lakes measured with SF_6. Tellus 42B:364-377.

Van Scoy, K. A., K. P. Morris, J. E. Robertson, and A. J. Watson. 1995. Thermal skin effect and the air-sea flux of carbon dioxide: A seasonal high-resolution estimate. Global Biogeochem. Cycles 9:253-262.

Vézina, A. F., and M. L. Pace. 1994. An inverse model analysis of planktonic food webs in experimental lakes. Can. J. Fish. Aquat. Sci. 51:2034-2044.

Volk, T., and Z. Liu. 1988. Controls of CO_2 sources and sinks in the Earth scale surface ocean: Temperature and nutrients. Global Biogeochem. Cycles 2:73-89.

Wanninkhof, R., J. R. Ledwell, and W. S. Broecker. 1985. Gas exchange - wind speed relation measured with sulfur hexafluoride on a lake. Science 227:1224-1226.

Wanninkhof, R., J. R. Ledwell, W. S. Broecker, and M. Hamilton. 1987. Gas exchange on Mono Lake and Crowley Lake, California. J. Geophys. Res. 92:14567-14580.

Wanninkhof, R. J. 1992. Relationship between wind speed and gas exchange over the ocean. J. Geophys. Res. 97:7373-7382.

Wanninkhof, R., and K. Thoning. 1993. Measurement of fugacity of CO_2 in surface water using continuous and discrete methods. Mar. Chem. 44:189-204.

Wanninkhof, R., and M. Knox. 1996. Chemical enhancement of CO_2 exchange in natural waters. Limnol. Oceanogr. 41:689-697.

Waples, J. T., B. J. Eadie and J. V. Klump. (1993) An isotopic mass balance for sedimentary carbon diagenesis in Green Bay, Lake Michigan. IAGLR Annual Meeting, De Pere, WI.

Waples, J. T., E. Ruben, and J. V. Klump. 1994. Methane evasion from two large freshwater lakes. EOS 75 (3):69.

Watson, A. J., R. C. Upstill-Goddard, and P. S. Liss. 1991. Air-sea gas exchange in rough and stormy seas measured by a dual-tracer technique. Nature 349:145-147.

Weiler, R. R. 1975. Carbon dioxide exchange and productivity in Lake Erie and Lake Ontario. Verh. Internat. Verein. Limnol. 19:694-704.

Weiss, R. F. 1974. Carbon dioxide in water and seawater: the solubility of a non-ideal gas. Mar. Chem. 2:203-215.

Weiss, R. F., R. A. Jahne, and C. D. Keeling. 1982. Seasonal effects of temperature and salinity on the partial pressure of CO_2 in seawater. Nature 300:511-513.

Weiss, R. F., and B. A. Price. 1980. Nitrous oxide solubility in water and seawater. Mar. Chem. 8:347-359.

Weiss, R. F., F. A. Van Woy, P. K. Salameh, C. Goyet, and E. T. Peltzer. 1994. A comparison of two methods for the measurement of surface ocean partial pressures of carbon dioxide. EOS 75 (3):182.

Wesely, M. L. 1986. Response to "Isotopic versus micrometeorological ocean CO_2 fluxes: A serious conflict" by W. Broecker et al. J. Geophys. Res. 91:10533-10535.

Whiticar, M. J., and E. Faber. 1986. Methane oxidation in sediment and water column environments-Isotope evidence. Org. Geochem. 10:759-768.

Whiting, G. L., and J. P. Chanton. 1993. Primary production control of methane emission from wetlands. Nature 364:794-795.

Wigley, T. M. L., and L. N. Plummer. 1976. Mixing of carbonate waters. Gechim. Cosmochim. Acta 40:989-995.

Wilke, C. R., and P. Chang. 1955. Correlation of diffusion coefficients in dilute solutions. J. Am. Inst. Chem. Eng. 1:264-270.

Williams, D. D., and R. R. Miller. 1962. An instrument for on-stream stripping and gas chromatographic determination of dissolved gases in liquids. Anal. Chem. 34:657-659.

Williams, P. J. le B., K. R. Heinemann, J. Marra, and D. A. Purdie. 1983. Comparison of ^{14}C and O_2 measurements of phytoplankton production in oligotrophic waters. Nature 305:49-50.

Winn, C. D., F. T. Mackenzie, C. J. Carrillo, C. L. Sabine, and D. M. Karl. 1994. Air-sea carbon dioxide exchange in the North Pacific Subtropical Gyre: Implications for the global carbon budget. Global Biogeochem. Cycles 8:157-163.

Woolf, D. K. 1993. Bubbles and the air-sea transfer velocity of gases. Atmosphere-Ocean 31:517-540.

Wu, L., and D. A. Culver. 1991. Zooplankton grazing and phytoplankton abundance: An assessment before and after invasion of *Dreissena polymorpha*. J. Great Lakes Res. 17:425-436.

Yamamoto, S., J. B. Alcauskas, and T. E. Crozier. 1976. Solubility of methane in distilled water and sea water. J. Chem. Eng. Data 21:78-80.

Appendix 1

Green Bay Stations

GREEN BAY SAMPLING STATIONS

Station	latitude (N) degrees	longitude (W) degrees	UTM N meters	UTM E meters
FR	44.520	-88.012	4929949	419560
-1	44.558	-87.946	4934070	424867
0	44.558	-88.008	4934129	419943
1	44.611	-87.883	4939901	429935
2	44.611	-87.946	4939957	424936
3	44.611	-88.008	4940016	420016
4	44.658	-87.758	4945022	439902
5	44.658	-87.821	4945071	434907
6	44.658	-87.883	4945122	429991
7	44.658	-87.946	4945178	424996
8	44.706	-87.758	4950354	439951
9	44.706	-87.821	4950402	434961
10	44.706	-87.883	4950454	430049
11	44.706	-87.946	4950510	425058
12	44.750	-87.758	4955242	439997
13	44.750	-87.821	4955290	435010
14	44.750	-87.883	4955341	430102
15	44.750	-87.946	4955397	425115
16	44.794	-87.696	4960085	444947
17	44.794	-87.758	4960129	440043
18	44.794	-87.821	4960178	435059
19	44.794	-87.883	4960229	430155
20	44.839	-87.663	4965062	447598
21	44.839	-87.696	4965084	444990
22	44.839	-87.758	4965128	440089
23	44.839	-87.821	4965176	435110
24	44.883	-87.508	4969862	459879
25	44.883	-87.571	4969895	454904
26	44.883	-87.633	4969931	450007
27	44.883	-87.696	4969972	445031
28	44.883	-87.758	4970016	440135
29	44.883	-87.821	4970064	435159
30	44.928	-87.446	4974832	464803
31	44.928	-87.508	4974861	459911
32	44.928	-87.571	4974894	454939
33	44.928	-87.633	4974930	450046
34	44.928	-87.696	4974971	445074
35	44.928	-87.758	4975014	440181
36	44.928	-87.821	4975063	435210
37	44.975	-87.383	4980027	469800
38	44.975	-87.446	4980053	464832
39	44.975	-87.508	4980082	459943
40	44.975	-87.571	4980115	454976
41	44.975	-87.633	4980151	450087
42	45.021	-87.383	4985137	469824
43	45.021	-87.446	4985163	464860
44	45.021	-87.508	4985192	459975
45	45.021	-87.571	4985225	455012
46	45.067	-87.321	4990226	474729

GREEN BAY SAMPLING STATIONS

Station	latitude (N) degrees	longitude (W) degrees	UTM N meters	UTM E meters
E39	45.065	-87.378	4990023	470241
47	45.067	-87.383	4990247	469848
48	45.067	-87.446	4990273	464888
49	45.067	-87.508	4990302	460007
50	45.067	-87.571	4990335	455048
51	45.111	-87.321	4995114	474748
52	45.111	-87.383	4995135	469871
53	45.111	-87.446	4995161	464915
54	45.111	-87.508	4995189	460038
55	45.111	-87.571	4995223	455082
56	45.156	-87.258	5000095	479720
57	45.156	-87.321	5000113	474768
58	45.156	-87.383	5000134	469895
59	45.156	-87.446	5000160	464943
60	45.156	-87.508	5000188	460069
61	45.156	-87.571	5000222	455117
62	45.200	-87.133	5004959	489554
63	45.200	-87.196	5004970	484606
64	45.200	-87.258	5004983	479736
65	45.200	-87.321	5005001	474788
66	45.200	-87.383	5005022	469918
67	45.200	-87.446	5005048	464970
68	45.200	-87.508	5005076	460100
69	45.244	-87.133	5009847	489562
70	45.244	-87.196	5009858	484617
71	45.244	-87.258	5009871	479752
72	45.244	-87.321	5009889	474807
73	45.244	-87.383	5009910	469941
74	45.244	-87.446	5009936	464997
75	45.289	-86.883	5014845	509175
76	45.289	-86.946	5014839	504235
77	45.289	-87.133	5014847	489570
78	45.289	-87.196	5014857	484630
79	45.289	-87.258	5014870	479768
80	45.289	-87.321	5014888	474827
81	45.289	-87.383	5014909	469965
82	45.333	-87.008	5019726	499373
83	45.333	-87.071	5019729	494436
84	45.333	-87.133	5019735	489578
85	45.333	-87.196	5019745	484641
86	45.333	-87.258	5019758	479783
87	45.333	-87.321	5019776	474847
88	45.333	-87.383	5019797	469988
89	45.379	-87.008	5024836	499374
90	45.379	-87.071	5024839	494441
91	45.379	-87.133	5024845	489587
92	45.379	-87.196	5024855	484654
93	45.379	-87.258	5024869	479800
94	45.379	-87.321	5024886	474867

GREEN BAY SAMPLING STATIONS

Station	latitude (N) degrees	longitude (W) degrees	UTM N meters	UTM E meters
95	45.425	-86.758	5029975	518932
96	45.425	-86.883	5029953	509153
97	45.425	-86.946	5029948	504225
98	45.425	-87.000	5029947	500000
99	45.425	-87.071	5029949	494445
100	45.425	-87.133	5029955	489595
101	45.425	-87.196	5029965	484666
102	45.425	-87.258	5029979	479816
103	45.425	-87.321	5029997	474887
104	45.471	-86.821	5035073	513992
105	45.471	-86.883	5035064	509146
106	45.471	-86.946	5035059	504221
107	45.471	-87.008	5035057	499375
108	45.471	-87.071	5035060	494450
109	45.471	-87.133	5035066	489603
110	45.471	-87.196	5035076	484679
111	45.471	-87.258	5035089	479832
112	45.517	-86.696	5040212	523744
113	45.517	-86.821	5040183	513981
114	45.517	-86.883	5040174	509138
115	45.517	-86.946	5040169	504218
116	45.517	-87.008	5040168	499375
117	45.517	-87.071	5040170	494455
118	45.517	-87.133	5040176	489612
119	45.517	-87.196	5040186	484691
120	45.517	-87.258	5040200	479849
121	45.561	-86.696	5045101	523726
122	45.561	-86.758	5045084	518887
123	45.561	-86.821	5045071	513970
124	45.561	-86.883	5045062	509131
125	45.561	-86.946	5045057	504214
126	45.561	-87.008	5045056	499376
127	45.561	-87.071	5045058	494459
128	45.561	-87.133	5045064	489620
129	45.561	-87.196	5045074	484703
130	45.606	-86.696	5050100	523707
131	45.606	-86.758	5050084	518872
132	45.606	-86.821	5050071	513959
133	45.606	-86.883	5050062	509124
134	45.606	-86.946	5050057	504211
135	45.606	-87.008	5050055	499376
136	45.606	-87.071	5050058	494463
137	45.606	-87.133	5050064	489628
138	45.606	-87.196	5050074	484715
139	45.650	-86.758	5054972	518857
140	45.650	-86.821	5054959	513948
141	45.650	-86.883	5054950	509117
142	45.650	-86.946	5054945	504208
143	45.650	-87.008	5054944	499377

GREEN BAY SAMPLING STATIONS

Station	latitude (N) degrees	longitude (W) degrees	UTM N meters	UTM E meters
144	45.650	-87.071	5054946	494468
145	45.650	-87.133	5054952	489636
146	45.696	-86.696	5060099	523669
147	45.696	-86.758	5060083	518842
148	45.696	-86.821	5060070	513937
149	45.696	-86.883	5060061	509109
150	45.696	-87.008	5060054	499377
151	45.696	-87.071	5060057	494472
152	45.742	-86.696	5065210	523649
153	45.742	-86.758	5065193	518826
154	45.742	-86.821	5065180	513925
155	45.742	-87.008	5065165	499378
156	45.786	-86.633	5070119	528528
157	45.786	-86.696	5070098	523631
158	45.786	-86.758	5070082	518811
159	45.786	-87.008	5070053	499378
160	45.831	-86.571	5075142	533320
161	45.831	-86.633	5075118	528505
162	45.831	-86.696	5075098	523612
163	45.831	-86.758	5075081	518796
164	45.831	-87.008	5075053	499379
165	45.875	-86.571	5080031	533294
166	45.875	-86.977	5079942	501785

Ice Stations	latitude (N) degrees	longitude (W) degrees			aka
A	45.028	-87.292			*Egg Harbor*
B	45.020	-87.341			*Horseshoe Point*
C	44.886	-87.501			*Sand Bay*
D	44.828	-87.732			*Ernjoys*
E	44.667	-87.780			*Dyckesville*
F	44.520	-88.014			*Fox River*
G	44.734	-87.950			*Geano Beach*
17	44.794	-87.758	4960129	440043	
21	44.839	-87.696	4965084	444990	

Appendix 2

Expressing Gas Concentrations

Gas concentrations are commonly expressed as either mole fractions, partial pressures or fugacities. Mole fractions are designated with the notation x(gas) and represent the ratio of moles of a particular gas to the total number of moles of all gases present (or the fraction of a particular gas in one mole of all gases present). For carbon dioxide and methane in air, the units are in parts per million (ppm).

Partial pressures and fugacities are both expressed in units of atmospheres or micro-atmospheres (μatm) and take the notation *p*(gas) and *f*(gas) respectively. A gas's partial pressure is simply its mole fraction multiplied by atmospheric pressure. A gas's fugacity takes into account the non-ideal behavior of a real gas due to a slight attraction between the gas molecules and finite molecular volumes. The difference between ideal and real behavior depends somewhat on the gas itself, but more importantly on total pressure, temperature and its mole fraction.

At normal atmospheric pressure and temperature, gas behavior is nearly ideal. For example, for 350 ppm CO_2 in air at 1 atmosphere and 20°C, the pCO_2 equals 350 μatm and the fCO_2 equals 348.8 μatm (approximately 0.3% lower than its partial pressure).

Gas concentrations are additionally designated as either wet or dry depending on whether or not water vapor is included in the atmospheric pressure. Atmospheric trace gas concentrations are generally expressed as mole fractions in dry air since both water vapor and total atmospheric pressure can vary significantly. Conversely, a dissolved gas equilibrates with its fugacity in water saturated (wet) air.

Concentrations of dissolved gases are given on both molarity and molality scales (M (mol/liter) and *M* (mol/kg) respectively). The latter scale has the advantage of not being affected by changes in water density due to variations in temperature or pressure. In Green Bay (and most other freshwater environments), the two scales differ by ~0.3% at the most. Given the accuracy of the measurements in this study, the scales may be considered equivalent (dissolved gas concentrations are given on both scales in the data tables of Appendix 3).

Dissolved gas concentrations are also expressed in terms of their apparent partial pressures or fugacities, especially in conjunction with atmospheric gas concentrations. This allows one to quickly determine the direction of gas flux across the air-water interface.

Appendix 3

Methane and Carbon Dioxide Data Tables

The following pages contain all measurements of Green Bay surface water methane and carbon dioxide made during the transect cruises of 1993, 1994 and 1995.

Methane

The methane data tables have the following format:

1 Date (1993, 1994 or 1995)
2 Day - beginning with 1 on January 1
3 Time - of day in hours or *transect in hours*
4 Latitude
5 Longitude
6 UTM (E) - in meters, corresponding to Longitude
7 UTM (N) - in meters, corresponding to Latitude
8 Dist (km) - cumulative distance along transect
9 T_{eq} - equilibrator temperature in °C
10 T_w - *in situ* water temperature in °C
11 $x(CH_4)_{eq}$ - equilibrator mole fraction in units of ppm in wet air
12 $p(CH_4)_{eq}$ - equilibrator partial pressure in units of μatm in wet air
13 $[CH_4]_1$ - *in situ* methane concentration in units of μmol/kg
14 $[CH_4]_2$ - *in situ* methane concentration in units of μmol/l
15 $[CH_4]_{mod}$ - corrected methane concentration (eq 2-3) in units of μmol/l

Note that for discrete sample analyses (1993, 23 August and September 1994), an asterisk appears in column 15. Time given in *italics* in column 3 represents the elapsed time along a particular leg of the day's transect. Generally, a day's transect was split into three legs with each leg beginning or ending at a profile station.

Carbon Dioxide

The carbon dioxide data tables have the following format:

1 Date (1994 or 1995)
2 Day - beginning with 1 on January 1
3 Latitude
4 Longitude
5 UTM (E) - in meters, corresponding to Longitude

6 UTM (N) - in meters, corresponding to Latitude
7 Dist (km) - cumulative distance along transect
8 T_{eq} - equilibrator temperature in °C
9 T_w - *in situ* water temperature in °C
10 PSU - estimated salinity in ‰
11 P hPa - atmospheric pressure in hPa
12 $x(CO_2)_{eq}$ - equilibrator mole fraction in units of ppm in dry air
13 $x(CO_2)_w$ - warming corrected *in situ* mole fraction in units of ppm in dry air
14 $f(CO_2)_w$ - warming corrected *in situ* fugacity in units of μatm in wet air
15 $[CO_2]$ - warming corrected *in situ* concentration in units of μmol/kg

1993 METHANE DATA

1993 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	X(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
02-Nov	306	*	44.8745	-87.4132	467451	4968992	0.00	*	*	*	*	*	0.062	*
02-Nov	306	*	45.0403	-87.3740	470567	4987319	18.59	*	*	*	*	*	0.079	*
02-Nov	306	*	45.1000	-87.3333	473803	4993913	25.94	*	*	*	*	*	0.017	*
02-Nov	306	*	45.1350	-87.2880	477411	4997781	31.22	*	*	*	*	*	0.017	*
02-Nov	306	*	45.1922	-87.2877	477437	5004099	37.54	*	*	*	*	*	0.015	*
02-Nov	306	*	45.2403	-87.2135	483339	5009422	45.49	*	*	*	*	*	0.059	*
02-Nov	306	*	45.2883	-87.1393	489241	5014727	53.43	*	*	*	*	*	0.016	*
02-Nov	306	*	45.3350	-87.0703	494732	5019884	60.96	*	*	*	*	*	0.009	*
02-Nov	306	*	45.3337	-87.1568	487849	5019737	67.84	*	*	*	*	*	0.010	*
02-Nov	306	*	45.3338	-87.2388	481324	5019755	74.37	*	*	*	*	*	0.010	*
02-Nov	306	*	45.3335	-87.3203	474838	5019719	80.86	*	*	*	*	*	0.011	*
02-Nov	306	*	45.2898	-87.3618	471536	5014893	86.70	*	*	*	*	*	0.010	*
02-Nov	306	*	45.2452	-87.4033	468233	5009956	92.64	*	*	*	*	*	0.016	*
02-Nov	306	*	45.2017	-87.4452	464904	5005149	98.49	*	*	*	*	*	0.015	*
02-Nov	306	*	45.1493	-87.4500	464519	4999365	104.29	*	*	*	*	*	0.025	*
02-Nov	306	*	45.1000	-87.4580	463883	4993913	109.78	*	*	*	*	*	0.016	*
02-Nov	306	*	45.0497	-87.4662	463233	4988351	115.38	*	*	*	*	*	0.026	*
02-Nov	306	*	44.9942	-87.4477	464705	4982217	121.68	*	*	*	*	*	0.081	*
02-Nov	306	*	44.9402	-87.4313	466005	4976249	127.79	*	*	*	*	*	0.071	*
02-Nov	306	*	44.8842	-87.4137	467411	4970060	134.14	*	*	*	*	*	0.055	*
03-Nov	307	*	44.8747	-87.4127	467490	4969010	0.00	*	*	*	*	*	0.085	*
03-Nov	307	*	44.9167	-87.4602	463710	4973652	5.99	*	*	*	*	*	0.097	*
03-Nov	307	*	44.9282	-87.5697	454997	4974923	14.79	*	*	*	*	*	0.034	*
03-Nov	307	*	44.9402	-87.6928	445195	4976249	24.68	*	*	*	*	*	0.024	*
03-Nov	307	*	44.8682	-87.7525	440447	4968292	33.95	*	*	*	*	*	0.031	*
03-Nov	307	*	44.7968	-87.8108	435805	4960409	43.10	*	*	*	*	*	0.037	*
03-Nov	307	*	44.7507	-87.8483	432821	4955307	49.01	*	*	*	*	*	0.028	*
03-Nov	307	*	44.7083	-87.8833	430036	4950628	54.45	*	*	*	*	*	0.035	*
03-Nov	307	*	44.6583	-87.8833	430036	4945102	59.98	*	*	*	*	*	0.038	*
03-Nov	307	*	44.6667	-87.8000	436667	4946023	66.67	*	*	*	*	*	0.019	*
03-Nov	307	*	44.7148	-87.7548	440262	4951346	73.10	*	*	*	*	*	0.019	*
03-Nov	307	*	44.7605	-87.7138	443524	4956393	79.11	*	*	*	*	*	0.038	*
03-Nov	307	*	44.8053	-87.6733	446747	4961348	85.02	*	*	*	*	*	0.062	*
03-Nov	307	*	44.8503	-87.6333	449930	4966321	90.92	*	*	*	*	*	0.085	*
03-Nov	307	*	44.8752	-87.5572	455991	4969066	97.57	*	*	*	*	*	0.116	*

1993 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	X(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
03-Nov	307	•	44.9000	-87.4833	461867	4971810	104.06	•	•	•	•	•	0.080	•
03-Nov	307	•	44.8933	-87.4260	466429	4971073	108.68	•	•	•	•	•	0.062	•

1994 METHANE DATA

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
02-Jun	153	0.849	44.8307	-87.3793	470013	4963992	0.00	15.1	14.7	84.1	83.2	0.143	0.143	
02-Jun	153	0.883	44.8315	-87.3787	470066	4964085	0.11	15.1	14.7	89.9	88.9	0.153	0.153	0.224
02-Jun	153	0.962	44.8363	-87.3833	469700	4964622	0.76	15.1	14.7	92.5	91.4	0.157	0.157	0.169
02-Jun	153	1.054	44.8423	-87.3885	469295	4965291	1.54	15.0	14.7	76.3	75.4	0.130	0.130	0.065
02-Jun	153	1.183	44.8508	-87.3950	468786	4966237	2.61	15.1	14.8	57.2	56.5	0.097	0.097	0.046
02-Jun	153	1.259	44.8560	-87.3997	468419	4966815	3.30	15.1	14.7	43.6	43.1	0.074	0.074	0.008
02-Jun	153	1.358	44.8628	-87.4050	468003	4967574	4.16	15.1	14.7	32.8	32.4	0.056	0.056	0.016
02-Jun	153	1.397	44.8655	-87.4070	467846	4967873	4.50	15.0	14.7	28.7	28.3	0.049	0.049	0.006
02-Jun	153	1.442	44.8688	-87.4087	467715	4968242	4.89	15.0	14.7	25.1	24.8	0.043	0.043	0.011
02-Jun	153	1.491	44.8755	-87.4120	467457	4968986	5.68	14.9	14.6	21.3	21.0	0.036	0.036	0.006
02-Jun	153	1.679	44.9055	-87.4198	466855	4972321	9.07	14.5	14.2	11.3	11.1	0.019	0.019	0.004
02-Jun	153	1.711	44.9107	-87.4212	466752	4972895	9.65	14.4	14.0	11.6	11.5	0.020	0.020	0.026
02-Jun	153	1.764	44.9192	-87.4232	466599	4973840	10.61	14.3	14.0	9.1	9.0	0.016	0.016	
02-Jun	153	1.868	44.9358	-87.4267	466333	4975692	12.48	14.2	13.8	6.5	6.5	0.011	0.011	0.003
02-Jun	153	1.915	44.9437	-87.4283	466206	4976564	13.36	14.3	13.9	6.0	5.9	0.010	0.010	0.005
02-Jun	153	2.092	44.9730	-87.4348	465711	4979826	16.66	14.3	14.0	4.7	4.7	0.008	0.008	0.006
02-Jun	153	2.126	44.9785	-87.4362	465608	4980437	17.28	14.2	13.8	4.9	4.8	0.008	0.008	0.011
02-Jun	153	2.258	45.0003	-87.4410	465242	4982863	19.73	13.4	13.0	4.1	4.1	0.007	0.007	0.006
02-Jun	153	2.296	45.0067	-87.4427	465113	4983568	20.45	13.2	12.8	3.9	3.8	0.007	0.007	0.004
02-Jun	153	2.398	45.0207	-87.4462	464846	4985125	22.03	13.1	12.7	3.9	3.9	0.007	0.007	0.007
02-Jun	153	2.437	45.0207	-87.4467	464806	4985125	22.07	12.9	12.5	3.6	3.6	0.006	0.006	0.003
02-Jun	153	0.291	45.0267	-87.4387	465440	4985788	22.99	13.5	13.1	3.8	3.7	0.007	0.007	0.007
02-Jun	153	0.317	45.0298	-87.4348	465745	4986138	23.45	13.3	12.9	3.4	3.4	0.006	0.006	
02-Jun	153	0.482	45.0503	-87.4102	467699	4988405	26.44	12.9	12.5	3.1	3.1	0.006	0.006	0.005
02-Jun	153	0.525	45.0557	-87.4038	468201	4988996	27.22	12.9	12.5	3.0	2.9	0.005	0.005	0.004
02-Jun	153	0.600	45.0652	-87.3923	469112	4990047	28.61	13.0	12.6	3.1	3.1	0.006	0.006	0.006
02-Jun	153	0.670	45.0738	-87.3815	469970	4991004	29.90	13.0	12.6	2.9	2.9	0.005	0.005	0.004
02-Jun	153	0.761	45.0852	-87.3678	471051	4992259	31.55	13.1	12.7	3.5	3.4	0.006	0.006	0.008
02-Jun	153	0.856	45.0970	-87.3535	472185	4993569	33.28	12.9	12.6	4.2	4.1	0.007	0.007	0.010
02-Jun	153	0.888	45.1007	-87.3485	472580	4993974	33.85	12.7	12.3	4.8	4.8	0.009	0.009	0.017
02-Jun	153	0.966	45.1105	-87.3367	473515	4995064	35.29	12.4	12.0	3.4	3.3	0.006	0.006	
02-Jun	153	1.065	45.1227	-87.3220	474675	4996410	37.06	12.3	11.9	3.3	3.3	0.006	0.006	0.006
02-Jun	153	1.117	45.1287	-87.3138	475319	4997074	37.99	12.6	12.2	4.1	4.1	0.007	0.007	0.013
02-Jun	153	1.292	45.1500	-87.2887	477306	4999437	41.08	12.2	11.8	2.8	2.8	0.005	0.005	0.003
02-Jun	153	1.338	45.1568	-87.2847	477623	5000193	41.90	12.5	12.1	3.0	2.9	0.005	0.005	0.007
02-Jun	153	1.423	45.1693	-87.2772	478218	5001580	43.40	12.7	12.3	2.9	2.9	0.005	0.005	0.005

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
02-Jun	153	*1.599*	45.1958	-87.2607	479524	5004520	46.62	12.6	12.2	3.4	3.3	0.006	0.006	0.007
02-Jun	153	*0.324*	45.2110	-87.2807	477959	5006211	48.93	12.2	11.8	1.8	1.8	0.003	0.003	0.003
02-Jun	153	*0.404*	45.2183	-87.2963	476732	5007029	50.40	12.2	11.8	1.5	1.5	0.003	0.003	0.001
02-Jun	153	*0.598*	45.2337	-87.3365	473586	5008745	53.98	12.4	12.0	2.5	2.5	0.005	0.005	0.006
02-Jun	153	*0.625*	45.2320	-87.3425	473114	5008563	54.49	12.3	11.9	2.2	2.1	0.004	0.004	
02-Jun	153	*0.776*	45.2210	-87.3745	470596	5007352	57.28	11.7	11.2	2.7	2.7	0.005	0.005	0.006
02-Jun	153	*0.822*	45.2178	-87.3845	469810	5007002	58.14	11.7	11.3	2.7	2.6	0.005	0.005	0.005
02-Jun	153	*0.895*	45.2133	-87.4007	468537	5006509	59.51	11.7	11.3	3.0	3.0	0.006	0.006	0.007
02-Jun	153	*0.996*	45.2070	-87.4227	466806	5005815	61.37	11.7	11.3	3.0	3.0	0.006	0.005	0.005
02-Jun	153	*1.091*	45.2008	-87.4432	465192	5005138	63.12	11.9	11.4	3.0	3.0	0.006	0.006	0.006
02-Jun	153	*0.255*	45.1647	-87.4428	465197	5001120	67.14	12.5	12.1	3.0	3.0	0.005	0.005	0.005
02-Jun	153	*0.296*	45.1582	-87.4418	465271	5000398	67.87	12.5	12.1	3.0	2.9	0.005	0.005	0.004
02-Jun	153	*0.491*	45.1255	-87.4382	465539	4996768	71.51	12.7	12.3	2.5	2.5	0.005	0.005	0.004
02-Jun	153	*0.551*	45.1160	-87.4372	465612	4995712	72.57	12.6	12.2	2.7	2.6	0.005	0.005	0.006
02-Jun	153	*0.643*	45.1007	-87.4355	465735	4994008	74.28	12.5	12.1	2.5	2.4	0.004	0.004	0.004
02-Jun	153	*0.746*	45.0835	-87.4337	465868	4992100	76.19	12.6	12.2	2.8	2.8	0.005	0.005	0.006
02-Jun	153	*0.896*	45.0588	-87.4312	466050	4989358	78.94	12.8	12.4	2.8	2.8	0.005	0.005	0.005
02-Jun	153	*1.238*	45.0022	-87.4267	466371	4983062	85.24	13.5	13.1	3.9	3.8	0.007	0.007	0.007
02-Jun	153	*1.351*	44.9837	-87.4248	466506	4981006	87.30	14.1	13.8	4.1	4.0	0.007	0.007	0.007
02-Jun	153	*1.419*	44.9723	-87.4232	466630	4979745	88.57	14.4	14.0	4.3	4.3	0.007	0.007	0.009
02-Jun	153	*1.523*	44.9550	-87.4212	466778	4977821	90.50	14.3	13.9	4.5	4.5	0.008	0.008	0.009
02-Jun	153	*1.736*	44.9197	-87.4180	467008	4973894	94.43	14.2	13.9	3.8	3.7	0.007	0.007	0.006
02-Jun	153	*1.786*	44.9112	-87.4170	467082	4972949	95.38	14.3	13.9	4.3	4.3	0.007	0.007	0.012
02-Jun	153	*1.846*	44.9017	-87.4158	467168	4971893	96.44	14.4	14.0	4.7	4.7	0.008	0.008	0.011
02-Jun	153	*1.885*	44.8952	-87.4153	467204	4971171	97.16	14.7	14.4	5.0	4.9	0.009	0.008	0.010
02-Jun	153	*1.939*	44.8863	-87.4147	467251	4970189	98.14	14.9	14.6	5.0	5.0	0.009	0.009	0.009
02-Jun	153	*2.013*	44.8743	-87.4125	467417	4968855	99.49	15.1	14.8	6.7	6.7	0.011	0.011	0.020
02-Jun	153	*2.059*	44.8673	-87.4078	467781	4968075	100.35	15.3	15.0	9.7	9.6	0.016	0.016	0.042
02-Jun	153	*2.127*	44.8575	-87.4003	468368	4966982	101.59	15.4	15.1	11.8	11.7	0.020	0.020	0.032
02-Jun	153	*2.196*	44.8475	-87.3925	468982	4965868	102.86	15.6	15.3	15.0	14.8	0.025	0.025	0.043
02-Jun	153	*2.245*	44.8407	-87.3867	469438	4965106	103.75	15.6	15.3	20.0	19.8	0.034	0.034	0.074
02-Jun	153	*2.322*	44.8343	-87.3813	469857	4964399	104.57	15.5	15.2	31.1	30.8	0.052	0.052	0.107
02-Jun	153	*2.395*	44.8328	-87.3805	469923	4964232	104.75	15.5	15.2	48.4	47.9	0.081	0.081	0.172
02-Jun	153	*2.449*	44.8298	-87.3800	469961	4963899	105.09	15.5	15.2	57.8	57.2	0.097	0.097	0.167
02-Jun	153	*2.485*	44.8298	-87.3803	469934	4963899	105.11	15.5	15.2	63.0	62.4	0.106	0.106	0.165

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
03-Jun	154	11.000	44.8516	-87.3961	468700	4966325	0.00	16.0	15.7	52.4	51.9	0.087	0.087	0.087
03-Jun	154	11.083	44.8645	-87.4056	467956	4967767	1.62	15.9	15.6	39.4	39.0	0.066	0.066	0.008
03-Jun	154	11.617	44.9149	-87.4578	463864	4973382	8.57	15.5	15.2	9.8	9.8	0.017	0.017	0.009
03-Jun	154	11.733	44.9191	-87.4843	461775	4973856	10.71	15.2	14.9	9.1	9.0	0.015	0.015	0.013
03-Jun	154	11.867	44.9223	-87.5160	459275	4974226	13.24	15.0	14.7	6.2	6.1	0.011	0.010	0.003
03-Jun	154	11.950	44.9242	-87.5358	457714	4974457	14.82	15.1	14.8	5.6	5.6	0.010	0.010	0.007
03-Jun	154	12.017	44.9258	-87.5517	456460	4974643	16.09	14.8	14.5	5.8	5.7	0.010	0.010	0.011
03-Jun	154	12.083	44.9274	-87.5675	455215	4974828	17.34	14.4	14.1	6.4	6.3	0.011	0.011	0.015
03-Jun	154	12.117	44.9278	-87.5715	454899	4974876	17.66	14.4	14.1	6.8	6.7	0.012	0.012	0.017
03-Jun	154	12.167	44.9279	-87.5715	454899	4974877	17.66	14.3	14.0	7.3	7.2	0.013	0.013	0.017
03-Jun	154	12.217	44.9279	-87.5715	454899	4974879	17.67	13.8	13.5	7.5	7.5	0.013	0.013	0.016
03-Jun	154	14.617	44.9150	-87.5906	453382	4973457	19.75	16.5	16.2	4.4	4.4	0.007	0.007	0.007
03-Jun	154	14.667	44.9092	-87.5988	452730	4972819	20.66	16.6	16.3	4.5	4.5	0.007	0.007	0.008
03-Jun	154	14.750	44.8995	-87.6123	451656	4971754	22.17	16.8	16.5	5.1	5.1	0.008	0.008	0.011
03-Jun	154	14.883	44.8841	-87.6340	449929	4970049	24.60	17.2	16.9	6.5	6.5	0.011	0.011	0.014
03-Jun	154	14.950	44.8763	-87.6448	449069	4969198	25.81	17.3	17.0	7.7	7.6	0.013	0.013	0.019
03-Jun	154	15.017	44.8686	-87.6556	448209	4968346	27.02	17.4	17.1	8.1	8.0	0.013	0.013	0.015
03-Jun	154	15.100	44.8593	-87.6683	447197	4967316	28.46	17.6	17.4	8.3	8.3	0.013	0.013	0.014
03-Jun	154	15.133	44.8556	-87.6733	446799	4966909	29.03	17.6	17.4	8.4	8.4	0.014	0.014	0.015
03-Jun	154	15.217	44.8460	-87.6864	445755	4965860	30.51	17.9	17.7	8.4	8.4	0.013	0.013	0.013
03-Jun	154	15.300	44.8361	-87.7002	444655	4964768	32.06	18.0	17.8	0.0				
03-Jun	154	15.333	44.8322	-87.7057	444216	4964331	32.68	18.0	17.8	7.9	7.9	0.013	0.013	
03-Jun	154	15.467	44.8163	-87.7279	442446	4962585	35.17	17.8	17.6	7.6	7.6	0.012	0.012	0.012
03-Jun	154	15.500	44.8123	-87.7334	442007	4962149	35.79	17.7	17.5	7.7	7.7	0.012	0.012	0.014
03-Jun	154	15.617	44.7985	-87.7528	440458	4960621	37.96	18.1	17.9	7.8	7.8	0.013	0.012	0.013
03-Jun	154	15.683	44.7944	-87.7584	440011	4960175	38.59	17.7	17.5	8.0	7.9	0.013	0.013	0.014
03-Jun	154	18.467	44.7664	-87.7853	437854	4957087	42.36	18.1	17.9	6.8	6.7	0.011	0.011	0.011
03-Jun	154	18.617	44.7464	-87.8026	436463	4954876	44.97	18.2	18.0	7.2	7.1	0.011	0.011	0.012
03-Jun	154	18.833	44.7172	-87.8290	434340	4951652	48.83	18.2	18.0	7.5	7.5	0.012	0.012	0.012
03-Jun	154	18.900	44.7082	-87.8373	433672	4950656	50.03	18.1	17.9	8.0	7.9	0.013	0.013	0.015
03-Jun	154	18.967	44.6991	-87.8456	433004	4949659	51.23	18.2	18.0	8.2	8.2	0.013	0.013	0.015
03-Jun	154	19.117	44.6788	-87.8643	431498	4947418	53.93	18.3	18.1	7.1	7.0	0.011	0.011	0.009
03-Jun	154	19.183	44.6698	-87.8726	430830	4946423	55.13	18.3	18.1	7.1	7.0	0.011	0.011	0.011
03-Jun	154	19.250	44.6608	-87.8809	430161	4945427	56.33	18.2	18.0	7.2	7.1	0.011	0.011	0.012
03-Jun	154	20.317	44.7347	-87.7762	438540	4953550	68.00	17.6	17.4	4.9	4.9	0.008	0.008	0.008
03-Jun	154	20.367	44.7404	-87.7677	439219	4954181	68.93	17.6	17.4	5.2	5.1	0.008	0.008	0.010

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
03-Jun	154	20.433	44.7480	-87.7563	440130	4955022	70.17	17.4	17.1	5.8	5.7	0.009	0.009	0.013
03-Jun	154	20.617	44.7691	-87.7249	442636	4957334	73.58	17.0	16.7	7.2	7.1	0.012	0.012	0.014
03-Jun	154	20.683	44.7767	-87.7135	443546	4958175	74.82	16.8	16.5	7.6	7.5	0.012	0.012	0.015
03-Jun	154	20.867	44.7977	-87.6822	446042	4960488	78.22	16.5	16.2	8.3	8.2	0.014	0.014	0.015
03-Jun	154	20.900	44.8015	-87.6765	446496	4960910	78.84	16.5	16.2	8.4	8.3	0.014	0.014	0.016
03-Jun	154	21.017	44.8149	-87.6566	448082	4962382	81.00	16.3	16.0	9.3	9.2	0.015	0.015	0.018
03-Jun	154	21.083	44.8226	-87.6452	448990	4963225	82.24	16.3	16.0	9.1	9.0	0.015	0.015	0.014
03-Jun	154	21.150	44.8302	-87.6338	449898	4964066	83.48	16.4	16.1	9.1	9.0	0.015	0.015	0.015
03-Jun	154	21.317	44.8481	-87.6037	452292	4966042	86.58	16.2	15.9	10.2	10.1	0.017	0.017	0.019
03-Jun	154	21.383	44.8546	-87.5907	453325	4966754	87.84	16.2	15.9	10.6	10.5	0.018	0.018	0.020
03-Jun	154	21.450	44.8611	-87.5778	454349	4967467	89.09	15.8	15.5	11.6	11.4	0.019	0.019	0.025
03-Jun	154	21.517	44.8676	-87.5648	455381	4968180	90.34	16.0	15.7	12.5	12.4	0.021	0.021	0.026
03-Jun	154	21.583	44.8741	-87.5519	456405	4968892	91.59	16.3	16.0	13.5	13.3	0.022	0.022	0.028
03-Jun	154	21.800	44.8951	-87.5097	459753	4971211	95.66	15.9	15.6	14.7	14.5	0.025	0.025	0.026
03-Jun	154	21.850	44.9000	-87.5000	460523	4971746	96.60	15.8	15.5	14.7	14.6	0.025	0.025	0.025
03-Jun	154	21.917	44.9000	-87.4846	461739	4971739	97.81	15.8	15.5	14.9	14.7	0.025	0.025	0.026
03-Jun	154	21.983	44.9000	-87.4692	462955	4971732	99.03	15.8	15.5	15.0	14.8	0.025	0.025	0.026
03-Jun	154	22.050	44.9000	-87.4538	464170	4971725	100.25	15.8	15.5	14.9	14.7	0.025	0.025	0.024
03-Jun	154	22.117	44.9000	-87.4383	465394	4971718	101.47	15.2	14.9	14.1	13.9	0.024	0.024	0.020
03-Jun	154	22.183	44.8941	-87.4240	466520	4971057	102.78	14.3	14.0	13.7	13.5	0.024	0.024	0.023
03-Jun	154	22.233	44.8897	-87.4133	467362	4970560	103.75	14.9	14.6	15.6	15.4	0.027	0.027	0.040
03-Jun	154	22.300	44.8820	-87.4103	467595	4969704	104.64	16.0	15.7	17.3	17.1	0.029	0.029	0.037
03-Jun	154	22.367	44.8743	-87.4073	467827	4968847	105.53	16.0	15.7	20.2	19.9	0.034	0.034	0.050
03-Jun	154	22.433	44.8666	-87.4043	468060	4967991	106.42	16.2	15.9	22.0	21.7	0.036	0.036	0.046
03-Jun	154	22.517	44.8569	-87.4005	468355	4966921	107.53	16.3	16.0	27.5	27.1	0.045	0.045	0.070
03-Jun	154	22.583	44.8492	-87.3975	468588	4966064	108.41	16.4	16.1	45.7	45.2	0.075	0.075	0.181
03-Jun	154	22.633	44.8435	-87.3953	468759	4965421	109.08	16.3	16.0	73.2	72.3	0.121	0.121	0.342
03-Jun	154	22.683	44.8377	-87.3930	468937	4964779	109.74	16.3	16.0	106.6	105.3	0.176	0.176	0.444
13-Jul	194	*0.432*	44.5203	-88.0125	419534	4929948	0.00	23.8	23.6	161.2	159.0	0.229	0.228	
13-Jul	194	*0.766*	44.5203	-88.0125	419534	4929948	0.00	23.8	23.6	385.7	380.7	0.548	0.547	0.757
13-Jul	194	*0.910*	44.5203	-88.0125	419534	4929948	0.00	23.8	23.7	318.9	314.7	0.453	0.452	0.257
13-Jul	194	*1.111*	44.5283	-88.0082	419888	4930832	0.95	23.9	23.8	472.0	465.8	0.669	0.667	0.959
13-Jul	194	*1.141*	44.5308	-88.0078	419919	4931110	1.23	24.0	23.8	470.4	464.3	0.666	0.664	0.632
13-Jul	194	*1.168*	44.5315	-88.0085	419867	4931186	1.32	24.0	23.8					
13-Jul	194	*1.323*	44.5508	-87.9978	420741	4933322	3.63	24.1	23.9	501.7	495.2	0.708	0.707	0.772

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
13-Jul	194	1.582	44.5810	-87.9803	422171	4936657	7.26	22.5	22.3	428.9	423.4	0.624	0.623	0.545
13-Jul	194	1.622	44.5842	-87.9735	422718	4937002	7.91	22.3	22.1	414.5	409.2	0.606	0.605	0.459
13-Jul	194	1.729	44.5937	-87.9530	424358	4938038	9.85	22.2	22.0	272.6	269.1	0.399	0.399	
13-Jul	194	1.778	44.6003	-87.9470	424843	4938772	10.73	22.2	22.0	265.4	262.0	0.389	0.388	0.317
13-Jul	194	1.844	44.6097	-87.9385	425529	4939802	11.96	22.1	21.9	251.4	248.2	0.369	0.368	0.274
13-Jul	194	1.888	44.6157	-87.9330	425973	4940463	12.76	22.0	21.8	238.8	235.7	0.351	0.350	0.212
13-Jul	194	2.018	44.6337	-87.9163	427317	4942447	15.16	21.8	21.6	202.7	200.1	0.299	0.298	0.185
13-Jul	194	2.049	44.6380	-87.9123	427640	4942926	15.73	21.8	21.6	196.7	194.2	0.291	0.290	0.200
13-Jul	194	2.134	44.6472	-87.9248	426660	4943955	17.16	21.6	21.4	182.1	179.8	0.270	0.269	0.194
13-Jul	194	2.173	44.6510	-87.9318	426110	4944388	17.86	21.4	21.2	171.2	169.0	0.255	0.254	0.129
13-Jul	194	2.243	44.6573	-87.9445	425114	4945101	19.08	21.4	21.2	158.3	156.3	0.235	0.235	0.149
13-Jul	194	2.276	44.6587	-87.9437	425181	4945249	19.24	21.5	21.3	149.4	147.5	0.222	0.222	0.086
13-Jul	194	2.358	44.6580	-87.9252	426647	4945159	20.71	21.3	21.1	133.4	131.7	0.199	0.198	0.100
13-Jul	194	2.444	44.6578	-87.9055	428207	4945122	22.27	21.4	21.2	121.6	120.1	0.181	0.180	
13-Jul	194	2.494	44.6580	-87.8942	429105	4945132	23.17	21.4	21.2	116.9	115.4	0.174	0.174	0.141
13-Jul	194	2.589	44.6580	-87.8833	429964	4945122	24.03	21.5	21.3	109.7	108.3	0.163	0.163	0.130
13-Jul	194	0.093	44.6658	-87.8650	431428	4945975	25.72	21.2	21.0	21.2	20.9	0.032	0.032	
13-Jul	194	0.143	44.6652	-87.8552	432205	4945894	26.51	21.2	21.0	22.9	22.6	0.034	0.034	0.050
13-Jul	194	0.238	44.6638	-87.8373	433618	4945730	27.93	21.2	21.0	27.0	26.7	0.040	0.040	0.060
13-Jul	194	0.301	44.6630	-87.8253	434568	4945629	28.88	21.2	21.0	28.8	28.5	0.043	0.043	0.056
13-Jul	194	0.341	44.6625	-87.8177	435175	4945568	29.49	21.3	21.1	22.8	22.6	0.034	0.034	
13-Jul	194	0.394	44.6617	-87.8075	435981	4945466	30.31	21.3	21.1	22.6	22.4	0.034	0.034	0.032
13-Jul	194	0.450	44.6608	-87.7970	436813	4945365	31.14	21.3	21.1	28.0	27.7	0.042	0.042	0.088
13-Jul	194	0.512	44.6600	-87.7852	437749	4945265	32.08	21.4	21.2	27.1	26.8	0.040	0.040	0.033
13-Jul	194	0.583	44.6588	-87.7717	438818	4945123	33.16	21.7	21.5	27.3	27.0	0.040	0.040	0.041
13-Jul	194	0.633	44.6582	-87.7622	439571	4945043	33.92	21.8	21.6	28.3	28.0	0.042	0.042	0.050
13-Jul	194	0.803	44.6818	-87.7780	438341	4947683	36.83	21.5	21.3	27.7	27.3	0.041	0.041	0.040
13-Jul	194	0.856	44.6897	-87.7833	437927	4948558	37.80	21.4	21.2	27.7	27.4	0.041	0.041	0.042
13-Jul	194	0.913	44.6980	-87.7890	437487	4949489	38.83	21.3	21.1	29.8	29.5	0.044	0.044	0.063
13-Jul	194	1.037	44.7163	-87.8013	436529	4951533	41.09	20.9	20.6	34.2	33.8	0.052	0.051	0.068
13-Jul	194	1.102	44.7260	-87.8080	436013	4952614	42.28	20.7	20.5	33.1	32.7	0.050	0.050	0.043
13-Jul	194	1.130	44.7302	-87.8110	435780	4953078	42.80	20.7	20.4	32.5	32.1	0.049	0.049	0.038
13-Jul	194	1.235	44.7455	-87.8217	434951	4954791	44.71	20.4	20.2	30.8	30.4	0.047	0.047	0.040
13-Jul	194	1.263	44.7497	-87.8243	434745	4955255	45.21	20.4	20.2	30.6	30.2	0.046	0.046	0.043
13-Jul	194	1.309	44.7567	-87.8292	434370	4956036	46.08	20.4	20.2	30.0	29.6	0.046	0.045	0.040
13-Jul	194	1.345	44.7618	-87.8327	434099	4956612	46.72	20.4	20.1	30.1	29.8	0.046	0.046	0.048

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
13-Jul	194	1.469	44.7805	-87.8450	433145	4958697	49.01	20.2	20.0	33.4	33.0	0.051	0.051	0.062
13-Jul	194	1.546	44.7917	-87.8528	432538	4959944	50.40	20.3	20.1	29.1	28.8	0.044	0.044	0.018
13-Jul	194	1.601	44.7995	-87.8582	432125	4960819	51.37	20.3	20.1	32.0	31.7	0.049	0.049	0.074
13-Jul	194	1.668	44.8003	-87.8497	432798	4960903	52.04	20.4	20.2	34.0	33.6	0.052	0.052	0.065
13-Jul	194	1.724	44.7992	-87.8368	433812	4960764	53.07	20.5	20.2	36.0	35.5	0.055	0.054	0.070
13-Jul	194	1.802	44.7973	-87.8197	435167	4960545	54.44	20.5	20.3	37.5	37.1	0.057	0.057	0.066
13-Jul	194	1.881	44.7962	-87.8015	436604	4960402	55.88	20.5	20.3	37.1	36.7	0.056	0.056	0.054
13-Jul	194	1.944	44.7955	-87.7872	437736	4960318	57.02	20.5	20.2	36.5	36.0	0.055	0.055	0.050
13-Jul	194	2.066	44.7943	-87.7588	439976	4960165	59.26	20.2	20.0	33.8	33.4	0.052	0.051	0.043
13-Jul	194	2.115	44.7947	-87.7573	440095	4960202	59.39	20.1	19.9	32.2	31.9	0.049	0.049	0.034
13-Jul	194	0.210	44.7948	-87.7407	441413	4960208	60.71	20.0	19.8	4.1	4.0	0.006	0.006	
13-Jul	194	0.292	44.7945	-87.7217	442916	4960159	62.21	20.1	19.9	3.9	3.8	0.006	0.006	0.005
13-Jul	194	0.330	44.7943	-87.7130	443602	4960133	62.90	20.1	19.9	4.7	4.6	0.007	0.007	0.018
13-Jul	194	0.403	44.7943	-87.6962	444933	4960121	64.23	20.2	20.0	8.7	8.6	0.013	0.013	0.038
13-Jul	194	0.514	44.8075	-87.7087	443957	4961594	65.99	20.4	20.2	8.9	8.8	0.014	0.013	0.014
13-Jul	194	0.565	44.8143	-87.7157	443410	4962356	66.93	20.5	20.2	9.7	9.5	0.015	0.015	0.022
13-Jul	194	0.620	44.8217	-87.7232	442824	4963177	67.94	20.4	20.2	10.0	9.9	0.015	0.015	0.018
13-Jul	194	0.673	44.8288	-87.7302	442278	4963977	68.91	20.3	20.0	9.7	9.6	0.015	0.015	0.012
13-Jul	194	0.715	44.8347	-87.7358	441836	4964630	69.70	20.1	19.9	9.3	9.2	0.014	0.014	0.010
13-Jul	194	0.897	44.8600	-87.7588	440045	4967461	73.05	20.0	19.7	10.8	10.7	0.017	0.016	0.020
13-Jul	194	0.961	44.8685	-87.7675	439369	4968412	74.21	20.0	19.8	12.1	11.9	0.018	0.018	0.028
13-Jul	194	1.018	44.8758	-87.7755	438745	4969231	75.24	19.8	19.6	14.6	14.4	0.022	0.022	0.044
13-Jul	194	1.063	44.8815	-87.7817	438263	4969867	76.04	19.4	19.2	16.1	15.9	0.025	0.025	0.042
13-Jul	194	1.121	44.8890	-87.7897	437639	4970706	77.09	19.4	19.2	17.1	16.9	0.027	0.026	0.035
13-Jul	194	1.191	44.8983	-87.7987	436939	4971748	78.34	19.6	19.4	18.2	17.9	0.028	0.028	0.034
13-Jul	194	1.235	44.9008	-87.7968	437087	4972025	78.66	19.6	19.4	19.1	18.8	0.029	0.029	0.039
13-Jul	194	1.283	44.9012	-87.7862	437929	4972054	79.50	19.8	19.5	19.4	19.2	0.030	0.030	0.033
13-Jul	194	1.350	44.9015	-87.7712	439113	4972081	80.68	19.9	19.7	20.2	19.9	0.031	0.031	0.036
13-Jul	194	1.399	44.9018	-87.7603	439970	4972108	81.54	20.0	19.8	8.8	8.7	0.013	0.013	
13-Jul	194	1.428	44.9020	-87.7535	440510	4972123	82.08	20.0	19.8	20.6	20.4	0.032	0.032	0.229
13-Jul	194	1.458	44.9023	-87.7468	441036	4972154	82.61	20.0	19.8	21.8	21.5	0.033	0.033	
13-Jul	194	1.495	44.9028	-87.7387	441681	4972203	83.26	19.9	19.7	21.4	21.1	0.033	0.033	0.028
13-Jul	194	1.553	44.9038	-87.7253	442735	4972305	84.31	19.9	19.7	8.9	8.8	0.014	0.014	
13-Jul	194	1.615	44.9047	-87.7115	443828	4972389	85.41	19.9	19.7	16.1	15.9	0.025	0.025	0.079
13-Jul	194	1.644	44.9048	-87.7047	444367	4972402	85.95	19.9	19.7	16.3	16.1	0.025	0.025	0.028
13-Jul	194	1.666	44.9052	-87.6997	444762	4972436	86.35	19.9	19.7	16.7	16.5	0.026	0.026	0.036

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
13-Jul	194	*1.694*	44.9055	-87.6930	445290	4972469	86.88	19.9	19.7	14.6	14.5	0.022	0.022	
13-Jul	194	*1.861*	44.9072	-87.6550	448291	4972629	89.88	19.9	19.7	7.6	7.5	0.012	0.012	
13-Jul	194	*1.916*	44.9075	-87.6423	449291	4972658	90.88	19.9	19.7	8.5	8.4	0.013	0.013	0.021
13-Jul	194	*1.986*	44.9082	-87.6263	450555	4972722	92.15	19.9	19.7	9.7	9.6	0.015	0.015	0.023
13-Jul	194	*2.090*	44.9088	-87.6023	452450	4972781	94.04	19.9	19.7	11.2	11.1	0.017	0.017	0.024
13-Jul	194	*2.178*	44.9095	-87.5820	454056	4972845	95.65	19.9	19.6	12.4	12.3	0.019	0.019	0.025
13-Jul	194	*2.249*	44.9107	-87.5653	455372	4972964	96.97	19.8	19.6	13.5	13.4	0.021	0.021	0.028
13-Jul	194	*2.313*	44.9120	-87.5505	456545	4973105	98.15	19.8	19.6	14.9	14.7	0.023	0.023	0.033
13-Jul	194	*2.393*	44.9133	-87.5318	458018	4973242	99.63	19.7	19.5	15.4	15.2	0.024	0.024	0.027
13-Jul	194	*2.497*	44.9148	-87.5078	459914	4973396	101.53	19.6	19.3	16.9	16.7	0.026	0.026	0.033
13-Jul	194	*2.591*	44.9157	-87.4863	461612	4973479	103.23	19.3	19.1	17.4	17.2	0.027	0.027	0.030
13-Jul	194	*2.705*	44.9165	-87.4602	463677	4973561	105.30	19.6	19.4	16.8	16.5	0.026	0.026	0.023
13-Jul	194	*2.788*	44.9077	-87.4458	464804	4972572	106.80	19.8	19.6	16.9	16.6	0.026	0.026	0.026
13-Jul	194	*2.895*	44.8962	-87.4273	466257	4971287	108.74	19.9	19.7	20.5	20.2	0.031	0.031	0.046
13-Jul	194	*2.928*	44.8925	-87.4220	466677	4970878	109.33	20.0	19.8	22.8	22.5	0.035	0.035	0.070
13-Jul	194	*2.989*	44.8852	-87.4135	467344	4970059	110.38	20.1	19.9	28.3	27.9	0.043	0.043	0.084
13-Jul	194	*3.016*	44.8810	-87.4135	467342	4969597	110.84	20.1	19.9	30.4	30.0	0.046	0.046	0.085
13-Jul	194	*3.041*	44.8768	-87.4138	467312	4969133	111.31	20.1	19.9	32.4	32.0	0.049	0.049	0.090
13-Jul	194	*3.074*	44.8718	-87.4110	467534	4968576	111.91	20.1	19.9	35.6	35.1	0.054	0.054	0.101
13-Jul	194	*3.117*	44.8652	-87.4068	467859	4967835	112.72	20.2	20.0	39.1	38.6	0.060	0.059	0.099
13-Jul	194	*3.148*	44.8607	-87.4035	468120	4967334	113.28	20.2	20.0	42.9	42.3	0.065	0.065	0.123
13-Jul	194	*3.190*	44.8545	-87.3988	468485	4966648	114.06	20.3	20.1	51.5	50.8	0.078	0.078	0.177
13-Jul	194	*3.230*	44.8488	-87.3940	468864	4966015	114.80	20.3	20.1	59.8	59.0	0.091	0.091	0.191
13-Jul	194	*3.286*	44.8408	-87.3877	469359	4965124	115.82	20.2	20.0	83.6	82.4	0.127	0.127	0.327
13-Jul	194	*3.308*	44.8380	-87.3848	469582	4964809	116.20	20.2	20.0	92.0	90.7	0.140	0.140	0.334
13-Jul	194	*3.349*	44.8338	-87.3815	469844	4964344	116.74	20.1	19.9	131.0	129.2	0.200	0.199	0.651
13-Jul	194	*3.382*	44.8323	-87.3803	469935	4964177	116.93	20.0	19.8	164.8	162.5	0.251	0.251	0.761
13-Jul	194	*3.420*	44.8288	-87.3787	470065	4963787	117.34	20.0	19.8	209.1	206.2	0.319	0.319	0.881
13-Jul	194	*3.443*	44.8280	-87.3783	470091	4963696	117.43	20.0	19.8	236.6	233.3	0.361	0.361	0.974
14-Jul	195	11.750	44.9718	-87.4337	465803	4979695	0.00	19.2	19.0	145.4	143.1	0.225	0.225	
14-Jul	195	11.800	44.9777	-87.4353	465675	4980345	0.66	19.2	19.0	138.8	136.5	0.215	0.214	0.165
14-Jul	195	11.833	44.9830	-87.4370	465547	4980938	1.27	19.2	19.0	132.3	130.1	0.205	0.205	0.134
14-Jul	195	11.867	44.9893	-87.4390	465393	4981642	1.99	19.0	18.8	122.5	120.5	0.190	0.190	0.085
14-Jul	195	11.900	44.9947	-87.4405	465278	4982235	2.59	19.1	18.8	116.3	114.4	0.181	0.180	0.110
14-Jul	195	11.933	45.0000	-87.4415	465202	4982828	3.19	19.1	18.9	110.0	108.2	0.171	0.170	0.098

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
14-Jul	195	12.000	45.0102	-87.4432	465077	4983958	4.33	19.1	18.9	102.5	100.8	0.159	0.159	0.119
14-Jul	195	17.717	45.0192	-87.4468	464793	4984960	5.37	18.7	18.5	5.1	5.0	0.008	0.008	0.008
14-Jul	195	17.767	45.0243	-87.4517	464416	4985535	6.06	18.7	18.5	5.7	5.6	0.009	0.009	0.014
14-Jul	195	17.833	45.0335	-87.4605	463726	4986558	7.29	18.9	18.6	4.6	4.5	0.007	0.007	
14-Jul	195	17.883	45.0400	-87.4667	463244	4987283	8.16	18.9	18.7	5.9	5.8	0.009	0.009	0.019
14-Jul	195	17.950	45.0492	-87.4753	462567	4988305	9.39	18.9	18.7	6.1	6.0	0.010	0.010	0.011
14-Jul	195	18.017	45.0567	-87.4827	461995	4989142	10.40	18.8	18.6	6.9	6.8	0.011	0.011	0.015
14-Jul	195	18.200	45.0777	-87.5112	459766	4991488	13.64							
14-Jul	195	18.350	45.0918	-87.5417	457375	4993077	16.51							
14-Jul	195	18.383	45.0927	-87.5478	456891	4993174	17.00	18.6	18.4	3.7	3.6	0.006	0.006	
14-Jul	195	18.433	45.0942	-87.5580	456092	4993346	17.82	18.4	18.2	7.0	6.9	0.011	0.011	0.035
14-Jul	195	18.500	45.0958	-87.5735	454874	4993539	19.05							
14-Jul	195	18.567	45.0963	-87.5858	453903	4993601	20.03	19.4	19.2	18.8	18.5	0.029	0.029	
14-Jul	195	18.617	45.0947	-87.5920	453417	4993420	20.54	20.7	20.5	41.3	40.6	0.062	0.062	0.221
14-Jul	195	18.667	45.0952	-87.5962	453089	4993478	20.88	21.3	21.1	53.3	52.3	0.079	0.079	0.162
14-Jul	195	19.533	45.0947	-87.5963	453076	4993423	20.93	21.7	21.5	167.4	164.5	0.246	0.246	0.253
14-Jul	195		45.0947	-87.5963	453076	4993423	20.93	21.7	21.5	165.9	163.1	0.244	0.244	0.246
14-Jul	195	20.767	45.0947	-87.5963	453076	4993423	20.93	21.8	21.6	216.6	212.8	0.318	0.318	
14-Jul	195	20.800	45.0947	-87.5905	453535	4993419	21.39	21.8	21.6	221.1	217.2	0.325	0.324	0.373
14-Jul	195	20.850	45.0970	-87.5835	454088	4993674	22.00	21.8	21.6	246.6	242.3	0.362	0.362	0.547
14-Jul	195	20.900	45.0998	-87.5735	454877	4993983	22.85	20.7	20.5	232.1	228.1	0.348	0.347	0.279
14-Jul	195	20.967	45.0907	-87.5683	455276	4992963	23.94	19.1	18.9	183.7	180.5	0.284	0.284	0.069
14-Jul	195	21.067	45.0800	-87.5605	455884	4991773	25.28	18.3	18.1	153.3	150.6	0.241	0.241	0.152
14-Jul	195	21.150	45.0612	-87.5580	456067	4989680	27.38	18.5	18.2	113.8	111.8	0.179	0.178	0.017
14-Jul	195	21.217	45.0508	-87.5593	455954	4988532	28.54	18.6	18.3	106.3	104.4	0.166	0.166	0.126
14-Jul	195	21.317	45.0360	-87.5600	455890	4986885	30.18	18.8	18.5	78.2	76.8	0.122	0.122	0.029
14-Jul	195	21.383	45.0220	-87.5627	455669	4985331	31.75	18.9	18.7	57.9	56.9	0.090	0.090	
14-Jul	195	21.467	45.0105	-87.5637	455581	4984054	33.03	19.0	18.7	55.1	54.1	0.086	0.085	0.074
14-Jul	195	21.533	44.9995	-87.5647	455494	4982833	34.26	19.0	18.8	45.9	45.1	0.071	0.071	0.023
14-Jul	195	21.600	44.9868	-87.5660	455379	4981426	35.67	19.0	18.8	38.9	38.2	0.060	0.060	0.024
14-Jul	195	21.700	44.9713	-87.5670	455288	4979705	37.39	19.1	18.8	34.1	33.5	0.053	0.053	0.037
14-Jul	195	21.850	44.9462	-87.5692	455098	4976911	40.19							
14-Jul	195	21.933	44.9333	-87.5707	454969	4975486	41.62	19.2	18.9	14.3	14.0	0.022	0.022	
14-Jul	195	22.000	44.9250	-87.5623	455620	4974556	42.76	19.3	19.1	15.1	14.8	0.023	0.023	0.027
14-Jul	195	22.100	44.9238	-87.5423	457198	4974415	44.34	19.4	19.2	15.7	15.4	0.024	0.024	0.026
14-Jul	195	22.233	44.9210	-87.5112	459656	4974085	46.82	19.3	19.1	17.1	16.8	0.026	0.026	0.030

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
14-Jul	195	22.317	44.9192	-87.4913	461220	4973872	48.40	19.2	18.9	18.4	18.0	0.028	0.028	0.034
14-Jul	195	22.383	44.9177	-87.4760	462429	4973698	49.62	19.1	18.9	17.5	17.2	0.027	0.027	0.023
14-Jul	195	22.467	44.9150	-87.4563	463980	4973392	51.20	19.1	18.9	18.8	18.4	0.029	0.029	0.034
14-Jul	195	22.533	44.9078	-87.4455	464830	4972591	52.37	19.0	18.8	20.0	19.6	0.031	0.031	0.037
14-Jul	195	22.633	44.8963	-87.4280	466205	4971306	54.25	19.0	18.7	23.4	23.0	0.036	0.036	0.048
14-Jul	195	22.683	44.8913	-87.4208	466768	4970748	55.05	19.0	18.7	27.6	27.1	0.043	0.043	0.073
14-Jul	195	22.833	44.8680	-87.4090	467690	4968151	57.80	19.2	19.0	55.1	54.1	0.085	0.085	0.139
14-Jul	195	22.883	44.8575	-87.4013	468290	4966982	59.12	19.3	19.1	77.8	76.4	0.120	0.120	0.283
14-Jul	195	22.933	44.8540	-87.3985	468512	4966592	59.56	19.4	19.2	103.4	101.5	0.159	0.159	0.342
14-Jul	195	23.017	44.8427	-87.3895	469217	4965330	61.01	19.3	19.1	227.1	223.0	0.350	0.349	0.851
14-Jul	195	23.083	44.8342	-87.3823	469779	4964383	62.11	19.3	19.1	348.9	342.7	0.538	0.537	1.176
15-Jul	196	10.717	44.9650	-87.4003	468428	4978923	0.00	19.7	19.4	120.0	118.0	0.184	0.184	
15-Jul	196	10.867	44.9902	-87.3922	469085	4981716	2.87	18.5	18.2	102.8	101.1	0.161	0.161	0.133
15-Jul	196	11.033	45.0175	-87.3833	469796	4984749	5.98	17.4	17.2	79.0	77.8	0.127	0.127	0.091
15-Jul	196	11.133	45.0327	-87.3782	470210	4986432	7.72	18.8	18.5	74.5	73.2	0.116	0.116	0.094
15-Jul	196	11.250	45.0490	-87.3658	471191	4988242	9.78	19.2	19.0	68.5	67.4	0.106	0.106	0.088
15-Jul	196	11.450	45.0748	-87.3465	472725	4991104	13.02	20.0	19.7	58.5	57.5	0.089	0.089	0.074
15-Jul	196	11.550	45.0890	-87.3348	473650	4992675	14.85	20.7	20.5	54.9	54.0	0.082	0.082	0.068
15-Jul	196	11.667	45.1057	-87.3208	474759	4994522	17.00	19.8	19.6	49.5	48.7	0.076	0.076	0.063
15-Jul	196	11.783	45.1215	-87.3082	475762	4996277	19.02	20.1	19.9	45.4	44.6	0.069	0.069	0.057
15-Jul	196	11.900	45.1370	-87.2962	476712	4997995	20.99	20.1	19.9	41.1	40.5	0.063	0.062	0.051
15-Jul	196	11.983	45.1483	-87.2877	477385	4999251	22.41	20.1	19.8	39.0	38.4	0.059	0.059	0.051
15-Jul	196	12.133	45.1710	-87.2745	478429	5001766	25.13	20.0	19.8	34.6	34.1	0.053	0.053	0.044
15-Jul	196	12.267	45.1915	-87.2630	479340	5004040	27.58	20.0	19.8	31.6	31.1	0.048	0.048	0.041
15-Jul	196	12.350	45.2005	-87.2575	479775	5005039	28.67	20.0	19.8	29.8	29.4	0.045	0.045	0.038
15-Jul	196	12.417	45.2002	-87.2572	479801	5005002	28.72			28.3				
15-Jul	196	13.917	45.2120	-87.2745	478444	5006321	30.61	19.7	19.4	11.1	11.0	0.017	0.017	
15-Jul	196	13.967	45.2175	-87.2817	477884	5006934	31.44	19.6	19.4	10.7	10.5	0.016	0.016	0.013
15-Jul	196	14.033	45.2245	-87.2913	477128	5007714	32.53	19.5	19.3	9.5	9.4	0.015	0.015	0.009
15-Jul	196	14.083	45.2303	-87.3000	476450	5008364	33.47	19.5	19.2	9.2	9.1	0.014	0.014	0.012
15-Jul	196	14.183	45.2423	-87.3170	475120	5009702	35.35	19.3	19.0	8.4	8.3	0.013	0.013	0.011
15-Jul	196	14.233	45.2487	-87.3265	474378	5010410	36.38	19.2	19.0	8.0	7.9	0.012	0.012	0.009
15-Jul	196	14.283	45.2535	-87.3333	473846	5010948	37.13	19.3	19.0	8.4	8.3	0.013	0.013	0.016
15-Jul	196	14.333	45.2593	-87.3417	473192	5011599	38.06	19.3	19.1	7.5	7.4	0.012	0.012	0.005
15-Jul	196	14.650	45.2778	-87.3917	469279	5013672	42.49	19.4	19.2	6.0	5.9	0.009	0.009	0.008

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
15-Jul	196	14.700	45.2700	-87.3973	468831	5012804	43.46	19.4	19.2	6.3	6.3	0.010	0.010	0.013
15-Jul	196	14.817	45.2543	-87.4085	467946	5011068	45.41	19.5	19.3	6.8	6.7	0.011	0.010	0.012
15-Jul	196	14.883	45.2437	-87.4157	467377	5009886	46.72	19.5	19.2	7.3	7.2	0.011	0.011	0.014
15-Jul	196	14.967	45.2322	-87.4238	466730	5008612	48.15	19.5	19.2	7.7	7.6	0.012	0.012	0.013
15-Jul	196	15.067	45.2190	-87.4328	466016	5007153	49.78	19.7	19.5	7.6	7.5	0.012	0.012	0.011
15-Jul	196	17.167	45.1640	-87.4702	463048	5001059	56.55	20.1	19.9	5.2	5.1	0.008	0.008	
15-Jul	196	17.217	45.1563	-87.4755	462624	5000210	57.50	20.0	19.8	5.4	5.3	0.008	0.008	0.010
15-Jul	196	17.383	45.1320	-87.4923	461285	4997515	60.51	19.8	19.6	6.7	6.6	0.010	0.010	0.012
15-Jul	196	17.450	45.1223	-87.4988	460767	4996444	61.70	19.8	19.6	7.5	7.4	0.011	0.011	0.016
15-Jul	196	17.600	45.1017	-87.5128	459652	4994155	64.25	19.7	19.5	9.3	9.1	0.014	0.014	0.018
15-Jul	196	17.733	45.0810	-87.5260	458600	4991866	66.77	19.7	19.5	12.9	12.7	0.020	0.020	0.028
15-Jul	196	17.817	45.0702	-87.5330	458042	4990666	68.09	19.7	19.5	18.5	18.2	0.028	0.028	0.051
15-Jul	196	17.900	45.0603	-87.5428	457260	4989578	69.43	19.9	19.7	23.7	23.4	0.036	0.036	0.057
15-Jul	196	17.983	45.0438	-87.5462	456985	4987747	71.28	20.0	19.7	24.8	24.4	0.038	0.038	0.042
15-Jul	196	18.083	45.0282	-87.5500	456672	4986010	73.05	20.2	19.9	23.6	23.3	0.036	0.036	0.032
15-Jul	196	18.167	45.0165	-87.5522	456492	4984714	74.35	20.2	20.0	23.5	23.1	0.036	0.036	0.035
15-Jul	196	18.217	45.0052	-87.5545	456300	4983457	75.63	20.2	20.0	22.9	22.5	0.035	0.035	0.030
15-Jul	196	18.333	44.9400	-87.5578	455987	4976219	82.87	20.2	20.0	22.6	22.2	0.034	0.034	0.034
15-Jul	196	18.417	44.9763	-87.5602	455831	4980256	86.91	20.2	20.0	22.9	22.5	0.035	0.035	0.036
15-Jul	196	18.517	44.9602	-87.5640	455516	4978463	88.73	20.0	19.8	21.3	21.0	0.033	0.032	0.028
15-Jul	196	18.600	44.9473	-87.5673	455243	4977039	90.18	20.1	19.9	20.6	20.3	0.031	0.031	0.028
15-Jul	196	18.683	44.9335	-87.5705	454983	4975504	91.74	20.3	20.1	19.9	19.6	0.030	0.030	0.027
15-Jul	196	20.417	44.9233	-87.5337	457881	4974355	94.86	20.4	20.2	12.1				
15-Jul	196	20.467	44.9222	-87.5207	458907	4974219	95.89	20.5	20.3	11.7				
15-Jul	196	20.550	44.9205	-87.5028	460313	4974025	97.31	20.5	20.3	11.7	11.5	0.018	0.018	
15-Jul	196	20.650	44.9180	-87.4755	462469	4973734	99.49	20.5	20.3	12.5	12.3	0.019	0.019	0.022
15-Jul	196	20.750	44.9143	-87.4565	463966	4973318	101.04	20.5	20.3	12.9	12.7	0.019	0.019	0.021
15-Jul	196	20.833	44.9055	-87.4420	465105	4972331	102.55	20.5	20.3	13.1	12.9	0.020	0.020	0.020
15-Jul	196	20.900	44.8963	-87.4273	466258	4971306	104.09	21.0	20.8	13.6	13.4	0.020	0.020	0.022
15-Jul	196	20.983	44.8882	-87.4152	467214	4970394	105.41	20.4	20.1	19.2	18.9	0.029	0.029	0.052
15-Jul	196	21.050	44.8862	-87.4122	467449	4970171	105.74	20.2	20.0	28.6	28.1	0.043	0.043	0.093
15-Jul	196	21.117	44.8713	-87.4108	467547	4968522	107.39	20.3	20.1	34.0	33.5	0.052	0.051	0.080
15-Jul	196	21.200	44.8600	-87.4032	468146	4967260	108.78	20.3	20.1	39.5	38.9	0.060	0.060	0.082
15-Jul	196	21.367	44.8375	-87.3847	469596	4964754	111.68	20.3	20.1	111.9	110.3	0.170	0.169	0.294
15-Jul	196	21.433	44.8335	-87.3813	469858	4964308	112.20	20.1	19.9	221.4	218.1	0.337	0.336	0.914
15-Jul	196	21.483	44.8335	-87.3808	469897	4964308	112.24	20.0	19.8	329.6	324.7	0.503	0.502	1.290

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
15-Jul	196	21.500	44.8318	-87.3798	469975	4964122	112.44	20.0	19.7	386.5	380.7	0.590	0.589	1.915
02-Aug	214	*1.268*	44.5342	-88.0062	420055	4931479	0.00	24.8	24.6	73.5	72.6	0.103	0.102	
02-Aug	214	*1.339*	44.5398	-88.0030	420316	4932105	0.68	25.2	25.0	145.0	143.1	0.201	0.200	0.551
02-Aug	214	*1.378*	44.5458	-88.0003	420535	4932769	1.38	24.9	24.7	162.6	160.5	0.226	0.226	0.404
02-Aug	214	*1.450*	44.5570	-87.9947	421000	4934005	2.70	24.3	24.1	206.6	203.9	0.291	0.290	0.514
02-Aug	214	*1.506*	44.5657	-87.9895	421423	4934962	3.74	23.2	23.0	227.0	224.1	0.326	0.326	0.484
02-Aug	214	*1.573*	44.5755	-87.9835	421913	4936049	4.94	22.7	22.5	213.4	210.6	0.309	0.309	0.246
02-Aug	214	*1.644*	44.5840	-87.9727	422783	4936983	6.21	22.4	22.2	190.7	188.2	0.278	0.277	0.172
02-Aug	214	*1.858*	44.6088	-87.9393	425461	4939709	10.03	22.2	22.0	115.3	113.8	0.169	0.169	0.076
02-Aug	214	*1.924*	44.6178	-87.9308	426147	4940701	11.24	22.2	22.0	109.2	107.8	0.160	0.160	0.127
02-Aug	214	*2.000*	44.6282	-87.9215	426901	4941841	12.61	22.1	21.9	102.5	101.1	0.150	0.150	0.119
02-Aug	214	*2.065*	44.6370	-87.9133	427560	4942816	13.78	22.1	21.9	93.7	92.5	0.137	0.137	0.090
02-Aug	214	*2.193*	44.6507	-87.9310	426176	4944349	15.85	22.3	22.1	79.1	78.1	0.116	0.115	0.079
02-Aug	214	*2.263*	44.6572	-87.9442	425139	4945083	17.12	22.3	22.1	60.8	60.0	0.089	0.089	
02-Aug	214	*2.317*	44.6588	-87.9400	425473	4945264	17.50	22.3	22.1	64.0	63.1	0.093	0.093	0.114
02-Aug	214	*2.367*	44.6583	-87.9287	426370	4945198	18.40	22.4	22.2	58.2	57.5	0.085	0.085	0.043
02-Aug	214	*2.432*	44.6578	-87.9137	427559	4945129	19.59	22.4	22.2	55.2	54.5	0.081	0.080	0.064
02-Aug	214	*2.470*	44.6578	-87.9052	428232	4945121	20.26	22.4	22.2	52.1	51.4	0.076	0.076	0.045
02-Aug	214	*2.550*	44.6582	-87.8870	429674	4945143	21.70	22.2	22.0	43.5	42.9	0.064	0.064	0.028
02-Aug	214	*2.575*	44.6580	-87.8832	429977	4945122	22.01	22.0	21.8	41.2	40.6	0.060	0.060	0.027
02-Aug	214	*2.616*	44.6575	-87.8835	429951	4945067	22.07	21.9	21.7	41.0	40.5	0.060	0.060	0.060
02-Aug	214	*0.095*	44.6582	-87.8803	430202	4945137	22.33	22.6	22.4	20.5	20.2	0.030	0.030	
02-Aug	214	*0.132*	44.6575	-87.8817	430095	4945065	22.46	22.5	22.3	20.8	20.6	0.030	0.030	0.034
02-Aug	214	*0.649*	44.6603	-87.8763	430522	4945374	22.99	22.7	22.5	19.3	19.1	0.028	0.028	0.028
02-Aug	214	*0.686*	44.6600	-87.8682	431169	4945332	23.63	22.8	22.6	20.4	20.2	0.030	0.030	0.041
02-Aug	214	*0.740*	44.6595	-87.8562	432119	4945266	24.59	22.9	22.7	23.2	22.9	0.034	0.034	0.052
02-Aug	214	*0.799*	44.6588	-87.8428	433176	4945179	25.65	22.8	22.6	27.7	27.4	0.040	0.040	0.067
02-Aug	214	*0.847*	44.6585	-87.8323	434008	4945135	26.48	22.6	22.4	31.2	30.8	0.045	0.045	0.073
02-Aug	214	*0.898*	44.6582	-87.8208	434920	4945088	27.39	22.4	22.2	34.0	33.5	0.050	0.049	0.070
02-Aug	214	*0.945*	44.6580	-87.8103	435752	4945062	28.23	22.3	22.1	35.8	35.4	0.052	0.052	0.068
02-Aug	214	*0.993*	44.6580	-87.7998	436585	4945054	29.06	22.2	22.0	36.8	36.4	0.054	0.054	0.062
02-Aug	214	*1.039*	44.6578	-87.7895	437404	4945026	29.88	22.0	21.8	38.4	37.9	0.056	0.056	0.070
02-Aug	214	*1.109*	44.6578	-87.7738	438646	4945014	31.12	21.8	21.6	42.7	42.2	0.063	0.063	0.085
02-Aug	214	*1.146*	44.6578	-87.7655	439307	4945008	31.78	21.6	21.4	45.8	45.2	0.068	0.068	0.100
02-Aug	214	*1.190*	44.6612	-87.7638	439442	4945378	32.17	21.2	21.0	53.7	53.0	0.080	0.080	0.150

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
02-Aug	214	1.236	44.6677	-87.7687	439065	4946103	32.99	21.2	21.0	51.4	50.7	0.077	0.077	0.058
02-Aug	214	1.279	44.6738	-87.7732	438715	4946791	33.76	21.4	21.2	49.8	49.2	0.074	0.074	0.058
02-Aug	214	1.327	44.6808	-87.7783	438313	4947572	34.64	21.4	21.2	48.5	47.9	0.072	0.072	0.062
02-Aug	214	1.375	44.6878	-87.7832	437937	4948354	35.51	21.2	21.0	50.4	49.8	0.075	0.075	0.091
02-Aug	214	1.517	44.7087	-87.7967	436890	4950679	38.06	21.2	21.0	49.7	49.1	0.074	0.074	0.073
02-Aug	214	1.573	44.7170	-87.8017	436503	4951609	39.07	21.2	21.0	48.7	48.1	0.073	0.073	0.066
02-Aug	214	1.639	44.7267	-87.8078	436026	4952687	40.25	21.5	21.3	47.5	46.9	0.070	0.070	0.062
02-Aug	214	1.682	44.7333	-87.8123	435677	4953430	41.07	21.7	21.5	43.5	43.0	0.064	0.064	0.029
02-Aug	214	1.729	44.7405	-87.8170	435316	4954232	41.95	21.9	21.7	40.9	40.4	0.060	0.060	0.039
02-Aug	214	1.797	44.7508	-87.8242	434759	4955384	43.23	22.1	21.9	39.5	39.0	0.058	0.058	0.049
02-Aug	214	1.858	44.7602	-87.8308	434243	4956427	44.39	22.2	22.0	37.4	36.9	0.055	0.055	0.042
02-Aug	214	1.911	44.7682	-87.8362	433829	4957320	45.37	22.3	22.1	33.9	33.5	0.050	0.049	0.025
02-Aug	214	1.962	44.7763	-87.8408	433470	4958230	46.35	22.5	22.3	31.9	31.5	0.046	0.046	0.032
02-Aug	214	2.009	44.7838	-87.8442	433214	4959066	47.23	22.6	22.4	30.3	29.9	0.044	0.044	0.031
02-Aug	214	2.051	44.7897	-87.8493	432813	4959719	47.99	22.8	22.6	30.8	30.4	0.045	0.045	0.049
02-Aug	214	2.228	44.7990	-87.8415	433443	4960750	49.20	22.9	22.7					
02-Aug	214	2.266	44.7973	-87.8335	434074	4960556	49.86	22.9	22.7	32.1	31.7	0.046	0.046	0.048
02-Aug	214	2.310	44.7942	-87.8248	434756	4960198	50.63	22.9	22.7	31.3	30.9	0.045	0.045	0.039
02-Aug	214	2.359	44.7915	-87.8148	435544	4959895	51.48	22.9	22.7	30.4	30.0	0.044	0.044	0.037
02-Aug	214	2.454	44.7935	-87.7928	437286	4960100	53.23	22.8	22.6	28.8	28.4	0.042	0.042	0.036
02-Aug	214	2.504	44.7945	-87.7815	438184	4960202	54.13	22.7	22.5	28.4	28.0	0.041	0.041	0.038
02-Aug	214	2.587	44.7947	-87.7625	439687	4960206	55.64	22.5	22.3	27.6	27.2	0.040	0.040	0.037
02-Aug	214	2.821	44.7940	-87.7592	439949	4960130	55.91	21.9	21.7	28.0	27.6	0.041	0.041	0.042
02-Aug	214	2.961	44.7942	-87.7592	439949	4960148	55.93	22.2	22.0	27.8	27.4	0.041	0.041	0.040
02-Aug	214	0.102	44.7947	-87.7477	440860	4960195	56.84	22.0	21.8	15.4	15.2	0.023	0.023	
02-Aug	214	0.138	44.7945	-87.7395	441506	4960171	57.49	21.8	21.6	16.6	16.4	0.025	0.025	0.038
02-Aug	214	0.198	44.7943	-87.7255	442614	4960141	58.59	21.5	21.3	17.6	17.4	0.026	0.026	0.032
02-Aug	214	0.253	44.7942	-87.7058	444169	4960110	60.15	21.2	21.0	18.1	17.9	0.027	0.027	0.031
02-Aug	214	0.318	44.7940	-87.6980	444789	4960087	60.77	20.0	19.8	21.8	21.5	0.033	0.033	0.055
02-Aug	214	0.354	44.7955	-87.6968	444882	4960253	60.96	19.5	19.3	24.5	24.2	0.038	0.038	0.068
02-Aug	214	0.388	44.8000	-87.7015	444517	4960756	61.58	19.8	19.5	26.7	26.3	0.041	0.041	0.063
02-Aug	214	0.431	44.8055	-87.7073	444061	4961371	62.35	20.2	20.0	28.4	28.0	0.043	0.043	0.056
02-Aug	214	0.475	44.8113	-87.7135	443579	4962021	63.16	20.6	20.4	29.4	29.1	0.044	0.044	0.051
02-Aug	214	0.515	44.8167	-87.7188	443162	4962618	63.88	20.9	20.7	29.6	29.2	0.044	0.044	0.045
02-Aug	214	0.581	44.8257	-87.7280	442447	4963624	65.12	21.2	21.0	23.4	23.1	0.035	0.035	
02-Aug	214	0.683	44.8398	-87.7415	441394	4965207	67.02	21.6	21.4	15.9	15.7	0.024	0.024	

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
02-Aug	214	0.733	44.8468	-87.7482	440873	4965989	67.96	21.9	21.7	17.4	17.2	0.026	0.026	0.036
02-Aug	214	0.805	44.8568	-87.7575	440147	4967107	69.29	22.2	22.0	19.5	19.3	0.029	0.029	0.038
02-Aug	214	0.875	44.8665	-87.7668	439419	4968189	70.60	22.3	22.1	21.3	21.0	0.031	0.031	0.039
02-Aug	214	0.944	44.8760	-87.7758	438718	4969251	71.87	21.7	21.5	23.7	23.4	0.035	0.035	0.049
02-Aug	214	1.008	44.8843	-87.7845	438043	4970182	73.02	20.6	20.4	28.6	28.2	0.043	0.043	0.073
02-Aug	214	1.050	44.8898	-87.7898	437627	4970797	73.76	20.1	19.9	32.2	31.8	0.049	0.049	0.084
02-Aug	214	1.093	44.8955	-87.7957	437172	4971433	74.54	20.0	19.8	34.3	33.8	0.052	0.052	0.071
02-Aug	214	1.140	44.9005	-87.8000	436837	4971991	75.19	20.2	20.0	36.0	35.6	0.055	0.055	0.067
02-Aug	214	1.195	44.9008	-87.7833	438154	4972014	76.51	20.2	20.0	38.7	38.2	0.059	0.059	0.076
02-Aug	214	1.253	44.9012	-87.7742	438876	4972045	77.23	20.5	20.3	39.5	39.0	0.060	0.060	0.063
02-Aug	214	1.305	44.9015	-87.7500	440786	4972065	79.14	20.8	20.6	40.1	39.5	0.060	0.060	0.063
02-Aug	214	1.378	44.9020	-87.7453	441161	4972117	79.52	21.2	21.0	41.9	41.4	0.063	0.062	0.070
02-Aug	214	1.435	44.9028	-87.7167	443418	4972188	81.78	21.6	21.4	42.1	41.6	0.062	0.062	0.062
02-Aug	214	1.507	44.9038	-87.7000	444735	4972287	83.10	21.6	21.4	40.7	40.2	0.060	0.060	0.053
02-Aug	214	1.567	44.9047	-87.6943	445185	4972377	83.56	21.7	21.5	38.5	38.0	0.057	0.057	0.043
02-Aug	214	1.658	44.9095	-87.6787	446426	4972904	84.91	21.5	21.3	35.5	35.0	0.053	0.053	0.042
02-Aug	214	1.735	44.9000	-87.6654	447464	4971840	86.40	21.5	21.3	20.4	20.1	0.030	0.030	
02-Aug	214	1.779	44.9143	-87.6578	448075	4973429	88.10	21.4	21.2	33.0	32.6	0.049	0.049	
02-Aug	214	1.853	44.9144	-87.5755	454573	4973387	94.60	21.3	21.1	31.8	31.4	0.047	0.047	0.042
02-Aug	214	1.906	44.9145	-87.5593	455850	4973384	95.87	21.2	21.0	30.7	30.3	0.046	0.046	0.039
02-Aug	214	1.955	44.9145	-87.6162	451364	4973422	100.36	21.2	21.0	29.6	29.2	0.044	0.044	0.035
02-Aug	214	2.033	44.9146	-87.5967	452903	4973420	101.90	21.1	20.9	29.1	28.7	0.043	0.043	0.042
02-Aug	214	2.174	44.9147	-87.5083	459876	4973388	108.87	20.9	20.7	28.6	28.2	0.043	0.043	0.042
02-Aug	214	2.208	44.9148	-87.5085	459864	4973392	108.89	20.9	20.6	29.2	28.8	0.044	0.044	0.051
02-Aug	214	2.229	44.9148	-87.5086	459856	4973394	108.89	20.9	20.6					
02-Aug	214	2.316	44.9149	-87.5090	459824	4973404	108.93	20.8	20.5	29.9	29.5	0.045	0.045	
02-Aug	214	2.348	44.9149	-87.5091	459813	4973408	108.94	20.7	20.5	30.1	29.7	0.045	0.045	0.048
02-Aug	214	2.388	44.9150	-87.5093	459798	4973413	108.95	20.8	20.6	30.3	29.9	0.046	0.046	0.048
02-Aug	214	2.429	44.9150	-87.5095	459783	4973417	108.97	20.8	20.6	30.7	30.3	0.046	0.046	0.049
02-Aug	214	2.472	44.9151	-87.4958	460862	4973420	110.05	20.9	20.6	30.9	30.5	0.046	0.046	0.048
02-Aug	214	2.508	44.9152	-87.4880	461480	4973425	110.67	20.9	20.7	31.3	30.9	0.047	0.047	0.051
02-Aug	214	2.543	44.9153	-87.4805	462072	4973435	111.26	20.9	20.7	31.2	30.8	0.047	0.047	0.045
02-Aug	214	2.584	44.9155	-87.4730	462665	4973455	111.85	20.9	20.6	31.4	31.0	0.047	0.047	0.049
02-Aug	214	2.618	44.9160	-87.4630	463454	4973506	112.64	20.8	20.6	31.7	31.3	0.048	0.048	0.051
02-Aug	214	2.663	44.9119	-87.4561	463993	4973046	113.35	20.8	20.6	31.8	31.3	0.048	0.048	0.048
02-Aug	214	2.742	44.9047	-87.4436	464975	4972237	114.62	20.8	20.6	32.8	32.4	0.049	0.049	0.054

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
02-Aug	214	*2.776*	44.9015	-87.4383	465398	4971889	115.17	20.9	20.7	34.0	33.6	0.051	0.051	0.063
02-Aug	214	*2.808*	44.8986	-87.4332	465796	4971562	115.69	20.8	20.6	34.8	34.3	0.052	0.052	0.062
02-Aug	214	*2.841*	44.8956	-87.4280	466206	4971224	116.22	20.3	20.1	40.6	40.1	0.062	0.062	0.132
02-Aug	214	*2.884*	44.8917	-87.4212	466741	4970784	116.91	20.2	20.0	50.2	49.5	0.076	0.076	0.158
02-Aug	214	*2.920*	44.8857	-87.4179	466997	4970125	117.62	21.3	21.0	55.2	54.5	0.082	0.082	0.123
02-Aug	214	*2.964*	44.8785	-87.4139	467310	4969319	118.48	21.8	21.6	59.3	58.5	0.087	0.087	0.117
02-Aug	214	*3.005*	44.8718	-87.4101	467601	4968569	119.29	22.1	21.9	65.8	64.9	0.097	0.096	0.152
02-Aug	214	*3.043*	44.8655	-87.4067	467872	4967873	120.03	22.2	22.0	69.8	68.8	0.102	0.102	0.139
02-Aug	214	*3.100*	44.8565	-87.4007	468341	4966871	121.14	22.3	22.1	78.0	77.0	0.114	0.114	0.165
02-Aug	214	*3.134*	44.8513	-87.3962	468693	4966293	121.82	22.2	22.0	97.3	95.9	0.142	0.142	0.356
02-Aug	214	*3.177*	44.8452	-87.3912	469085	4965607	122.61	22.2	22.0	120.6	118.9	0.177	0.176	0.377
02-Aug	214	*3.230*	44.8378	-87.3850	469570	4964790	123.56	22.2	22.0	147.2	145.3	0.216	0.215	0.397
02-Aug	214	*3.276*	44.8345	-87.3820	469805	4964420	124.00	22.0	21.8	200.2	197.5	0.294	0.293	0.727
02-Aug	214	*3.325*	44.8310	-87.3793	470014	4964030	124.44	21.9	21.7	252.5	249.1	0.372	0.371	0.759
03-Aug	215	*0.389*	44.8395	-87.3862	469477	4964977	0.00	21.2	21.0	849.3	835.9	1.264	1.262	
03-Aug	215	*0.436*	44.8462	-87.3915	469060	4965718	0.85	21.2	21.0	853.1	839.7	1.270	1.268	1.301
03-Aug	215	*0.492*	44.8538	-87.3985	468511	4966572	1.87	21.2	21.0	360.3	354.4	0.536	0.535	
03-Aug	215	*0.523*	44.8585	-87.4020	468237	4967093	2.45	21.2	21.0	355.6	349.8	0.529	0.528	0.466
03-Aug	215	*0.558*	44.8637	-87.4058	467937	4967668	3.10	21.2	21.0	285.8	281.1	0.425	0.424	
03-Aug	215	*0.594*	44.8692	-87.4092	467676	4968280	3.77	21.2	21.0	263.0	258.7	0.391	0.391	
03-Aug	215	*0.644*	44.8768	-87.4137	467325	4969133	4.69	21.4	21.2	256.0	251.9	0.379	0.379	0.314
03-Aug	215	*0.683*	44.8832	-87.4138	467316	4969837	5.40	21.4	21.2	257.0	252.9	0.381	0.380	0.391
03-Aug	215	*0.727*	44.8900	-87.4147	467253	4970597	6.16	21.4	21.2	242.9	238.9	0.360	0.359	0.226
03-Aug	215	*0.774*	44.8977	-87.4165	467114	4971449	7.02	21.4	21.2	221.7	218.1	0.329	0.328	0.147
03-Aug	215	*0.808*	44.9032	-87.4178	467011	4972061	7.64	21.2	21.0	212.0	208.6	0.315	0.315	0.207
03-Aug	215	*0.869*	44.9130	-87.4202	466832	4973155	8.75	19.9	19.7	187.3	184.3	0.286	0.285	0.160
03-Aug	215	*0.903*	44.9185	-87.4215	466731	4973766	9.37	20.4	20.2	172.4	169.7	0.261	0.260	0.058
03-Aug	215	*0.958*	44.9275	-87.4235	466579	4974767	10.38	20.7	20.5	148.7	146.3	0.223	0.223	0.045
03-Aug	215	*1.001*	44.9343	-87.4248	466477	4975525	11.15	20.7	20.5	133.0	130.9	0.200	0.199	0.051
03-Aug	215	*1.091*	44.9487	-87.4280	466236	4977119	12.76	21.2	21.0	108.6	106.8	0.162	0.161	0.053
03-Aug	215	*1.141*	44.9567	-87.4302	466069	4978009	13.66	20.9	20.7	98.1	96.5	0.147	0.147	0.069
03-Aug	215	*1.190*	44.9645	-87.4323	465903	4978881	14.55	20.7	20.5	90.7	89.2	0.136	0.136	0.078
03-Aug	215	*1.283*	44.9792	-67.4363	465596	4980511	16.21	20.6	20.4	76.7	75.5	0.115	0.115	0.060
03-Aug	215	*1.346*	44.9892	-87.4392	465378	4981623	17.34	20.5	20.3	68.7	67.6	0.104	0.103	0.055
03-Aug	215	*1.395*	44.9970	-87.4410	465240	4982495	18.23	20.5	20.3	63.0	62.0	0.095	0.095	0.048

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
03-Aug	215	*1.458*	45.0072	-87.4430	465088	4983624	19.37	20.6	20.4	56.4	55.5	0.085	0.085	0.042
03-Aug	215	*1.518*	45.0168	-87.4448	464949	4984698	20.45	20.8	20.6	50.7	49.9	0.076	0.076	0.037
03-Aug	215	*1.533*	45.0192	-87.4453	464911	4984958	20.71	20.8	20.6	42.9	42.2	0.064	0.064	
03-Aug	215	*1.675*	45.0192	-87.4448	464950	4984958	20.75	21.2	21.0	38.7	38.1	0.058	0.057	0.047
03-Aug	215	*0.484*	45.0063	-87.4430	465088	4983531	22.18	21.6	21.4	14.0	13.8	0.021	0.021	
03-Aug	215	*0.518*	45.0005	-87.4415	465202	4982884	22.84	21.6	21.4	14.5	14.3	0.021	0.021	0.028
03-Aug	215	*0.558*	44.9940	-87.4395	465356	4982161	23.58	21.6	21.4	15.4	15.1	0.023	0.023	0.031
03-Aug	215	*0.600*	44.9870	-87.4378	465483	4981382	24.37	21.7	21.5	16.2	15.9	0.024	0.024	0.031
03-Aug	215	*0.653*	44.9782	-87.4355	465662	4980399	25.37	21.7	21.5	17.8	17.5	0.026	0.026	0.039
03-Aug	215	*0.704*	44.9700	-87.4335	465815	4979492	26.29	21.7	21.5	19.2	18.8	0.028	0.028	0.039
03-Aug	215	*0.751*	44.9622	-87.4320	465928	4978620	27.17	21.7	21.5	20.4	20.1	0.030	0.030	0.041
03-Aug	215	*0.785*	44.9567	-87.4308	466017	4978009	27.79	21.7	21.5	21.1	20.8	0.031	0.031	0.040
03-Aug	215	*0.813*	44.9518	-87.4298	466093	4977471	28.33	21.7	21.5	21.9	21.5	0.032	0.032	0.043
03-Aug	215	*0.862*	44.9437	-87.4280	466233	4976564	29.25	21.7	21.5	23.4	23.0	0.034	0.034	0.047
03-Aug	215	*0.903*	44.9370	-87.4265	466347	4975823	30.00	21.7	21.5	24.0	23.5	0.035	0.035	0.041
03-Aug	215	*0.957*	44.9282	-87.4247	466486	4974841	30.99	21.7	21.5	24.5	24.0	0.036	0.036	0.040
03-Aug	215	*1.018*	44.9185	-87.4218	466704	4973766	32.09	21.7	21.5	23.9	23.5	0.035	0.035	0.032
03-Aug	215	*1.074*	44.9095	-87.4193	466897	4972765	33.10	21.7	21.5	24.5	24.1	0.036	0.036	0.040
03-Aug	215	*1.108*	44.9042	-87.4177	467025	4972172	33.71	21.7	21.5	29.1	28.5	0.043	0.043	0.097
03-Aug	215	*1.161*	44.8958	-87.4160	467153	4971244	34.65	21.5	21.3	44.2	43.4	0.065	0.065	0.180
03-Aug	215	*1.206*	44.8887	-87.4143	467280	4970448	35.45	21.4	21.2	54.6	53.6	0.081	0.081	0.176
03-Aug	215	*1.246*	44.8822	-87.4140	467303	4969726	36.18	21.4	21.2	66.6	65.4	0.098	0.098	0.221
03-Aug	215	*1.314*	44.8715	-87.4112	467519	4968541	37.38	21.3	21.1	116.7	114.6	0.173	0.173	0.460
03-Aug	215	*1.385*	44.8608	-87.4038	468093	4967352	38.70	21.7	21.5	152.9	150.0	0.225	0.224	0.417
03-Aug	215	*1.453*	44.8508	-87.3958	468720	4966238	39.98	21.7	21.5	184.5	181 1	0.271	0.271	0.451
03-Aug	215	*1.501*	44.8440	-87.3902	469164	4965478	40.86	21.7	21.5	217.6	213.6	0.320	0.319	0.601
03-Aug	215	*1.550*	44.8385	-87.3852	469556	4964865	41.59	21.7	21.5	360.3	353.7	0.530	0.529	1.697
03-Aug	215	*1.581*	44.8350	-87.3827	469752	4964475	42.02	21.6	21.4	463.0	454.4	0.682	0.681	2.035
03-Aug	215	*1.624*	44.8315	-87.3797	469987	4964086	42.48	21.4	21.2	617.1	605.7	0.913	0.911	2.394
03-Aug	215	*1.675*	44.8275	-87.3782	470103	4963641	42.94	21.1	20.9	775.5	761.2	1.153	1.151	2.422
23-Aug	235	*0.461*	44.5228	-88.0103	419709	4930224	0.00	*	23.1	*	*		0.071	0.071
23-Aug	235	*0.513*	44.5273	-88.0085	419862	4930722	0.52	*	22.9	*	*		0.072	0.072
23-Aug	235	*0.577*	44.5318	-88.0080	419907	4931221	1.02	*	22.9	*	*		0.067	0.067
23-Aug	235	*0.649*	44.5392	-88.0035	420275	4932032	1.91	*	23.0	*	*		0.091	0.091
23-Aug	235	*0.736*	44.5463	-88.0002	420549	4932824	2.75	*	22.2	*	*		0.141	0.141

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
23-Aug	235	0.832	44.5542	-87.9963	420864	4933691	3.67	•	22.3	•	•		0.097	0.097
23-Aug	235	0.899	44.5595	-87.9937	421083	4934282	4.30	•	22.0	•	•		0.087	0.087
23-Aug	235	0.992	44.5668	-87.9890	421464	4935090	5.20	•	21.3	•	•		0.121	0.121
23-Aug	235	1.090	44.5743	-87.9842	421857	4935919	6.11	•	21 4	•	•		0.086	0.086
23-Aug	235	1.186	44.5813	-87.9783	422330	4936691	7.02	•	21.0	•	•		0.124	0.124
23-Aug	235	1.379	44.5907	-87.9593	423851	4937710	8.85	•	20.7	•	•		0.105	0.105
23-Aug	235	1.530	44.6000	-87.9472	424828	4938737	10.27	•	20.6	•	•		0.155	0.155
23-Aug	235	1.704	44.6127	-87.9357	425757	4940132	11.94	•	20.7	•	•		0.122	0.122
23-Aug	235	1.880	44.6257	-87.9240	426700	4941566	13.66	•	20.7	•	•		0.135	0.135
23-Aug	235	2.052	44.6383	-87.9122	427653	4942961	15.35	•	20.8	•	•		0.172	0.172
23-Aug	235	2.228	44.6483	-87.9260	426570	4944085	16.91	•	20.4	•	•		0.213	0.213
23-Aug	235	2.351	44.6587	-87.9443	425129	4945250	18.76	•	20.4	•	•		0.125	0.125
23-Aug	235	2.496	44.6573	-87.9110	427770	4945071	21.41	•	20.4	•	•		0.188	0.188
23-Aug	235	2.583	44.6578	-87.8908	429369	4945109	23.01	•	20.5	•	•		0.170	0.170
23-Aug	235	0.248	44.6580	-87.8455	432964	4945090	26.61	•	20.6	•	•		0.093	0.093
23-Aug	235	0.366	44.6582	-87.8178	435158	4945086	28.80	•	20.5	•	•		0.098	0.098
23-Aug	235	0.491	44.6578	-87.7890	437444	4945026	31.09	•	20.4	•	•		0.080	0.080
23-Aug	235	0.612	44.6583	-87.7622	439571	4945061	33.21	•	20.3	•	•		0.077	0.077
23-Aug	235	0.742	44.6768	-87.7748	438587	4947125	35.50	•	20.4	•	•		0.059	0.059
23-Aug	235	0.841	44.6915	-87.7843	437849	4948763	37.30	•	20.3	•	•		0.044	0.044
23-Aug	235	0.937	44.7057	-87.7940	437099	4950343	39.05	•	20.1	•	•		0.035	0.035
23-Aug	235	1.041	44.7208	-87.8047	436270	4952036	40.93	•	20.3	•	•		0.028	0.028
23-Aug	235	1.155	44.7373	-87.8167	435338	4953878	43.00	•	20.3	•	•		0.025	0.025
23-Aug	235	1.368	44.7685	-87.8388	433619	4957359	46.88	•	20.3	•	•		0.044	0.044
23-Aug	235	1.469	44.7845	-87.8423	433360	4959140	48.68	•	20.3	•	•		0.042	0.042
23-Aug	235	1.574	44.7982	-87.8565	432256	4960669	50.56	•	20.3	•	•		0.055	0.055
23-Aug	235	1.716	44.7980	-87.8330	434115	4960632	52.42	•	20.4	•	•		0.052	0.052
23-Aug	235	1.799	44.7952	-87.8147	435560	4960301	53.90	•	20.4	•	•		0.045	0.045
23-Aug	235	1.903	44.7952	-87.7903	437486	4960282	55.83	•	20.2	•	•		0.039	0.039
23-Aug	235	2.045	44.7948	-87.7585	440004	4960221	58.35	•	20.1	•	•		0.030	0.030
23-Aug	235	0.333	44.7942	-87.7438	441163	4960137	59.51	•	19.8	•	•		0.033	0.033
23-Aug	235	0.480	44.7943	-87.7097	443865	4960130	62.21	•	19.7	•	•		0.042	0.042
23-Aug	235	0.564	44.7960	-87.6965	444909	4960308	63.27	•	19.7	•	•		0.039	0.039
23-Aug	235	0.668	44.8098	-87.7107	443801	4961853	65.17	•	19.8	•	•		0.035	0.035
23-Aug	235	0.772	44.8238	-87.7248	442695	4963418	67.09	•	19.9	•	•		0.028	0.028
23-Aug	235	0.863	44.8358	-87.7372	441732	4964760	68.74	•	19.8	•	•		0.028	0.028

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
23-Aug	235	0.956	44.8485	-87.7495	440771	4966177	70.45	*	19.6	*	*		0.025	0.025
23-Aug	235	1.063	44.8633	-87.7635	439680	4967834	72.44	*	19.4	*	*		0.031	0.031
23-Aug	235	1.172	44.8783	-87.7775	438590	4969510	74.44	*	19.8	*	*		0.117	0.117
23-Aug	235	1.263	44.8903	-87.7900	437615	4970853	76.10	*	19.9	*	*		0.136	0.136
23-Aug	235	1.362	44.9002	-87.7993	436889	4971953	77.41	*	19.9	*	*		0.207	0.207
23-Aug	235	1.460	44.9012	-87.7768	438666	4972047	79.20	*	19.9	*	*		0.164	0.164
23-Aug	235	1.531	44.9020	-87.7607	439943	4972128	80.47	*	19.7	*	*		0.097	0.097
23-Aug	235	1.661	44.9033	-87.7303	442340	4972253	82.87	*	19.6	*	*		0.053	0.053
23-Aug	235	1.744	44.9040	-87.7113	443840	4972315	84.38	*	19.6	*	*		0.045	0.045
23-Aug	235	1.843	44.9007	-87.6928	445298	4971931	85.88	*	19.5	*	*		0.049	0.049
23-Aug	235	1.937	44.8928	-87.6815	446186	4971053	87.13	*	19.6	*	*		0.034	0.034
23-Aug	235	2.060	44.8963	-87.6532	448425	4971423	89.40	*	19.4	*	*		0.030	0.030
23-Aug	235	2.156	44.8990	-87.6310	450179	4971707	91.18	*	19.2	*	*		0.027	0.027
23-Aug	235	2.277	44.9022	-87.6032	452378	4972042	93.40	*	19.4	*	*		0.026	0.026
23-Aug	235	2.379	44.9047	-87.5798	454223	4972306	95.27	*	19.5	*	*		0.027	0.027
23-Aug	235	2.512	44.9080	-87.5495	456620	4972660	97.69	*	19.5	*	*		0.029	0.029
23-Aug	235	2.601	44.9103	-87.5290	458240	4972907	99.33	*	19.1	*	*		0.028	0.028
23-Aug	235	2.722	44.9135	-87.5010	460453	4973246	101.57	*	18.9	*	*		0.027	0.027
23-Aug	235	2.833	44.9157	-87.4760	462428	4973474	103.56	*	18.8	*	*		0.030	0.030
23-Aug	235	2.958	44.9107	-87.4502	464463	4972907	105.67	*	18.9	*	*		0.030	0.030
23-Aug	235	3.056	44.8997	-87.4333	465786	4971678	107.47	*	19.1	*	*		0.035	0.035
23-Aug	235	3.148	44.8893	-87.4178	467004	4970523	109.15	*	18.8	*	*		0.042	0.042
23-Aug	235	3.243	44.8755	-87.4137	467324	4968986	110.72	*	18.8	*	*		0.117	0.117
23-Aug	235	3.344	44.8603	-87.4028	468172	4967296	112.61	*	18.9	*	*		0.161	0.161
23-Aug	235	3.454	44.8447	-87.3905	469139	4965551	114.61	*	18.7	*	*		0.617	0.617
23-Aug	235	3.548	44.8342	-87.3815	469844	4964382	115.97	*	19.1	*	*		1.083	1.083
23-Aug	235	3.640	44.8295	-87.3807	469907	4963864	116.50	*	19.0	*	*		1.445	1.445
13-Sep	256	*	44.5203	-88.0122	419560	4929949	*	*	22.1	*	*	*	4.798	4.798
13-Sep	256	*	44.5203	-88.0122	419560	4929949	*	*	22.1	*	*	*	4.856	4.856
13-Sep	256	*	44.6580	-87.8830	429991	4945122	*	*	19.4	*	*	*	0.136	0.136
13-Sep	256	*	44.7940	-87.7580	440043	4960129	*	*	19.5	*	*	*	0.055	0.055
14-Sep	257	*	45.1992	-87.2585	479696	5004891	*	*	18.5	*	*	*	0.018	0.018
14-Sep	257	*	45.2000	-87.4460	464970	5005048	*	*	18.6	*	*	*	0.020	0.020
14-Sep	257	*	45.2000	-87.4460	464970	5005048	*	*	18.6	*	*	*	0.031	0.031

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
15-Sep	258	•	45.0198	-87.4453	464912	4985033	•	•	18.8	•	•	•	0.029	0.029
15-Sep	258	•	44.9280	-87.5710	454939	4974894	•	•	19.3	•	•	•	0.022	0.022
25-Oct	298	*0.243*	44.5195	-88.0143	419387	4929859	0.00	12.3	11.9	567.2	556.7	1.020	1.020	
25-Oct	298	*0.325*	44.5195	-88.0143	419387	4929859	0.00	12.3	11.9	778.5	764.2	1.400	1.399	2.247
25-Oct	298	*0.534*	44.5197	-88.0142	419400	4929876	0.02	12.3	11.9	886.2	869.9	1.594	1.593	1.717
25-Oct	298	*0.691*	44.5263	-88.0088	419833	4930611	0.87	12.4	12.0	1089.5	1069.5	1.953	1.953	2.301
25-Oct	298	*1.007*	44.5572	-87.9948	420987	4934023	4.48	10.3	9.8	172.7	169.6	0.326	0.326	
25-Oct	298	*1.105*	44.5690	-87.9875	421586	4935331	5.92	11.2	10.7	145.2	142.6	0.269	0.269	0.168
25-Oct	298	*1.230*	44.5807	-87.9792	422262	4936618	7.37	11.8	11.4	118.5	116.3	0.216	0.215	0.146
25-Oct	298	*1.337*	44.5908	-87.9592	423864	4937728	9.32	12.1	11.7	98.6	96.8	0.178	0.178	0.119
25-Oct	298	*1.438*	44.6098	-87.9383	425542	4939819	12.00	12.2	11.8	73.8	72.5	0.133	0.133	0.055
25-Oct	298	*1.558*	44.6353	-87.9148	427439	4942631	15.39	12.3	11.8	57.2	56.2	0.103	0.103	0.061
25-Oct	298	*1.686*	44.6482	-87.9255	426609	4944066	17.05	12.3	11.9	27.7	27.2	0.050	0.050	
25-Oct	298	*1.862*	44.6587	-87.9405	425433	4945246	18.71	12.2	11.8	19.5	19.2	0.035	0.035	0.023
25-Oct	298	*1.919*	44.6578	-87.9230	426820	4945137	20.10	12.3	11.9	17.3	16.9	0.031	0.031	0.017
25-Oct	298	*1.981*	44.6570	-87.9025	428444	4945028	21.73	12.4	12.0	21.5	21.1	0.039	0.039	0.062
25-Oct	298	*2.051*	44.6585	-87.8830	429992	4945178	23.29	12.5	12.1	21.0	20.6	0.038	0.038	0.035
25-Oct	298	*2.602*	44.6585	-87.8830	429992	4945178	23.29	12.4	12.0	20.7	20.3	0.037	0.037	
25-Oct	298	*0.204*	44.6580	-87.8500	432608	4945094	25.91	12.5	12.0	15.8	15.5	0.028	0.028	
25-Oct	298	*0.283*	44.6590	-87.8320	434036	4945191	27.34	12.4	12.0	11.7	11.5	0.021	0.021	0.004
25-Oct	298	*0.318*	44.6590	-87.8240	434670	4945184	27.97	12.4	12.0	17.9	17.7	0.032	0.032	0.100
25-Oct	298	*0.652*	44.6660	-87.7670	439197	4945918	32.56	11.4	11.0	26.7	26.3	0.049	0.049	
25-Oct	298	*0.758*	44.6820	-87.7770	438421	4947702	34.50	11.9	11.5	24.7	24.3	0.045	0.045	0.038
25-Oct	298	*0.844*	44.6940	-87.7860	437720	4949042	36.01	12.2	11.8	22.9	22.5	0.041	0.041	0.034
25-Oct	298	*0.908*	44.7040	-87.7920	437256	4950158	37.22	12.3	11.9	21.9	21.6	0.040	0.040	0.034
25-Oct	298	*0.973*	44.7130	-87.7990	436711	4951163	38.37	12.4	12.0	21.8	21.4	0.039	0.039	0.038
25-Oct	298	*1.068*	44.7250	-87.8080	436011	4952503	39.88	12.6	12.2	22.8	22.5	0.041	0.041	0.044
25-Oct	298	*1.126*	44.7330	-87.8140	435545	4953396	40.89	12.7	12.3	22.4	22.0	0.040	0.040	0.037
25-Oct	298	*1.183*	44.7420	-87.8190	435159	4954400	41.96	12.7	12.4	21.4	21.1	0.038	0.038	0.032
25-Oct	298	*1.266*	44.7540	-87.8270	434539	4955739	43.44	12.8	12.4	23.8	23.5	0.042	0.042	0.052
25-Oct	298	*1.318*	44.7610	-87.8330	434073	4956522	44.35	12.9	12.5	24.9	24.5	0.044	0.044	0.051
25-Oct	298	*1.374*	44.7690	-87.8380	433686	4957414	45.32	12.9	12.5	26.6	26.1	0.047	0.047	0.058
25-Oct	298	*1.439*	44.7790	-87.8450	433144	4958531	46.56	12.8	12.4	30.2	29.7	0.054	0.054	0.073
25-Oct	298	*1.491*	44.7870	-87.8500	432757	4959424	47.53	12.7	12.3	32.0	31.5	0.057	0.057	0.070

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
25-Oct	298	1.576	44.7990	-87.8580	432138	4960763	49.01	12.5	12.1	29.4	28.9	0.053	0.053	0.043
25-Oct	298	1.726	44.7980	-87.8290	434431	4960628	51.31	12.4	12.0	25.2	24.8	0.045	0.045	0.038
25-Oct	298	1.806	44.7970	-87.8100	435933	4960502	52.81	12.7	12.3	25.4	25.0	0.045	0.045	0.046
25-Oct	298	1.866	44.7970	-87.7960	437040	4960491	53.92	13.0	12.6	27.9	27.5	0.050	0.050	0.063
25-Oct	298	1.920	44.7960	-87.7840	437988	4960371	54.88	13.1	12.7	30.7	30.2	0.054	0.054	0.072
25-Oct	298	1.979	44.7950	-87.7710	439015	4960250	55.91	13.1	12.7	30.0	29.5	0.053	0.053	0.048
25-Oct	298	2.408	44.7940	-87.7580	440043	4960129	56.95	13.1	12.7	28.5	28.1	0.050	0.050	0.050
25-Oct	298	0.426	44.8040	-87.7050	444244	4961202	61.28	12.7	12.3	33.6	33.1	0.060	0.060	
25-Oct	298	0.488	44.8110	-87.7130	443619	4961985	62.28	12.8	12.4	35.8	35.2	0.064	0.064	0.075
25-Oct	298	0.546	44.8180	-87.7200	443072	4962768	63.24	12.9	12.5	36.8	36.3	0.066	0.066	0.072
25-Oct	298	0.624	44.8280	-87.7290	442370	4963885	64.56	12.9	12.5	36.2	35.6	0.064	0.064	0.061
25-Oct	298	0.689	44.8360	-87.7370	441746	4964779	65.65	12.9	12.5	37.2	36.6	0.066	0.066	0.071
25-Oct	298	0.792	44.8490	-87.7490	440811	4966232	67.38	13.0	12.6	40.7	40.0	0.072	0.072	0.083
25-Oct	298	0.927	44.8660	-87.7660	439485	4968133	69.69	13.0	12.6	45.9	45.2	0.081	0.081	0.093
25-Oct	298	0.993	44.8740	-87.7740	438862	4969028	70.79	12.9	12.5	45.4	44.7	0.081	0.081	0.079
25-Oct	298	1.063	44.8830	-87.7830	438160	4970034	72.01	12.4	12.0	36.8	36.2	0.066	0.066	0.027
25-Oct	298	1.130	44.8910	-87.7920	437458	4970930	73.15	12.3	11.9	32.4	31.9	0.059	0.059	0.037
25-Oct	298	1.192	44.8990	-87.7990	436914	4971824	74.20	12.5	12.1	31.3	30.8	0.056	0.056	0.049
25-Oct	298	1.259	44.8990	-87.7900	437625	4971817	74.91	12.6	12.2	33.6	33.1	0.060	0.060	0.071
25-Oct	298	1.336	44.8980	-87.7720	439045	4971692	76.33	12.9	12.5	41.1	40.4	0.073	0.073	0.105
25-Oct	298	1.389	44.8970	-87.7600	439991	4971572	77.29	13.0	12.6	47.6	46.9	0.085	0.084	0.128
25-Oct	298	1.437	44.8970	-87.7490	440860	4971564	78.16	13.0	12.7	53.2	52.3	0.094	0.094	0.135
25-Oct	298	1.491	44.8960	-87.7370	441806	4971445	79.11	13.0	12.7	64.2	63.2	0.114	0.114	0.186
25-Oct	298	1.540	44.8950	-87.7250	442753	4971325	80.06	13.0	12.6	64.9	63.9	0.115	0.115	0.120
25-Oct	298	1.620	44.8930	-87.7070	444172	4971090	81.50	13.0	12.6	65.0	64.0	0.115	0.115	0.116
25-Oct	298	1.730	44.8930	-87.6810	446225	4971073	83.56	12.9	12.5	29.5	29.0	0.052	0.052	
25-Oct	298	1.803	44.8950	-87.6650	447491	4971284	84.84	12.9	12.5	30.6	30.1	0.054	0.054	0.060
25-Oct	298	1.864	44.8960	-87.6500	448676	4971386	86.03	13.0	12.6	34.0	33.4	0.060	0.060	0.079
25-Oct	298	1.930	44.8980	-87.6350	449862	4971599	87.23	12.9	12.5	38.6	38.0	0.069	0.069	0.093
25-Oct	298	1.993	44.8990	-87.6210	450968	4971701	88.34	12.9	12.6	40.7	40.0	0.072	0.072	0.083
25-Oct	298	2.073	44.9010	-87.6030	452391	4971913	89.78	13.0	12.6	44.0	43.3	0.078	0.078	0.091
25-Oct	298	2.169	44.9030	-87.5810	454130	4972122	91.53	12.9	12.5	49.1	48.3	0.087	0.087	0.105
25-Oct	298	2.189	44.9040	-87.5760	454525	4972230	91.94	12.8	12.4	51.7	50.9	0.092	0.092	0.142
25-Oct	298	2.273	44.9060	-87.5570	456027	4972442	93.46	12.9	12.6	30.3	29.9	0.054	0.054	
25-Oct	298	2.351	44.9080	-87.5390	457449	4972655	94.90	13.1	12.7	28.4	28.0	0.050	0.050	0.042
25-Oct	298	2.446	44.9110	-87.5170	459188	4972977	96.67	13.1	12.7	33.1	32.6	0.059	0.059	0.074

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
25-Oct	298	2.602	44.9150	-87.4820	461954	4973404	99.46	13.0	12.6	29.5	29.1	0.052	0.052	0.046
25-Oct	298	2.802	44.9050	-87.4410	465184	4972275	102.89	13.1	12.7	37.8	37.2	0.067	0.067	0.077
25-Oct	298	2.979	44.8840	-87.4140	467304	4969931	106.05	12.2	11.7	23.0	22.6	0.042	0.042	0.021
25-Oct	298	3.038	44.8740	-87.4110	467535	4968819	107.18	11.8	11.4	35.2	34.6	0.064	0.064	0.138
25-Oct	298	3.098	44.8650	-87.4060	467925	4967817	108.26	11.8	11.4	30.1	29.6	0.055	0.055	0.025
25-Oct	298	3.163	44.8560	-87.3990	468473	4966814	109.40	11.6	11.2	54.9	54.0	0.101	0.101	0.231
25-Oct	298	3.259	44.8420	-87.3880	469335	4965255	111.18	11.6	11.1	87.1	85.8	0.160	0.160	0.266
25-Oct	298	3.338	44.8330	-87.3800	469962	4964252	112.37	11.2	10.8	80.3	79.1	0.149	0.149	0.124
25-Oct	298	3.389	44.8300	-87.3790	470040	4963919	112.71	10.9	10.5	86.4	85.1	0.161	0.161	0.207
26-Oct	299	0.768	44.8940	-87.4150	467230	4971042	0.00	12.1	11.6	37.9	37.5	0.069	0.069	
26-Oct	299	0.959	44.9250	-87.4130	467406	4974485	3.45	12.7	12.3	30.3	30.0	0.054	0.054	0.044
26-Oct	299	1.084	44.9440	-87.4060	467969	4976593	5.63	12.6	12.2	33.5	33.2	0.060	0.060	0.068
26-Oct	299	1.156	44.9560	-87.4020	468291	4977924	7.00	12.7	12.3	29.7	29.4	0.053	0.053	0.036
26-Oct	299	1.228	44.9670	-87.3990	468534	4979145	8.24	12.7	12.3	29.3	29.0	0.053	0.053	0.050
26-Oct	299	1.324	44.9820	-87.3940	468936	4980809	9.96	12.8	12.4	29.3	29.0	0.053	0.053	0.052
26-Oct	299	1.397	44.9940	-87.3910	469179	4982141	11.31	12.8	12.4	30.0	29.7	0.054	0.054	0.057
26-Oct	299	1.504	45.0110	-87.3850	469661	4984027	13.26	13.0	12.6	27.1	26.9	0.048	0.048	0.040
26-Oct	299	1.586	45.0230	-87.3780	470219	4985358	14.70	13.0	12.7	27.1	26.8	0.048	0.048	0.048
26-Oct	299	1.768	45.0500	-87.3600	471650	4988351	18.02	13.2	12.8	30.6	30.3	0.054	0.054	0.059
26-Oct	299	1.839	45.0600	-87.3520	472285	4989459	19.29	13.2	12.9	26.6	26.3	0.047	0.047	0.028
26-Oct	299	1.931	45.0730	-87.3420	473079	4990899	20.94	13.2	12.8	22.6	22.4	0.040	0.040	0.026
26-Oct	299	2.015	45.0850	-87.3330	473793	4992230	22.45	13.0	12.6	21.9	21.7	0.039	0.039	0.037
26-Oct	299	2.081	45.0950	-87.3260	474348	4993338	23.69	13.1	12.7	20.5	20.3	0.037	0.037	0.029
26-Oct	299	2.213	45.1140	-87.3150	475222	4995445	25.97	12.9	12.6	17.9	17.7	0.032	0.032	0.026
26-Oct	299	2.286	45.1240	-87.3050	476013	4996553	27.33	12.9	12.5	12.6	12.5	0.022	0.022	
26-Oct	299	2.364	45.1350	-87.2960	476725	4997773	28.74	12.9	12.5	11.6	11.5	0.021	0.021	0.016
26-Oct	299	2.419	45.1430	-87.2910	477121	4998660	29.71	12.8	12.4	10.4	10.3	0.019	0.019	0.012
26-Oct	299	2.506	45.1560	-87.2840	477677	5000102	31.26	12.9	12.5	9.1	9.0	0.016	0.016	0.011
26-Oct	299	2.588	45.1690	-87.2770	478232	5001544	32.81	12.9	12.5	7.8	7.7	0.014	0.014	0.008
26-Oct	299	2.661	45.1800	-87.2700	478786	5002765	34.15	12.9	12.5	7.4	7.4	0.013	0.013	0.012
26-Oct	299	2.713	45.1880	-87.2660	479103	5003652	35.09	12.9	12.5	6.7	6.7	0.012	0.012	0.007
26-Oct	299	2.798	45.2000	-87.2580	479736	5004983	36.56	12.8	12.4	6.0	5.9	0.011	0.011	0.008
26-Oct	299	3.156	45.2000	-87.2570	479814	5004983	36.64	12.8	12.4	4.4	4.4	0.008	0.008	0.007
26-Oct	299	3.184	45.2000	-87.2570	479814	5004983	36.64	12.8	12.4	4.3	4.2	0.008	0.008	0.005
26-Oct	299	0.071	45.2020	-87.2610	479501	5005206	37.03	12.7	12.3	4.0	4.0	0.007	0.007	

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
26-Oct	299	0.151	45.2110	-87.2740	478483	5006209	38.45	12.7	12.3	3.7	3.7	0.007	0.007	0.006
26-Oct	299	0.229	45.2200	-87.2870	477466	5007213	39.88	12.5	12.1	4.5	4.5	0.008	0.008	0.011
26-Oct	299	0.332	45.2320	-87.3040	476136	5008551	41.77	12.5	12.1	4.5	4.5	0.008	0.008	
26-Oct	299	0.411	45.2410	-87.3170	475120	5009554	43.20	12.5	12.1	4.8	4.8	0.009	0.009	0.010
26-Oct	299	0.474	45.2480	-87.3280	474260	5010336	44.36	12.5	12.1	5.2	5.2	0.009	0.009	0.012
26-Oct	299	0.568	45.2590	-87.3440	473009	5011563	46.11	12.5	12.1	5.6	5.5	0.010	0.010	0.011
26-Oct	299	0.666	45.2700	-87.3600	471759	5012790	47.86	12.6	12.2	5.7	5.6	0.010	0.010	0.011
26-Oct	299	0.752	45.2800	-87.3740	470666	5013906	49.43	12.7	12.3	5.1	5.0	0.009	0.009	0.007
26-Oct	299	0.841	45.2840	-87.3860	469727	5014355	50.47	12.8	12.4	4.7	4.7	0.008	0.008	0.007
26-Oct	299	0.924	45.2720	-87.3950	469015	5013025	51.98	12.8	12.4	4.7	4.6	0.008	0.008	0.008
26-Oct	299	1.011	45.2590	-87.4030	468380	5011584	53.55	12.8	12.4	4.2	4.2	0.008	0.008	0.006
26-Oct	299	1.159	45.2370	-87.4170	467269	5009146	56.23	12.8	12.4	3.9	3.9	0.007	0.007	0.006
26-Oct	299	1.228	45.2270	-87.4170	467263	5008035	57.34	12.8	12.4	4.2	4.1	0.008	0.008	0.009
26-Oct	299	1.288	45.2180	-87.4320	466080	5007041	58.89	12.8	12.4	4.2	4.1	0.007	0.007	0.007
26-Oct	299	1.353	45.2090	-87 4330	465996	5006042	59.89	12.9	12.5	5.2	5.2	0.009	0.009	0.015
26-Oct	299	1.776	45.2000	-87.4450	465048	5005047	61.26	13.1	12.7	6.3	6.3	0.011	0.011	0.012
26-Oct	299	1.832	45.1830	-87.4450	465038	5003159	63.15	13.1	12.7	6.8	6.8	0.012	0.012	0.015
26-Oct	299	0.184	45.1800	-87.4460	464958	5002826	63.49	13.0	12.6	5.2	5.1	0.009	0.009	
26-Oct	299	0.243	45.1710	-87.4460	464952	5001826	64.49	13.0	12.6	5.8	5.7	0.010	0.010	0.014
26-Oct	299	0.352	45.1530	-87.4460	464941	4999826	66.49	13.0	12.6	8.2	8.2	0.015	0.015	
26-Oct	299	0.526	45.1240	-87.4460	464923	4996605	69.71	13.0	12.6	7.0	6.9	0.013	0.013	0.011
26-Oct	299	0.602	45.1120	-87.4460	464916	4995272	71.05	13.0	12.7	6.1	6.1	0.011	0.011	0.007
26-Oct	299	0.664	45.1020	-87.4460	464910	4994161	72.16	13.1	12.7	7.7	7.6	0.014	0.014	0.022
26-Oct	299	0.715	45.0930	-87.4460	464904	4993161	73.16	13.1	12.7	7.1	7.0	0.013	0.013	0.009
26-Oct	299	0.784	45.0820	-87.4460	464898	4991939	74.38	13.1	12.7	6.5	6.4	0.012	0.012	0.009
26-Oct	299	0.842	45.0720	-87.4470	464813	4990829	75.49	13.1	12.7	7.2	7.1	0.013	0.013	0.017
26-Oct	299	0.894	45.0640	-87.4470	464808	4989940	76.38	13.1	12.7	8.7	8.6	0.016	0.016	0.026
26-Oct	299	0.954	45.0540	-87.4470	464802	4988829	77.49	13.1	12.7	9.2	9.1	0.016	0.016	0.019
26-Oct	299	1.070	45.0350	-87.4470	464790	4986718	79.60	13.0	12.7	15.2	15.0	0.027	0.027	
26-Oct	299	1.161	45.0200	-87.4460	464860	4985052	81.27	13.1	12.7	23.6	23.4	0.042	0.042	0.072
26-Oct	299	1.222	45.0190	-87.4460	464859	4984941	81.38	13.1	12.7	26.8	26.5	0.048	0.048	0.066
26-Oct	299	1.271	45.0190	-87.4460	464859	4984941	81.38	13.1	12.7	27.8	27.5	0.050	0.049	0.057
26-Oct	299	1.325	45.0190	-87.4460	464859	4984941	81.38	13.1	12.7	28.4	28.1	0.051	0.051	0.054
26-Oct	299	1.389	45.0190	-87.4460	464859	4984941	81.38	13.1	12.7	28.0	27.8	0.050	0.050	0.048
26-Oct	299	1.449	45.0190	-87.4460	464859	4984941	81.38	13.1	12.7	29.7	29.4	0.053	0.053	0.063
26-Oct	299	1.516	45.0190	-87.4460	464859	4984941	81.38	13.1	12.7	31.4	31.1	0.056	0.056	0.064

1994 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
26-Oct	299	*1.710*	45.0050	-87.4420	465166	4983384	82.97	13.1	12.7	26.3	26.1	0.047	0.047	0.040
26-Oct	299	*1.792*	44.9920	-87.4390	465394	4981938	84.43	13.1	12.7	28.3	28.0	0.050	0.050	0.058
26-Oct	299	*1.875*	44.9780	-87.4360	465622	4980382	86.01	13.0	12.7	29.1	28.9	0.052	0.052	0.055
26-Oct	299	*1.978*	44.9620	-87.4320	465928	4978603	87.81	13.0	12.6	29.5	29.2	0.053	0.053	0.054
26-Oct	299	*2.079*	44.9450	-87.4280	466234	4976713	89.73	12.9	12.6	34.6	34.3	0.062	0.062	0.078
26-Oct	299	*2.172*	44.9300	-87.4250	466462	4975045	91.41	12.9	12.5	42.3	41.9	0.076	0.076	0.103
26-Oct	299	*2.283*	44.9120	-87.4220	466688	4973044	93.42	12.8	12.4	45.0	44.6	0.081	0.081	0.089
26-Oct	299	*2.385*	44.8960	-87.4180	466995	4971265	95.23	12.8	12.4	41.8	41.4	0.075	0.075	0.065
26-Oct	299	*2.488*	44.8790	-87.4140	467301	4969375	97.14	12.5	12.1	38.9	38.5	0.070	0.070	0.062
26-Oct	299	*2.558*	44.8680	-87.4080	467769	4968151	98.45	11.8	11.3	42.4	42.0	0.078	0.078	0.098
26-Oct	299	*2.631*	44.8570	-87.4010	468316	4966926	99.80	11.5	11.0	51.6	51.1	0.096	0.096	0.140
26-Oct	299	*2.700*	44.8480	-87.3930	468943	4965923	100.98	11.3	10.9	67.6	66.9	0.126	0.125	0.205
26-Oct	299	*2.773*	44.8390	-87.3850	469570	4964921	102.16	11.2	10.8	68.8	68.1	0.128	0.128	0.135
26-Oct	299	*2.849*	44.8340	-87.3810	469884	4964364	102.80	11.1	10.6	80.5	79.8	0.151	0.150	0.203

1995 METHANE DATA

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
18-Apr	108	*0.256*			470131	4963752	0.00	5.6	4.8	51.8	49.9	0.109	0.109	
18-Apr	108	*0.385*			469700	4964660	1.01	5.3	4.6	76.5	73.7	0.161	0.161	0.214
18-Apr	108	*0.538*			468956	4965923	2.47	5.0	4.2	66.0	63.5	0.141	0.141	0.125
18-Apr	108	*0.758*			467872	4967873	4.70	4.3	3.5	44.2	42.5	0.096	0.096	0.077
18-Apr	108	*0.887*			467314	4969375	6.31	4.4	3.6	35.6	34.2	0.077	0.077	0.059
18-Apr	108	*1.048*			467153	4971300	8.24	3.1	2.2	27.6	26.6	0.062	0.062	0.052
18-Apr	108	*1.173*			466624	4973545	10.54	3.2	2.3	26.7	25.7	0.060	0.060	0.058
18-Apr	108	*1.236*			466381	4974674	11.70	3.2	2.3	31.8	30.7	0.071	0.071	0.098
18-Apr	108	*1.440*			465782	4978399	15.47	3.1	2.2	27.0	26.0	0.061	0.061	0.056
19-Apr	109	*0.033*			470144	4963769	0.00	5.1	4.4	59.0	57.5	0.127	0.127	
19-Apr	109	*0.147*			469752	4964587	0.91	4.9	4.1	74.5	72.5	0.161	0.161	0.200
19-Apr	109	*0.313*			468943	4965979	2.52	4.9	4.2	75.7	73.7	0.163	0.163	0.165
19-Apr	109	*0.532*			467755	4968131	4.97	4.4	3.6	55.7	54.2	0.122	0.122	0.105
19-Apr	109	*0.607*			467495	4969243	6.12	3.9	3.1	45.6	44.3	0.101	0.101	0.062
19-Apr	109	*0.712*			467191	4971058	7.96	3.5	2.7	38.5	37.5	0.087	0.087	0.069
19-Apr	109	*0.849*			466690	4973468	10.42	3.4	2.6	37.3	36.3	0.084	0.084	0.082
19-Apr	109	*0.940*			466457	4975075	12.04	3.4	2.6	35.1	34.2	0.079	0.079	0.072
19-Apr	109	*1.086*			466100	4977651	14.64	3.4	2.5	38.1	37.1	0.086	0.086	0.091
19-Apr	109	*1.251*			465649	4980733	17.76	3.1	2.2	31.8	31.0	0.072	0.072	0.064
19-Apr	109	*1.702*			464993	4985569	22.64	3.1	2.2	19.4	18.9	0.044	0.044	0.042
19-Apr	109	*1.746*			465020	4985568	22.66	3.1	2.2	18.7	18.2	0.043	0.043	0.037
19-Apr	109	*1.843*			465006	4985551	22.69	3.1	2.2	18.4	17.9	0.042	0.042	0.041
19-Apr	109	*0.568*			470655	4991688	31.03	3.1	2.2	17.7	17.2	0.040	0.040	
19-Apr	109	*0.633*			471485	4992517	32.20	3.0	2.1	16.5	16.1	0.038	0.038	0.032
19-Apr	109	*0.681*			472090	4993126	33.06	3.0	2.1	15.5	15.1	0.035	0.035	0.028
19-Apr	109	*0.803*			473552	4994563	35.11	3.0	2.1	15.0	14.7	0.034	0.034	0.033
19-Apr	109	*0.919*			474974	4996131	37.23	3.1	2.2	11.0	10.8	0.025	0.025	0.015
19-Apr	109	*1.036*			476501	4997642	39.38	3.3	2.4	12.4	12.1	0.028	0.028	0.031
19-Apr	109	*1.252*			478191	5001118	43.24	3.1	2.2	10.1	9.9	0.023	0.023	0.021
19-Apr	109	*1.321*			478470	5002357	44.51	3.2	2.3	10.0	9.7	0.023	0.023	0.022
19-Apr	109	*2.009*			479932	5005018	47.55	3.1	2.3	4.7	4.6	0.011	0.011	0.010
19-Apr	109	*2.347*			479945	5005018	47.56	3.2	2.3	4.7	4.6	0.011	0.011	0.011
19-Apr	109	*0.273*			476553	5008251	52.25	3.0	2.1	5.8	5.7	0.013	0.013	
19-Apr	109	*0.413*			474676	5009945	54.77	3.0	2.1	9.8	9.6	0.023	0.023	0.030
19-Apr	109	*0.507*			473250	5009931	56.20	3.0	2.1	6.0	5.9	0.014	0.014	

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
19-Apr	109	*0.629*			471388	5008828	58.36	2.9	2.0	10.2	10.0	0.023	0.023	0.033
19-Apr	109	*0.679*			470626	5008369	59.25	2.9	2.0	7.0	6.9	0.016	0.016	
19-Apr	109	*0.814*			468540	5007102	61.69	2.9	2.0	9.4	9.2	0.022	0.022	0.026
19-Apr	109	*0.919*			466873	5006184	63.60	2.9	2.0	9.8	9.6	0.023	0.023	0.024
19-Apr	109	*1.033*			465140	5005138	65.62	2.9	2.0	9.8	9.6	0.023	0.023	0.023
19-Apr	109	*1.455*			465139	5005009	65.75	2.9	2.0	9.1	8.9	0.021	0.021	0.021
19-Apr	109	*0.168*			464757	5002140	68.64	2.9	2.0	10.2	10.0	0.023	0.023	
19-Apr	109	*0.288*			464522	4999920	70.88	2.9	2.0	9.8	9.7	0.023	0.023	0.022
19-Apr	109	*0.430*			464232	4997331	73.48	2.9	2.0	12.0	11.8	0.028	0.028	0.032
19-Apr	109	*0.520*			464039	4995683	75.14	2.9	2.0	13.2	12.9	0.030	0.030	0.034
19-Apr	109	*0.623*			463819	4993758	77.08	2.9	2.0	14.3	14.0	0.033	0.033	0.036
19-Apr	109	*0.725*			463702	4991870	78.97	2.9	2.0	15.2	14.9	0.035	0.035	0.038
19-Apr	109	*0.811*			463825	4990259	80.59	2.8	1.9	15.5	15.2	0.036	0.036	0.037
19-Apr	109	*0.895*			463829	4988703	82.14	2.9	2.0	15.4	15.1	0.035	0.035	0.035
19-Apr	109	*0.972*			463624	4987280	83.58	2.9	2.0	14.2	14.0	0.033	0.033	0.028
19-Apr	109	*1.081*			463061	4985302	85.64	2.9	2.0	14.1	13.8	0.033	0.033	0.032
19-Apr	109	*1.166*			462671	4983749	87.24	2.9	2.0	13.6	13.3	0.031	0.031	0.029
19-Apr	109	*1.264*			462266	4981936	89.09	2.9	2.0	12.3	12.1	0.028	0.028	0.024
19-Apr	109	*1.616*			459870	4979027	92.86	3.0	2.1	8.9	8.7	0.021	0.021	0.019
19-Apr	109	*1.697*			459117	4978327	93.89	3.1	2.2	9.0	8.8	0.021	0.021	0.021
19-Apr	109	*1.851*			456948	4976546	96.70	3.2	2.3	7.5	7.4	0.017	0.017	0.015
19-Apr	109	*1.949*			455480	4975296	98.63	4.0	3.2	7.6	7.5	0.017	0.017	0.017
19-Apr	109	*2.096*			454845	4974819	99.42	3.3	2.5	8.6	8.4	0.020	0.020	0.021
19-Apr	109	*0.218*			457487	4974543	102.08	3.0	2.1	6.7	6.6	0.015	0.015	
19-Apr	109	*0.374*			460235	4974192	104.85	3.2	2.3	12.4	12.2	0.028	0.028	0.037
19-Apr	109	*0.471*			461957	4973977	106.58	3.5	2.6	20.8	20.4	0.047	0.047	0.073
19-Apr	109	*0.581*			463929	4973761	108.57	3.7	2.9	29.7	29.2	0.067	0.067	0.090
19-Apr	109	*0.684*			465357	4972643	110.38	3.5	2.7	30.4	29.9	0.069	0.069	0.071
19-Apr	109	*0.783*			466680	4971434	112.17	3.5	2.6	27.7	27.2	0.063	0.063	0.055
19-Apr	109	*0.902*			467355	4969819	113.92	4.3	3.4	20.4	20.1	0.045	0.045	0.027
19-Apr	109	*0.979*			467468	4968632	115.11	4.1	3.3	20.6	20.3	0.046	0.046	0.047
19-Apr	109	*1.058*			468055	4967539	116.36	4.7	3.9	21.0	20.6	0.046	0.046	0.046
19-Apr	109	*1.149*			468760	4966313	117.77	4.7	3.9	26.9	26.5	0.059	0.059	0.079
19-Apr	109	*1.220*			469282	4965440	118.79	4.9	4.1	41.3	40.7	0.090	0.090	0.156
19-Apr	109	*1.292*			469713	4964698	119.65	5.1	4.4	66.3	65.2	0.144	0.144	0.256
19-Apr	109	*1.349*			470027	4964103	120.32	5.1	4.3	84.8	83.6	0.184	0.184	0.295

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
20-Apr	110	*1.001*	44.9222	-87.4643	463352	4974191	0.000	3.6	2.8	14.3	14.1	0.032	0.032	
20-Apr	110	*1.073*	44.9160	-87.4794	462157	4973518	1.37	3.6	2.7	19.4	19.1	0.044	0.044	0.066
20-Apr	110	*1.414*	44.8867	-87.5503	456538	4970290	7.85	3.7	2.9	18.1	17.8	0.041	0.041	0.040
20-Apr	110	*1.507*	44.8778	-87.5688	455070	4969318	9.61	3.6	2.7	21.7	21.4	0.049	0.049	0.061
20-Apr	110	*1.607*	44.8690	-87.5888	453483	4968350	11.47	3.7	2.8	24.4	24.0	0.055	0.055	0.063
20-Apr	110	*1.708*	44.8600	-87.6095	451844	4967362	13.39	4.0	3.2	27.9	27.5	0.062	0.062	0.072
20-Apr	110	*1.798*	44.8522	-87.6280	450375	4966502	15.09	4.0	3.2	29.2	28.8	0.065	0.065	0.070
20-Apr	110	*1.972*	44.8325	-87.6597	447854	4964338	18.41	4.1	3.2	29.1	28.7	0.065	0.065	0.065
20-Apr	110	*2.102*	44.8172	-87.6820	446076	4962649	20.86	4.4	3.6	28.6	28.1	0.063	0.063	0.061
20-Apr	110	*2.227*	44.8022	-87.7033	444374	4960997	23.23	4.5	3.7	27.2	26.8	0.060	0.060	0.057
20-Apr	110	*2.362*	44.7857	-87.7260	442565	4959180	25.80	4.5	3.7	27.0	26.5	0.060	0.060	0.059
20-Apr	110	*2.532*	44.7652	-87.7543	440302	4956923	28.99	4.4	3.6	26.3	25.8	0.058	0.058	0.057
20-Apr	110	*2.650*	44.7505	-87.7733	438783	4955309	31.21	4.7	3.9	23.4	23.0	0.051	0.051	0.044
20-Apr	110	*2.759*	44.7375	-87.7913	437344	4953878	33.24	4.6	3.8	21.0	20.6	0.046	0.046	0.040
20-Apr	110	*2.886*	44.7230	-87.8132	435599	4952285	35.60	4.4	3.6	21.1	20.8	0.047	0.047	0.047
20-Apr	110	*3.009*	44.7092	-87.8348	433868	4950765	37.91	4.6	3.8	20.3	20.0	0.045	0.045	0.043
20-Apr	110	*3.126*	44.6952	-87.8540	432334	4949225	40.08	4.6	3.8	15.1	14.8	0.033	0.033	0.020
20-Apr	110	*3.255*	44.6795	-87.8745	430691	4947503	42.46	4.4	3.6	21.3	20.9	0.047	0.047	0.060
20-Apr	110	*3.367*	44.6640	-87.8890	429523	4945794	44.53	5.1	4.3	16.7	16.4	0.036	0.036	0.024
20-Apr	110	*3.456*	44.6518	-87.9002	428622	4944450	46.15	5.4	4.6	14.8	14.5	0.032	0.032	0.025
20-Apr	110	*3.579*	44.6348	-87.9157	427371	4942576	48.40	5.3	4.5	15.4	15.2	0.033	0.033	0.035
20-Apr	110	*3.679*	44.6208	-87.9283	426349	4941032	50.25	5.8	5.1	13.5	13.2	0.029	0.029	0.022
20-Apr	110	*3.824*	44.6008	-87.9467	424869	4938827	52.91	6.7	6.0	21.9	21.5	0.045	0.045	0.060
20-Apr	110	*3.897*	44.5918	-87.9572	424024	4937837	54.21	7.2	6.6	39.3	38.6	0.080	0.080	0.157
20-Apr	110	*3.967*	44.5857	-87.9705	422958	4937165	55.47	7.8	7.2	51.0	50.1	0.103	0.103	0.156
20-Apr	110	*4.069*	44.5738	-87.9847	421817	4935864	57.20	7.5	6.9	63.5	62.3	0.129	0.129	0.167
20-Apr	110	*4.222*	44.5510	-87.9977	420753	4933341	59.94	8.8	8.2	148.6	145.8	0.291	0.291	0.436
20-Apr	110	*4.333*	44.5382	-88.0037	420259	4931921	61.44	13.0	12.6	259.0	254.1	0.458	0.457	0.716
20-Apr	110	*4.404*	44.5303	-88.0075	419945	4931054	62.36	8.8	8.3	314.8	308.9	0.617	0.617	0.997
20-Apr	110	*4.469*	44.5247	-88.0093	419791	4930427	63.01	8.8	8.3	352.7	346.1	0.691	0.691	0.887
20-Apr	110	*0.176*	44.5427	-88.0022	420385	4932419	65.09	10.0	9.5	414.9	407.2	0.789	0.789	
20-Apr	110	*0.265*	44.5525	-87.9972	420795	4933508	66.25	9.2	8.6	461.0	452.4	0.895	0.895	1.088
20-Apr	110	*0.356*	44.5625	-87.9918	421233	4934613	67.44	8.3	7.7	456.0	447.5	0.906	0.906	0.926
20-Apr	110	*0.481*	44.5758	-87.9837	421899	4936085	69.06	7.8	7.2	425.7	417.7	0.856	0.856	0.799
20-Apr	110	*0.632*	44.5868	-87.9687	423104	4937293	70.76	7.7	7.1	315.3	309.1	0.636	0.636	0.444

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
20-Apr	110	0.682	44.5890	-87.9632	423544	4937530	71.26	7.6	7.0	271.5	266.1	0.548	0.548	0.246
20-Apr	110	0.887	44.6102	-87.9380	425569	4939857	74.35	6.7	6.0	176.8	173.3	0.366	0.366	0.270
20-Apr	110	1.075	44.6367	-87.9138	427520	4942779	77.86	5.4	4.6	22.8	22.4	0.049	0.049	
20-Apr	110	1.166	44.6497	-87.9025	428435	4944213	79.56	5.2	4.5	20.0	19.6	0.043	0.043	0.034
20-Apr	110	1.269	44.6638	-87.8888	429535	4945774	81.47	5.3	4.6	17.3	16.9	0.037	0.037	0.029
20-Apr	110	1.450	44.6887	-87.8647	431480	4948512	84.83	4.4	3.6	13.8	13.5	0.030	0.030	0.026
20-Apr	110	1.575	44.7045	-87.8457	433004	4950256	87.15	4.4	3.6	13.6	13.3	0.030	0.030	0.030
20-Apr	110	1.672	44.7170	-87.8310	434181	4951632	88.96	4.7	4.0	12.6	12.3	0.027	0.027	0.024
20-Apr	110	1.881	44.7432	-87.7987	436769	4954513	92.83	4.4	3.6	14.7	14.5	0.032	0.032	0.035
20-Apr	110	2.058	44.7657	-87.7712	438970	4956991	96.14	4.4	3.6	14.8	14.5	0.033	0.033	0.033
20-Apr	110	2.108	44.7720	-87.7635	439585	4957690	97.07	4.3	3.5	15.3	15.0	0.034	0.034	0.038
20-Apr	110	2.744	44.8225	-87.6888	445540	4963246	105.22	3.8	3.0	14.6	14.3	0.033	0.033	0.033
20-Apr	110	2.842	44.8318	-87.6700	447038	4964269	107.03	4.0	3.2	19.2	18.9	0.043	0.043	0.057
20-Apr	110	2.918	44.8392	-87.6550	448230	4965075	108.47	4.1	3.2	21.7	21.2	0.048	0.048	0.058
20-Apr	110	3.071	44.8537	-87.6242	450679	4966667	111.39	4.1	3.3	23.3	22.8	0.052	0.052	0.054
20-Apr	110	3.193	44.8630	-87.5982	452741	4967689	113.69	4.1	3.2	25.0	24.5	0.056	0.056	0.059
20-Apr	110	3.292	44.8707	-87.5775	454381	4968528	115.54	4.1	3.3	26.5	26.0	0.059	0.059	0.063
20-Apr	110	3.394	44.8795	-87.5567	456032	4969498	117.45	3.6	2.7	27.9	27.3	0.063	0.063	0.068
20-Apr	110	3.491	44.8878	-87.5367	457618	4970412	119.28	3.8	3.0	28.1	27.6	0.063	0.063	0.063
20-Apr	110	3.588	44.8960	-87.5167	459203	4971310	121.10	3.8	2.9	29.7	29.1	0.067	0.067	0.072
20-Apr	110	3.698	44.9050	-87.4943	460973	4972299	123.13	3.8	2.9	31.8	31.2	0.071	0.071	0.077
20-Apr	110	3.856	44.9168	-87.4605	463652	4973596	126.11	4.2	3.3	34.7	34.0	0.077	0.077	0.081
20-Apr	110	3.991	44.9027	-87.4358	465590	4972013	128.61	3.8	2.9	33.0	32.4	0.074	0.074	0.072
20-Apr	110	4.116	44.8890	-87.4145	467267	4970486	130.88	4.4	3.6	28.5	28.0	0.063	0.063	0.052
20-Apr	110	4.201	44.8748	-87.4133	467351	4968911	132.46	4.3	3.5	26.4	25.9	0.058	0.058	0.051
20-Apr	110	4.302	44.8598	-87.4025	468199	4967240	134.33	4.8	4.0	25.2	24.7	0.055	0.055	0.050
20-Apr	110	4.457	44.8437	-87.3897	469203	4965440	136.39	5.2	4.5	37.7	36.9	0.081	0.081	0.101
20-Apr	110	4.532	44.8378	-87.3847	469595	4964789	137.15	5.3	4.5	57.9	56.8	0.125	0.125	0.211
22-May	142	0.112	44.5207	-88.0105	419693	4929985	0	17.7	17.5	933.0	919.2	1.491	1.490	
22-May	142	0.312	44.5207	-88.0105	419693	4929985	0.00	17.7	17.5	941.4	927.4	1.505	1.503	1.514
22-May	142	0.665	44.5207	-88.0105	419693	4929985	0.00	17.8	17.6	1359.5	1339.4	2.169	2.166	2.380
22-May	142	0.333	44.5537	-87.9963	420864	4933636	3.83	17.6	17.4	877.5	862.8	1.403	1.401	
22-May	142	0.438	44.5703	-87.9870	421628	4935479	5.83	15.6	15.3	679.9	668.5	1.135	1.134	0.650
22-May	142	0.017	44.5920	-87.9560	424117	4937856	9.27	15.1	14.8	285.8	281.0	0.483	0.482	
22-May	142	0.033	44.6157	-87.9462	424928	4940476	12.01	14.5	14.2	164.0	161.2	0.281	0.281	

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
22-May	142	0.248	44.6517	-87.9458	425002	4944474	16.01	14.5	14.2	74.7	73.4	0.128	0.128	0.027
22-May	142	0.025	44.6592	-87.9077	428037	4945273	19.15	12.9	12.6	43.6	42.8	0.077	0.077	
22-May	142	0.125	44.6588	-87.8830	429992	4945215	21.11	12.8	12.5	26.0	25.5	0.046	0.046	
22-May	142	0.290	44.6588	-87.8828	430006	4945214	21.12	12.7	12.4	18.5	18.2	0.033	0.033	0.021
22-May	142	0.018	44.6748	-87.8595	431874	4946972	23.69	12.5	12.2	11.5	11.3	0.021	0.021	
22-May	142	0.025	44.6977	-87.8270	434476	4949482	27.30	12.4	12.0	15.5	15.2	0.028	0.028	
22-May	142	0.017	44.7138	-87.8037	436342	4951259	29.88	12.3	11.9	15.4	15.0	0.028	0.028	
22-May	142	0.006	44.7350	-87.7733	438768	4953587	33.24	13.0	12.7	21.3	20.9	0.038	0.038	
22-May	142	0.088	44.7433	-87.7612	439739	4954503	34.58	13.5	13.2	23.3	22.8	0.041	0.041	0.047
22-May	142	0.198	44.7568	-87.7425	441231	4955989	36.68	13.9	13.6	20.1	19.7	0.035	0.035	0.025
22-May	142	0.288	44.7665	-87.7290	442309	4957054	38.20	13.9	13.6	21.7	21.3	0.038	0.038	0.044
22-May	142	0.362	44.7760	-87.7153	443400	4958099	39.71	13.8	13.5	22.1	21.7	0.038	0.038	0.040
22-May	142	0.427	44.7830	-87.7047	444250	4958869	40.86	13.6	13.3	21.7	21.3	0.038	0.038	0.036
22-May	142	0.083	44.8480	-87.6053	452163	4966027	51.52	13.6	13.3	28.0	27.5	0.049	0.049	
22-May	142	0.123	44.8665	-87.5695	455009	4968061	55.02	13.4	13.1	29.2	28.6	0.051	0.051	
22-May	142	0.055	44.8825	-87.5375	457549	4969821	58.11	12.0	11.6	28.8	28.2	0.052	0.052	
22-May	142	0.032	44.8967	-87.5060	460047	4971379	61.06	11.4	11.0	30.4	29.8	0.056	0.056	
22-May	142	0.017	44.9090	-87.4808	462042	4972737	63.47	11.4	11.0	29.3	28.7	0.054	0.054	
22-May	142	0.028	44.9160	-87.4575	463888	4973504	65.47	10.6	10.2	28.4	27.8	0.053	0.053	
22-May	142	0.034	44.9005	-87.4327	465839	4971771	68.08	11.9	11.5	25.4	24.9	0.046	0.046	
22-May	142	0.132	44.8890	-87.4168	467083	4970487	69.87	10.5	10.0	25.1	24.6	0.047	0.047	0.049
22-May	142	0.213	44.8763	-87.4138	467313	4969079	71.29	12.5	12.2	25.0	24.5	0.045	0.045	0.039
22-May	142	0.290	44.8645	-87.4062	467911	4967761	72.74	13.1	12.8	28.6	28.1	0.050	0.050	0.065
22-May	142	0.455	44.8408	-87.3875	469374	4965125	75.76	14.1	13.8	121.7	119.3	0.210	0.210	0.362
22-May	142	0.537	44.8343	-87.3820	469805	4964401	76.60	13.9	13.6	397.0	389.2	0.687	0.687	1.805
22-May	142	0.627	44.8280	-87.3782	470104	4963696	77.36	13.5	13.2	594.7	582.9	1.039	1.038	1.763
22-May	142	0.787	44.8278	-87.3782	470104	4963678	77.38	13.5	13.2	889.5	871.9	1.553	1.553	2.057
22-May	142	0.878	44.8278	-87.3782	470104	4963678	77.38	13.4	13.1	971.2	952.0	1.700	1.699	1.994
23-May	143	0.691			468184	4967222	0.00	12.6	12.3	275.3	269.3	0.490	0.490	
23-May	143	0.817			467341	4969411	2.35	12.0	11.6	156.8	153.4	0.283	0.283	0.016
23-May	143	0.990			465814	4972011	5.36	12.0	11.6	77.5	75.8	0.140	0.140	0.021
23-May	143	1.141			463599	4973652	8.12	10.6	10.2	43.5	42.6	0.081	0.081	0.025
23-May	143	1.330			460191	4973526	11.53	10.4	10.0	31.5	30.8	0.059	0.059	0.044
23-May	143	1.444			458111	4973390	13.61	10.6	10.2	27.8	27.2	0.052	0.052	0.042
23-May	143	1.495			457178	4973323	14.55	10.5	10.1	28.8	28.2	0.054	0.054	0.061

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
23-May	143	1.631			454675	4973136	17.06	10.8	10.4	26.9	26.3	0.050	0.050	0.045
23-May	143	1.724			452965	4973019	18.77	11.0	10.6	26.3	25.7	0.049	0.049	0.046
23-May	143	1.866			450358	4972835	21.39	10.8	10.4	24.7	24.2	0.046	0.046	0.043
23-May	143	2.037			447198	4972600	24.55	11.2	10.8	23.1	22.6	0.042	0.042	0.040
23-May	143	2.131			445460	4972486	26.30	11.6	11.2	21.6	21.1	0.039	0.039	0.034
23-May	143	2.409			440337	4972087	31.43	12.3	11.9	26.1	25.6	0.047	0.047	0.050
23-May	143	2.487			438929	4971971	32.85	12.5	12.2	26.7	26.1	0.048	0.048	0.050
23-May	143	2.575			437284	4971987	34.49	12.7	12.4	25.5	24.9	0.045	0.045	0.040
23-May	143	2.672			437287	4971078	35.40	13.1	12.8	22.9	22.4	0.040	0.040	0.031
23-May	143	2.823			438872	4968768	38.20	13.4	13.1	30.5	29.9	0.053	0.053	0.067
23-May	143	2.955			440315	4966792	40.65	11.8	11.4	24.1	23.6	0.044	0.044	0.032
23-May	143	3.092			441850	4964723	43.23	11.7	11.3	22.1	21.6	0.040	0.040	0.036
23-May	143	3.194			442930	4963138	45.14	11.6	11.2	23.5	23.0	0.043	0.043	0.047
23-May	143	3.329			444322	4961035	47.67	11.9	11.5	25.1	24.6	0.046	0.045	0.049
23-May	143	3.424			445025	4960009	48.91	13.2	12.9	26.8	26.3	0.047	0.047	0.050
23-May	143	3.504			443745	4960002	50.19	12.8	12.5	28.5	27.9	0.051	0.050	0.058
23-May	143	3.649			441084	4960175	52.86	11.0	10.6	26.2	25.6	0.048	0.048	0.046
23-May	143	3.734			439462	4960190	54.48	11.2	10.8	26.7	26.1	0.049	0.049	0.051
23-May	143	3.817			437908	4960316	56.04	11.3	10.9	25.9	25.4	0.048	0.048	0.044
23-May	143	3.916			436065	4960556	57.90	12.6	12.3	24.9	24.3	0.044	0.044	0.038
23-May	143	4.008			434365	4960702	59.60	13.1	12.8	23.9	23.4	0.042	0.042	0.038
23-May	143	4.128			432243	4960762	61.72	13.7	13.4	18.6	18.3	0.032	0.032	0.018
23-May	143	4.259			432649	4959203	63.34	13.3	13.0	16.5	16.1	0.029	0.029	0.024
23-May	143	4.402			433850	4956782	66.04	12.5	12.2	15.6	15.3	0.028	0.028	0.027
23-May	143	4.546			435105	4954363	68.76	11.4	11.0	17.0	16.6	0.031	0.031	0.035
23-May	143	4.655			435972	4952503	70.82	11.7	11.3	19.2	18.8	0.035	0.035	0.041
23-May	143	4.753			436668	4950810	72.65	12.3	11.9	21.0	20.5	0.038	0.038	0.042
23-May	143	4.834			437381	4949452	74.18	12.5	12.2	22.1	21.6	0.039	0.039	0.044
23-May	143	4.986			438717	4946977	76.99	13.4	13.1	20.2	19.8	0.035	0.035	0.031
23-May	143	5.126			439636	4944949	79.22	14.2	13.9	19.7	19.2	0.034	0.034	0.032
23-May	143	5.213			438697	4944922	80.16	14.0	13.7	18.7	18.3	0.032	0.032	0.029
23-May	143	5.296			437205	4944972	81.65	14.0	13.7	18.5	18.1	0.032	0.032	0.031
23-May	143	5.419			434946	4944977	83.91	13.6	13.3	17.4	17.0	0.030	0.030	0.028
23-May	143	5.607			431498	4945106	87.36	12.6	12.3	14.6	14.3	0.026	0.026	0.023
23-May	143	0.028			430371	4946080	88.85	12.5	12.2	13.8	13.5	0.025	0.025	
23-May	143	0.108			431243	4947293	90.34	12.2	11.8	15.0	14.7	0.027	0.027	0.032

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
23-May	143	0.317			433508	4950435	94.22	12.0	11.6	16.3	16.0	0.029	0.029	0.031
23-May	143	0.423			434607	4952072	96.19	11.8	11.4	18.9	18.5	0.034	0.034	0.042
23-May	143	0.559			435974	4954149	98.68	11.5	11.1	19.7	19.3	0.036	0.036	0.038
23-May	143	0.656			436927	4955695	100.49	11.8	11.4	20.0	19.5	0.036	0.036	0.037
23-May	143	0.805			438532	4957995	103.30	11.1	10.7	18.5	18.1	0.034	0.034	0.032
23-May	143	1.009			439977	4960221	105.95	11.3	10.9	21.9	21.5	0.040	0.040	0.044
23-May	143	1.694			440070	4960202	106.05	11.3	10.9	29.1	28.5	0.054	0.054	0.054
23-May	143	0.066			440056	4960220	106.07	11.5	11.1	23.6	23.1	0.043	0.043	
23-May	143	0.188			440364	4960662	106.61	11.5	11.1	23.2	22.7	0.042	0.042	0.041
23-May	143	0.325			442185	4962478	109.18	11.5	11.1	24.4	23.9	0.045	0.045	0.047
23-May	143	0.393			443090	4963379	110.46	11.7	11.3	25.4	24.9	0.046	0.046	0.051
23-May	143	0.493			444406	4964680	112.31	11.9	11.5	23.1	22.6	0.042	0.042	0.034
23-May	143	0.625			446211	4966369	114.78	12.3	11.9	26.0	25.5	0.047	0.047	0.053
23-May	143	0.753			447963	4968021	117.19	12.0	11.6	22.4	21.9	0.040	0.040	0.032
23-May	143	0.833			449078	4969085	118.73	11.5	11.1	23.6	23.2	0.043	0.043	0.050
23-May	143	0.978			450989	4971034	121.46	10.9	10.5	23.2	22.7	0.043	0.043	0.043
23-May	143	1.087			452447	4972448	123.49	10.8	10.4	22.1	21.7	0.041	0.041	0.038
23-May	143	1.163			453507	4973404	124.92	11.0	10.6	22.9	22.4	0.042	0.042	0.045
23-May	143	1.677			454964	4974949	127.04	10.6	10.2	26.6	26.1	0.050	0.050	
23-May	143	1.677			454964	4974949	127.04	10.5	10.1	27.0	26.4	0.051	0.051	
23-May	143	0.176			456489	4974678	128.59	10.3	9.9					
23-May	143	0.398			460602	4974079	132.74	9.9	9.5	15.3	14.9	0.029	0.029	
23-May	143	0.524			462942	4973749	135.11	9.6	9.2	16.2	15.9	0.031	0.031	0.033
23-May	143	0.774			466638	4971081	139.67	11.9	11.5	20.9	20.4	0.038	0.038	0.041
23-May	143	0.871			467342	4969597	141.31	12.3	11.9	25.8	25.3	0.046	0.046	0.062
23-May	143	0.946			467676	4968262	142.68	12.1	11.7	36.5	35.8	0.066	0.066	0.114
23-May	143	1.033			468367	4966815	144.29	12.8	12.5	38.3	37.6	0.068	0.068	0.073
23-May	143	1.166			469556	4964865	146.57	13.4	13.1	185.7	182.0	0.325	0.325	0.648
23-May	143	1.253			469923	4964215	147.32	13.1	12.8	286.7	281.0	0.505	0.505	0.887
23-May	143	1.333			470078	4963696	147.86	13.1	12.8	348.3	341.4	0.614	0.614	0.867
23-May	143	1.513			470104	4963696	147.89	13.0	12.7	432.6	424.5	0.765	0.765	0.889
24-May	144	0.086			469034	4965756	0.00	12.9	12.6	286.7	282.4	0.510	0.510	
24-May	144	0.217			467885	4967797	2.34	12.2	11.8	201.9	199.0	0.365	0.365	0.187
24-May	144	0.363			467292	4970393	5.00	12.3	11.9	111.5	109.9	0.201	0.201	0.027
24-May	144	0.486			466962	4972579	7.21	11.4	11.0	74.3	73.2	0.137	0.137	0.053

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
24-May	144	0.617			466540	4974951	9.62	11.7	11.3	51.9	51.1	0.095	0.095	0.044
24-May	144	0.744			466158	4977286	11.99	11.5	11.1	39.3	38.7	0.072	0.072	0.044
24-May	144	0.855			465826	4979325	14.06	9.3	8.9	30.8	30.3	0.060	0.060	0.042
24-May	144	0.977			465457	4981549	16.31	8.8	8.4	26.8	26.4	0.053	0.053	0.044
24-May	144	1.061			465216	4983068	17.85	8.5	8.0	23.6	23.2	0.047	0.047	0.035
24-May	144	1.175			464859	4984976	19.79	8.5	8.0	20.1	19.8	0.040	0.040	0.031
24-May	144	0.177			464871	4989662	24.48	8.6	8.1	13.2	13.0	0.026	0.026	
24-May	144	0.259			464879	4991197	26.01	8.4	7.9	13.6	13.4	0.027	0.027	0.029
24-May	144	0.329			464913	4992530	27.34	8.4	7.9	12.8	12.6	0.025	0.025	0.021
24-May	144	0.421			464935	4994234	29.05	9.1	8.7	12.1	11.9	0.024	0.024	0.021
24-May	144	0.518			464906	4996067	30.88	9.5	9.1	12.4	12.3	0.024	0.024	0.025
24-May	144	0.604			464863	4997678	32.49	9.7	9.3	13.3	13.1	0.026	0.026	0.028
24-May	144	0.725			464928	4999973	34.79	9.6	9.2	13.7	13.5	0.026	0.026	0.028
24-May	144	0.832			464978	5002010	36.83	9.9	9.5	13.4	13.2	0.026	0.026	0.024
24-May	144	0.939			464989	5004028	38.84	9.6	9.2	13.5	13.4	0.026	0.026	0.027
24-May	144	1.027			465022	5005103	39.92	9.4	9.0	12.1	11.9	0.023	0.023	0.018
24-May	144	0.218			466994	5009054	44.34	9.4	9.0	6.5	6.4	0.013	0.013	
24-May	144	0.299			467693	5010383	45.84	9.5	9.1	6.8	6.8	0.013	0.013	0.014
24-May	144	0.426			468816	5012489	48.22	9.2	8.8	7.7	7.6	0.015	0.015	0.017
24-May	144	0.522			469647	5014058	50.00	9.4	9.0	7.5	7.4	0.015	0.015	0.014
24-May	144	0.768			472189	5012473	53.00	8.3	7.8	6.7	6.7	0.013	0.013	0.013
24-May	144	0.857			473374	5011284	54.67	9.6	9.2	6.8	6.7	0.013	0.013	0.013
24-May	144	1.091			476514	5008272	59.02	9.4	9.0	8.3	8.2	0.016	0.016	0.018
24-May	144	1.172			477491	5007137	60.52	10.9	10.5	9.9	9.8	0.018	0.018	0.024
24-May	144	1.304			479266	5005485	62.95	11.3	10.9	12.4	12.2	0.023	0.023	0.028
24-May	144	1.438			479670	5004872	63.68	11.2	10.8	14.2	14.0	0.026	0.026	0.030
24-May	144	1.596			479630	5004890	63.72	11.3	10.9	15.7	15.4	0.029	0.029	0.031
24-May	144	2.391			479315	5004374	64.33	11.3	10.9	15.7	15.5	0.029	0.029	0.029
24-May	144	2.481			478563	5002856	66.02	10.5	10.1	15.1	14.9	0.029	0.029	0.028
24-May	144	2.592			477731	5000935	68.12	10.8	10.4	15.1	14.9	0.028	0.028	0.028
24-May	144	2.670			477373	4999492	69.60	11.3	10.9	15.5	15.2	0.029	0.029	0.029
24-May	144	2.752			476817	4998106	71.10	11.4	11.0	16.2	16.0	0.030	0.030	0.033
24-May	144	2.817			475910	4997294	72.31	11.4	11.0	16.7	16.4	0.031	0.031	0.033
24-May	144	2.864			475227	4996685	73.23	11.6	11.2	16.6	16.4	0.030	0.030	0.029
24-May	144	2.947			474121	4995596	74.78	10.8	10.4	16.9	16.7	0.032	0.032	0.034
24-May	144	3.042			472948	4994233	76.58	10.8	10.4	16.8	16.6	0.031	0.031	0.031

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
24-May	144	*3.146*			471774	4992718	78.50	10.7	10.3	17.2	16.9	0.032	0.032	0.034
24-May	144	*3.288*			470661	4990355	81.11	11.1	10.7	18.5	18.2	0.034	0.034	0.037
24-May	144	*3.406*			469825	4988321	83.31	11.4	11.0	19.0	18.7	0.035	0.035	0.036
24-May	144	*3.491*			469254	4986842	84.89	11.2	10.8	19.4	19.2	0.036	0.036	0.038
24-May	144	*3.604*			468548	4984884	86.97	11.0	10.6	20.2	19.9	0.038	0.038	0.040
24-May	144	*0.016*			468119	4983015	88.89	11.2	10.8	20.8	20.6	0.039	0.039	
24-May	144	*0.092*			468007	4981609	90.30	11.1	10.7	21.2	20.9	0.039	0.039	0.041
24-May	144	*0.241*			467835	4978871	93.05	11.7	11.3	21.5	21.2	0.039	0.039	0.039
24-May	144	*0.337*			467708	4977112	94.81	11.8	11.4	21.4	21.1	0.039	0.039	0.039
24-May	144	*0.406*			467623	4975817	96.11	11.9	11.5	21.6	21.3	0.039	0.039	0.040
24-May	144	*0.474*			467537	4974557	97.37	11.6	11.2	22.4	22.1	0.041	0.041	0.046
24-May	144	*0.542*			467400	4973281	98.65	12.0	11.6	23.2	22.8	0.042	0.042	0.045
24-May	144	*0.632*			467194	4971653	100.29	12.5	12.2	24.2	23.9	0.044	0.043	0.046
24-May	144	*0.724*			467250	4970004	101.94	12.7	12.4	27.4	27.0	0.049	0.049	0.060
24-May	144	*0.794*			467429	4968726	103.23	12.7	12.4	31.6	31.2	0.057	0.057	0.078
24-May	144	*0.935*			468654	4966369	105.89	13.6	13.3	53.2	52.5	0.093	0.093	0.136
24-May	144	*1.026*			469413	4965106	107.36	13.5	13.2	94.3	93.0	0.166	0.166	0.314
24-May	144	*1.093*			469818	4964382	108.19	13.4	13.1	155.0	152.9	0.273	0.273	0.581
24-May	144	*1.155*			470026	4963937	108.69	13.4	13.1	199.5	196.7	0.351	0.351	0.602
24-May	144	*1.232*			470104	4963696	108.94	13.5	13.2	326.5	322.0	0.574	0.573	1.124
18-Jul	199	*0.161*	44.8202	-87.3572	471760	4962818	0.00	22.0	21.8	122.9	120.2	0.179	0.179	
18-Jul	199	*0.236*	44.8173	-87.3502	472312	4962500	0.64	22.0	21.8	273.3	267.4	0.398	0.397	0.910
18-Jul	199	*0.287*	44.8152	-87.3453	472694	4962258	1.09	22.0	21.8	291.4	285.0	0.424	0.423	0.332
18-Jul	199	*0.343*	44.8122	-87.3405	473075	4961923	1.60	22.0	21.8	344.1	336.6	0.502	0.501	0.812
18-Jul	199	*0.397*	44.8092	-87.3360	473430	4961589	2.08	22.1	21.9	456.7	446.8	0.664	0.663	1.328
18-Jul	199	*0.475*	44.8048	-87.3297	473927	4961105	2.78	22.3	22.1	414.6	405.6	0.600	0.599	0.242
18-Jul	199	*0.525*	44.8018	-87.3252	474282	4960770	3.27	22.1	21.9	398.0	389.3	0.579	0.578	0.536
18-Jul	199	*0.591*	44.7980	-87.3197	474715	4960344	3.87	21.9	21.7	351.3	343.6	0.512	0.511	0.290
18-Jul	199	*0.642*	44.7950	-87.3153	475057	4960009	4.35	21.9	21.7	359.6	351.8	0.525	0.524	0.650
18-Jul	199	*0.696*	44.7920	-87.3108	475412	4959675	4.84	21.9	21.7	361.0	353.2	0.527	0.526	0.523
18-Jul	199	*0.743*	44.7888	-87.3072	475700	4959320	5.30	21.0	20.8	351.5	343.9	0.522	0.521	0.492
18-Jul	199	*0.808*	44.7890	-87.3022	476096	4959339	5.69	19.4	19.1	274.9	268.9	0.422	0.421	0.077
18-Jul	199	*0.883*	44.7925	-87.2962	476572	4959726	6.31	18.3	18.0	114.6	112.1	0.180	0.180	
18-Jul	199	*0.942*	44.7952	-87.2917	476929	4960020	6.77	18.4	18.1	65.5	64.0	0.102	0.102	0.049
18-Jul	199	*1.053*	44.7907	-87.2837	477560	4959518	7.57	18.4	18.1	42.1	41.2	0.066	0.066	0.077

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
18-Jul	199	1.106	44.7875	-87.2798	477862	4959166	8.04	18.4	18.2	38.6	37.8	0.060	0.060	0.073
18-Jul	199	1.178	44.7832	-87.2760	478164	4958683	8.61	18.6	18.3	29.8	29.1	0.046	0.046	0.009
18-Jul	199	1.231	44.7800	-87.2723	478453	4958331	9.06	18.6	18.4	28.4	27.8	0.044	0.044	0.049
18-Jul	199	1.282	44.7767	-87.2688	478729	4957959	9.53	18.7	18.4	25.3	24.7	0.039	0.039	0.019
18-Jul	199	1.361	44.7718	-87.2693	478687	4957421	10.07	18.7	18.4	20.2	19.8	0.031	0.031	0.015
18-Jul	199	1.549	44.7598	-87.2837	477548	4956092	11.82	18.6	18.4	46.5	45.5	0.072	0.072	0.118
18-Jul	199	1.647	44.7605	-87.2907	476994	4956170	12.38	18.5	18.2	29.4	28.8	0.046	0.046	
18-Jul	199	1.724	44.7655	-87.2948	476667	4956726	13.02	18.5	18.2	32.6	31.9	0.051	0.051	0.091
18-Jul	199	1.790	44.7698	-87.2983	476392	4957207	13.58	18.7	18.4	56.5	55.3	0.088	0.088	0.208
18-Jul	199	1.856	44.7743	-87.3018	476116	4957708	14.15	18.7	18.4	89.3	87.4	0.139	0.139	0.275
18-Jul	199	1.900	44.7773	-87.3042	475933	4958042	14.53	18.6	18.4	111.1	108.7	0.173	0.173	0.301
18-Jul	199	1.978	44.7827	-87.3083	475606	4958636	15.21	18.9	18.6	152.1	148.8	0.236	0.235	0.378
18-Jul	199	2.066	44.7883	-87.3067	475739	4959265	15.85	19.6	19.3	144.8	141.7	0.221	0.221	0.122
18-Jul	199	2.113	44.7910	-87.3097	475503	4959563	16.23	20.0	19.8	185.8	181.8	0.282	0.281	0.602
18-Jul	199	2.163	44.7940	-87.3137	475188	4959898	16.69	21.7	21.5	311.4	304.6	0.456	0.455	1.257
18-Jul	199	2.213	44.7972	-87.3182	474833	4960250	17.19	21.9	21.7	346.3	338.8	0.506	0.505	0.575
18-Jul	199	2.279	44.8012	-87.3240	474375	4960696	17.83	21.8	21.6	350.4	342.8	0.512	0.511	0.485
18-Jul	199	2.338	44.8048	-87.3295	473942	4961105	18.42	21.9	21.7	351.2	343.6	0.513	0.512	0.508
18-Jul	199	2.388	44.8077	-87.3337	473614	4961421	18.88	21.9	21.7	347.8	340.3	0.507	0.506	0.477
18-Jul	199	2.447	44.8112	-87.3333	473641	4961810	19.27	22.0	21.8	394.0	385.4	0.574	0.573	0.854
18-Jul	199	2.515	44.8150	-87.3388	473208	4962238	19.88	21.9	21.7	402.3	393.6	0.587	0.586	0.565
18-Jul	199	2.658	44.8200	-87.3588	471630	4962797	21.55	21.9	21.7	328.9	321.8	0.480	0.479	0.312
18-Jul	199	2.735	44.8223	-87.3646	471176	4963063	22.08	22.0	21.8	228.4	223.5	0.333	0.332	
18-Jul	199	2.827	44.8252	-87.3694	470799	4963377	22.57	21.9	21.7	177.8	173.9	0.259	0.259	0.224
18-Jul	199	2.876	44.8267	-87.3720	470596	4963547	22.83	21.9	21.7	160.0	156.5	0.234	0.233	0.177
18-Jul	199	2.944	44.8288	-87.3755	470317	4963779	23.20	21.8	21.6	160.4	156.9	0.234	0.234	0.262
18-Jul	199	3.011	44.8308	-87.3790	470040	4964010	23.56	21.8	21.6	154.6	151.2	0.226	0.225	0.194
18-Jul	199	3.080	44.8308	-87.3790	470040	4964010	23.56	21.9	21.7	148.4	145.2	0.217	0.216	0.192
19-Jul	200	1.576			449263	4964085	0	22.7	22.5	19.6	19.2	0.028	0.028	
19-Jul	200	1.627			448534	4963480	0.95	22.5	22.3	15.1	14.8	0.022	0.022	
19-Jul	200	1.686			447723	4962784	2.02	22.2	22.0	13.9	13.6	0.020	0.020	0.016
19-Jul	200	1.751			446808	4962032	3.20	21.9	21.7	11.7	11.5	0.017	0.017	0.011
19-Jul	200	1.817			445906	4961262	4.39	21.8	21.6	9.1	8.9	0.013	0.013	
19-Jul	200	1.895			444830	4960326	5.81	21.5	21.3	8.0	7.9	0.012	0.012	0.009
19-Jul	200	1.989			443528	4959209	7.53	21.7	21.5	7.3	7.2	0.011	0.011	0.009

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
19-Jul	200	*2.178*			440948	4956917	10.98	22.3	22.1	10.0	9.8	0.015	0.015	0.016
19-Jul	200	*2.256*			439898	4955965	12.40	22.4	22.2	9.7	9.5	0.014	0.014	0.013
19-Jul	200	*2.343*			438752	4954845	14.00	22.4	22.2	9.6	9.4	0.014	0.014	0.014
19-Jul	200	*2.465*			437192	4953231	16.24	22.3	22.1	9.1	8.9	0.013	0.013	0.012
19-Jul	200	*2.746*			433762	4949395	21.39	21.9	21.7	6.9	6.7	0.010	0.010	0.009
19-Jul	200	*2.851*			432504	4947928	23.32	21.7	21.5	7.2	7.0	0.011	0.011	0.011
19-Jul	200	*3.013*			430565	4945689	26.28	21.7	21.5	8.1	8.0	0.012	0.012	0.013
19-Jul	200	*3.156*			428800	4943764	28.90	22.0	21.8	12.7	12.4	0.018	0.018	0.023
19-Jul	200	*3.356*			426362	4941052	32.54	22.9	22.7	31.5	30.8	0.045	0.045	0.057
19-Jul	200	*3.433*			425595	4939874	33.95	23.2	23.0	31.2	30.6	0.044	0.044	0.043
19-Jul	200	*3.518*			424707	4938589	35.51	23.4	23.2	53.0	51.9	0.075	0.075	0.123
19-Jul	200	*3.613*			423463	4937437	37.20	23.4	23.2	57.6	56.5	0.082	0.082	0.091
19-Jul	200	*3.800*			421382	4934889	40.49	23.8	23.6	108.3	106.1	0.153	0.152	0.189
19-Jul	200	*3.907*			420631	4933083	42.45	25.5	25.3	106.0	104.0	0.145	0.145	0.135
19-Jul	200	*3.986*			420274	4931921	43.67	26.5	26.3	113.2	111.0	0.152	0.152	0.165
19-Jul	200	*4.045*			420042	4931442	44.20	26.6	26.4	69.3	68.0	0.093	0.093	0.047
19-Jul	200	*4.124*			419834	4930666	45.00	26.5	26.3	46.3	45.4	0.062	0.062	
19-Jul	200	*4.223*			419494	4929893	45.85	26.6	26.4	30.4	29.8	0.041	0.041	
19-Jul	200	*4.317*			419439	4929858	45.91	26.5	26.3	21.4	20.9	0.029	0.029	
19-Jul	200	*0.129*			419835	4930722	46.86	26.4	26.2	37.5	36.8	0.051	0.050	
19-Jul	200	*0.210*			420056	4931572	47.74	26.3	26.1	40.2	39.4	0.054	0.054	0.060
19-Jul	200	*0.324*			420645	4933083	49.36	24.7	24.5	71.2	69.7	0.099	0.098	0.147
19-Jul	200	*0.406*			421204	4934465	50.85	24.4	24.2	51.8	50.7	0.072	0.072	
19-Jul	200	*0.460*			421599	4935349	51.82	23.8	23.6	94.5	92.5	0.133	0.133	0.298
19-Jul	200	*0.536*			422183	4936601	53.20	23.8	23.6	84.1	82.3	0.118	0.118	0.092
19-Jul	200	*0.602*			423210	4937256	54.42	23.5	23.3	53.1	51.9	0.075	0.075	
19-Jul	200	*0.719*			424801	4938626	56.52	23.4	23.2	43.8	42.9	0.062	0.062	0.049
19-Jul	200	*0.899*			425961	4941779	59.88	22.8	22.6	20.0	19.6	0.029	0.029	0.019
19-Jul	200	*0.966*			425630	4942984	61.13	22.8	22.6	13.1	12.9	0.019	0.019	
19-Jul	200	*1.093*			424996	4945178	63.41	22.7	22.5	11.6	11.4	0.017	0.017	0.015
19-Jul	200	*1.188*			426309	4945172	64.73	22.4	22.2	13.1	12.8	0.019	0.019	0.022
19-Jul	200	*1.251*			427172	4945168	65.59	22.3	22.1	13.1	12.9	0.019	0.019	0.019
19-Jul	200	*1.380*			428943	4945161	67.36	21.8	21.6	9.5	9.3	0.014	0.014	0.010
19-Jul	200	*1.444*			429821	4945157	68.24	21.8	21.6	8.8	8.6	0.013	0.013	0.011
19-Jul	200	*0.063*			433106	4944867	71.54	21.8	21.6	7.9	7.7	0.012	0.011	
19-Jul	200	*0.118*			434112	4944856	72.54	21.8	21.6	7.2	7.0	0.011	0.011	0.008

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
19-Jul	200	0.169			435064	4944882	73.49	22.0	21.8	9.4	9.2	0.014	0.014	0.023
19-Jul	200	0.229			436175	4944982	74.61	22.3	22.1	11.5	11.2	0.017	0.017	0.023
19-Jul	200	0.300			437484	4945101	75.92	22.7	22.5	14.2	13.9	0.020	0.020	0.027
19-Jul	200	0.402			439346	4944952	77.79	23.5	23.3	22.7	22.3	0.032	0.032	0.047
19-Jul	200	0.473			439730	4945170	78.23	23.5	23.3	40.8	39.9	0.058	0.058	0.107
19-Jul	200	0.558			439070	4946621	79.83	22.5	22.4	25.9	25.4	0.037	0.037	0.041
19-Jul	200	0.634			438475	4947886	81.23	22.3	22.1	19.4	19.0	0.028	0.028	
19-Jul	200	0.726			437764	4949431	82.93	22.1	21.9	12.7	12.4	0.018	0.018	0.007
19-Jul	200	0.865			436571	4951720	85.51	22.1	21.9	9.4	9.2	0.014	0.014	
19-Jul	200	0.949			435752	4953041	87.06	22.2	22.0	7.2	7.0	0.010	0.010	0.005
19-Jul	200	1.013			435129	4954029	88.23	22.1	21.9	8.6	8.4	0.013	0.013	0.017
19-Jul	200	1.114			434407	4955758	90.10	21.4	21.2	7.1	6.9	0.010	0.010	0.008
19-Jul	200	1.281			433025	4958532	93.20	21.5	21.3	8.6	8.4	0.013	0.013	0.014
19-Jul	200	1.324			432610	4959239	94.02	21.8	21.6	9.1	8.8	0.013	0.013	0.015
19-Jul	200	1.485			433345	4960286	95.30	21.6	21.4	13.1	12.8	0.019	0.019	
19-Jul	200	1.563			434808	4960216	96.77	21.7	21.5	17.2	16.8	0.025	0.025	0.035
19-Jul	200	1.697			437338	4960099	99.30	21.6	21.4	14.1	13.8	0.021	0.021	
19-Jul	200	2.069			440108	4960184	102.07	21.7	21.5	12.4	12.1	0.018	0.018	0.018
19-Jul	200	2.201			440083	4960184	102.10	21.7	21.5	11.8	11.5	0.017	0.017	0.016
19-Jul	200	0.026			440899	4960212	102.91	21.7	21.5	14.6	14.3	0.021	0.021	
19-Jul	200	0.086			441967	4960203	103.98	21.7	21.5	16.8	16.4	0.025	0.025	0.032
19-Jul	200	0.146			443074	4960157	105.09	21.5	21.3	16.9	16.4	0.025	0.025	0.025
19-Jul	200	0.239			444774	4960087	106.79	21.3	21.1	15.4	15.0	0.023	0.023	0.020
19-Jul	200	0.310			444766	4960642	107.35	21.4	21.2	12.2	11.9	0.018	0.018	0.009
19-Jul	200	0.372			444155	4961592	108.48	21.4	21.2	10.6	10.3	0.016	0.016	0.010
19-Jul	200	0.449			443401	4962783	109.88	21.3	21.1	13.3	13.0	0.020	0.020	0.026
19-Jul	200	0.520			442686	4963862	111.18	21.3	21.1	9.7	9.5	0.014	0.014	0.013
19-Jul	200	0.582			442048	4964795	112.31	21.3	21.1	10.0	9.8	0.015	0.015	0.016
19-Jul	200	0.696			440853	4966510	114.40	21.3	21.1	8.4	8.2	0.012	0.012	0.010
19-Jul	200	0.757			440202	4967422	115.52	21.2	21.0	7.1	6.9	0.010	0.010	0.006
19-Jul	200	0.869			439609	4968667	116.90	21.1	20.9	10.8	10.5	0.016	0.016	0.022
19-Jul	200	0.923			439614	4969223	117.46	21.1	20.9	12.0	11.7	0.018	0.018	0.022
19-Jul	200	1.052			438849	4970490	118.94	21.1	20.9	10.9	10.6	0.016	0.016	0.015
19-Jul	200	1.296			437518	4971707	120.74	20.9	20.7	19.0	18.5	0.028	0.028	0.032
19-Jul	200	1.383			439019	4971821	122.24	21.0	20.8	14.2	13.9	0.021	0.021	0.011
19-Jul	200	1.468			440587	4971973	123.82	21.1	20.9	8.7	8.5	0.013	0.013	

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
19-Jul	200	*1.607*			443142	4972228	126.39	21.2	21.0	12.7	12.3	0.019	0.019	0.018
19-Jul	200	*1.704*			444919	4972286	128.17	21.2	21.0	11.5	11.2	0.017	0.017	0.015
19-Jul	200	*1.987*			450107	4972688	133.37	21.1	20.9	16.1	15.7	0.024	0.024	0.025
19-Jul	200	*2.141*			452963	4972815	136.23	21.1	20.9	12.7	12.4	0.019	0.019	0.019
19-Jul	200	*2.308*			456017	4973033	139.29	21.0	20.8	15.2	14.8	0.022	0.022	0.025
19-Jul	200	*2.434*			458413	4973239	141.69	20.8	20.6	12.7	12.4	0.019	0.019	0.016
19-Jul	200	*2.533*			460243	4973505	143.54	20.8	20.6	7.8	7.6	0.012	0.012	0.008
19-Jul	200	*2.631*			462048	4973883	145.39	20.9	20.7	5.7	5.6	0.008	0.008	0.005
19-Jul	200	*2.807*			464898	4973165	148.33	21.9	21.7	11.2	10.9	0.016	0.016	0.020
19-Jul	200	*2.891*			465998	4972048	149.89	21.9	21.7	13.6	13.2	0.020	0.020	0.025
19-Jul	200	*3.009*			467345	4970355	152.06	22.0	21.8	13.6	13.2	0.020	0.020	0.020
19-Jul	200	*3.102*			467468	4968670	153.75	21.9	21.7	12.6	12.3	0.018	0.018	0.017
19-Jul	200	*3.164*			467937	4967612	154.90	21.8	21.6	12.9	12.5	0.019	0.019	0.020
19-Jul	200	*3.213*			468354	4966795	155.82	21.3	21.1	16.9	16.4	0.025	0.025	0.042
19-Jul	200	*3.296*			469099	4965514	157.30	21.4	21.2	139.6	135.9	0.205	0.204	0.479
19-Jul	200	*3.376*			469556	4964810	158.14	21.6	21.4	484.8	471.9	0.708	0.707	1.515
19-Jul	200	*3.506*			470013	4963825	159.23	21.3	21.1	810.9	789.2	1.191	1.189	1.589
25-Jul	206	*0.083*	44.8428	-87.3897	469202	4965347	0	23.2	23.0	815.1	795.8	1.159	1.156	
25-Jul	206	*0.138*	44.8468	-87.3930	468942	4965792	0.52	23.2	23.0	836.7	816.9	1.189	1.187	1.303
25-Jul	206	*0.203*	44.8523	-87.3977	468575	4966405	1.23	23.2	23.0	740.9	723.3	1.053	1.051	0.629
25-Jul	206	*0.280*	44.8623	-87.4053	467976	4967519	2.50	23.2	23.0	518.2	505.9	0.737	0.735	0.199
25-Jul	206	*0.422*	44.8838	-87.4135	467343	4969910	4.97	23.5	23.3	323.3	315.6	0.457	0.456	0.121
25-Jul	206	*0.516*	44.8985	-87.4125	467430	4971541	6.60	24.0	23.8	226.8	221.4	0.318	0.317	0.032
25-Jul	206	*0.569*	44.9070	-87.4122	467460	4972485	7.55	23.7	23.5	192.1	187.6	0.271	0.270	0.088
25-Jul	206	*0.657*	44.9213	-87.4102	467626	4974075	9.14	24.0	23.8	175.8	171.6	0.246	0.246	0.191
25-Jul	206	*0.708*	44.9297	-87.4087	467749	4975001	10.08	23.8	23.6	158.9	155.1	0.223	0.223	0.129
25-Jul	206	*0.777*	44.9408	-87.4068	467901	4976240	11.33	23.9	23.7	127.6	124.6	0.179	0.179	0.049
25-Jul	206	*0.853*	44.9533	-87.4053	468026	4977628	12.72	23.9	23.7	95.7	93.5	0.134	0.134	0.017
25-Jul	206	*1.066*	44.9877	-87.4040	468151	4981442	16.54	23.6	23.4	59.8	58.4	0.084	0.084	0.051
25-Jul	206	*1.184*	45.0068	-87.4033	468213	4983570	18.67	23.6	23.4	49.0	47.8	0.069	0.069	0.046
25-Jul	206	*1.276*	45.0215	-87.4018	468340	4985200	20.30	23.9	23.7	43.6	42.5	0.061	0.061	0.044
25-Jul	206	*1.336*	45.0303	-87.3968	468739	4986178	21.36	24.0	23.8	40.2	39.3	0.056	0.056	0.040
25-Jul	206	*1.376*	45.0363	-87.3933	469017	4986843	22.08	23.7	23.5	37.2	36.4	0.052	0.052	0.032
25-Jul	206	*1.456*	45.0475	-87.3850	469680	4988082	23.48	23.8	23.6	32.4	31.6	0.045	0.045	0.028
25-Jul	206	*1.556*	45.0617	-87.3837	469792	4989654	25.06	23.1	22.9	27.1	26.5	0.039	0.039	0.026

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
25-Jul	206	*1.738*	45.0735	-87.3720	470717	4990965	26.66	22.8	22.6	17.7	17.3	0.025	0.025	0.014
25-Jul	206	*1.826*	45.0773	-87.3583	471795	4991385	27.82	23.0	22.8	15.7	15.3	0.022	0.022	0.016
25-Jul	206	*0.209*	45.0320	-87.3878	469448	4986361	33.37	23.2	23.0	9.5	9.3	0.014	0.014	
25-Jul	206	*0.443*	44.9962	-87.4045	468116	4982386	37.56	23.0	22.8	10.5	10.3	0.015	0.015	
25-Jul	206	*0.508*	44.9855	-87.4058	468005	4981203	38.75	23.0	22.8	11.7	11.4	0.017	0.017	0.022
25-Jul	206	*0.576*	44.9747	-87.4065	467947	4979999	39.95	23.1	22.9	11.6	11.4	0.017	0.017	0.016
25-Jul	206	*0.654*	44.9618	-87.4073	467873	4978573	41.38	23.5	23.3	13.2	12.9	0.019	0.019	0.024
25-Jul	206	*0.827*	44.9335	-87.4092	467712	4975427	44.53	23.3	23.1	19.2	18.8	0.027	0.027	0.035
25-Jul	206	*1.001*	44.9047	-87.4118	467486	4972225	47.74	23.3	23.1	50.9	49.8	0.072	0.072	0.113
25-Jul	206	*1.119*	44.8858	-87.4133	467357	4970133	49.84	23.3	23.1	93.9	91.8	0.133	0.133	0.225
25-Jul	206	*1.270*	44.8625	-87.4053	467976	4967539	52.50	24.0	23.8	83.8	82.0	0.118	0.117	0.100
25-Jul	206	*1.371*	44.8480	-87.3940	468864	4965924	54.35	24.0	23.8	137.1	134.2	0.192	0.192	0.333
25-Jul	206	*1.493*	44.8367	-87.3843	469621	4964660	55.82	23.6	23.4	329.7	322.5	0.466	0.465	0.862
25-Jul	206	*1.563*	44.8317	-87.3805	469922	4964104	56.45	23.3	23.1	417.0	408.0	0.593	0.591	0.956
25-Jul	206	*1.618*	44.8283	-87.3795	470000	4963732	56.83	22.9	22.7	520.2	508.9	0.745	0.743	1.309
28-Jul	209	*0.283*	44.9315	-87.5358	457716	4975263	0	23.5	23.3	26.8	26.2	0.038	0.038	
28-Jul	209	*0.340*	44.9390	-87.5280	458340	4976093	1.04	23.5	23.3	24.2	23.7	0.034	0.034	0.018
28-Jul	209	*0.399*	44.9465	-87.5198	458989	4976922	2.09	23.4	23.2	21.0	20.5	0.030	0.030	0.011
28-Jul	209	*0.516*	44.9612	-87.5030	460328	4978542	4.19	23.3	23.1	16.2	15.8	0.023	0.023	0.010
28-Jul	209	*0.566*	44.9673	-87.4957	460909	4979222	5.09	23.4	23.2	14.7	14.4	0.021	0.021	0.010
28-Jul	209	*0.627*	44.9748	-87.4863	461651	4980051	6.20	23.5	23.3	10.6	10.3	0.015	0.015	
28-Jul	209	*0.742*	44.9813	-87.4773	462365	4980769	7.21	23.3	23.1	9.6	9.4	0.014	0.014	0.011
28-Jul	209	*1.147*	44.9873	-87.4702	462933	4981432	8.09	23.4	23.2	9.4	9.2	0.013	0.013	0.013
28-Jul	209	*1.200*	44.9937	-87.4620	463582	4982133	9.04	23.4	23.2	9.4	9.2	0.013	0.013	0.013
28-Jul	209	*1.271*	45.0020	-87.4510	464454	4983054	10.31	23.5	23.3	9.2	9.0	0.013	0.013	0.012
28-Jul	209	*1.334*	45.0095	-87.4413	465220	4983883	11.44	23.6	23.4	9.0	8.8	0.013	0.013	0.011
28-Jul	209	*1.512*	45.0322	-87.4165	467191	4986390	14.63	23.6	23.4	7.7	7.5	0.011	0.011	0.009
28-Jul	209	*1.596*	45.0432	-87.4048	468115	4987607	16.16	23.6	23.4	7.3	7.1	0.010	0.010	0.009
28-Jul	209	*1.689*	45.0550	-87.3925	469094	4988918	17.79	23.5	23.3	8.9	8.7	0.013	0.013	0.018
28-Jul	209	*2.213*	45.0622	-87.3917	469162	4989713	18.59	23.7	23.5	5.4	5.3	0.008	0.008	0.007
28-Jul	209	*2.279*	45.0705	-87.3818	469941	4990636	19.80	23.7	23.5	6.2	6.0	0.009	0.009	0.013
28-Jul	209	*2.404*	45.0860	-87.3627	471457	4992351	22.09	23.6	23.4	7.3	7.2	0.010	0.010	0.013
28-Jul	209	*2.491*	45.0967	-87.3488	472552	4993530	23.69	23.6	23.4	7.4	7.3	0.010	0.010	0.011
28-Jul	209	*2.601*	45.1098	-87.3313	473935	4994986	25.70	23.4	23.2	8.1	8.0	0.012	0.012	0.014
28-Jul	209	*2.703*	45.1222	-87.3147	475250	4996352	27.60	23.4	23.2	9.0	8.8	0.013	0.013	0.015

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
28-Jul	209	*2.773*	45.1307	-87.3038	476107	4997293	28.87	23.2	23.0	10.0	9.8	0.014	0.014	0.019
28-Jul	209	*2.861*	45.1420	-87.2913	477094	4998549	30.47	23.1	22.9	12.2	12.0	0.017	0.017	0.026
28-Jul	209	*2.983*	45.1607	-87.2807	477939	5000619	32.70	22.9	22.7	14.4	14.1	0.021	0.021	0.026
28-Jul	209	*3.117*	45.1807	-87.2670	479022	5002837	35.17	23.2	23.0	19.2	18.8	0.027	0.027	0.038
28-Jul	209	*3.231*	45.1938	-87.2540	480048	5004296	36.96	23.2	23.0	16.5	16.1	0.023	0.023	0.016
28-Jul	209	*0.088*	45.1793	-87.2215	482596	5002677	39.98							
28-Jul	209	*0.209*	45.1743	-87.2162	483013	5002121	40.67	22.7	22.5	31.4	30.7	0.045	0.045	
28-Jul	209	*0.335*	45.1750	-87.2158	483040	5002196	40.75	22.8	22.6	35.2	34.4	0.050	0.050	0.060
28-Jul	209	*0.464*	45.1743	-87.2147	483131	5002121	40.87	23.0	22.8	42.2	41.2	0.060	0.060	0.077
28-Jul	209	*0.523*	45.1742	-87.2077	483681	5002101	41.42	23.1	22.9	39.3	38.4	0.056	0.056	0.038
29-Aug	241	*0.356*	44.5373	-88.0047	420179	4931829	0	25.4	25.2	342.2	337.8	0.473	0.471	
29-Aug	241	*0.470*	44.5490	-87.9990	420646	4933121	1.37	24.7	24.5	394.0	389.0	0.551	0.549	0.710
29-Aug	241	*0.579*	44.5615	-87.9917	421244	4934502	2.88	24.3	24.1	406.1	400.9	0.572	0.570	0.616
29-Aug	241	*0.640*	44.5685	-87.9872	421611	4935275	3.73	24.5	24.3	427.8	422.4	0.600	0.599	0.718
29-Aug	241	*0.700*	44.5757	-87.9838	421886	4936067	4.57	23.8	23.6	425.9	420.5	0.605	0.604	0.625
29-Aug	241	*0.795*	44.5847	-87.9712	422903	4937055	5.99	23.5	23.3	399.7	394.5	0.571	0.570	0.485
29-Aug	241	*0.872*	44.5902	-87.9583	423929	4937654	7.18	23.5	23.3	382.3	377.4	0.546	0.545	0.467
29-Aug	241	*0.994*	44.6050	-87.9490	424690	4939294	8.99	23.5	23.3	352.6	348.1	0.504	0.503	0.425
29-Aug	241	*1.086*	44.6198	-87.9485	424749	4940939	10.63	23.5	23.3	301.2	297.3	0.430	0.429	0.241
29-Aug	241	*1.310*	44.6552	-87.9465	424953	4944863	14.56	23.1	22.9	194.0	191.5	0.279	0.279	0.157
29-Aug	241	*1.424*	44.6582	-87.9300	426265	4945181	15.91	23.3	23.1	110.4	109.0	0.158	0.158	
29-Aug	241	*1.519*	44.6573	-87.9090	427929	4945069	17.58	23.4	23.2	114.7	113.3	0.164	0.164	0.179
29-Aug	241	*1.603*	44.6578	-87.8902	429422	4945108	19.07	23.4	23.2	125.1	123.5	0.179	0.179	0.221
29-Aug	241	*1.760*	44.6577	-87.8843	429885	4945085	19.54	23.5	23.3	131.2	129.5	0.187	0.187	0.198
29-Aug	241	*0.080*	44.6577	-87.8740	430704	4945077	20.36	23.9	23.7	98.3	96.9	0.139	0.139	
29-Aug	241	*0.173*	44.6577	-87.8532	432355	4945059	22.01	23.9	23.7	92.0	90.7	0.130	0.130	0.107
29-Aug	241	*0.226*	44.6580	-87.8412	433307	4945087	22.96	24.0	23.8	96.8	95.4	0.137	0.137	0.168
29-Aug	241	*0.278*	44.6582	-87.8297	434219	4945095	23.87	24.0	23.8	101.2	99.8	0.143	0.143	0.174
29-Aug	241	*0.341*	44.6583	-87.8153	435356	4945102	25.01	24.0	23.8	104.8	103.4	0.148	0.148	0.169
29-Aug	241	*0.408*	44.6583	-87.8003	436545	4945090	26.20	24.2	24.0	106.5	105.0	0.150	0.150	0.156
29-Aug	241	*0.470*	44.6583	-87.7863	437655	4945079	27.31	24.5	24.3	110.3	108.8	0.155	0.154	0.173
29-Aug	241	*0.594*	44.6583	-87.7622	439571	4945061	29.22	24.2	24.0	142.8	140.9	0.201	0.201	0.286
29-Aug	241	*0.641*	44.6612	-87.7635	439469	4945377	29.56	24.2	24.0	160.5	158.3	0.226	0.226	0.365
29-Aug	241	*0.741*	44.6762	-87.7735	438692	4947051	31.40	24.5	24.3	154.0	151.9	0.216	0.215	0.191
29-Aug	241	*0.956*	44.7083	-87.7958	436956	4950640	35.39	23.9	23.7		0.0			

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
29-Aug	241	*1.033*	44.7195	-87.8043	436295	4951889	36.80	23.6	23.4	133.8	132.0	0.191	0.190	
29-Aug	241	*1.118*	44.7318	-87.8137	435569	4953265	38.36	23.7	23.5	122.4	120.7	0.174	0.174	0.127
29-Aug	241	*1.193*	44.7410	-87.8203	435052	4954290	39.51	23.3	23.1	118.2	116.5	0.169	0.169	0.153
29-Aug	241	*1.556*	44.7792	-87.8460	433065	4958549	44.21	23.4	23.2	94.3	93.0	0.135	0.135	0.122
29-Aug	241	*1.616*	44.7873	-87.8527	432546	4959461	45.26	23.2	23.0	90.3	89.0	0.130	0.129	0.107
29-Aug	241	*1.733*	44.7933	-87.8542	432434	4960129	45.93	23.2	23.0	91.2	89.9	0.131	0.131	0.133
29-Aug	241	*1.829*	44.7915	-87.8332	434093	4959910	47.61	23.3	23.1	100.0	98.6	0.143	0.143	0.173
29-Aug	241	*2.003*	44.7917	-87.7948	437126	4959897	50.64	23.2	23.0	96.0	94.7	0.138	0.138	0.131
29-Aug	241	*2.125*	44.7938	-87.7677	439277	4960116	52.80	23.2	23.0	86.4	85.2	0.124	0.124	0.099
29-Aug	241	*2.243*	44.7925	-87.7575	440081	4959962	53.62	23.3	23.1	74.9	73.8	0.107	0.107	0.075
29-Aug	241	*0.207*	44.8071	-87.7088	443945	4961549	57.80	23.3	23.1	43.5	42.9	0.062	0.062	0.119
29-Aug	241	*0.270*	44.8147	-87.7166	443339	4962395	58.84	23.1	22.9	40.7	40.1	0.058	0.058	0.043
29-Aug	241	*0.380*	44.8282	-87.7305	442254	4963909	60.70	23.0	22.8	36.2	35.7	0.052	0.052	0.039
29-Aug	241	*0.575*	44.8531	-87.7553	440317	4966691	64.09	23.0	22.8	32.1	31.6	0.046	0.046	0.040
29-Aug	241	*0.647*	44.8644	-87.7658	439497	4967958	65.60	23.1	22.9	38.2	37.7	0.055	0.055	0.085
29-Aug	241	*0.758*	44.8813	-87.7776	438585	4969846	67.70	22.8	22.6	58.3	57.5	0.084	0.084	0.143
29-Aug	241	*0.917*	44.8975	-87.7920	437468	4971653	69.82	22.9	22.7	64.1	63.2	0.093	0.092	0.096
29-Aug	241	*1.050*	44.8995	-87.8012	436743	4971881	70.58	23.0	22.8	75.1	74.0	0.108	0.108	0.133
29-Aug	241	*1.213*	44.8985	-87.7813	438308	4971755	72.15	23.0	22.8	74.3	73.3	0.107	0.107	0.105
29-Aug	241	*1.322*	44.8982	-87.7573	440203	4971699	74.05	23.0	22.8	72.4	71.4	0.104	0.104	0.098
29-Aug	241	*0.017*	44.8977	-87.7202	443136	4971619	76.98	22.9	22.7	71.8	70.8	0.104	0.103	
29-Aug	241	*0.133*	44.8983	-87.6940	445204	4971672	79.05	23.0	22.8	66.0	65.0	0.095	0.095	0.078
29-Aug	241	*0.372*	44.8995	-87.6412	449375	4971769	83.22	22.9	22.7	55.5	54.7	0.080	0.080	0.069
29-Aug	241	*0.463*	44.9008	-87.6213	450943	4971904	84.80	22.9	22.7	47.7	47.1	0.069	0.069	0.040
29-Aug	241	*0.568*	44.9033	-87.5987	452734	4972168	86.61	23.0	22.8	42.5	41.9	0.061	0.061	0.045
29-Aug	241	*0.043*	44.9078	-87.5698	455015	4972651	88.94	22.9	22.7	37.5	37.0	0.054	0.054	
29-Aug	241	*0.135*	44.9110	-87.5502	456569	4972994	90.53	22.8	22.6	34.5	34.0	0.050	0.050	0.039
29-Aug	241	*0.278*	44.9150	-87.5195	458994	4973422	92.99	22.9	22.7	31.4	31.0	0.045	0.045	0.039
29-Aug	241	*0.387*	44.9170	-87.4958	460863	4973633	94.87	22.9	22.7	31.4	31.0	0.045	0.045	0.045
29-Aug	241	*0.520*	44.9197	-87.4660	463220	4973914	97.25	22.6	22.4	32.8	32.3	0.048	0.047	0.051
29-Aug	241	*0.073*	44.9040	-87.4382	465406	4972162	100.05	22.3	22.1	31.4	30.9	0.046	0.046	
29-Aug	241	*0.158*	44.8947	-87.4240	466520	4971119	101.57	22.2	22.0	32.6	32.1	0.048	0.048	0.052
29-Aug	241	*0.262*	44.8817	-87.4137	467328	4969671	103.23	22.9	22.7	36.6	36.1	0.053	0.053	0.064
29-Aug	241	*0.417*	44.8585	-87.4022	468223	4967093	105.96	23.0	22.8	58.4	57.6	0.084	0.084	0.126
29-Aug	241	*0.023*	44.8467	-87.3923	468994	4965774	107.49	22.4	22.2	112.7	111.0	0.164	0.164	
29-Aug	241	*0.087*	44.8418	-87.3888	469268	4965235	108.09	22.4	22.2	282.9	278.7	0.412	0.411	1.366

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
29-Aug	241	*0.178*	44.8355	-87.3835	469687	4964531	108.91	22.5	22.3	542.2	534.2	0.788	0.786	1.737
29-Aug	241	*0.270*	44.8290	-87.3790	470039	4963808	109.72	22.6	22.4	824.6	812.4	1.196	1.193	2.227
29-Aug	241	*0.375*	44.8273	-87.3780	470118	4963621	109.92	22.6	22.4	1009.8	994.9	1.465	1.462	2.041
06-Oct	279	*0.158*	44.8450	-87.3908	469112	4965589	0	14.4	14.1	77.4	75.1	0.131	0.131	
06-Oct	279	*0.287*	44.8557	-87.3992	468459	4966777	1.36	14.8	14.5	100.0	97.0	0.168	0.168	0.218
06-Oct	279	*0.340*	44.8623	-87.4040	468082	4967518	2.19	14.9	14.6	92.0	89.3	0.154	0.154	0.100
06-Oct	279	*0.473*	44.8795	-87.4142	467287	4969431	4.26	14.8	14.5	77.3	75.0	0.130	0.130	0.097
06-Oct	279	*0.622*	44.9030	-87.4183	466972	4972043	6.89	15.2	14.9	63.2	61.3	0.105	0.105	0.077
06-Oct	279	*0.696*	44.9145	-87.4210	466767	4973322	8.18	15.2	14.9	61.6	59.8	0.102	0.102	0.095
06-Oct	279	*0.902*	44.9400	-87.4282	466214	4976154	11.07	15.2	14.9	62.7	60.9	0.104	0.104	0.106
06-Oct	279	*1.022*	44.9619	-87.4328	465865	4978587	13.53	15.2	14.9					
06-Oct	279	*1.053*	44.9674	-87.4340	465777	4979204	14.15	15.2	14.9	59.8	58.0	0.099	0.099	
06-Oct	279	*1.172*	44.9890	-87.4385	465433	4981603	16.57	15.3	15.0	59.7	57.9	0.099	0.099	0.098
06-Oct	279	*1.329*	45.0048	-87.4428	465099	4983364	18.37	15.2	14.9	44.6	43.3	0.074	0.074	0.048
06-Oct	279	*1.431*	45.0178	-87.4462	464844	4984810	19.84	15.2	14.9	35.4	34.4	0.059	0.059	0.030
06-Oct	279	*1.494*	45.0220	-87.4473	464755	4985274	20.31	15.2	14.9	34.3	33.3	0.057	0.057	0.051
06-Oct	279	*0.243*	45.0150	-87.4560	464069	4984501	21.34	15.2	14.9	14.4	14.0	0.024	0.024	
06-Oct	279	*0.314*	45.0067	-87.4675	463157	4983579	22.64	15.2	14.9	18.4	17.8	0.031	0.031	0.049
06-Oct	279	*0.511*	44.9838	-87.4982	460724	4981057	26.14	15.3	15.0	21.9	21.2	0.036	0.036	0.041
06-Oct	279	*0.568*	44.9772	-87.5072	460009	4980321	27.17	15.3	15.0	24.6	23.8	0.041	0.041	0.057
06-Oct	279	*0.779*	44.9517	-87.5395	457442	4977505	30.98	15.2	14.9	21.1	20.4	0.035	0.035	0.031
06-Oct	279	*0.871*	44.9407	-87.5540	456290	4976291	32.65	15.1	14.8	24.2	23.5	0.040	0.040	0.052
06-Oct	279	*1.077*	44.9268	-87.5722	454845	4974763	34.76	15.1	14.8	49.6	48.0	0.083	0.082	0.113
06-Oct	279	*1.207*	44.9263	-87.5750	454622	4974709	34.99	15.1	14.8	60.2	58.3	0.100	0.100	0.124
06-Oct	279	*0.136*	44.9238	-87.5555	456159	4974421	36.55	15.2	14.9	68.3	66.2	0.113	0.113	
06-Oct	279	*0.201*	44.9223	-87.5407	457327	4974246	37.73	15.3	15.0	79.4	76.9	0.132	0.131	0.189
06-Oct	279	*0.314*	44.9202	-87.5143	459405	4973993	39.82	15.2	14.9	80.3	77.8	0.133	0.133	0.136
06-Oct	279	*0.388*	44.9195	-87.4973	460746	4973911	41.17	15.3	15.0	72.8	70.5	0.121	0.120	0.085
06-Oct	279	*0.426*	44.9190	-87.4887	461429	4973851	41.85	15.3	15.0	72.4	70.1	0.120	0.120	0.116
06-Oct	279	*0.492*	44.9182	-87.4732	462652	4973751	43.08	15.2	14.9	71.0	68.7	0.118	0.118	0.111
06-Oct	279	*0.583*	44.9148	-87.4535	464203	4973371	44.68	15.2	14.9	65.8	63.8	0.109	0.109	0.091
06-Oct	279	*0.655*	44.9068	-87.4413	465158	4972477	45.99	15.3	15.0	58.1	56.3	0.096	0.096	0.060
06-Oct	279	*0.724*	44.8993	-87.4293	466101	4971639	47.25	15.2	14.9	55.2	53.4	0.092	0.092	0.078
06-Oct	279	*0.818*	44.8888	-87.4137	467332	4970466	48.95	15.1	14.8	47.6	46.1	0.079	0.079	0.054
06-Oct	279	*0.931*	44.8710	-87.4113	467506	4968486	50.94	15.0	14.7	46.4	44.9	0.077	0.077	0.074

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
06-Oct	279	1.078	44.8497	-87.3948	468798	4966109	53.64	14.8	14.5	69.0	66.8	0.116	0.115	0.159
06-Oct	279	1 156	44.8412	-87.3875	469374	4965162	54.75	14.5	14.2	101.2	98.0	0.171	0.171	0.310
06-Oct	279	1.212	44.8360	-87.3833	469700	4964587	55.41	14.5	14.2	130.1	126.0	0.219	0.219	0.396
06-Oct	279	1.460	44.8278	-87.3780	470118	4963676	56.41	14.6	14.3	193.2	187.1	0.325	0.325	0.381
09-Oct	282	0.308	44.9203	-87.4133	467376	4973965	0	14.7	14.4	45.9	45.1	0.078	0.078	
09-Oct	282	0.405	44.9333	-87.4115	467529	4975408	1.45	14.8	14.5	44.7	43.9	0.076	0.076	0.072
09-Oct	282	0.454	44.9398	-87.4103	467624	4976130	2.18	14.8	14.5	47.5	46.7	0.081	0.081	0.101
09-Oct	282	0.570	44.9553	-87.4078	467830	4977851	3.91	14.8	14.5	52.9	52.0	0.090	0.090	0.104
09-Oct	282	0.711	44.9782	-87.4042	468131	4980387	6.47	14.8	14.5	47.2	46.3	0.080	0.080	0.068
09-Oct	282	0.787	44.9903	-87.4025	468271	4981737	7.82	14.8	14.5	44.1	43.3	0.075	0.075	0.062
09-Oct	282	0.848	45.0002	-87.4008	468407	4982829	8.92	14.8	14.5	42.1	41.3	0.071	0.071	0.060
09-Oct	282	0.972	45.0200	-87.3973	468694	4985032	11.15	14.6	14.3	36.8	36.2	0.063	0.063	0.050
09-Oct	282	1.074	45.0343	-87.3853	469647	4986618	13.00	14.6	14.3	32.0	31.4	0.055	0.055	0.040
09-Oct	282	1.159	45.0460	-87.3753	470440	4987912	14.51	14.6	14.3	28.6	28.1	0.049	0.049	0.035
09-Oct	282	1.248	45.0583	-87.3648	471273	4989277	16.11	14.7	14.4	26.3	25.9	0.045	0.045	0.036
09-Oct	282	1.337	45.0705	-87.3543	472106	4990626	17.70	14.7	14.4	24.4	24.0	0.042	0.042	0.035
09-Oct	282	1.428	45.0830	-87.3432	472990	4992011	19.34	14.7	14.4	23.9	23.4	0.041	0.041	0.039
09-Oct	282	1.489	45.0913	-87.3360	473559	4992933	20.42	14.6	14.3	23.1	22.6	0.039	0.039	0.035
09-Oct	282	1.556	45.1003	-87.3280	474193	4993930	21.61	14.5	14.2	21.6	21.3	0.037	0.037	0.030
09-Oct	282	1.650	45.1132	-87.3165	475103	4995353	23.30	14.7	14.4	19.7	19.3	0.033	0.033	0.026
09-Oct	282	1.788	45.1323	-87.2995	476449	4997476	25.81	14.7	14.4	17.7	17.4	0.030	0.030	0.026
09-Oct	282	1.864	45.1433	-87.2905	477161	4998695	27.22	14.5	14.2	16.8	16.5	0.029	0.029	0.025
09-Oct	282	1.933	45.1540	-87.2852	477583	4999880	28.48	14.3	14.0	14.9	14.6	0.026	0.026	0.017
09-Oct	282	2.028	45.1688	-87.2777	478178	5001525	30.23	14.2	13.9	12.7	12.4	0.022	0.022	0.014
09-Oct	282	2.128	45.1840	-87.2677	478970	5003208	32.09	14.0	13.7	12.1	11.9	0.021	0.021	0.019
09-Oct	282	2.192	45.1935	-87.2608	479511	5004262	33.27	14.1	13.8	10.8	10.6	0.019	0.019	0.011
09-Oct	282	2.255	45.2000	-87.2582	479722	5004983	34.02	14.1	13.8	10.4	10.2	0.018	0.018	0.016
09-Oct	282	2.406	45.2013	-87.2595	479619	5005130	34.20	14.1	13.8	9.6	9.4	0.017	0.016	0.015
09-Oct	282	2.493	45.2015	-87.2597	479605	5005150	34.23	14.0	13.7	7.7	7.5	0.013	0.013	0.006
09-Oct	282	2.584	45.2013	-87.2598	479592	5005130	34.25	14.1	13.8	7.1	7.0	0.012	0.012	0.010
09-Oct	282	2.697	45.2015	-87.2598	479594	5005150	34.27	14.1	13.8	7.3	7.2	0.013	0.013	0.013
09-Oct	282	0.123	45.2102	-87.2725	478601	5006116	35.66	14.2	13.9	5.1	5.0	0.009	0.009	
09-Oct	282	0.219	45.2213	-87.2742	478473	5007356	36.90	14.2	13.9	5.6	5.5	0.010	0.010	0.011
09-Oct	282	0.270	45.2295	-87.2720	478647	5008264	37.83	14.2	13.9	5.5	5.4	0.010	0.010	0.009
09-Oct	282	0.334	45.2400	-87.2703	478782	5009430	39.00	14.2	13.9	5.4	5.3	0.009	0.009	0.009

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
09-Oct	282	0.461	45.2592	-87.2773	478239	5011560	41.20	14.4	14.1	6.0	5.9	0.010	0.010	
09-Oct	282	0.529	45.2655	-87.2897	477274	5012268	42.40	14.6	14.3	6.9	6.8	0.012	0.012	0.016
09-Oct	282	0.592	45.2690	-87.3032	476216	5012661	43.53	14.7	14.4	7.9	7.8	0.014	0.013	0.019
09-Oct	282	0.738	45.2765	-87.3348	473736	5013504	46.15	14.7	14.4	9.6	9.5	0.016	0.016	0.020
09-Oct	282	0.913	45.2860	-87.3732	470734	5014572	49.33	14.6	14.3	10.4	10.2	0.018	0.018	
09-Oct	282	1.009	45.2862	-87.3863	469702	5014595	50.36	14.5	14.2	10.2	10.0	0.017	0.017	0.017
09-Oct	282	1.068	45.2790	-87.3915	469293	5013802	51.26	14.6	14.3	9.7	9.5	0.017	0.017	0.013
09-Oct	282	1.133	45.2695	-87.3982	468764	5012749	52.43	14.6	14.3	9.3	9.2	0.016	0.016	0.014
09-Oct	282	1.200	45.2597	-87.4048	468236	5011658	53.65	14.4	14.1	9.1	9.0	0.016	0.016	0.015
09-Oct	282	1.271	45.2493	-87.4122	467654	5010513	54.93	14.3	14.0	8.4	8.3	0.014	0.014	0.011
09-Oct	282	1.382	45.2330	-87.4235	466756	5008704	56.95	14.2	13.9	8.8	8.6	0.015	0.015	0.016
09-Oct	282	1.446	45.2237	-87.4300	466241	5007669	58.11	14.3	14.0	9.7	9.6	0.017	0.017	0.022
09-Oct	282	1.522	45.2123	-87.4377	465631	5006413	59.50	14.7	14.4	9.5	9.3	0.016	0.016	0.015
09-Oct	282	1.576	45.2045	-87.4432	465194	5005546	60.47	14.7	14.4	9.5	9.3	0.016	0.016	0.016
09-Oct	282	1.631	45.1997	-87.4457	464995	5005010	61.05	14.7	14.4	9.5	9.3	0.016	0.016	0.017
09-Oct	282	0.177	45.1783	-87.4673	463280	5002649	63.96	14.7	14.4	8.9	8.7	0.015	0.015	
09-Oct	282	0.232	45.1707	-87.4743	462725	5001801	64.98	14.7	14.4	9.1	8.9	0.015	0.015	0.017
09-Oct	282	0.389	45.1475	-87.4903	461452	4999236	67.84	14.5	14.2	9.8	9.7	0.017	0.017	0.018
09-Oct	282	0.478	45.1340	-87.4978	460853	4997740	69.45	14.8	14.5	10.8	10.6	0.018	0.018	0.022
09-Oct	282	0.546	45.1238	-87.5040	460362	4996612	70.68	14.8	14.5	10.9	10.7	0.018	0.018	0.018
09-Oct	282	0.616	45.1138	-87.5110	459804	4995504	71.92	15.0	14.7	11.9	11.7	0.020	0.020	0.025
09-Oct	282	0.678	45.1055	-87.5188	459181	4994584	73.03	15.0	14.7	13.3	13.0	0.022	0.022	0.030
09-Oct	282	0.752	45.0952	-87.5278	458466	4993440	74.38	14.9	14.6	13.3	13.0	0.022	0.022	0.023
09-Oct	282	0.876	45.0777	-87.5417	457364	4991503	76.61	14.7	14.4	12.0	11.8	0.020	0.020	0.018
09-Oct	282	0.924	45.0708	-87.5467	456965	4990746	77.47	14.8	14.5	11.7	11.5	0.020	0.020	0.017
09-Oct	282	0.988	45.0617	-87.5500	456697	4989730	78.52	14.7	14.4	11.3	11.1	0.019	0.019	0.017
09-Oct	282	1.093	45.0468	-87.5392	457538	4988076	80.37	14.7	14.4	11.3	11.1	0.019	0.019	0.020
09-Oct	282	1.157	45.0377	-87.5320	458097	4987054	81.54	14.6	14.3	11.2	11.0	0.019	0.019	0.018
09-Oct	282	1.248	45.0253	-87.5203	459006	4985678	83.19	14.8	14.5	11.9	11.7	0.020	0.020	0.023
09-Oct	282	1.321	45.0153	-87.5112	459721	4984562	84.51	14.9	14.6	13.0	12.8	0.022	0.022	0.027
09-Oct	282	1.386	45.0065	-87.5037	460306	4983579	85.66	15.0	14.7	13.1	12.9	0.022	0.022	0.023
09-Oct	282	1.452	44.9963	-87.4983	460720	4982445	86.86	15.0	14.7	14.8	14.5	0.025	0.025	0.033
09-Oct	282	1.516	44.9872	-87.4917	461238	4981424	88.01	15.0	14.7	16.8	16.5	0.028	0.028	0.039
09-Oct	282	1.585	44.9770	-87.4845	461798	4980292	89.27	14.9	14.6	22.3	21.9	0.038	0.038	0.065
09-Oct	282	1.653	44.9678	-87.4758	462474	4979269	90.50	14.9	14.6	25.3	24.8	0.043	0.043	0.057
09-Oct	282	1.705	44.9608	-87.4692	462995	4978488	91.44	15.0	14.7	27.5	26.9	0.046	0.046	0.061

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
09-Oct	282	*1.774*	44.9512	-87.4610	463634	4977411	92.69	14.9	14.6	29.0	28.4	0.049	0.049	0.057
09-Oct	282	*1.838*	44.9423	-87.4537	464206	4976426	93.83	14.8	14.5	36.4	35.7	0.062	0.062	0.103
09-Oct	282	*1.934*	44.9288	-87.4425	465080	4974921	95.57	14.8	14.5	48.1	47.2	0.082	0.082	0.121
09-Oct	282	*1.996*	44.9203	-87.4357	465613	4973974	96.66	14.8	14.5	50.8	49.9	0.086	0.086	0.101
09-Oct	282	*2.067*	44.9102	-87.4277	466239	4972842	97.95	14.8	14.5	54.5	53.5	0.093	0.092	0.110
09-Oct	282	*2.160*	44.8968	-87.4172	467060	4971356	99.65	14.7	14.4	52.9	51.9	0.090	0.090	0.085
09-Oct	282	*2.208*	44.8895	-87.4150	467228	4970542	100.48	14.5	14.2	53.0	52.0	0.091	0.090	0.093
09-Oct	282	*2.277*	44.8783	-87.4135	467340	4969300	101.73	14.4	14.1	59.2	58.1	0.101	0.101	0.133
09-Oct	282	*2.334*	44.8693	-87.4095	467651	4968298	102.77	14.4	14.1	57.8	56.7	0.099	0.099	0.090
09-Oct	282	*2.402*	44.8597	-87.4025	468199	4967222	103.98	14.3	14.0	63.4	62.2	0.109	0.109	0.138
09-Oct	282	*2.477*	44.8490	-87.3940	468864	4966035	105.34	13.9	13.6	126.4	124.0	0.219	0.219	0.504
09-Oct	282	*2.549*	44.8418	-87.3883	469308	4965235	106.26	13.7	13.4	232.3	227.9	0.404	0.404	0.903
09-Oct	282	*2.624*	44.8360	-87.3835	469687	4964587	107.01	13.1	12.8	338.3	332.0	0.597	0.597	1.085
09-Oct	282	*2.698*	44.8307	-87.3788	470053	4963992	107.71	13.1	12.8	409.6	401.9	0.723	0.722	1.044
09-Oct	282	*2.767*	44.8278	-87.3778	470130	4963676	108.03	13.1	12.8	484.3	475.3	0.855	0.854	1.227
10-Oct	283	*0.348*	44.6000	-87.9448	425015	4938734	0	13.6	13.3	321.7	316.6	0.563	0.562	
10-Oct	283	*0.424*	44.5934	-87.9549	424208	4938015	1.08	13.5	13.2	314.8	309.9	0.552	0.552	0.525
10-Oct	283	*0.541*	44.5834	-87.9703	422972	4936912	2.74	13.4	13.1	274.8	270.4	0.483	0.483	0.380
10-Oct	283	*0.650*	44.5740	-87.9847	421817	4935884	4.28	13.8	13.5	284.6	280.2	0.496	0.495	0.516
10-Oct	283	*0.744*	44.5592	-87.9935	421097	4934244	6.08	14.7	14.4	330.1	324.9	0.563	0.563	0.699
10-Oct	283	*0.857*	44.5422	-88.0025	420359	4932364	8.09	15.3	15.0	355.4	349.8	0.598	0.598	0.655
10-Oct	283	*0.966*	44.5310	-88.0085	419867	4931130	9.42	14.3	14.0	364.3	358.6	0.627	0.627	0.675
10-Oct	283	*1.072*	44.5252	-88.0098	419752	4930483	10.08	14.3	14.0	358.8	353.2	0.618	0.617	0.601
10-Oct	283	*1.139*	44.5205	-88.0123	419547	4929968	10.63	14.3	14.0	358.4	352.8	0.617	0.617	0.614
10-Oct	283	*1.311*	44.5198	-88.0142	419400	4929894	10.80	14.3	14.0	361.9	356.2	0.623	0.623	0.628
10-Oct	283	*0.070*	44.5220	-88.0105	419695	4930133	11.18	14.3	14.0	286.6	282.1	0.493	0.493	
10-Oct	283	*0.121*	44.5268	-88.0090	419821	4930667	11.73	14.3	14.0	279.3	274.9	0.481	0.480	0.429
10-Oct	283	*0.313*	44.5478	-87.9993	420617	4932990	14.18	15.2	14.9	315.7	310.7	0.532	0.532	0.573
10-Oct	283	*0.352*	44.5538	-87.9962	420876	4933653	14.90	14.8	14.5	303.4	298.6	0.516	0.516	0.426
10-Oct	283	*0.426*	44.5650	-87.9898	421395	4934889	16.24	14.6	14.3	327.4	322.2	0.560	0.559	0.677
10-Oct	283	*0.499*	44.5758	-87.9833	421926	4936085	17.54	14.1	13.8	348.7	343.2	0.603	0.603	0.717
10-Oct	283	*0.563*	44.5838	-87.9747	422624	4936965	18.67	13.7	13.4	344.4	339.0	0.601	0.601	0.595
10-Oct	283	*0.650*	44.5897	-87.9610	423718	4937601	19.93	13.8	13.5	334.9	329.6	0.583	0.583	0.544
10-Oct	283	*0.704*	44.5952	-87.9517	424464	4938203	20.89	13.9	13.6	311.4	306.5	0.541	0.541	0.381
10-Oct	283	*0.766*	44.6045	-87.9482	424754	4939237	21.97	14.0	13.7	284.3	279.8	0.493	0.493	0.337

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
10-Oct	283	0.844	44.6170	-87.9472	424850	4940625	23.36	14.2	13.9	263.8	259.6	0.455	0.455	0.361
10-Oct	283	0.902	44.6262	-87.9468	424889	4941642	24.38	14.3	14.0	239.8	236.0	0.413	0.413	0.265
10-Oct	283	0.972	44.6375	-87.9462	424956	4942901	25.64	14.3	14.0	209.8	206.5	0.361	0.361	0.215
10-Oct	283	1.025	44.6460	-87.9458	424993	4943845	26.58	14.2	13.9	191.3	188.2	0.330	0.330	0.208
10-Oct	283	1.091	44.6568	-87.9455	425034	4945046	27.78	14.3	14.0	166.3	163.7	0.286	0.286	0.154
10-Oct	283	1.152	44.6590	-87.9387	425578	4945282	28.38	14.4	14.1	140.7	138.5	0.242	0.242	0.092
10-Oct	283	1.202	44.6588	-87.9273	426477	4945252	29.27	14.5	14.2	120.2	118.3	0.206	0.206	0.059
10-Oct	283	1.269	44.6572	-87.9125	427651	4945054	30.47	14.7	14.4	104.6	103.0	0.179	0.178	0.095
10-Oct	283	1.326	44.6552	-87.9000	428640	4944821	31.48	14.7	14.4	89.5	88.1	0.153	0.153	0.060
10-Oct	283	1.389	44.6570	-87.8865	429713	4945014	32.57	14.7	14.4	77.1	75.8	0.131	0.131	0.063
10-Oct	283	1.527	44.6583	-87.8815	430111	4945156	32.99	14.7	14.4	47.1	46.4	0.080	0.080	0.016
10-Oct	283	1.771	44.6583	-87.8815	430111	4945156	32.99	14.6	14.3	30.9	30.3	0.053	0.053	0.038
10-Oct	283	1.855	44.6585	-87.8817	430097	4945176	33.02	14.6	14.3	29.3	28.8	0.050	0.050	0.044
10-Oct	283	2.082	44.6583	-87.8818	430084	4945157	33.04	14.6	14.3	26.4	26.0	0.045	0.045	0.042
10-Oct	283	0.037	44.6578	-87.8813	430123	4945101	33.11	14.6	14.3	26.0	25.5	0.044	0.044	
10-Oct	283	0.066	44.6577	-87.8755	430585	4945078	33.57	14.6	14.3	24.9	24.5	0.043	0.043	0.029
10-Oct	283	0.175	44.6578	-87.8508	432541	4945075	35.53	14.3	14.0	23.1	22.7	0.040	0.040	0.035
10-Oct	283	0.259	44.6585	-87.8320	434035	4945135	37.02	14.3	14.0	23.6	23.2	0.041	0.041	0.042
10-Oct	283	0.331	44.6580	-87.8158	435316	4945067	38.31	14.4	14.1	24.0	23.6	0.041	0.041	0.043
10-Oct	283	0.389	44.6577	-87.8027	436359	4945018	39.35	14.3	14.0	24.7	24.3	0.042	0.042	0.047
10-Oct	283	0.444	44.6577	-87.7902	437350	4945009	40.34	14.2	13.9	25.4	24.9	0.044	0.044	0.048
10-Oct	283	0.517	44.6582	-87.7738	438646	4945052	41.64	14.2	13.9	23.1	22.7	0.040	0.040	0.029
10-Oct	283	0.571	44.6583	-87.7630	439506	4945061	42.50	14.2	13.9	23.4	23.0	0.040	0.040	0.042
10-Oct	283	0.614	44.6602	-87.7620	439587	4945265	42.72	14.2	13.9	24.8	24.3	0.043	0.043	0.054
10-Oct	283	0.675	44.6682	-87.7675	439159	4946158	43.71	14.3	14.0	25.4	25.0	0.044	0.044	0.047
10-Oct	283	0.726	44.6753	-87.7727	438756	4946957	44.60	14.3	14.0	26.1	25.7	0.045	0.045	0.050
10-Oct	283	0.845	44.6927	-87.7848	437811	4948892	46.76	14.4	14.1	28.9	28.4	0.050	0.050	0.057
10-Oct	283	0.893	44.6995	-87.7898	437422	4949656	47.61	14.4	14.1	30.1	29.6	0.052	0.052	0.061
10-Oct	283	0.963	44.7095	-87.7972	436851	4950773	48.87	14.5	14.2	33.0	32.5	0.057	0.057	0.070
10-Oct	283	1.027	44.7185	-87.8038	436334	4951777	50.00	14.5	14.2	34.5	34.0	0.059	0.059	0.067
10-Oct	283	1.097	44.7285	-87.8112	435763	4952894	51.25	14.7	14.4	35.4	34.8	0.060	0.060	0.064
10-Oct	283	1.166	44.7382	-87.8187	435180	4953973	52.48	14.8	14.5	33.8	33.2	0.057	0.057	0.049
10-Oct	283	1.233	44.7477	-87.8260	434612	4955034	53.68	14.7	14.4	28.3	27.8	0.048	0.048	0.020
10-Oct	283	1.289	44.7558	-87.8320	434146	4955945	54.71	14.6	14.3	27.7	27.2	0.047	0.047	0.044
10-Oct	283	1.383	44.7697	-87.8412	433435	4957490	56.41	14.6	14.3	30.7	30.2	0.052	0.052	0.063
10-Oct	283	1.487	44.7847	-87.8513	432649	4959165	58.26	14.6	14.3	34.9	34.3	0.060	0.060	0.073

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
10-Oct	283	*1.559*	44.7940	-87.8582	432118	4960208	59.43	14.5	14.2	37.5	36.8	0.064	0.064	0.076
10-Oct	283	*1.624*	44.7950	-87.8495	432806	4960312	60.12	14.6	14.3	40.2	39.5	0.069	0.069	0.083
10-Oct	283	*1.691*	44.7945	-87.8345	433992	4960244	61.31	14.6	14.3	37.5	36.8	0.064	0.064	0.050
10-Oct	283	*1.764*	44.7940	-87.8177	435322	4960175	62.64	14.5	14.2	36.8	36.2	0.063	0.063	0.060
10-Oct	283	*1.807*	44.7940	-87.8078	436100	4960167	63.42	14.5	14.2	36.9	36.2	0.063	0.063	0.064
10-Oct	283	*1.866*	44.7947	-87.7945	437156	4960230	64.48	14.5	14.2	36.4	35.8	0.062	0.062	0.060
10-Oct	283	*1.916*	44.7952	-87.7830	438066	4960277	65.39	14.6	14.3	36.0	35.4	0.062	0.061	0.058
10-Oct	283	*1.992*	44.7942	-87.7658	439423	4960153	66.75	14.7	14.4	33.2	32.7	0.057	0.057	0.044
10-Oct	283	*2.072*	44.7947	-87.7583	440016	4960203	67.35	14.8	14.5	33.2	32.7	0.057	0.056	0.056
10-Oct	283	*0.267*	44.7938	-87.7305	442218	4960089	69.55	14.8	14.5	36.6	36.0	0.062	0.062	
10-Oct	283	*0.304*	44.7938	-87.7220	442890	4960083	70.22	14.8	14.5	38.6	37.9	0.066	0.066	0.086
10-Oct	283	*0.353*	44.7938	-87.7107	443785	4960075	71.12	14.8	14.5	46.2	45.4	0.079	0.078	0.133
10-Oct	283	*0.401*	44.7938	-87.7000	444630	4960068	71.96	14.8	14.5	57.8	56.8	0.098	0.098	0.187
10-Oct	283	*0.463*	44.7945	-87.6945	445066	4960140	72.41	14.7	14.4	78.3	77.0	0.133	0.133	0.248
10-Oct	283	*0.514*	44.8010	-87.6998	444650	4960866	73.24	14.8	14.5	88.9	87.4	0.151	0.151	0.224
10-Oct	283	*0.573*	44.8092	-87.7072	444077	4961777	74.32	14.8	14.5	88.1	86.6	0.150	0.150	0.145
10-Oct	283	*0.631*	44.8165	-87.7153	443439	4962598	75.36	14.8	14.5	86.2	84.8	0.147	0.147	0.135
10-Oct	283	*0.706*	44.8260	-87.7258	442618	4963661	76.70	14.8	14.5	82.3	80.9	0.140	0.140	0.122
10-Oct	283	*0.830*	44.8423	-87.7423	441330	4965485	78.93	14.8	14.5	76.4	75.1	0.130	0.130	0.115
10-Oct	283	*0.893*	44.8505	-87.7508	440667	4966400	80.06	14.8	14.5	70.7	69.6	0.120	0.120	0.089
10-Oct	283	*0.939*	44.8567	-87.7567	440212	4967089	80.89	14.8	14.5	66.0	64.9	0.112	0.112	0.075
10-Oct	283	*0.988*	44.8635	-87.7627	439745	4967853	81.79	14.8	14.5	60.8	59.7	0.103	0.103	0.065
10-Oct	283	*1.034*	44.8698	-87.7683	439304	4968559	82.62	14.8	14.5	55.5	54.6	0.094	0.094	0.053
10-Oct	283	*1.087*	44.8767	-87.7755	438746	4969324	83.57	14.6	14.3	51.3	50.5	0.088	0.088	0.061
10-Oct	283	*1.149*	44.8845	-87.7842	438069	4970202	84.67	14.2	13.9	49.3	48.4	0.085	0.085	0.076
10-Oct	283	*1.184*	44.8892	-87.7892	437679	4970723	85.32	14.2	13.9	48.8	48.0	0.084	0.084	0.079
10-Oct	283	*1.232*	44.8957	-87.7948	437239	4971450	86.17	14.1	13.8	46.7	45.9	0.081	0.081	0.066
10-Oct	283	*1.282*	44.9010	-87.7998	436850	4972047	86.89	13.7	13.4	49.3	48.5	0.086	0.086	0.107
10-Oct	283	*1.335*	44.9015	-87.7950	437233	4972099	87.27	13.8	13.5	59.3	58.3	0.103	0.103	0.169
10-Oct	283	*1.382*	44.9017	-87.7873	437838	4972111	87.88	14.1	13.8	57.5	56.5	0.099	0.099	0.082
10-Oct	283	*1.433*	44.9018	-87.7757	438758	4972119	88.80	14.6	14.3	52.9	52.1	0.090	0.090	0.054
10-Oct	283	*1.482*	44.9018	-87.7647	439627	4972111	89.67	14.8	14.5	46.6	45.9	0.079	0.079	0.031
10-Oct	283	*1.545*	44.9017	-87.7502	440772	4972083	90.81	14.8	14.5	42.4	41.7	0.072	0.072	0.049
10-Oct	283	*1.584*	44.9018	-87.7410	441496	4972094	91.54	14.8	14.5	40.2	39.5	0.068	0.068	0.048
10-Oct	283	*1.629*	44.9025	-87.7241	442829	4972157	92.87	14.8	14.5	38.2	37.6	0.065	0.065	0.049
10-Oct	283	*1.691*	44.9033	-87.7051	444332	4972235	94.38	14.8	14.5	36.6	36.0	0.062	0.062	0.053

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
10-Oct	283	*1.746*	44.9042	-87.6883	445659	4972317	95.71	14.8	14.5	34.5	34.0	0.059	0.059	0.045
10-Oct	283	*1.799*	44.9048	-87.6761	446620	4972382	96.67	14.9	14.6	31.1	30.6	0.053	0.053	0.030
10-Oct	283	*1.856*	44.9055	-87.6652	447487	4972451	97.54	14.9	14.6	29.3	28.8	0.050	0.050	0.038
10-Oct	283	*1.901*	44.9062	-87.6565	448175	4972519	98.23	14.8	14.5	27.9	27.5	0.048	0.047	0.037
10-Oct	283	*1.947*	44.9066	-87.6475	448880	4972560	98.94	14.8	14.5	26.7	26.2	0.045	0.045	0.035
10-Oct	283	*2.044*	44.9075	-87.6286	450375	4972648	100.43	14.7	14.4	32.3	31.8	0.055	0.055	0.074
10-Oct	283	*2.100*	44.9080	-87.6179	451224	4972698	101.28	14.7	14.4	38.3	37.7	0.065	0.065	0.103
10-Oct	283	*2.136*	44.9083	-87.6109	451776	4972731	101.84	14.7	14.4	40.0	39.4	0.068	0.068	0.086
10-Oct	283	*2.196*	44.9089	-87.5994	452684	4972785	102.75	14.6	14.3	39.5	38.9	0.068	0.068	0.065
10-Oct	283	*2.245*	44.9093	-87.5902	453410	4972829	103.47	14.6	14.3	40.4	39.7	0.069	0.069	0.075
10-Oct	283	*2.314*	44.9102	-87.5783	454345	4972916	104.41	14.8	14.5	46.2	45.5	0.079	0.079	0.106
10-Oct	283	*2.374*	44.9117	-87.5593	455846	4973072	105.92	15.0	14.7	57.5	56.6	0.097	0.097	0.163
10-Oct	283	*2.438*	44.9128	-87.5445	457019	4973193	107.10	15.0	14.7	58.6	57.7	0.099	0.099	0.105
10-Oct	283	*2.507*	44.9137	-87.5285	458282	4973278	108.37	15.0	14.7	54.4	53.6	0.092	0.092	0.071
10-Oct	283	*2.551*	44.9143	-87.5185	459072	4973346	109.16	15.0	14.7	50.0	49.2	0.085	0.085	0.048
10-Oct	283	*2.614*	44.9150	-87.5042	460203	4973415	110.29	15.0	14.7	46.9	46.1	0.079	0.079	0.062
10-Oct	283	*2.717*	44.9162	-87.4808	462046	4973532	112.14	14.9	14.6	46.7	46.0	0.079	0.079	0.079
10-Oct	283	*2.777*	44.9168	-87.4672	463125	4973599	113.22	14.8	14.5	47.5	46.8	0.081	0.081	0.086
10-Oct	283	*2.839*	44.9152	-87.4537	464189	4973409	114.30	14.7	14.4	49.9	49.1	0.085	0.085	0.099
10-Oct	283	*2.897*	44.9092	-87.4437	464975	4972738	115.34	14.8	14.5	51.0	50.2	0.087	0.087	0.093
10-Oct	283	*2.943*	44.9045	-87.4355	465618	4972217	116.16	14.8	14.5	51.5	50.6	0.088	0.088	0.091
10-Oct	283	*3.011*	44.8972	-87.4238	466534	4971397	117.39	14.8	14.5	51.6	50.8	0.088	0.088	0.088
10-Oct	283	*3.058*	44.8918	-87.4160	467150	4970800	118.25	14.8	14.5	51.6	50.8	0.088	0.088	0.088
10-Oct	283	*3.129*	44.8808	-87.4133	467354	4969577	119.49	14.8	14.5	50.2	49.4	0.085	0.085	0.078
10-Oct	283	*3.182*	44.8725	-87.4108	467547	4968652	120.44	14.6	14.3	51.2	50.4	0.088	0.088	0.096
10-Oct	283	*3.236*	44.8643	-87.4058	467937	4967741	121.43	14.4	14.1	59.0	58.1	0.101	0.101	0.154
10-Oct	283	*3.304*	44.8547	-87.3983	468525	4966665	122.65	14.3	14.0	71.0	69.9	0.122	0.122	0.184
10-Oct	283	*3.357*	44.8472	-87.3922	469007	4965830	123.62	14.0	13.7	95.6	94.1	0.166	0.166	0.334
10-Oct	283	*3.416*	44.8418	-87.3878	469347	4965235	124.30	13.9	13.6	170.4	167.7	0.296	0.296	0.737
10-Oct	283	*3.486*	44.8365	-87.3833	469700	4964642	124.99	13.8	13.5	281.6	277.2	0.490	0.490	1.040
10-Oct	283	*3.534*	44.8327	-87.3802	469948	4964215	125.49	13.7	13.4	349.9	344.4	0.611	0.610	1.122
09-Nov	313	*0.196*	44.8472	-87.3912	469086	4965829	0.00	4.6	3.8	89.3	87.7	0.196	0.196	
09-Nov	313	*0.267*	44.8528	-87.3957	468734	4966460	0.72	5.1	4.3	85.8	84.3	0.186	0.186	0.164
09-Nov	313	*0.387*	44.8622	-87.4030	468160	4967500	1.91	5.6	4.8	69.2	67.9	0.148	0.148	0.106
09-Nov	313	*0.479*	44.8693	-87.4083	467743	4968298	2.81	5.9	5.2	55.8	54.7	0.118	0.118	0.071

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
09-Nov	313	*0.593*	44.8788	-87.4135	467340	4969355	3.94	5.3	4.6	45.3	44.4	0.097	0.097	0.073
09-Nov	313	*0.643*	44.8832	-87.4137	467329	4969837	4.42	5.4	4.7	43.5	42.7	0.093	0.093	0.081
09-Nov	313	*0.689*	44.8873	-87.4135	467345	4970299	4.89	5.9	5.2	40.3	39.6	0.085	0.085	0.056
09-Nov	313	*0.729*	44.8908	-87.4135	467347	4970688	5.28	6.9	6.2					
09-Nov	313	*0.785*	44.8957	-87.4210	466758	4971229	6.08	7.5	6.8	39.2	38.4	0.080	0.080	
09-Nov	313	*0.828*	44.9002	-87.4285	466168	4971732	6.85	7.6	7.0	39.3	38.5	0.079	0.079	0.079
09-Nov	313	*0.888*	44.9063	-87.4388	465355	4972420	7.92	7.4	6.8	35.8	35.2	0.073	0.073	0.054
09-Nov	313	*0.922*	44.9097	-87.4448	464884	4972794	8.52	7.5	6.9	34.8	34.1	0.070	0.070	0.058
09-Nov	313	*0.951*	44.9128	-87.4498	464491	4973147	9.05	7.4	6.8	34.7	34.0	0.071	0.071	0.071
09-Nov	313	*0.980*	44.9155	-87.4552	464071	4973447	9.56	7.4	6.8					
09-Nov	313	*0.996*	44.9172	-87.4580	463850	4973633	9.85	7.4	6.8	35.0	34.3	0.071	0.071	
09-Nov	313	*1.035*	44.9198	-87.4655	463259	4973932	10.51	7.4	6.8	34.4	33.7	0.070	0.070	0.065
09-Nov	313	*1.221*	44.9232	-87.5060	460065	4974322	13.73	7.9	7.3	37.9	37.1	0.076	0.076	0.080
09-Nov	313	*1.324*	44.9250	-87.5262	458474	4974536	15.34	8.2	7.6	42.9	42.1	0.085	0.085	0.099
09-Nov	313	*1.390*	44.9262	-87.5392	457449	4974672	16.37	8.1	7.5	43.1	42.2	0.086	0.086	0.087
09-Nov	313	*1.634*	44.9283	-87.5722	454846	4974930	18.99	6.2	5.5	72.2	70.7	0.151	0.151	0.176
09-Nov	313	*1.837*	44.9287	-87.5712	454925	4974967	19.07	6.5	5.8	87.2	85.3	0.181	0.181	0.197
09-Nov	313	*1.867*	44.9288	-87.5713	454913	4974985	19.09	6.5	5.8	88.3	86.4	0.184	0.184	0.197
09-Nov	313	*2.005*	44.9288	-87.5715	454900	4974985	19.11	6.5	5.8	88.0	86.1	0.183	0.183	0.182
09-Nov	313	*2.147*	44.9288	-87.5715	454900	4974985	19.11	6.5	5.8	83.2	81.4	0.173	0.173	0.164
09-Nov	313	*0.032*	44.9288	-87.5725	454821	4974986	19.19	6.7	6.0					
09-Nov	313	*0.059*	44.9283	-87.5720	454860	4974930	19.25	6.7	6.0	73.6	71.9	0.152	0.152	
09-Nov	313	*0.116*	44.9282	-87.5720	454860	4974912	19.27	6.5	5.9	77.1	75.4	0.160	0.160	0.182
09-Nov	313	*0.227*	44.9258	-87.5565	456081	4974643	20.52	7.4	6.7	87.1	85.0	0.176	0.176	0.198
09-Nov	313	*0.287*	44.9250	-87.5433	457119	4974545	21.57	8.1	7.5	85.0	83.0	0.169	0.169	0.148
09-Nov	313	*0.339*	44.9242	-87.5317	458039	4974446	22.49	8.1	7.5	80.8	78.9	0.160	0.160	0.132
09-Nov	313	*0.404*	44.9232	-87.5177	459143	4974328	23.60	8.1	7.5	80.4	78.5	0.160	0.160	0.158
09-Nov	313	*0.470*	44.9220	-87.5032	460287	4974192	24.75	7.8	7.2	73.9	72.1	0.148	0.148	0.118
09-Nov	313	*0.513*	44.9213	-87.4938	461023	4974112	25.49	7.7	7.0	68.4	66.7	0.137	0.137	0.095
09-Nov	313	*0.643*	44.9185	-87.4500	464482	4973778	28.97	7.5	6.8	57.4	55.9	0.116	0.116	0.093
09-Nov	313	*0.796*	44.9092	-87.4410	465183	4972738	30.22	7.4	6.8	47.8	46.6	0.097	0.097	0.080
09-Nov	313	*1.037*	44.8943	-87.4230	466600	4971083	32.40	7.3	6.7	42.8	41.7	0.087	0.087	0.083
09-Nov	313	*1.098*	44.8906	-87.4177	467018	4970663	32.99	6.7	6.0	43.1	41.9	0.089	0.089	0.094
09-Nov	313	*1.153*	44.8872	-87.4128	467397	4970281	33.53	5.9	5.2	42.6	41.5	0.090	0.090	0.092
09-Nov	313	*1.228*	44.8772	-87.4132	467365	4969171	34.64	5.5	4.7	43.0	41.9	0.092	0.092	0.096
09-Nov	313	*1.323*	44.8642	-87.4048	468016	4967723	36.23	5.5	4.8	43.3	42.1	0.092	0.092	0.092

1995 Date	Day	Time	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	x(CH4)eq	p(CH4)eq	[CH4]1	[CH4]2	[CH4]mod
09-Nov	313	*1.387*	44.8560	-87.3985	468513	4966814	37.27	5.0	4.2	46.4	45.1	0.100	0.100	0.120
09-Nov	313	*1.441*	44.8485	-87.3923	468995	4965979	38.23	4.4	3.6	58.6	57.0	0.128	0.128	0.209
09-Nov	313	*1.508*	44.8413	-87.3870	469414	4965179	39.13	4.4	3.6	86.5	84.1	0.189	0.189	0.325
09-Nov	313	*1.623*	44.8348	-87.3807	469910	4964455	40.01	4.7	3.9	128.5	124.9	0.279	0.279	0.380

1994 CARBON DIOXIDE DATA

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
02-Jun	153	44.8332	-87.3805	469923	4964270	0.00	15.1	14.7	0.15	1001	422.4	416.7	403.5	18.52
02-Jun	153	44.8355	-87.3827	469752	4964531	0.31	15.1	14.7	0.15	1001	419.1	413.4	400.4	18.38
02-Jun	153	44.8410	-87.3873	469386	4965144	1.03	15.0	14.7	0.15	1001	415.5	409.9	397.0	18.23
02-Jun	153	44.8513	-87.3957	468733	4966293	2.35	15.1	14.8	0.15	1001	392.7	387.4	375.2	17.20
02-Jun	153	44.8543	-87.3983	468524	4966628	2.74	15.1	14.8	0.15	1001	375.5	370.4	358.7	16.45
02-Jun	153	44.8633	-87.4055	467964	4967630	3.89	15.1	14.7	0.15	1001	375.7	370.6	358.9	16.48
02-Jun	153	44.8663	-87.4073	467820	4967964	4.25	15.0	14.7	0.15	1001	363.7	358.7	347.4	15.96
02-Jun	153	44.8702	-87.4093	467664	4968391	4.71	15.0	14.7	0.15	1001	352.8	348.0	337.0	15.51
02-Jun	153	44.8788	-87.4135	467340	4969355	5.73	14.7	14.4	0.15	1001	356.7	351.7	340.7	15.83
02-Jun	153	44.9042	-87.4195	466881	4972172	8.58	14.5	14.2	0.15	1001	365.4	360.2	349.0	16.30
02-Jun	153	44.9087	-87.4207	466790	4972673	9.09	14.4	14.1	0.15	1001	357.9	352.7	341.8	16.03
02-Jun	153	44.9148	-87.4222	466676	4973358	9.78	14.4	14.0	0.15	1001	361.5	356.3	345.3	16.20
02-Jun	153	44.9330	-87.4262	466370	4975379	11.83	14.1	13.7	0.15	1001	345.1	339.9	329.5	15.61
02-Jun	153	44.9418	-87.4282	466218	4976359	12.82	14.2	13.9	0.15	1001	345.1	340.0	329.5	15.53
02-Jun	153	44.9712	-87.4345	465737	4979621	16.12	14.3	14.0	0.15	1001	327.6	322.8	312.8	14.70
02-Jun	153	44.9755	-87.4355	465660	4980104	16.61	14.2	13.9	0.15	1001	333.6	328.8	318.6	15.02
02-Jun	153	44.9992	-87.4408	465254	4982734	19.27	13.4	13.0	0.15	1001	364.6	358.9	348.1	16.89
02-Jun	153	45.0047	-87.4422	465151	4983346	19.89	13.2	12.8	0.15	1001	368.5	362.6	351.7	17.17
02-Jun	153	45.0205	-87.4462	464846	4985107	21.67	13.1	12.7	0.15	1001	369.0	363.0	352.2	17.23
02-Jun	153	45.0208	-87.4465	464821	4985143	21.72	12.9	12.5	0.15	1001	369.2	363.1	352.4	17.36
02-Jun	153	45.0248	-87.4408	465269	4985585	22.35	13.5	13.1	0.15	1003	359.3	353.7	343.7	16.61
02-Jun	153	45.0292	-87.4357	465678	4986065	22.98	13.3	12.9	0.14	1003	364.4	358.6	348.5	16.95
02-Jun	153	45.0493	-87.4113	467607	4988294	25.93	12.9	12.5	0.14	1003	343.9	338.2	328.8	16.21
02-Jun	153	45.0618	-87.3963	468795	4989677	27.75	12.9	12.5	0.14	1003	352.1	346.3	336.7	16.60
02-Jun	153	45.0698	-87.3867	469560	4990562	28.92	13.0	12.6	0.14	1003	357.2	351.3	341.5	16.78
02-Jun	153	45.0837	-87.3697	470905	4992093	30.96	13.2	12.8	0.15	1003	362.9	357.1	347.1	16.96
02-Jun	153	45.0958	-87.3548	472079	4993439	32.74	13.0	12.6	0.15	1003	388.8	382.4	371.8	18.28
02-Jun	153	45.1040	-87.3445	472896	4994344	33.96	12.5	12.1	0.15	1003	394.7	388.0	377.4	18.84
02-Jun	153	45.1193	-87.3260	474359	4996040	36.20	12.2	11.8	0.14	1003	379.7	373.0	362.9	18.32
02-Jun	153	45.1282	-87.3145	475267	4997018	37.54	12.6	12.2	0.14	1003	351.1	345.2	335.7	16.72
02-Jun	153	45.1525	-87.2873	477413	4999714	40.98	12.3	11.9	0.14	1003	371.8	365.3	355.4	17.90
02-Jun	153	45.1598	-87.2828	477769	5000526	41.87	12.5	12.0	0.14	1003	386.6	380.0	369.6	18.51
02-Jun	153	45.1677	-87.2782	478139	5001396	42.81	12.6	12.2	0.14	1003	372.0	365.7	355.7	17.74
02-Jun	153	45.1993	-87.2585	479696	5004908	46.66	12.6	12.2	0.15	1003	406.8	399.9	389.0	19.36
02-Jun	153	45.1997	-87.2585	479697	5004946	46.69	12.6	12.2	0.15	1003	398.0	391.3	380.5	18.93
02-Jun	153	45.2098	-87.2782	478155	5006079	48.61	12.2	11.8	0.14	1003	381.0	374.3	364.0	18.36

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
02-Jun	153	45.2145	-87.2885	477346	5006602	49.57	12.2	11.8	0.14	1003	380.5	373.7	363.5	18.38
02-Jun	153	45.2312	-87.3277	474277	5008465	53.16	12.4	12.0	0.14	1003	381.0	374.4	364.0	18.25
02-Jun	153	45.2340	-87.3353	473677	5008783	53.84	12.4	12.0	0.14	1003	375.7	369.2	359.0	17.99
02-Jun	153	45.2305	-87.3473	472733	5008398	54.86	12.2	11.7	0.14	1003	365.5	359.0	349.2	17.66
02-Jun	153	45.2225	-87.3702	470936	5007517	56.86	11.6	11.1	0.14	1003	387.3	380.1	369.9	19.10
02-Jun	153	45.2195	-87.3787	470268	5007187	57.61	11.7	11.3	0.14	1003	380.7	373.7	363.6	18.68
02-Jun	153	45.2148	-87.3952	468969	5006673	59.00	11.7	11.2	0.14	1003	380.7	373.6	363.5	18.70
02-Jun	153	45.2102	-87.4118	467659	5006162	60.41	11.7	11.3	0.14	1003	376.5	369.5	359.5	18.45
02-Jun	153	45.2037	-87.4343	465888	5005449	62.32	11.8	11.3	0.14	1003	358.1	351.5	342.0	17.53
02-Jun	153	45.2003	-87.4450	465049	5005083	63.23	11.9	11.5	0.14	1003	345.9	339.6	330.4	16.86
02-Jun	153	45.1625	-87.4425	465222	5000880	67.44	12.5	12.1	0.15	1003	414.7	407.6	396.3	19.80
02-Jun	153	45.1548	-87.4413	465308	5000027	68.30	12.6	12.2	0.15	1003	410.9	403.9	392.7	19.59
02-Jun	153	45.1300	-87.4387	465503	4997268	71.06	12.6	12.2	0.14	1003	387.6	381.1	370.4	18.45
02-Jun	153	45.1205	-87.4377	465575	4996212	72.12	12.6	12.3	0.14	1003	368.8	362.5	352.4	17.53
02-Jun	153	45.1090	-87.4365	465661	4994934	73.40	12.6	12.2	0.14	1003	357.0	350.9	341.1	17.00
02-Jun	153	45.0912	-87.4343	465821	4992952	75.39	12.5	12.1	0.14	1003	349.6	343.5	334.0	16.68
02-Jun	153	45.0672	-87.4322	465976	4990285	78.06	12.8	12.4	0.14	1003	333.8	328.2	319.0	15.80
02-Jun	153	45.0460	-87.4300	466136	4987933	80.42	12.8	12.4	0.14	1002	344.2	338.5	328.8	16.29
02-Jun	153	45.0413	-87.4297	466158	4987413	80.94	12.8	12.4	0.14	1002	345.0	339.2	329.5	16.33
02-Jun	153	45.0042	-87.4270	466347	4983284	85.07	13.5	13.1	0.15	1002	346.2	340.7	330.8	16.01
02-Jun	153	44.9930	-87.4257	466445	4982044	86.32	14.0	13.7	0.15	1002	320.7	315.9	306.5	14.56
02-Jun	153	44.9863	-87.4250	466495	4981301	87.06	14.2	13.8	0.15	1002	325.8	321.0	311.4	14.71
02-Jun	153	44.9770	-87.4238	466581	4980266	88.10	14.3	14.0	0.15	1002	321.2	316.5	307.0	14.44
02-Jun	153	44.9642	-87.4223	466691	4978839	89.53	14.4	14.1	0.15	1002	321.0	316.3	306.8	14.39
02-Jun	153	44.9155	-87.4173	467058	4973431	94.95	14.3	14.0	0.15	1002	330.5	325.6	315.9	14.86
02-Jun	153	44.9072	-87.4165	467119	4972504	95.88	14.3	13.9	0.15	1002	353.4	348.3	337.8	15.92
02-Jun	153	44.8997	-87.4158	467167	4971671	96.72	14.5	14.2	0.15	1002	354.1	349.1	338.5	15.83
02-Jun	153	44.8905	-87.4152	467214	4970653	97.73	14.8	14.5	0.15	1002	344.2	339.5	329.1	15.21
02-Jun	153	44.8798	-87.4138	467314	4969466	98.93	15.1	14.8	0.15	1002	333.6	329.1	319.0	14.63
02-Jun	153	44.8720	-87.4105	467573	4968596	99.83	15.2	14.9	0.15	1002	349.6	344.9	334.3	15.26
02-Jun	153	44.8633	-87.4048	468016	4967630	100.90	15.4	15.1	0.15	1002	338.0	333.5	323.2	14.68
02-Jun	153	44.8525	-87.3965	468669	4966425	102.27	15.5	15.2	0.15	1002	332.4	328.0	317.8	14.40
02-Jun	153	44.8437	-87.3893	469230	4965440	103.40	15.7	15.4	0.15	1002	356.5	352.0	341.0	15.34
02-Jun	153	44.8357	-87.3825	469766	4964549	104.44	15.5	15.2	0.15	1002	384.6	379.6	367.8	16.62
02-Jun	153	44.8338	-87.3812	469870	4964344	104.67	15.5	15.2	0.15	1002	396.2	391.1	378.9	17.12
02-Jun	153	44.8320	-87.3797	469987	4964141	104.90	15.5	15.2	0.15	1002	396.2	391.1	378.9	17.13

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
02-Jun	153	44.8298	-87.3807	469907	4963899	105.16	15.5	15.2	0.15	1002	408.1	402.8	390.2	17.64
03-Jun	154	44.8516	-87.3961	468700	4966325	0	16.0	15.7	0.15	1004	363.7	359.4	348.6	15.53
03-Jun	154	44.8569	-87.4004	468365	4966911	0.67	15.9	15.6	0.15	1004	344.6	340.5	330.3	14.76
03-Jun	154	44.8645	-87.4056	467953	4967767	1.62	15.9	15.6	0.15	1004	340.5	336.5	326.4	14.58
03-Jun	154	44.9149	-87.4578	463862	4973381	8.57	15.5	15.2	0.15	1004	333.4	329.3	319.6	14.46
03-Jun	154	44.9187	-87.4803	462089	4973810	10.40	15.2	14.9	0.15	1004	327.9	323.8	314.4	14.36
03-Jun	154	44.9199	-87.4922	461150	4973949	11.34	15.2	14.9	0.15	1004	328.2	324.1	314.6	14.37
03-Jun	154	44.9226	-87.5200	458962	4974272	13.56	14.9	14.6	0.15	1004	348.6	344.1	334.2	15.41
03-Jun	154	44.9238	-87.5319	458025	4974411	14.50	15.0	14.7	0.15	1004	349.1	344.6	334.6	15.38
03-Jun	154	44.9258	-87.5517	456462	4974643	16.08	14.8	14.5	0.15	1004	351.7	347.1	337.2	15.59
03-Jun	154	44.9278	-87.5715	454899	4974876	17.66	14.4	14.1	0.15	1004	390.2	385.0	374.2	17.53
03-Jun	154	44.9278	-87.5715	454899	4974876	17.66	14.4	14.1	0.15	1004	397.7	392.4	381.3	17.86
03-Jun	154	44.9169	-87.5879	453595	4973670	19.44	16.3	16.0	0.15	1004	350.7	346.7	336.1	14.83
03-Jun	154	44.9111	-87.5960	452949	4973032	20.35	16.6	16.3	0.15	1004	368.2	364.0	352.9	15.43
03-Jun	154	44.9014	-87.6098	451872	4971967	21.86	16.9	16.6	0.15	1004	344.8	341.0	330.4	14.31
03-Jun	154	44.8957	-87.6177	451225	4971327	22.77	16.6	16.3	0.15	1004	328.7	324.9	315.0	13.77
03-Jun	154	44.8802	-87.6394	449502	4969623	25.20	17.2	16.9	0.15	1004	306.0	302.6	293.1	12.58
03-Jun	154	44.8725	-87.6502	448638	4968771	26.41	17.3	17.0	0.15	1004	305.0	301.7	292.2	12.50
03-Jun	154	44.8611	-87.6658	447394	4967520	28.17	17.5	17.3	0.15	1004	300.0	296.8	287.3	12.18
03-Jun	154	44.8556	-87.6733	446797	4966909	29.03	17.6	17.4	0.15	1004	310.7	307.5	297.7	12.58
03-Jun	154	44.8480	-87.6836	445978	4966078	30.19	17.8	17.6	0.15	1004	310.0	306.8	297.0	12.48
03-Jun	154	44.8401	-87.6947	445096	4965205	31.44	18.0	17.8	0.15	1004	297.1	294.1	284.5	11.88
03-Jun	154	44.8223	-87.7196	443109	4963240	34.23	18.1	17.9	0.15	1004	292.7	289.8	280.4	11.67
03-Jun	154	44.8143	-87.7307	442226	4962367	35.47	17.7	17.5	0.15	1004	292.5	289.5	280.2	11.81
03-Jun	154	44.8044	-87.7445	441122	4961276	37.02	17.9	17.7	0.15	1004	280.7	277.8	268.8	11.26
03-Jun	154	44.7945	-87.7584	440013	4960181	38.58	18.1	17.9	0.15	1004	286.2	283.3	274.1	11.41
03-Jun	154	44.7709	-87.7815	438162	4957578	41.78	18.1	17.9	0.15	1002	245.3	242.8	234.4	9.76
03-Jun	154	44.7620	-87.7892	437543	4956595	42.94	18.1	17.9	0.15	1002	254.8	252.2	243.5	10.14
03-Jun	154	44.7397	-87.8084	435995	4954138	45.84	18.2	18.0	0.15	1002	245.7	243.3	234.8	9.75
03-Jun	154	44.7127	-87.8332	434004	4951153	49.43	18.1	17.9	0.15	1002	258.4	255.8	247.0	10.28
03-Jun	154	44.7059	-87.8394	433503	4950406	50.33	18.1	17.9	0.15	1002	262.8	260.1	251.1	10.46
03-Jun	154	44.6946	-87.8498	432668	4949161	51.83	18.2	18.0	0.15	1002	252.3	249.8	241.1	10.01
03-Jun	154	44.6743	-87.8685	431163	4946920	54.53	18.3	18.1	0.15	1002	300.7	297.7	287.3	11.89
03-Jun	154	44.6720	-87.8705	430996	4946671	54.83	18.3	18.1	0.15	1002	274.9	272.1	262.6	10.87
03-Jun	154	44.6630	-87.8788	430326	4945675	56.03	18.2	18.0	0.15	1002	281.9	279.1	269.3	11.18

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
03-Jun	154	44.7385	-87.7705	438993	4953972	68.03	17.6	17.4	0.15	1001	273.9	271.0	261.7	11.06
03-Jun	154	44.7423	-87.7648	439448	4954392	68.65	17.5	17.3	0.15	1001	268.6	265.8	256.6	10.88
03-Jun	154	44.7595	-87.7392	441496	4956282	71.43	17.2	16.9	0.15	1001	329.1	325.6	314.5	13.50
03-Jun	154	44.7652	-87.7306	442178	4956914	72.36	17.2	16.9	0.15	1001	340.3	336.6	325.2	13.96
03-Jun	154	44.7767	-87.7135	443542	4958176	74.22	16.8	16.5	0.15	1001	317.2	313.7	303.1	13.17
03-Jun	154	44.7843	-87.7021	444451	4959017	75.46	16.7	16.4	0.15	1001	339.1	335.3	324.1	14.12
03-Jun	154	44.7958	-87.6851	445815	4960278	77.32	16.5	16.2	0.15	1001	316.7	313.1	302.7	13.27
03-Jun	154	44.7996	-87.6794	446269	4960700	77.94	16.5	16.2	0.15	1001	325.6	321.8	311.2	13.64
03-Jun	154	44.8206	-87.6480	448766	4963014	81.34	16.3	16.0	0.15	1001	332.9	329.1	318.0	14.03
03-Jun	154	44.8283	-87.6366	449674	4963856	82.58	16.4	16.1	0.15	1001	321.3	317.6	306.9	13.50
03-Jun	154	44.8340	-87.6281	450354	4964487	83.51	16.4	16.1	0.15	1001	316.2	312.6	302.1	13.29
03-Jun	154	44.8465	-87.6069	452035	4965864	85.68	16.3	16.0	0.15	1001	328.9	325.1	314.2	13.86
03-Jun	154	44.8530	-87.5940	453064	4966577	86.93	16.2	15.9	0.15	1001	344.8	340.8	329.4	14.58
03-Jun	154	44.8595	-87.5810	454094	4967289	88.18	15.8	15.5	0.15	1001	344.8	340.7	329.4	14.76
03-Jun	154	44.8676	-87.5648	455381	4968180	89.75	16.0	15.7	0.15	1001	328.2	324.3	313.5	13.96
03-Jun	154	44.8757	-87.5486	456667	4969071	91.31	16.3	16.0	0.15	1001	310.0	306.4	296.2	13.07
03-Jun	154	44.8968	-87.5065	460009	4971390	95.38	15.9	15.6	0.15	1001	298.5	294.9	285.2	12.74
03-Jun	154	44.9000	-87.4923	461131	4971743	96.56	15.6	15.3	0.15	1001	301.6	297.9	288.2	13.00
03-Jun	154	44.9000	-87.4769	462348	4971736	97.77	15.8	15.5	0.15	1001	297.6	294.0	284.3	12.74
03-Jun	154	44.9000	-87.4615	463566	4971728	98.99	15.8	15.5	0.15	1000	298.0	294.4	284.5	12.75
03-Jun	154	44.9000	-87.4460	464783	4971722	100.21	15.4	15.1	0.15	1000	301.6	297.9	287.9	13.07
03-Jun	154	44.8956	-87.4276	466235	4971222	101.74	14.4	14.1	0.15	1000	332.7	328.3	317.6	14.88
03-Jun	154	44.8926	-87.4205	466797	4970891	102.40	14.3	14.0	0.15	1000	344.3	339.7	328.7	15.45
03-Jun	154	44.8858	-87.4118	467476	4970132	103.42	15.4	15.1	0.15	1000	334.6	330.5	319.4	14.49
03-Jun	154	44.8800	-87.4096	467651	4969489	104.08	16.1	15.8	0.15	1000	310.0	306.4	295.9	13.14
03-Jun	154	44.8704	-87.4058	467943	4968419	105.19	16.3	16.0	0.15	1000	309.8	306.2	295.7	13.05
03-Jun	154	44.8608	-87.4020	468235	4967348	106.30	16.3	16.0	0.15	1000	313.9	310.2	299.5	13.22
03-Jun	154	44.8531	-87.3990	468469	4966493	107.19	16.3	16.0	0.15	1000	321.3	317.5	306.6	13.53
03-Jun	154	44.8473	-87.3968	468645	4965850	107.85	16.4	16.1	0.15	1000	344.6	340.6	328.9	14.47
03-Jun	154	44.8396	-87.3938	468878	4964993	108.74	16.3	16.0	0.15	1000	363.2	359.0	346.7	15.30
03-Jun	154	44.8338	-87.3915	469054	4964351	109.41	16.3	16.0	0.15	1000	371.7	367.4	354.8	15.65
13-Jul	194	44.5203	-88.0125	419534	4929948	0	23.8	23.6	0.17	1000	228.6	226.7	216.5	7.65
13-Jul	194	44.5203	-88.0125	419534	4929948	0.00	23.8	23.7	0.17	1000	204.6	202.9	193.7	6.84
13-Jul	194	44.5275	-88.0085	419862	4930742	0.86	23.9	23.7	0.17	1000	169.4	168.0	160.3	5.65
13-Jul	194	44.5303	-88.0080	419905	4931054	1.17	24.0	23.8	0.17	1000	183.4	181.9	173.6	6.11

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
13-Jul	194	44.5490	-87.9988	420659	4933120	3.37	24.4	24.3	0.18	1000	183.7	182.2	173.8	6.03
13-Jul	194	44.5813	-87.9798	422211	4936692	7.27	22.5	22.3	0.18	1000	184.0	182.5	174.7	6.40
13-Jul	194	44.5835	-87.9750	422598	4936930	7.72	22.3	22.1	0.18	1000	172.1	170.7	163.4	6.02
13-Jul	194	44.5943	-87.9522	424424	4938110	9.90	22.2	22.0	0.18	1000	264.6	262.4	251.3	9.29
13-Jul	194	44.5985	-87.9487	424707	4938571	10.44	22.2	22.0	0.18	1000	280.6	278.3	266.6	9.86
13-Jul	194	44.6107	-87.9377	425595	4939912	12.05	22.1	21.9	0.18	1000	336.5	333.7	319.7	11.86
13-Jul	194	44.6142	-87.9343	425865	4940298	12.52	22.0	21.8	0.17	1000	350.0	347.1	332.5	12.35
13-Jul	194	44.6327	-87.9173	427237	4942337	14.97	21.8	21.6	0.16	1000	464.8	460.9	441.8	16.50
13-Jul	194	44.6360	-87.9143	427479	4942706	15.42	21.8	21.6	0.16	1000	463.4	459.6	440.5	16.48
13-Jul	194	44.6462	-87.9230	426805	4943842	16.74	21.6	21.4	0.16	1000	470.5	466.6	447.3	16.80
13-Jul	194	44.6497	-87.9292	426319	4944236	17.36	21.4	21.2	0.15	1000	451.0	447.3	428.9	16.21
13-Jul	194	44.6587	-87.9415	425354	4945247	18.76	21.5	21.3	0.15	1000	425.2	421.6	404.3	15.25
13-Jul	194	44.6582	-87.9273	426476	4945179	19.88	21.3	21.1	0.15	1000	449.2	445.4	427.2	16.18
13-Jul	194	44.6578	-87.9173	427268	4945132	20.68	21.3	21.1	0.15	1000	475.5	471.5	452.2	17.13
13-Jul	194	44.6578	-87.9107	427796	4945126	21.21	21.4	21.2	0.15	1000	485.6	481.6	461.8	17.45
13-Jul	194	44.6580	-87.8953	429013	4945133	22.42	21.4	21.2	0.15	1000	475.0	471.0	451.7	17.07
13-Jul	194	44.6582	-87.8830	429991	4945140	23.40	21.5	21.3	0.15	1001	462.1	458.3	439.7	16.58
13-Jul	194	44.6655	-87.8618	431678	4945937	25.27	21.2	21.0	0.15	1001	450.7	446.9	429.2	16.32
13-Jul	194	44.6648	-87.8523	432430	4945854	26.02	21.2	21.0	0.15	1001	455.1	451.3	433.4	16.49
13-Jul	194	44.6637	-87.8338	433895	4945710	27.50	21.2	21.0	0.15	1001	491.9	487.8	468.5	17.80
13-Jul	194	44.6618	-87.8105	435744	4945487	29.36	21.3	21.1	0.15	1001	527.8	523.4	502.6	19.06
13-Jul	194	44.6610	-87.7997	436601	4945387	30.22	21.3	21.1	0.16	1001	551.5	546.9	525.1	19.91
13-Jul	194	44.6587	-87.7692	439016	4945104	32.65	21.7	21.5	0.16	1001	550.5	546.0	524.0	19.62
13-Jul	194	44.6592	-87.7622	439572	4945154	33.21	21.9	21.7	0.16	1001	496.8	492.8	472.7	17.63
13-Jul	194	44.6852	-87.7802	438172	4948056	36.43	21.5	21.2	0.16	1001	544.3	539.8	518.2	19.56
13-Jul	194	44.6942	-87.7865	437681	4949060	37.55	21.3	21.1	0.15	1001	507.0	502.8	482.8	18.30
13-Jul	194	44.7223	-87.8057	436192	4952203	41.03	20.8	20.5	0.15	1001	517.4	513.0	493.0	18.99
13-Jul	194	44.7275	-87.8090	435935	4952781	41.66	20.7	20.5	0.15	1001	511.6	507.2	487.5	18.81
13-Jul	194	44.7435	-87.8205	435042	4954568	43.66	20.4	20.2	0.15	1001	485.1	480.9	462.3	17.97
13-Jul	194	44.7483	-87.8238	434783	4955106	44.25	20.4	20.2	0.15	1001	482.2	477.9	459.6	17.88
13-Jul	194	44.7560	-87.8287	434409	4955963	45.19	20.4	20.2	0.15	1001	472.9	468.7	450.7	17.55
13-Jul	194	44.7668	-87.8360	433842	4957171	46.52	20.3	20.1	0.15	1001	460.8	456.7	439.2	17.12
13-Jul	194	44.7773	-87.8430	433300	4958343	47.81	20.3	20.0	0.15	1001	482.2	477.9	459.6	17.97
13-Jul	194	44.7875	-87.8498	432770	4959479	49.07	20.3	20.0	0.15	1001	485.4	481.1	462.8	18.09
13-Jul	194	44.7965	-87.8560	432294	4960484	50.18	20.3	20.1	0.15	1001	431.3	427.5	411.2	16.04
13-Jul	194	44.8007	-87.8552	432363	4960945	50.65	20.4	20.2	0.15	1001	386.6	383.2	368.5	14.34

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
13-Jul	194	44.7998	-87.8420	433405	4960841	51.69	20.4	20.2	0.15	1001	350.5	347.4	334.1	13.00
13-Jul	194	44.7982	-87.8283	434483	4960646	52.79	20.5	20.3	0.15	1001	328.6	325.7	313.2	12.14
13-Jul	194	44.7965	-87.8112	435839	4960448	54.16	20.4	20.2	0.15	1001	387.4	384.0	369.3	14.35
13-Jul	194	44.7958	-87.7947	437143	4960359	55.47	20.5	20.3	0.15	1001	425.1	421.4	405.2	15.73
13-Jul	194	44.7952	-87.7747	438724	4960271	57.05	20.4	20.2	0.15	1001	462.8	458.7	441.2	17.19
13-Jul	194	44.7943	-87.7573	440095	4960164	58.43	20.2	20.0	0.15	1001	455.6	451.6	434.4	17.01
13-Jul	194	44.7947	-87.7380	441625	4960188	59.96	20.0	19.8	0.15	1001	457.6	453.5	436.2	17.17
13-Jul	194	44.7943	-87.7040	444314	4960126	62.65	20.2	20.0	0.15	1000	457.9	453.8	436.1	17.09
13-Jul	194	44.7952	-87.6958	444960	4960214	63.30	20.3	20.1	0.15	1000	449.7	445.8	428.4	16.73
13-Jul	194	44.8100	-87.7112	443762	4961873	65.34	20.5	20.2	0.15	1000	433.7	429.9	413.0	16.05
13-Jul	194	44.8167	-87.7180	443229	4962618	66.26	20.5	20.2	0.15	1000	441.1	437.2	420.0	16.32
13-Jul	194	44.8230	-87.7243	442734	4963326	67.12	20.4	20.2	0.15	1000	429.2	425.4	408.7	15.92
13-Jul	194	44.8317	-87.7332	442044	4964295	68.31	20.2	20.0	0.15	1000	428.2	424.4	407.9	15.97
13-Jul	194	44.8380	-87.7390	441590	4965003	69.16	20.1	19.8	0.15	1000	438.6	434.7	417.8	16.43
13-Jul	194	44.8590	-87.7580	440110	4967350	71.93	20.0	19.7	0.15	1000	327.8	324.8	312.3	12.31
13-Jul	194	44.8630	-87.7620	439798	4967797	72.47	20.0	19.8	0.15	1000	441.1	437.1	420.2	16.56
13-Jul	194	44.8705	-87.7695	439213	4968636	73.50	20.0	19.8	0.15	1000	469.4	465.1	447.1	17.61
13-Jul	194	44.8787	-87.7785	438511	4969549	74.65	19.6	19.4	0.15	1000	452.9	448.8	431.7	17.21
13-Jul	194	44.8858	-87.7867	437873	4970350	75.67	19.3	19.1	0.15	1000	440.4	436.2	419.7	16.86
13-Jul	194	44.9007	-87.8000	436837	4972009	77.63	19.6	19.4	0.15	1000	416.5	412.6	396.9	15.80
13-Jul	194	44.9012	-87.7903	437600	4972057	78.39	19.7	19.5	0.15	1000	403.2	399.4	384.2	15.27
13-Jul	194	44.9015	-87.7745	438851	4972083	79.65	19.9	19.7	0.15	1000	416.0	412.2	396.1	15.65
13-Jul	194	44.9017	-87.7643	439654	4972093	80.45	20.0	19.7	0.15	1000	428.7	424.8	408.3	16.10
13-Jul	194	44.9018	-87.7583	440127	4972107	80.92	20.0	19.8	0.15	1000	429.2	425.3	408.7	16.11
13-Jul	194	44.9025	-87.7440	441260	4972172	82.06	20.0	19.7	0.15	1000	433.7	429.7	413.0	16.28
13-Jul	194	44.9033	-87.7318	442221	4972254	83.02	19.9	19.7	0.15	1000	428.4	424.6	408.0	16.10
13-Jul	194	44.9038	-87.7228	442932	4972303	83.73	19.9	19.7	0.15	1000	441.6	437.6	420.5	16.59
13-Jul	194	44.9047	-87.7090	444026	4972387	84.83	19.9	19.7	0.15	1000	465.7	461.5	443.5	17.50
13-Jul	194	44.9053	-87.6952	445117	4972451	85.92	19.9	19.7	0.15	1000	464.7	460.5	442.6	17.46
13-Jul	194	44.9072	-87.6515	448567	4972626	89.38	19.9	19.7	0.15	1000	477.4	473.1	454.7	17.94
13-Jul	194	44.9078	-87.6327	450054	4972688	90.87	19.9	19.7	0.15	1000	458.8	454.7	437.0	17.25
13-Jul	194	44.9083	-87.6172	451278	4972734	92.09	19.9	19.7	0.15	1000	482.0	477.7	459.1	18.12
13-Jul	194	44.9092	-87.5938	453121	4972814	93.94	19.9	19.7	0.15	1000	465.0	460.7	442.8	17.50
13-Jul	194	44.9103	-87.5715	454886	4972930	95.70	19.8	19.6	0.15	1000	477.4	473.1	454.7	17.99
13-Jul	194	44.9113	-87.5567	456056	4973033	96.88	19.8	19.6	0.15	1000	489.0	484.6	465.6	18.45
13-Jul	194	44.9128	-87.5400	457374	4973191	98.21	19.7	19.5	0.15	1000	488.8	484.3	465.4	18.47

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
13-Jul	194	44.9142	-87.5163	459243	4973327	100.08	19.6	19.4	0.15	1000	500.8	496.2	476.9	18.99
13-Jul	194	44.9155	-87.4953	460901	4973466	101.74	19.4	19.1	0.15	1000	501.3	496.6	477.5	19.17
13-Jul	194	44.9163	-87.4705	462862	4973545	103.71	19.5	19.3	0.15	1000	453.2	449.0	431.6	17.25
13-Jul	194	44.9117	-87.4518	464332	4973019	105.27	19.7	19.5	0.15	1000	440.4	436.3	419.3	16.65
13-Jul	194	44.9048	-87.4408	465197	4972255	106.42	19.9	19.7	0.15	1000	440.6	436.6	419.4	16.55
13-Jul	194	44.8910	-87.4197	466859	4970711	108.69	20.0	19.8	0.15	1000	500.3	495.9	476.3	18.75
13-Jul	194	44.8867	-87.4133	467357	4970226	109.39	20.1	19.9	0.15	1000	488.5	484.2	465.0	18.26
13-Jul	194	44.8832	-87.4133	467355	4969837	109.78	20.1	19.9	0.15	1000	496.3	491.8	472.4	18.54
13-Jul	194	44.8787	-87.4137	467326	4969337	110.28	20.1	19.9	0.15	1000	500.8	496.4	476.7	18.71
13-Jul	194	44.8730	-87.4115	467495	4968708	110.93	20.1	19.9	0.15	1000	500.8	496.4	476.7	18.70
13-Jul	194	44.8675	-87.4083	467742	4968096	111.59	20.2	19.9	0.15	1000	493.6	489.2	469.8	18.42
13-Jul	194	44.8628	-87.4050	468003	4967574	112.17	20.2	20.0	0.15	1000	489.0	484.7	465.4	18.23
13-Jul	194	44.8572	-87.4013	468289	4966944	112.86	20.2	20.0	0.15	1000	464.7	460.6	442.3	17.29
13-Jul	194	44.8522	-87.3968	468642	4966387	113.52	20.3	20.1	0.15	1000	465.0	460.8	442.5	17.28
13-Jul	194	44.8397	-87.3865	469452	4964995	115.13	20.2	20.0	0.15	999	465.5	461.3	442.7	17.32
13-Jul	194	44.8352	-87.3827	469752	4964493	115.72	20.1	19.9	0.15	999	500.8	496.4	476.4	18.68
13-Jul	194	44.8333	-87.3810	469884	4964288	115.96	20.1	19.9	0.15	999	589.0	583.8	560.3	22.02
13-Jul	194	44.8297	-87.3790	470040	4963881	116.40	20.0	19.8	0.15	999	607.5	602.1	577.9	22.75
13-Jul	194	44.8282	-87.3787	470064	4963714	116.57	20.0	19.8	0.15	999	636.7	631.0	605.7	23.86
14-Jul	195	44.9768	-87.4347	465727	4980251	0	19.2	19.0	0.14	996	401.3	397.4	381.0	15.36
14-Jul	195	44.9805	-87.4362	465611	4980660	0.42	19.2	19.0	0.14	996	397.5	393.7	377.4	15.20
14-Jul	195	44.9865	-87.4382	465457	4981327	1.11	19.1	18.9	0.14	996	401.0	397.2	380.8	15.40
14-Jul	195	44.9920	-87.4398	465329	4981939	1.73	19.0	18.8	0.14	996	399.1	395.2	378.9	15.35
14-Jul	195	44.9978	-87.4405	465280	4982587	2.38	19.1	18.9	0.14	996	390.1	386.3	370.3	14.98
14-Jul	195	45.0122	-87.4437	465039	4984181	4.00	19.2	18.9	0.14	996	422.9	418.9	401.3	16.21
14-Jul	195	45.0213	-87.4487	464650	4985201	5.09	18.7	18.5	0.14	996	419.8	415.7	398.4	16.31
14-Jul	195	45.0310	-87.4580	463921	4986279	6.39	18.8	18.6	0.14	996	408.8	404.7	387.9	15.84
14-Jul	195	45.0373	-87.4640	463452	4986985	7.24	18.9	18.7	0.14	996	388.7	385.0	368.9	15.01
14-Jul	195	45.0443	-87.4707	462932	4987765	8.18	19.0	18.7	0.14	996	379.8	376.1	360.3	14.64
14-Jul	195	45.0548	-87.4808	462138	4988937	9.59	18.9	18.6	0.14	995	379.8	376.1	360.3	14.68
14-Jul	195	45.0772	-87.5070	460093	4991431	12.82	18.9	18.7	0.14	995	361.9	358.4	343.3	13.97
14-Jul	195	45.0880	-87.5292	458356	4992645	14.93	18.8	18.6	0.14	995	390.1	386.2	370.0	15.10
14-Jul	195	45.0923	-87.5445	457153	4993134	16.23	18.7	18.4	0.14	995	401.3	397.3	380.7	15.60
14-Jul	195	45.0952	-87.5663	455437	4993461	17.98	18.3	18.0	0.14	995	398.4	394.3	378.1	15.68
14-Jul	195	45.0970	-87.5825	454166	4993674	19.27	18.4	18.1	0.14	995	411.9	407.7	390.8	16.16

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
14-Jul	195	45.0952	-87.5893	453627	4993474	19.84	20.2	20.0	0.14	995	654.9	649.2	620.8	24.27
14-Jul	195	45.0948	-87.5943	453233	4993439	20.24	20.9	20.7	0.14	995	730.3	724.2	691.8	26.51
14-Jul	195	45.0948	-87.5967	453050	4993441	20.42	21.4	21.2	0.14	995	852.4	845.4	807.0	30.53
14-Jul	195	45.0948	-87.5967	453050	4993441	20.42	21.4	21.2	0.14	995	951.7	944.0	901.1	34.09
14-Jul	195	45.0948	-87.5967	453050	4993441	20.42	21.4	21.2	0.14	995	956.9	949.1	906.0	34.27
14-Jul	195	45.0947	-87.5963	453076	4993423	20.45	21.8	21.6	0.14	995	951.7	944.1	900.4	33.69
14-Jul	195	45.0955	-87.5878	453745	4993510	21.13	21.8	21.6	0.14	995	958.7	951.1	907.1	33.94
14-Jul	195	45.0988	-87.5777	454548	4993874	22.01	21.6	21.4	0.14	995	942.9	935.3	892.3	33.56
14-Jul	195	45.0962	-87.5712	455057	4993575	22.60	19.5	19.3	0.14	995	664.5	658.4	630.1	25.18
14-Jul	195	45.0870	-87.5645	455575	4992553	23.75	18.5	18.3	0.14	995	522.7	517.5	495.9	20.40
14-Jul	195	45.0678	-87.5572	456137	4990419	25.95	18.4	18.1	0.14	995	515.1	509.9	488.7	20.21
14-Jul	195	45.0562	-87.5588	455997	4989125	27.26	18.5	18.3	0.14	995	492.3	487.4	467.0	19.24
14-Jul	195	45.0400	-87.5608	455827	4987330	29.06	18.7	18.5	0.14	995	481.0	476.3	456.3	18.67
14-Jul	195	45.0203	-87.5628	455655	4985146	31.25	18.9	18.7	0.14	995	511.8	506.9	485.4	19.76
14-Jul	195	44.9757	-87.5668	455305	4980187	36.22	19.1	18.8	0.14	995	556.8	551.6	528.1	21.39
14-Jul	195	44.9402	-87.5700	455027	4976245	40.17	19.2	19.0	0.14	995	640.0	634.0	607.0	24.49
14-Jul	195	44.9305	-87.5708	454954	4975171	41.25	19.2	19.0	0.14	995	523.2	518.2	496.1	19.99
14-Jul	195	44.9243	-87.5523	456409	4974476	42.86	19.4	19.1	0.14	995	477.7	473.3	452.8	18.17
14-Jul	195	44.9237	-87.5400	457382	4974396	43.84	19.4	19.2	0.14	995	465.5	461.1	441.2	17.68
14-Jul	195	44.9218	-87.5185	459078	4974180	45.55	19.4	19.1	0.14	995	465.5	461.1	441.2	17.71
14-Jul	195	44.9197	-87.4967	460799	4973930	47.29	19.2	19.0	0.14	995	492.3	487.6	466.6	18.80
14-Jul	195	44.9172	-87.4693	462955	4973639	49.46	19.1	18.9	0.14	995	490.4	485.7	464.9	18.81
14-Jul	195	44.9100	-87.4488	464569	4972833	51.27	19.0	18.8	0.14	995	465.2	460.8	441.1	17.88
14-Jul	195	44.9013	-87.4355	465616	4971865	52.69	18.9	18.7	0.14	995	480.8	476.1	455.9	18.54
14-Jul	195	44.8930	-87.4232	466585	4970934	54.04	19.0	18.7	0.14	995	480.8	476.2	455.8	18.51
14-Jul	195	44.8883	-87.4163	467122	4970413	54.78	18.9	18.7	0.14	995	500.2	495.4	474.3	19.29
14-Jul	195	44.8525	-87.3972	468616	4966425	59.04	19.4	19.2	0.14	995	580.6	575.2	550.4	22.06
14-Jul	195	44.8492	-87.3945	468825	4966054	59.47	19.4	19.2	0.14	995	589.8	584.4	559.1	22.40
15-Jul	196	45.0152	-87.3840	469742	4984490	0	17.6	17.3	0.14	996	749.8	741.9	712.7	30.22
15-Jul	196	45.0298	-87.3792	470130	4986117	1.67	18.6	18.4	0.14	996	607.0	601.1	576.6	23.67
15-Jul	196	45.0475	-87.3670	471098	4988075	3.86	19.1	18.9	0.14	996	509.9	505.0	484.1	19.59
15-Jul	196	45.0708	-87.3497	472474	4990661	6.79	19.9	19.7	0.14	996	436.4	432.5	414.1	16.34
15-Jul	196	45.0855	-87.3377	473425	4992287	8.67	20.8	20.6	0.14	996	408.9	405.4	387.7	14.92
15-Jul	196	45.1043	-87.3218	474680	4994373	11.10	19.8	19.6	0.14	996	408.7	405.0	387.8	15.35
15-Jul	196	45.1202	-87.3092	475683	4996129	13.13	20.1	19.8	0.14	996	421.4	417.6	399.8	15.72

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
15-Jul	196	45.1345	-87.2975	476607	4997718	14.96	20.1	19.9	0.14	996	428.8	425.0	406.8	15.96
15-Jul	196	45.1468	-87.2887	477306	4999085	16.50	20.1	19.9	0.14	996	408.9	405.3	388.0	15.24
15-Jul	196	45.1692	-87.2753	478363	5001563	19.19	20.0	19.8	0.14	997	433.3	429.4	411.5	16.20
15-Jul	196	45.1860	-87.2658	479116	5003430	21.21	20.0	19.8	0.14	997	425.2	421.4	403.8	15.90
15-Jul	196	45.2003	-87.2573	479789	5005020	22.93	20.0	19.8	0.14	997	425.0	421.2	403.6	15.89
15-Jul	196	45.2152	-87.2785	478132	5006674	25.27	19.7	19.4	0.14	997	420.2	416.3	399.2	15.89
15-Jul	196	45.2220	-87.2882	477375	5007435	26.35	19.6	19.4	0.14	998	408.9	405.1	388.7	15.50
15-Jul	196	45.2277	-87.2962	476749	5008067	27.24	19.5	19.3	0.14	998	401.5	397.7	381.6	15.25
15-Jul	196	45.2338	-87.3048	476072	5008754	28.20	19.4	19.2	0.14	998	390.6	386.9	371.3	14.89
15-Jul	196	45.2450	-87.3213	474782	5010000	30.00	19.2	19.0	0.14	998	385.6	381.9	366.6	14.77
15-Jul	196	45.2512	-87.3302	474091	5010688	30.97	19.2	19.0	0.14	998	384.8	381.2	365.9	14.74
15-Jul	196	45.2560	-87.3370	473557	5011227	31.73	19.3	19.1	0.14	998	385.3	381.7	366.3	14.73
15-Jul	196	45.2733	-87.3950	469015	5013173	36.67	19.4	19.2	0.14	998	418.1	414.1	397.4	15.91
15-Jul	196	45.2617	-87.4030	468381	5011881	38.11	19.5	19.3	0.14	998	405.1	401.3	385.1	15.39
15-Jul	196	45.2518	-87.4102	467813	5010791	39.34	19.5	19.3	0.14	998	401.2	397.5	381.4	15.24
15-Jul	196	45.2357	-87.4213	466928	5009000	41.34	19.4	19.2	0.14	998	407.3	403.4	387.1	15.50
15-Jul	196	45.2235	-87.4297	466266	5007651	42.84	19.6	19.4	0.14	998	401.2	397.5	381.4	15.21
15-Jul	196	45.2078	-87.4402	465432	5005915	44.76	19.8	19.6	0.14	998	386.0	382.5	366.9	14.52
15-Jul	196	45.1595	-87.4733	462797	5000561	50.73	20.0	19.8	0.14	998	373.0	369.6	354.5	13.95
15-Jul	196	45.1532	-87.4780	462426	4999860	51.53	19.9	19.7	0.14	998	382.2	378.7	363.3	14.33
15-Jul	196	45.1278	-87.4950	461072	4997053	54.64	19.8	19.6	0.14	998	385.1	381.5	366.1	14.49
15-Jul	196	45.1177	-87.5020	460515	4995927	55.90	19.8	19.6	0.14	998	393.8	390.2	374.4	14.83
15-Jul	196	45.1177	-87.5020	460515	4995927	55.90	19.8	19.5	0.14	998	405.1	401.4	385.2	15.28
15-Jul	196	45.0850	-87.5230	458839	4992309	59.89	19.7	19.5	0.14	998	389.7	386.1	370.5	14.72
15-Jul	196	45.0732	-87.5310	458201	4990999	61.34	19.7	19.5	0.14	998	396.2	392.5	376.7	14.95
15-Jul	196	45.0642	-87.5403	457460	4990004	62.58	19.7	19.5	0.14	998	409.2	405.4	389.1	15.44
15-Jul	196	45.0490	-87.5452	457068	4988321	64.31	20.0	19.7	0.14	998	400.8	397.1	381.0	15.02
15-Jul	196	45.0312	-87.5490	456753	4986342	66.31	20.0	19.8	0.14	998	401.2	397.6	381.5	15.00
15-Jul	196	44.9927	-87.5573	456067	4982070	70.64	20.2	20.0	0.14	998	406.1	402.4	386.0	15.12
15-Jul	196	44.9812	-87.5593	455901	4980794	71.93	20.2	20.0	0.14	998	400.3	396.7	380.5	14.89
15-Jul	196	44.9695	-87.5615	455720	4979498	73.24	20.3	20.0	0.14	998	382.7	379.2	363.7	14.21
15-Jul	196	44.9557	-87.5652	455420	4977964	74.80	20.0	19.8	0.14	998	367.6	364.3	349.5	13.77
15-Jul	196	44.9383	-87.5695	455065	4976040	76.76	20.2	20.0	0.14	998	398.8	395.3	379.1	14.85
15-Jul	196	44.9240	-87.5397	457408	4974432	79.60	20.4	20.2	0.14	998	325.5	322.6	309.2	12.03
15-Jul	196	44.9227	-87.5262	458473	4974278	80.67	20.5	20.3	0.14	998	322.5	319.7	306.3	11.90
15-Jul	196	44.9195	-87.4920	461167	4973909	83.39	20.5	20.3	0.14	998	342.0	338.9	324.8	12.59

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
15-Jul	196	44.9175	-87.4700	462903	4973676	85.14	20.5	20.3	0.14	998	342.5	339.4	325.3	12.63
15-Jul	196	44.9143	-87.4563	463980	4973318	86.28	20.5	20.3	0.14	998	342.5	339.4	325.2	12.63
15-Jul	196	44.9038	-87.4397	465288	4972144	88.04	20.5	20.3	0.14	998	353.5	350.3	335.7	13.02
15-Jul	196	44.8950	-87.4248	466455	4971157	89.57	21.1	20.8	0.14	998	353.7	350.7	335.7	12.82
15-Jul	196	44.8862	-87.4120	467463	4970171	90.98	20.3	20.0	0.14	998	448.6	444.6	426.2	16.65
15-Jul	196	44.8798	-87.4138	467315	4969467	91.69	20.3	20.1	0.14	998	467.9	463.8	444.6	17.37
15-Jul	196	44.8675	-87.4083	467742	4968096	93.13	20.3	20.1	0.14	998	256.8	254.5	243.9	9.52
15-Jul	196	44.8628	-87.4052	467989	4967576	93.71	20.3	20.1	0.14	998	494.9	490.6	470.2	18.33
15-Jul	196	44.8500	-87.3952	468772	4966146	95.34	20.4	20.2	0.14	998	475.0	470.8	451.2	17.55
15-Jul	196	44.8398	-87.3867	469439	4965013	96.65	20.4	20.2	0.14	998	486.7	482.5	462.4	17.98
15-Jul	196	44.8333	-87.3807	469910	4964289	97.52	20.0	19.8	0.14	998	551.4	546.5	524.0	20.62
15-Jul	196	44.8303	-87.3792	470027	4963955	97.87	20.0	19.7	0.14	998	782.6	775.7	743.9	29.33
02-Aug	214	44.5357	-88.0055	420111	4931645	0	24.8	24.6	0.19	1000	298.4	296.0	282.2	9.71
02-Aug	214	44.5385	-88.0030	420314	4931958	0.37	24.8	24.6	0.19	1000	365.3	362.4	345.4	11.87
02-Aug	214	44.5437	-88.0013	420453	4932530	0.96	25.2	25.0	0.19	1000	404.5	401.3	382.2	13.02
02-Aug	214	44.5533	-87.9965	420850	4933598	2.10	24.5	24.3	0.19	1000	453.9	450.4	429.5	14.91
02-Aug	214	44.5607	-87.9925	421178	4934410	2.98	23.9	23.7	0.18	1000	431.8	428.4	408.9	14.40
02-Aug	214	44.5693	-87.9873	421599	4935367	4.02	22.9	22.7	0.18	1000	386.4	383.3	366.5	13.26
02-Aug	214	44.5803	-87.9798	422210	4936581	5.38	22.6	22.4	0.17	1000	376.6	373.5	357.4	13.07
02-Aug	214	44.6060	-87.9417	425272	4939398	9.54	22.2	22.0	0.16	1000	330.1	327.4	313.4	11.57
02-Aug	214	44.6115	-87.9368	425663	4940005	10.26	22.1	21.9	0.16	1000	341.0	338.2	323.8	12.01
02-Aug	214	44.6235	-87.9257	426564	4941328	11.86	22.1	21.9	0.16	1000	232.9	231.0	221.1	8.19
02-Aug	214	44.6315	-87.9185	427144	4942210	12.92	22.1	21.9	0.15	1000	230.7	228.7	219.0	8.11
02-Aug	214	44.6410	-87.9127	427617	4943260	14.07	22.1	21.9	0.15	1000	213.5	211.7	202.7	7.51
02-Aug	214	44.6488	-87.9272	426477	4944141	15.51	22.3	22.1	0.15	1000	196.0	194.3	186.0	6.86
02-Aug	214	44.6590	-87.9432	425221	4945287	17.21	22.3	22.1	0.16	1000	172.6	171.2	163.9	6.04
02-Aug	214	44.6587	-87.9357	425815	4945242	17.81	22.3	22.1	0.16	1000	183.4	181.9	174.1	6.41
02-Aug	214	44.6580	-87.9215	426939	4945156	18.94	22.4	22.2	0.15	1000	166.8	165.4	158.3	5.82
02-Aug	214	44.6578	-87.9118	427704	4945127	19.70	22.4	22.2	0.15	1000	184.7	183.1	175.3	6.44
02-Aug	214	44.6578	-87.9010	428564	4945118	20.56	22.3	22.1	0.15	1000	196.2	194.6	186.3	6.86
02-Aug	214	44.6580	-87.8910	429357	4945129	21.35	22.2	22.0	0.15	1000	176.7	175.2	167.7	6.19
02-Aug	214	44.6580	-87.8830	429991	4945122	21.99	22.0	21.8	0.15	1000	**233.2**	231.2	221.4	8.23
02-Aug	214	44.6575	-87.8835	429951	4945067	22.06	21.9	21.7	0.15	1000	**249.5**	247.4	237.0	8.82
02-Aug	214	44.6580	-87.8808	430163	4945120	22.27	22.5	22.3	0.15	1000	194.2	192.6	184.4	6.75
02-Aug	214	44.6567	-87.8835	429950	4944974	22.53	22.5	22.3	0.15	1000	206.6	204.8	196.2	7.19

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
02-Aug	214	44.6603	-87.8788	430324	4945376	23.08	22.7	22.5	0.15	1001	229.1	227.2	217.6	7.93
02-Aug	214	44.6602	-87.8718	430879	4945353	23.64	22.8	22.6	0.15	1001	207.1	205.3	196.6	7.15
02-Aug	214	44.6597	-87.8615	431698	4945288	24.46	22.9	22.7	0.15	1001	194.5	192.9	184.6	6.69
02-Aug	214	44.6592	-87.8483	432741	4945222	25.50	22.9	22.7	0.15	1001	193.7	192.1	183.9	6.67
02-Aug	214	44.6587	-87.8372	433625	4945157	26.39	22.7	22.5	0.15	1001	212.1	210.3	201.4	7.35
02-Aug	214	44.6583	-87.8253	434563	4945110	27.33	22.5	22.3	0.15	1001	233.1	231.2	221.4	8.11
02-Aug	214	44.6580	-87.8140	435462	4945065	28.23	22.3	22.1	0.15	1001	256.0	253.9	243.2	8.95
02-Aug	214	44.6580	-87.8033	436307	4945057	29.07	22.2	22.0	0.15	1001	258.0	255.8	245.2	9.05
02-Aug	214	44.6578	-87.7940	437047	4945030	29.82	22.1	21.9	0.15	1001	252.8	250.6	240.3	8.91
02-Aug	214	44.6577	-87.7803	438130	4945001	30.90	21.9	21.7	0.15	1001	293.0	290.5	278.6	10.39
02-Aug	214	44.6578	-87.7682	439095	4945010	31.86	21.7	21.5	0.15	1001	324.8	322.0	308.9	11.58
02-Aug	214	44.6588	-87.7622	439571	4945117	32.35	21.3	21.1	0.15	1001	470.1	466.2	447.4	16.94
02-Aug	214	44.6648	-87.7665	439235	4945786	33.10	21.2	21.0	0.15	1001	581.9	577.0	553.9	21.07
02-Aug	214	44.6700	-87.7703	438936	4946365	33.75	21.3	21.1	0.15	1001	434.7	431.0	413.7	15.69
02-Aug	214	44.6775	-87.7758	438508	4947202	34.69	21.5	21.3	0.15	1001	353.4	350.4	336.2	12.67
02-Aug	214	44.6842	-87.7805	438146	4947945	35.52	21.2	21.0	0.15	1001	345.4	342.4	328.7	12.49
02-Aug	214	44.7050	-87.7943	437072	4950271	38.08	21.2	21.0	0.15	1001	347.6	344.6	330.8	12.56
02-Aug	214	44.7138	-87.7998	436646	4951255	39.15	21.2	21.0	0.15	1001	334.2	331.4	318.1	12.10
02-Aug	214	44.7212	-87.8045	436284	4952074	40.05	21.3	21.1	0.15	1001	335.5	332.6	319.2	12.10
02-Aug	214	44.7298	-87.8100	435858	4953040	41.10	21.6	21.4	0.15	1001	328.9	326.1	312.9	11.75
02-Aug	214	44.7387	-87.8157	435418	4954026	42.18	21.8	21.6	0.15	1001	280.0	277.6	266.2	9.95
02-Aug	214	44.7475	-87.8220	434928	4955013	43.29	22.1	21.9	0.15	1001	268.6	266.4	255.4	9.48
02-Aug	214	44.7577	-87.8288	434398	4956147	44.54	22.2	22.0	0.15	1001	281.4	279.1	267.5	9.89
02-Aug	214	44.7653	-87.8343	433971	4957003	45.49	22.3	22.1	0.15	1001	280.0	277.6	266.1	9.82
02-Aug	214	44.7723	-87.8392	433596	4957784	46.36	22.5	22.3	0.15	1001	280.9	278.6	267.0	9.79
02-Aug	214	44.7810	-87.8423	433356	4958751	47.36	22.6	22.4	0.15	1001	231.1	229.2	219.5	8.03
02-Aug	214	44.7877	-87.8475	432956	4959495	48.20	22.7	22.5	0.15	1001	207.1	205.3	196.7	7.16
02-Aug	214	44.7942	-87.8532	432514	4960222	49.05	22.8	22.6	0.15	1001	195.7	194.1	185.9	6.76
02-Aug	214	44.8000	-87.8582	432125	4960875	49.81	22.7	22.5	0.15	1001	206.6	204.8	196.2	7.14
02-Aug	214	44.7992	-87.8432	433311	4960769	51.00	22.9	22.7	0.15	1001	225.4	223.5	214.0	7.76
02-Aug	214	44.7983	-87.8363	433851	4960670	51.55	22.9	22.7	0.15	1001	225.6	223.8	214.2	7.76
02-Aug	214	44.7957	-87.8288	434441	4960369	52.21	22.9	22.7	0.15	1001	212.3	210.6	201.6	7.30
02-Aug	214	44.7922	-87.8192	435201	4959972	53.07	22.9	22.7	0.15	1001	211.1	209.3	200.4	7.27
02-Aug	214	44.7922	-87.8063	436217	4959962	54.09	22.8	22.6	0.15	1001	241.3	239.3	229.2	8.33
02-Aug	214	44.7938	-87.7882	437655	4960132	55.54	22.8	22.6	0.15	1001	253.3	251.2	240.5	8.75
02-Aug	214	44.7950	-87.7763	438593	4960254	56.48	22.6	22.4	0.15	1001	239.6	237.6	227.6	8.31

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
02-Aug	214	44.7945	-87.7585	440004	4960185	57.89	22.5	22.3	0.15	1001	249.0	247.0	236.6	8.67
02-Aug	214	44.7942	-87.7592	439949	4960148	57.96	22.0	21.8	0.15	1001	257.5	255.3	244.8	9.10
02-Aug	214	44.7942	-87.7592	439949	4960148	57.96	21.9	21.7	0.15	1001	265.6	263.4	252.6	9.41
02-Aug	214	44.7945	-87.7423	441282	4960174	59.29	21.9	21.7	0.15	1000	263.3	261.1	250.3	9.32
02-Aug	214	44.7943	-87.7343	441914	4960148	59.92	21.7	21.5	0.15	1000	282.2	279.8	268.3	10.06
02-Aug	214	44.7943	-87.7178	443220	4960136	61.23	21.3	21.1	0.15	1000	294.3	291.8	279.9	10.62
02-Aug	214	44.7942	-87.7053	444208	4960110	62.22	20.6	20.4	0.15	1000	388.0	384.6	369.3	14.27
02-Aug	214	44.7940	-87.6952	445012	4960085	63.02	19.7	19.5	0.15	1000	477.6	473.3	455.1	18.09
02-Aug	214	44.7977	-87.6988	444726	4960494	63.52	19.6	19.3	0.15	1000	513.3	508.6	489.1	19.51
02-Aug	214	44.8025	-87.7042	444308	4961035	64.21	20.0	19.8	0.15	1000	547.1	542.2	521.1	20.53
02-Aug	214	44.8083	-87.7102	443839	4961686	65.01	20.4	20.2	0.15	1000	468.4	464.3	446.0	17.36
02-Aug	214	44.8130	-87.7152	443448	4962209	65.66	20.7	20.5	0.15	1000	411.7	408.1	391.9	15.12
02-Aug	214	44.8218	-87.7240	442759	4963195	66.86	21.1	20.9	0.15	1000	317.1	314.4	301.7	11.51
02-Aug	214	44.8413	-87.7430	441277	4965375	69.50	21.7	21.5	0.15	1000	282.9	280.6	269.0	10.09
02-Aug	214	44.8498	-87.7510	440654	4966325	70.64	22.0	21.8	0.15	1000	233.9	232.0	222.2	8.25
02-Aug	214	44.8607	-87.7610	439875	4967537	72.08	22.3	22.1	0.15	1000	184.9	183.3	175.6	6.47
02-Aug	214	44.8715	-87.7717	439042	4968749	73.55	22.1	21.9	0.15	1000	186.6	185.0	177.3	6.56
02-Aug	214	44.8827	-87.7827	438185	4969997	75.06	20.8	20.6	0.15	1000	234.4	232.3	223.0	8.59
02-Aug	214	44.8882	-87.7882	437757	4970612	75.81	20.2	20.0	0.15	1000	295.2	292.6	281.1	11.00
02-Aug	214	44.8927	-87.7927	437406	4971115	76.42	20.0	19.8	0.15	1000	365.3	361.9	347.8	13.69
02-Aug	214	44.9000	-87.8000	436836	4971936	77.42	20.1	19.9	0.15	1000	342.9	339.8	326.5	12.82
02-Aug	214	44.9007	-87.7833	438154	4971997	78.74	20.3	20.0	0.15	1000	336.7	333.7	320.6	12.53
02-Aug	214	44.9010	-87.7798	438429	4972032	79.02	20.3	20.1	0.15	1000	289.5	286.9	275.5	10.75
02-Aug	214	44.9013	-87.7682	439350	4972059	79.94	20.7	20.4	0.15	1000	246.1	243.9	234.2	9.05
02-Aug	214	44.9018	-87.7537	440497	4972103	81.09	20.9	20.7	0.15	1000	234.4	232.3	223.0	8.54
02-Aug	214	44.9025	-87.7392	441641	4972168	82.23	21.5	21.2	0.15	1000	211.4	209.6	201.0	7.59
02-Aug	214	44.9033	-87.7088	444040	4972238	84.63	21.6	21.4	0.15	1000	203.8	202.1	193.7	7.28
02-Aug	214	44.9043	-87.7000	444736	4972343	85.34	21.6	21.4	0.15	1000	233.7	231.7	222.1	8.35
02-Aug	214	44.9050	-87.6893	445580	4972411	86.18	21.6	21.4	0.15	1000	258.0	255.8	245.3	9.22
02-Aug	214	44.9125	-87.6749	446727	4973235	87.60	21.5	21.3	0.15	1000	258.7	256.5	246.0	9.26
02-Aug	214	44.9143	-87.6620	447749	4973429	88.64	21.4	21.2	0.15	1000	269.4	267.1	256.1	9.67
02-Aug	214	44.9144	-87.6512	448601	4973427	89.49	21.3	21.1	0.15	1000	269.9	267.6	256.6	9.72
02-Aug	214	44.9144	-87.6350	449876	4973425	90.76	21.3	21.0	0.15	1000	269.4	267.1	256.2	9.73
02-Aug	214	44.9145	-87.6218	450917	4973424	91.81	21.2	21.0	0.15	1000	277.4	275.0	263.8	10.02
02-Aug	214	44.9145	-87.5427	457165	4973383	98.05	21.2	21.0	0.15	1000	283.4	281.0	269.6	10.25
02-Aug	214	44.9146	-87.5933	453167	4973420	102.05	21.1	20.9	0.15	1000	275.7	273.3	262.1	10.00

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
02-Aug	214	44.9148	-87.5088	459841	4973399	108.73	20.8	20.6	0.15	1000	306.3	303.6	291.3	11.20
02-Aug	214	44.9149	-87.5091	459818	4973407	108.75	20.7	20.5	0.15	1000	306.3	303.6	291.3	11.22
02-Aug	214	44.9149	-87.5092	459805	4973411	108.77	20.7	20.5	0.15	1000	318.3	315.5	302.7	11.66
02-Aug	214	44.9150	-87.5094	459795	4973414	108.78	20.8	20.6	0.15	1000	317.6	314.8	302.0	11.63
02-Aug	214	44.9150	-87.5030	460296	4973416	109.28	20.8	20.6	0.15	1000	307.0	304.3	292.0	11.22
02-Aug	214	44.9151	-87.4926	461120	4973423	110.10	20.9	20.7	0.15	1000	306.8	304.1	291.7	11.19
02-Aug	214	44.9152	-87.4846	461751	4973430	110.73	20.9	20.7	0.15	1000	306.3	303.6	291.2	11.17
02-Aug	214	44.9153	-87.4780	462270	4973438	111.25	20.9	20.7	0.15	1000	306.3	303.6	291.2	11.17
02-Aug	214	44.9157	-87.4695	462943	4973474	111.93	20.8	20.6	0.15	1000	306.1	303.4	291.0	11.19
02-Aug	214	44.9151	-87.4617	463558	4973404	112.54	20.8	20.6	0.15	1000	306.5	303.9	291.5	11.22
02-Aug	214	44.9110	-87.4546	464117	4972944	113.27	20.8	20.6	0.15	1000	319.5	316.7	303.8	11.69
02-Aug	214	44.9037	-87.4421	465100	4972135	114.54	20.9	20.7	0.15	1000	329.1	326.2	312.9	12.02
02-Aug	214	44.9007	-87.4368	465510	4971798	115.07	20.9	20.7	0.15	1000	334.3	331.4	317.9	12.19
02-Aug	214	44.8976	-87.4315	465932	4971450	115.62	20.8	20.5	0.15	1000	341.2	338.3	324.5	12.50
02-Aug	214	44.8948	-87.4266	466318	4971132	116.12	20.2	20.0	0.15	1000	375.9	372.5	357.7	14.01
02-Aug	214	44.8895	-87.4200	466833	4970547	116.90	20.8	20.6	0.15	1000	430.5	426.7	409.4	15.76
02-Aug	214	44.8834	-87.4166	467097	4969869	117.63	21.4	21.2	0.15	1000	369.5	366.4	351.2	13.27
02-Aug	214	44.8698	-87.4091	467687	4968349	119.26	22.1	21.9	0.15	999	346.0	343.2	328.5	12.17
02-Aug	214	44.8587	-87.4023	468211	4967111	120.60	22.3	22.1	0.15	999	317.1	314.5	300.9	11.09
02-Aug	214	44.8532	-87.3977	468576	4966499	121.31	22.3	22.1	0.15	999	310.9	308.3	295.0	10.88
02-Aug	214	44.8480	-87.3932	468929	4965924	121.99	22.2	22.0	0.15	999	329.3	326.6	312.6	11.55
02-Aug	214	44.8418	-87.3885	469295	4965235	122.77	22.2	22.0	0.15	999	340.5	337.7	323.2	11.96
02-Aug	214	44.8358	-87.3832	469713	4964567	123.56	22.1	21.9	0.15	999	323.1	320.4	306.7	11.38
02-Aug	214	44.8328	-87.3805	469923	4964233	123.95	22.0	21.8	0.15	999	376.6	373.5	357.6	13.30
02-Aug	214	44.8297	-87.3793	470013	4963881	124.31	21.9	21.7	0.15	999	399.5	396.2	379.4	14.13
03-Aug	215	44.8445	-87.3902	469164	4965534	0	21.2	21.0	0.14	997	537.9	533.6	510.3	19.40
03-Aug	215	44.8503	-87.3952	468772	4966182	0.76	21.2	21.0	0.14	997	533.2	529.0	505.9	19.23
03-Aug	215	44.8555	-87.3997	468419	4966759	1.43	21.2	21.0	0.14	997	441.6	438.1	418.7	15.92
03-Aug	215	44.8602	-87.4033	468132	4967278	2.03	21.2	21.0	0.14	997	449.7	446.1	426.4	16.21
03-Aug	215	44.8650	-87.4067	467871	4967817	2.63	21.2	21.0	0.14	997	536.7	532.4	508.9	19.35
03-Aug	215	44.8702	-87.4100	467612	4968392	3.26	21.3	21.1	0.14	997	582.7	578.2	552.6	20.95
03-Aug	215	44.8785	-87.4137	467326	4969320	4.23	21.4	21.2	0.14	997	526.7	522.6	499.4	18.88
03-Aug	215	44.8847	-87.4138	467317	4970004	4.91	21.4	21.2	0.14	997	462.5	458.9	438.5	16.58
03-Aug	215	44.8920	-87.4152	467215	4970820	5.73	21.5	21.3	0.14	997	430.9	427.5	408.4	15.40
03-Aug	215	44.8998	-87.4170	467076	4971689	6.61	21.3	21.1	0.14	997	434.2	430.8	411.7	15.61

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
03-Aug	215	44.9082	-87.4192	466908	4972617	7.56	20.7	20.5	0.14	997	395.0	391.7	374.7	14.45
03-Aug	215	44.9167	-87.4212	466756	4973562	8.51	20.2	20.0	0.14	997	371.9	368.7	353.0	13.81
03-Aug	215	44.9257	-87.4232	466603	4974562	9.53	20.7	20.5	0.14	997	351.6	348.7	333.5	12.86
03-Aug	215	44.9322	-87.4243	466515	4975285	10.25	20.7	20.5	0.14	997	358.7	355.7	340.3	13.12
03-Aug	215	44.9438	-87.4268	466325	4976581	11.56	20.7	20.5	0.14	997	359.7	356.7	341.2	13.16
03-Aug	215	44.9547	-87.4295	466121	4977786	12.79	21.1	20.9	0.14	997	370.7	367.7	351.5	13.40
03-Aug	215	44.9623	-87.4315	465968	4978638	13.65	20.7	20.5	0.14	997	370.9	367.9	351.9	13.57
03-Aug	215	44.9775	-87.4360	465622	4980326	15.38	20.6	20.4	0.14	997	370.7	367.6	351.7	13.60
03-Aug	215	44.9860	-87.4383	465443	4981271	16.34	20.6	20.4	0.14	997	340.6	337.7	323.1	12.50
03-Aug	215	44.9918	-87.4400	465315	4981919	17.00	20.4	20.2	0.14	997	342.3	339.4	324.8	12.64
03-Aug	215	44.9985	-87.4413	465214	4982661	17.75	20.4	20.2	0.14	997	327.0	324.2	310.2	12.07
03-Aug	215	45.0087	-87.4433	465062	4983791	18.89	20.7	20.5	0.14	997	335.1	332.3	317.9	12.26
03-Aug	215	45.0192	-87.4453	464911	4984958	20.06	20.8	20.6	0.14	996	327.5	324.8	310.5	11.94
03-Aug	215	45.0192	-87.4453	464911	4984958	20.06	20.8	20.6	0.14	996	318.1	315.4	301.6	11.60
03-Aug	215	45.0190	-87.4448	464950	4984940	20.11	21.2	21.0	0.14	996	331.4	328.7	314.2	11.94
03-Aug	215	45.0038	-87.4422	465151	4983253	21.81	21.6	21.4	0.14	995	311.9	309.4	295.1	11.09
03-Aug	215	44.9982	-87.4408	465253	4982623	22.44	21.6	21.4	0.14	995	339.6	336.9	321.3	12.08
03-Aug	215	44.9922	-87.4392	465380	4981956	23.12	21.6	21.4	0.14	995	322.3	319.7	305.0	11.46
03-Aug	215	44.9820	-87.4365	465585	4980826	24.27	21.7	21.5	0.14	995	317.3	314.8	300.2	11.25
03-Aug	215	44.9735	-87.4343	465751	4979881	25.23	21.7	21.5	0.14	994	327.5	324.9	309.6	11.60
03-Aug	215	44.9685	-87.4333	465826	4979325	25.79	21.7	21.5	0.14	994	293.7	291.4	277.6	10.41
03-Aug	215	44.9607	-87.4317	465953	4978454	26.67	21.7	21.5	0.14	994	305.7	303.2	289.0	10.83
03-Aug	215	44.9550	-87.4305	466042	4977824	27.31	21.7	21.5	0.14	994	310.6	308.2	293.7	11.01
03-Aug	215	44.9492	-87.4292	466143	4977175	27.96	21.7	21.5	0.14	994	293.2	290.9	277.2	10.39
03-Aug	215	44.9422	-87.4275	466272	4976397	28.75	21.7	21.5	0.14	994	301.4	299.0	285.0	10.68
03-Aug	215	44.9355	-87.4262	466372	4975657	29.50	21.7	21.5	0.14	994	310.9	308.4	293.9	11.02
03-Aug	215	44.9268	-87.4242	466525	4974691	30.48	21.7	21.5	0.14	994	306.4	304.0	289.7	10.86
03-Aug	215	44.9173	-87.4217	466716	4973635	31.55	21.7	21.5	0.14	994	306.4	304.0	289.7	10.86
03-Aug	215	44.9083	-87.4190	466923	4972634	32.57	21.7	21.5	0.14	994	312.4	309.9	295.3	11.07
03-Aug	215	44.9028	-87.4175	467038	4972023	33.20	21.6	21.4	0.14	994	299.4	297.0	283.1	10.64
03-Aug	215	44.8943	-87.4157	467177	4971078	34.15	21.4	21.2	0.14	994	327.5	324.9	309.7	11.71
03-Aug	215	44.8875	-87.4142	467291	4970320	34.92	21.4	21.2	0.14	994	327.7	325.1	309.9	11.72
03-Aug	215	44.8807	-87.4138	467314	4969560	35.68	21.4	21.2	0.14	994	342.8	340.0	324.2	12.25
03-Aug	215	44.8698	-87.4102	467597	4968354	36.92	21.3	21.1	0.14	994	366.1	363.1	346.2	13.13
03-Aug	215	44.8593	-87.4027	468184	4967185	38.22	21.7	21.5	0.14	994	366.3	363.4	346.3	12.98
03-Aug	215	44.8488	-87.3942	468850	4966015	39.57	21.6	21.4	0.14	994	481.0	477.2	454.8	17.10

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
03-Aug	215	44.8428	-87.3888	469269	4965346	40.36	21.7	21.5	0.14	994	582.7	578.3	551.0	20.65
03-Aug	215	44.8373	-87.3843	469622	4964734	41.07	21.7	21.5	0.14	994	570.9	566.5	539.8	20.23
03-Aug	215	44.8338	-87.3817	469830	4964344	41.51	21.6	21.4	0.14	994	539.9	535.7	510.6	19.19
03-Aug	215	44.8305	-87.3790	470040	4963974	41.93	21.3	21.1	0.14	994	522.8	518.7	494.5	18.75
03-Aug	215	44.8277	-87.3782	470104	4963658	42.26	20.7	20.5	0.14	994	534.2	529.8	505.2	19.48
23-Aug	235	44.5195	-88.0143	419387	4929859	0	23.2	23.0	0.19	999	245.8	243.8	232.8	8.37
23-Aug	235	44.5197	-88.0142	419400	4929876	0.02	23.2	23.0	0.19	999	261.9	259.8	248.2	8.92
23-Aug	235	44.5223	-88.0105	419696	4930168	0.44	23.3	23.1	0.19	999	261.9	259.8	248.1	8.90
23-Aug	235	44.5263	-88.0088	419833	4930611	0.90	23.1	22.9	0.19	999	257.8	255.7	244.3	8.80
23-Aug	235	44.5390	-88.0032	420300	4932014	2.38	23.2	23.0	0.19	999	320.6	318.0	303.7	10.91
23-Aug	235	44.5465	-88.0002	420549	4932844	3.25	22.4	22.2	0.18	999	397.6	394.4	377.2	13.85
23-Aug	235	44.5492	-87.9987	420672	4933138	3.56	22.3	22.1	0.18	999	463.2	459.5	439.5	16.19
23-Aug	235	44.5533	-87.9968	420823	4933598	4.05	22.5	22.3	0.18	999	488.4	484.5	463.4	17.00
23-Aug	235	44.5572	-87.9948	420987	4934023	4.50	22.5	22.3	0.19	999	435.8	432.3	413.4	15.16
23-Aug	235	44.5632	-87.9913	421273	4934686	5.23	22.0	21.8	0.18	999	273.5	271.2	259.6	9.66
23-Aug	235	44.5662	-87.9893	421436	4935017	5.60	21.5	21.3	0.18	999	249.9	247.7	237.3	8.95
23-Aug	235	44.5690	-87.9875	421586	4935331	5.94	21.5	21.3	0.17	999	332.2	329.4	315.6	11.90
23-Aug	235	44.5723	-87.9855	421750	4935698	6.35	21.6	21.4	0.18	999	281.6	279.3	267.5	10.04
23-Aug	235	44.5753	-87.9837	421898	4936029	6.71	21.4	21.2	0.17	999	244.1	242.0	231.8	8.76
23-Aug	235	44.5807	-87.9792	422262	4936618	7.40	21.2	21.0	0.17	999	238.3	236.2	226.4	8.60
23-Aug	235	44.5840	-87.9738	422691	4936984	7.96	21.2	21.0	0.17	999	238.0	235.9	226.1	8.61
23-Aug	235	44.5863	-87.9687	423104	4937237	8.45	21.2	21.0	0.17	999	221.8	219.8	210.7	8.01
23-Aug	235	44.5908	-87.9592	423864	4937728	9.35	20.9	20.7	0.16	999	202.0	200.2	192.0	7.37
23-Aug	235	44.5968	-87.9502	424586	4938386	10.33	20.8	20.6	0.16	999	226.6	224.6	215.4	8.29
23-Aug	235	44.6003	-87.9470	424843	4938772	10.79	20.8	20.6	0.16	999	226.1	224.1	214.9	8.27
23-Aug	235	44.6098	-87.9383	425542	4939819	12.05	20.9	20.7	0.16	999	228.8	226.8	217.5	8.35
23-Aug	235	44.6137	-87.9347	425837	4940242	12.57	20.9	20.7	0.16	999	216.6	214.7	205.9	7.89
23-Aug	235	44.6190	-87.9302	426201	4940831	13.26	21.0	20.8	0.16	999	223.0	221.0	211.9	8.11
23-Aug	235	44.6227	-87.9267	426483	4941235	13.75	21.0	20.7	0.16	999	249.9	247.7	237.5	9.10
23-Aug	235	44.6273	-87.9223	426834	4941749	14.38	21.0	20.8	0.16	999	239.9	237.8	228.0	8.73
23-Aug	235	44.6328	-87.9170	427264	4942355	15.12	21.0	20.8	0.16	999	240.2	238.1	228.3	8.74
23-Aug	235	44.6353	-87.9148	427439	4942631	15.45	21.0	20.8	0.15	1000	240.4	238.3	228.6	8.75
23-Aug	235	44.6403	-87.9123	427643	4943184	16.04	21.0	20.8	0.15	1000	240.2	238.1	228.4	8.74
23-Aug	235	44.6443	-87.9188	427133	4943634	16.72	20.8	20.6	0.15	1000	245.8	243.6	233.7	8.99
23-Aug	235	44.6482	-87.9255	426609	4944066	17.39	20.7	20.5	0.15	1000	234.4	232.3	222.9	8.61

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
23-Aug	235	44.6512	-87.9312	426163	4944405	17.96	20.6	20.4	0.15	1000	231.2	229.1	220.0	8.52
23-Aug	235	44.6545	-87.9378	425639	4944782	18.60	20.6	20.4	0.15	1000	222.7	220.7	211.9	8.21
23-Aug	235	44.6575	-87.9442	425140	4945121	19.20	20.6	20.4	0.15	1000	222.2	220.2	211.4	8.18
23-Aug	235	44.6587	-87.9405	425433	4945246	19.52	20.6	20.4	0.15	1000	209.8	207.9	199.6	7.71
23-Aug	235	44.6583	-87.9328	426040	4945202	20.13	20.6	20.4	0.15	1000	223.2	221.2	212.3	8.22
23-Aug	235	44.6578	-87.9230	426820	4945137	20.91	20.6	20.3	0.15	1000	238.5	236.4	226.9	8.79
23-Aug	235	44.6575	-87.9123	427664	4945092	21.76	20.6	20.4	0.15	1000	229.8	227.7	218.6	8.46
23-Aug	235	44.6570	-87.9025	428444	4945028	22.54	20.6	20.4	0.15	1000	248.7	246.4	236.5	9.15
23-Aug	235	44.6575	-87.8947	429065	4945077	23.16	20.7	20.5	0.15	1000	246.2	244.1	234.2	9.03
23-Aug	235	44.6585	-87.8830	429992	4945178	24.10	20.7	20.5	0.15	1000	217.6	215.7	207.0	7.99
23-Aug	235	44.6578	-87.8718	430876	4945092	24.98	20.9	20.7	0.15	1000	209.5	207.6	199.3	7.65
23-Aug	235	44.6578	-87.8647	431444	4945086	25.55	20.9	20.7	0.15	1000	209.2	207.4	199.0	7.64
23-Aug	235	44.6578	-87.8552	432197	4945078	26.31	20.9	20.7	0.15	1000	208.5	206.7	198.3	7.62
23-Aug	235	44.6580	-87.8463	432898	4945091	27.01	20.9	20.6	0.15	1000	233.2	231.1	221.8	8.52
23-Aug	235	44.6580	-87.8378	433572	4945084	27.68	20.9	20.6	0.15	1000	240.9	238.8	229.2	8.80
23-Aug	235	44.6582	-87.8213	434880	4945089	28.99	20.8	20.6	0.15	1000	256.5	254.2	244.0	9.38
23-Aug	235	44.6582	-87.8097	435805	4945079	29.91	20.6	20.4	0.15	1000	291.9	289.4	277.8	10.73
23-Aug	235	44.6580	-87.7917	437232	4945048	31.34	20.5	20.3	0.15	1000	296.3	293.6	281.9	10.93
23-Aug	235	44.6580	-87.7713	438844	4945032	32.95	20.5	20.3	0.15	1000	289.8	287.2	275.8	10.70
23-Aug	235	44.6582	-87.7650	439347	4945045	33.46	20.5	20.3	0.15	1000	308.3	305.5	293.4	11.39
23-Aug	235	44.6595	-87.7628	439520	4945192	33.68	20.5	20.3	0.15	1000	304.4	301.7	289.7	11.25
23-Aug	235	44.6655	-87.7672	439182	4945862	34.43	20.5	20.2	0.15	1000	292.2	289.6	278.1	10.80
23-Aug	235	44.6707	-87.7707	438910	4946438	35.07	20.5	20.3	0.15	1000	272.7	270.2	259.5	10.07
23-Aug	235	44.6770	-87.7748	438587	4947145	35.85	20.6	20.4	0.15	1000	244.3	242.2	232.5	9.00
23-Aug	235	44.6835	-87.7792	438250	4947871	36.65	20.6	20.4	0.15	1000	221.5	219.5	210.7	8.16
23-Aug	235	44.6897	-87.7832	437939	4948558	37.40	20.5	20.3	0.15	1000	232.7	230.6	221.4	8.59
23-Aug	235	44.6943	-87.7863	437694	4949078	37.98	20.4	20.2	0.15	1000	232.2	230.1	221.0	8.60
23-Aug	235	44.7007	-87.7905	437371	4949785	38.76	20.4	20.1	0.15	1000	221.2	219.2	210.5	8.20
23-Aug	235	44.7073	-87.7952	437008	4950529	39.58	20.4	20.2	0.15	1000	220.5	218.5	209.8	8.17
23-Aug	235	44.7143	-87.8000	436633	4951310	40.45	20.5	20.2	0.15	1000	209.5	207.6	199.3	7.74
23-Aug	235	44.7198	-87.8038	436335	4951924	41.13	20.5	20.3	0.15	1000	209.2	207.4	199.2	7.72
23-Aug	235	44.7253	-87.8078	436024	4952538	41.82	20.5	20.3	0.15	1000	209.0	207.1	198.9	7.71
23-Aug	235	44.7330	-87.8135	435585	4953396	42.78	20.5	20.3	0.15	1000	209.2	207.4	199.2	7.72
23-Aug	235	44.7415	-87.8195	435119	4954345	43.84	20.5	20.3	0.15	1000	224.9	222.9	214.1	8.30
23-Aug	235	44.7467	-87.8235	434808	4954921	44.50	20.5	20.3	0.15	1000	226.8	224.8	215.9	8.38
23-Aug	235	44.7583	-87.8317	434174	4956223	45.94	20.5	20.3	0.15	1000	237.1	234.9	225.6	8.75

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
23-Aug	235	44.7647	-87.8363	433812	4956931	46.74	20.5	20.3	0.15	1000	233.2	231.1	221.9	8.60
23-Aug	235	44.7732	-87.8417	433400	4957879	47.77	20.5	20.3	0.15	1000	244.8	242.6	233.1	9.04
23-Aug	235	44.7798	-87.8418	433395	4958619	48.51	20.5	20.3	0.15	1000	257.0	254.7	244.6	9.50
23-Aug	235	44.7860	-87.8435	433270	4959307	49.21	20.5	20.3	0.15	1000	255.3	253.0	243.0	9.44
23-Aug	235	44.7913	-87.8492	432827	4959903	49.95	20.5	20.3	0.15	1000	244.3	242.2	232.6	9.03
23-Aug	235	44.7958	-87.8538	432464	4960407	50.58	20.5	20.3	0.15	1000	237.1	234.9	225.7	8.76
23-Aug	235	44.7997	-87.8563	432271	4960835	51.05	20.5	20.3	0.15	1000	237.1	234.9	225.6	8.75
23-Aug	235	44.7993	-87.8472	432995	4960790	51.77	20.5	20.3	0.15	1000	233.4	231.3	222.2	8.62
23-Aug	235	44.7988	-87.8373	433772	4960726	52.55	20.6	20.4	0.15	1000	232.7	230.6	221.5	8.57
23-Aug	235	44.7967	-87.8302	434336	4960480	53.17	20.6	20.4	0.15	1000	237.1	234.9	225.6	8.73
23-Aug	235	44.7952	-87.8155	435496	4960302	54.34	20.6	20.4	0.15	1000	237.1	234.9	225.6	8.73
23-Aug	235	44.7952	-87.7922	437340	4960284	56.18	20.5	20.2	0.15	1000	233.4	231.3	222.2	8.63
23-Aug	235	44.7950	-87.7785	438422	4960256	57.27	20.4	20.2	0.15	1000	227.6	225.5	216.6	8.44
23-Aug	235	44.7948	-87.7628	439661	4960224	58.51	20.3	20.1	0.15	1000	229.0	226.9	218.0	8.52
23-Aug	235	44.7943	-87.7578	440056	4960165	58.90	20.1	19.8	0.14	1000	219.0	217.0	208.5	8.20
23-Aug	235	44.7943	-87.7527	440464	4960161	59.31	20.1	19.8	0.14	1000	214.0	212.0	203.7	8.01
23-Aug	235	44.7942	-87.7428	441242	4960136	60.09	20.0	19.8	0.15	1000	214.2	212.2	203.9	8.02
23-Aug	235	44.7940	-87.7295	442297	4960109	61.15	19.9	19.7	0.15	1000	223.1	221.0	212.4	8.38
23-Aug	235	44.7942	-87.7190	443128	4960119	61.98	19.9	19.7	0.15	1000	219.0	217.0	208.5	8.23
23-Aug	235	44.7943	-87.6972	444854	4960122	63.70	19.9	19.7	0.15	1000	223.1	221.0	212.4	8.38
23-Aug	235	44.8057	-87.7063	444140	4961388	65.16	20.0	19.7	0.15	1000	207.0	205.1	197.1	7.77
23-Aug	235	44.8112	-87.7122	443684	4962003	65.92	20.0	19.8	0.14	1000	207.7	205.8	197.8	7.79
23-Aug	235	44.8373	-87.7387	441614	4964927	69.51	20.0	19.8	0.15	1000	244.6	242.3	232.9	9.17
23-Aug	235	44.8405	-87.7418	441368	4965283	69.94	20.0	19.7	0.15	1000	244.4	242.1	232.6	9.18
23-Aug	235	44.8488	-87.7497	440757	4966213	71.05	19.9	19.6	0.15	1000	234.8	232.6	223.6	8.84
23-Aug	235	44.8578	-87.7582	440094	4967219	72.26	19.7	19.5	0.15	1000	246.3	243.9	234.4	9.32
23-Aug	235	44.8662	-87.7660	439485	4968151	73.37	19.7	19.4	0.15	1000	253.9	251.5	241.7	9.61
23-Aug	235	44.8730	-87.7722	439004	4968915	74.27	20.1	19.9	0.15	1000	231.0	228.8	219.8	8.63
23-Aug	235	44.8802	-87.7793	438446	4969716	75.25	20.0	19.8	0.15	1000	219.0	217.0	208.4	8.20
23-Aug	235	44.8883	-87.7878	437784	4970629	76.38	20.0	19.8	0.15	1000	230.5	228.4	219.4	8.63
23-Aug	235	44.8965	-87.7967	437095	4971545	77.52	20.1	19.9	0.15	1000	207.7	205.8	197.7	7.76
23-Aug	235	44.9002	-87.8007	436783	4971954	78.04	20.1	19.9	0.15	1000	207.7	205.8	197.7	7.76
23-Aug	235	44.9008	-87.7870	437864	4972017	79.12	20.2	19.9	0.15	1000	220.0	217.9	209.3	8.20
23-Aug	235	44.9017	-87.7672	439429	4972095	80.69	20.0	19.8	0.15	1000	224.5	222.4	213.7	8.41
23-Aug	235	44.9027	-87.7467	441049	4972191	82.31	19.8	19.6	0.15	1000	226.2	224.1	215.3	8.52
23-Aug	235	44.9033	-87.7302	442352	4972253	83.61	19.8	19.6	0.15	1000	222.8	220.7	212.1	8.41

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
23-Aug	235	44.9038	-87.7162	443458	4972298	84.72	19.8	19.6	0.15	1000	223.1	221.0	212.4	8.42
23-Aug	235	44.9042	-87.7068	444196	4972330	85.46	19.8	19.5	0.15	1000	223.1	221.0	212.4	8.42
23-Aug	235	44.9033	-87.6930	445288	4972227	86.56	19.7	19.5	0.14	1000	231.0	228.8	219.9	8.73
23-Aug	235	44.8950	-87.6918	445371	4971302	87.48	19.8	19.5	0.14	1000	234.8	232.6	223.5	8.87
23-Aug	235	44.8927	-87.6827	446092	4971036	88.25	19.8	19.6	0.15	1000	227.9	225.7	216.9	8.59
23-Aug	235	44.8943	-87.6703	447068	4971212	89.25	19.8	19.6	0.15	1000	214.7	212.7	204.4	8.10
23-Aug	235	44.8967	-87.6512	448583	4971460	90.78	19.6	19.4	0.15	999	219.0	216.9	208.4	8.30
23-Aug	235	44.8995	-87.6275	450456	4971761	92.68	19.5	19.2	0.15	999	230.0	227.8	218.9	8.76
23-Aug	235	44.9012	-87.6130	451602	4971936	93.84	19.6	19.4	0.15	999	225.2	223.1	214.3	8.54
23-Aug	235	44.9027	-87.5990	452708	4972095	94.95	19.7	19.4	0.15	999	214.0	211.9	203.6	8.10
23-Aug	235	44.9037	-87.5898	453432	4972200	95.69	19.7	19.4	0.15	999	214.0	211.9	203.6	8.10
23-Aug	235	44.9045	-87.5820	454052	4972289	96.31	19.7	19.5	0.15	999	214.0	212.0	203.6	8.08
23-Aug	235	44.9065	-87.5637	455500	4972501	97.77	19.8	19.6	0.15	999	219.2	217.2	208.6	8.26
23-Aug	235	44.9077	-87.5523	456396	4972624	98.68	19.7	19.5	0.15	999	215.2	213.1	204.7	8.12
23-Aug	235	44.9103	-87.5295	458201	4972907	100.51	19.4	19.2	0.14	999	254.6	252.2	242.3	9.72
23-Aug	235	44.9113	-87.5202	458937	4973014	101.25	19.2	19.0	0.14	999	261.0	258.5	248.4	10.01
23-Aug	235	44.9123	-87.5117	459609	4973121	101.93	19.1	18.9	0.14	999	277.9	275.2	264.5	10.69
23-Aug	235	44.9133	-87.5030	460295	4973227	102.62	19.1	18.9	0.14	999	269.8	267.2	256.8	10.38
23-Aug	235	44.9147	-87.4900	461322	4973370	103.66	19.1	18.8	0.14	999	269.8	267.2	256.8	10.40
23-Aug	235	44.9153	-87.4812	462019	4973439	104.36	19.0	18.8	0.14	999	269.8	267.2	256.8	10.41
23-Aug	235	44.9160	-87.4688	462993	4973509	105.34	19.1	18.9	0.14	999	277.5	274.7	264.1	10.68
23-Aug	235	44.9115	-87.4517	464345	4973001	106.78	19.2	18.9	0.14	999	275.3	272.6	262.0	10.58
23-Aug	235	44.8993	-87.4328	465825	4971640	108.79	19.4	19.1	0.14	998	319.1	316.1	303.3	12.17
23-Aug	235	44.8955	-87.4273	466257	4971214	109.40	19.5	19.3	0.14	998	300.5	297.6	285.5	11.40
23-Aug	235	44.8908	-87.4205	466794	4970691	110.15	19.2	18.9	0.14	998	312.3	309.3	296.9	11.99
23-Aug	235	44.8847	-87.4138	467317	4970004	111.01	18.9	18.7	0.14	998	351.4	348.0	334.1	13.60
23-Aug	235	44.8765	-87.4138	467312	4969097	111.92	18.9	18.7	0.14	998	362.4	358.9	344.6	14.01
23-Aug	235	44.8690	-87.4092	467676	4968262	112.83	19.2	18.9	0.14	998	370.4	366.9	352.2	14.22
23-Aug	235	44.8603	-87.4028	468172	4967296	113.92	19.1	18.9	0.14	998	358.7	355.2	341.0	13.79
23-Aug	235	44.8535	-87.3978	468563	4966536	114.77	18.7	18.5	0.14	998	379.1	375.3	360.5	14.75
23-Aug	235	44.8472	-87.3925	468982	4965830	115.59	18.7	18.5	0.14	998	415.0	410.9	394.7	16.16
23-Aug	235	44.8362	-87.3832	469713	4964604	117.02	19.4	19.2	0.14	998	484.3	479.7	460.4	18.45
23-Aug	235	44.8342	-87.3815	469844	4964382	117.28	19.3	19.1	0.14	998	427.4	423.3	406.3	16.33
23-Aug	235	44.8310	-87.3798	469974	4964030	117.65	19.3	19.1	0.14	998	404.8	400.9	384.8	15.48
13-Sep	256	44.5203	-88.0122	419560	4929949	0	22.3	22.1	0.19	997	253.9	252.0	240.4	8.86

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
13-Sep	256	44.6580	-87.8830	429991	4945122	18.41	19.8	19.6	0.15	997	255.7	253.4	242.8	9.60
13-Sep	256	44.6580	-87.8830	429991	4945122	18.41	19.8	19.6	0.15	997	255.5	253.2	242.5	9.60
13-Sep	256	44.7940	-87.7580	440043	4960129	36.47	19.8	19.6	0.15	995	226.6	224.6	214.9	8.51
14-Sep	257	45.1992	-87.2585	479696	5004891	0	18.9	18.6	0.15	996	286.4	283.6	271.8	11.07
14-Sep	257	45.1992	-87.2585	479696	5004891	0.00	18.9	18.6	0.15	996	287.1	284.3	272.5	11.10
14-Sep	257	45.2000	-87.4460	464970	5005048	14.73	18.7	18.5	0.15	996	265.8	263.2	252.5	10.33
14-Sep	257	45.2000	-87.4460	464970	5005048	14.73	18.7	18.5	0.15	996	266.0	263.5	252.7	10.34
15-Sep	258	45.0198	-87.4453	464912	4985033	0	19.7	19.5	0.15	993	264.9	262.5	250.5	9.95
15-Sep	258	45.0198	-87.4453	464912	4985033	0.00	19.6	19.4	0.15	993	255.4	253.0	241.4	9.61
15-Sep	258	44.9280	-87.5710	454939	4974894	14.22	19.2	19.0	0.15	991	260.8	258.4	246.2	9.92
15-Sep	258	44.9280	-87.5710	454939	4974894	14.22	19.3	19.0	0.15	991	266.3	263.8	251.4	10.12
25-Oct	298	44.5195	-88.0143	419387	4929859	0	12.3	11.9	0.19	994	924.1	908.5	875.9	44.06
25-Oct	298	44.5195	-88.0143	419387	4929859	0.00	12.3	11.9	0.19	994	923.9	908.3	875.7	44.05
25-Oct	298	44.5195	-88.0143	419387	4929859	0.00	12.3	11.9	0.19	994	910.7	895.4	863.3	43.44
25-Oct	298	44.5223	-88.0105	419696	4930168	0.44	12.3	11.9	0.20	994	947.7	931.8	898.4	45.17
25-Oct	298	44.5390	-88.0032	420300	4932014	2.38	13.7	13.3	0.20	994	1207.9	1190.3	1146.0	54.98
25-Oct	298	44.5492	-87.9987	420672	4933138	3.56	12.7	12.3	0.20	994	983.0	967.1	932.1	46.27
25-Oct	298	44.5533	-87.9968	420823	4933598	4.05	10.5	10.0	0.18	994	545.1	533.9	515.6	27.64
25-Oct	298	44.5632	-87.9913	421273	4934686	5.23	10.5	10.0	0.16	995	402.4	394.1	380.6	20.39
25-Oct	298	44.5662	-87.9893	421436	4935017	5.59	10.9	10.4	0.16	995	297.5	291.5	281.4	14.86
25-Oct	298	44.5723	-87.9855	421750	4935698	6.34	11.3	10.8	0.15	995	304.0	298.1	287.7	14.99
25-Oct	298	44.5753	-87.9837	421898	4936029	6.71	11.8	11.3	0.15	995	320.6	314.7	303.5	15.56
25-Oct	298	44.5840	-87.9738	422691	4936984	7.95	11.9	11.5	0.15	995	342.9	336.7	324.7	16.56
25-Oct	298	44.5863	-87.9687	423104	4937237	8.43	12.1	11.7	0.15	995	349.6	343.3	331.1	16.79
25-Oct	298	44.5968	-87.9502	424586	4938386	10.31	12.2	11.7	0.14	995	349.1	342.9	330.7	16.73
25-Oct	298	44.6190	-87.9302	426201	4940831	13.24	12.2	11.8	0.14	995	357.4	351.1	338.5	17.09
25-Oct	298	44.6273	-87.9223	426834	4941749	14.35	12.2	11.8	0.14	995	352.8	346.6	334.2	16.86
25-Oct	298	44.6403	-87.9123	427643	4943184	16.00	12.3	11.9	0.14	995	334.9	329.0	317.2	15.98
25-Oct	298	44.6443	-87.9188	427133	4943634	16.68	12.3	11.9	0.14	995	354.6	348.4	335.9	16.92
25-Oct	298	44.6512	-87.9312	426163	4944405	17.92	12.2	11.8	0.15	995	319.9	314.2	303.0	15.32
25-Oct	298	44.6545	-87.9378	425639	4944782	18.56	12.1	11.7	0.15	995	314.8	309.2	298.2	15.12
25-Oct	298	44.6575	-87.9442	425140	4945121	19.17	12.1	11.7	0.15	995	301.4	296.0	285.5	14.45
25-Oct	298	44.6583	-87.9328	426040	4945202	20.07	12.3	11.8	0.15	995	313.0	307.4	296.5	14.94

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
25-Oct	298	44.6575	-87.9123	427664	4945092	21.70	12.4	11.9	0.15	995	319.7	314.1	302.8	15.21
25-Oct	298	44.6575	-87.8947	429065	4945077	23.10	12.5	12.1	0.15	995	342.5	336.5	324.7	16.26
25-Oct	298	44.6585	-87.8830	429992	4945178	24.03	12.4	12.0	0.14	995	367.0	360.6	348.0	17.45
25-Oct	298	44.6585	-87.8830	429992	4945178	24.03	12.4	12.0	0.14	995	364.7	358.4	345.8	17.34
25-Oct	298	44.6585	-87.8830	429992	4945178	24.03	12.4	12.0	0.14	995	365.4	359.1	346.5	17.37
25-Oct	298	44.6580	-87.8530	432370	4945097	26.41	12.5	12.1	0.14	996	371.6	365.2	352.5	17.64
25-Oct	298	44.6590	-87.8440	433085	4945200	27.13	12.4	12.0	0.14	996	352.5	346.4	334.4	16.75
25-Oct	298	44.6590	-87.8350	433798	4945193	27.85	12.4	12.0	0.14	996	352.3	346.2	334.4	16.77
25-Oct	298	44.6590	-87.8160	435304	4945178	29.35	12.3	11.9	0.14	996	341.5	335.5	324.1	16.29
25-Oct	298	44.6590	-87.8090	435859	4945172	29.91	12.3	11.9	0.15	996	337.8	331.9	320.6	16.14
25-Oct	298	44.6590	-87.8010	436494	4945166	30.54	12.2	11.8	0.15	996	330.2	324.3	313.3	15.81
25-Oct	298	44.6580	-87.7960	436889	4945051	30.96	12.2	11.7	0.15	996	317.5	311.8	301.2	15.24
25-Oct	298	44.6580	-87.7780	438316	4945037	32.38	11.9	11.5	0.15	996	323.3	317.4	306.6	15.62
25-Oct	298	44.6580	-87.7630	439505	4945026	33.57	11.6	11.2	0.15	996	391.5	384.2	371.4	19.13
25-Oct	298	44.6600	-87.7630	439508	4945248	33.79	11.4	11.0	0.15	996	512.5	502.8	486.1	25.23
25-Oct	298	44.6690	-87.7690	439041	4946252	34.90	11.5	11.0	0.15	996	397.2	389.7	376.7	19.50
25-Oct	298	44.6770	-87.7740	438653	4947145	35.87	11.7	11.3	0.15	996	338.3	332.0	320.8	16.47
25-Oct	298	44.6860	-87.7800	438187	4948149	36.98	12.0	11.6	0.15	996	346.3	340.1	328.6	16.71
25-Oct	298	44.7000	-87.7900	437410	4949712	38.73	12.2	11.8	0.14	996	349.6	343.4	331.7	16.73
25-Oct	298	44.7090	-87.7960	436944	4950716	39.83	12.4	11.9	0.14	996	345.6	339.6	328.0	16.48
25-Oct	298	44.7190	-87.8040	436322	4951833	41.11	12.5	12.1	0.14	996	359.2	353.0	340.9	17.04
25-Oct	298	44.7300	-87.8110	435779	4953060	42.45	12.6	12.2	0.15	996	368.2	361.9	349.5	17.39
25-Oct	298	44.7370	-87.8160	435391	4953842	43.33	12.7	12.3	0.14	996	463.5	455.8	440.1	21.83
25-Oct	298	44.7490	-87.8240	434771	4955181	44.80	12.8	12.4	0.14	996	535.7	526.9	508.7	25.18
25-Oct	298	44.7570	-87.8300	434305	4956075	45.81	12.8	12.5	0.14	997	555.7	546.6	527.9	26.08
25-Oct	298	44.7660	-87.8360	433841	4957079	46.92	12.9	12.5	0.14	997	545.2	536.4	518.0	25.54
25-Oct	298	44.7760	-87.8430	433298	4958196	48.16	12.9	12.5	0.14	997	486.0	478.1	461.7	22.78
25-Oct	298	44.7840	-87.8480	432912	4959089	49.13	12.7	12.4	0.14	997	430.9	423.7	409.3	20.29
25-Oct	298	44.7910	-87.8520	432604	4959870	49.97	12.6	12.2	0.14	997	334.6	328.8	317.7	15.85
25-Oct	298	44.7960	-87.8560	432293	4960428	50.61	12.5	12.1	0.14	997	353.5	347.4	335.6	16.79
25-Oct	298	44.7990	-87.8360	433878	4960745	52.23	12.3	11.9	0.14	997	318.9	313.3	302.7	15.22
25-Oct	298	44.7980	-87.8210	435064	4960622	53.42	12.5	12.1	0.14	997	402.5	395.6	382.2	19.09
25-Oct	298	44.7970	-87.8030	436486	4960497	54.85	12.9	12.5	0.14	997	464.6	457.0	441.4	21.80
25-Oct	298	44.7960	-87.7900	437514	4960376	55.88	13.0	12.6	0.14	997	479.7	472.0	455.8	22.37
25-Oct	298	44.7950	-87.7760	438620	4960254	56.99	13.1	12.7	0.14	997	476.1	468.5	452.4	22.15
25-Oct	298	44.7950	-87.7630	439648	4960244	58.02	13.1	12.8	0.14	997	464.6	457.2	441.4	21.59

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
25-Oct	298	44.7940	-87.7580	440043	4960129	58.43	13.1	12.7	0.14	997	493.7	485.7	469.2	22.98
25-Oct	298	44.7940	-87.7580	440043	4960129	58.43	13.1	12.7	0.14	997	490.1	482.2	465.8	22.81
25-Oct	298	44.7940	-87.7570	440122	4960129	58.51	13.1	12.7	0.14	997	486.2	478.4	462.2	22.63
25-Oct	298	44.7950	-87.7420	441309	4960229	59.70	13.1	12.7	0.14	997	491.5	483.6	467.2	22.90
25-Oct	298	44.7950	-87.7300	442258	4960220	60.65	13.0	12.7	0.14	997	542.3	533.6	515.5	25.29
25-Oct	298	44.7950	-87.7240	442733	4960216	61.13	13.0	12.6	0.14	997	552.9	544.0	525.6	25.80
25-Oct	298	44.7950	-87.7170	443287	4960211	61.68	13.0	12.6	0.14	997	542.3	533.5	515.4	25.34
25-Oct	298	44.7950	-87.7070	444078	4960204	62.47	12.9	12.5	0.14	997	463.9	456.3	440.8	21.76
25-Oct	298	44.7950	-87.6970	444869	4960197	63.26	12.7	12.3	0.15	997	362.9	356.8	344.7	17.10
25-Oct	298	44.7950	-87.6950	445027	4960196	63.42	12.6	12.2	0.15	997	344.1	338.3	326.9	16.26
25-Oct	298	44.8010	-87.7010	444558	4960866	64.24	12.6	12.2	0.15	997	355.4	349.3	337.5	16.81
25-Oct	298	44.8060	-87.7070	444088	4961426	64.97	12.7	12.3	0.15	997	455.4	447.8	432.7	21.49
25-Oct	298	44.8140	-87.7150	443463	4962320	66.06	12.8	12.4	0.14	997	549.2	540.2	521.9	25.81
25-Oct	298	44.8220	-87.7240	442760	4963215	67.20	12.9	12.5	0.14	997	529.0	520.3	502.7	24.81
25-Oct	298	44.8320	-87.7330	442058	4964332	68.52	12.9	12.5	0.14	997	483.2	475.3	459.2	22.64
25-Oct	298	44.8420	-87.7430	441278	4965450	69.88	12.9	12.5	0.14	997	558.9	549.8	531.2	26.16
25-Oct	298	44.8530	-87.7530	440499	4966679	71.34	13.0	12.6	0.14	997	624.0	614.0	593.1	29.17
25-Oct	298	44.8680	-87.7680	439329	4968357	73.38	13.0	12.6	0.14	997	596.8	587.2	567.2	27.90
25-Oct	298	44.8800	-87.7800	438394	4969699	75.02	12.4	12.0	0.14	997	308.1	302.7	292.5	14.68
25-Oct	298	44.8840	-87.7850	438003	4970147	75.61	12.4	12.0	0.14	997	351.2	345.1	333.6	16.75
25-Oct	298	44.8940	-87.7940	437304	4971265	76.93	12.3	11.9	0.14	997	374.1	367.6	355.3	17.86
25-Oct	298	44.9000	-87.7970	437073	4971934	77.64	12.5	12.1	0.14	997	463.0	455.2	439.9	21.99
25-Oct	298	44.8990	-87.7840	438099	4971813	78.67	12.7	12.3	0.14	997	518.1	509.5	492.4	24.43
25-Oct	298	44.8980	-87.7690	439282	4971690	79.86	12.9	12.5	0.14	997	407.7	401.0	387.5	19.10
25-Oct	298	44.8970	-87.7570	440228	4971570	80.82	13.0	12.6	0.14	997	373.9	367.7	355.3	17.45
25-Oct	298	44.8960	-87.7420	441412	4971448	82.00	13.0	12.7	0.14	997	375.2	369.1	356.6	17.50
25-Oct	298	44.8950	-87.7300	442358	4971328	82.96	13.0	12.7	0.14	997	373.9	367.8	355.3	17.44
25-Oct	298	44.8940	-87.7120	443778	4971205	84.38	13.0	12.6	0.14	997	384.6	378.3	365.5	17.95
25-Oct	298	44.8930	-87.6890	445594	4971078	86.20	12.9	12.5	0.14	997	455.0	447.5	432.4	21.34
25-Oct	298	44.8940	-87.6740	446779	4971179	87.39	12.9	12.5	0.14	997	455.2	447.7	432.6	21.35
25-Oct	298	44.8960	-87.6580	448044	4971391	88.68	12.9	12.6	0.14	997	393.2	386.7	373.7	18.40
25-Oct	298	44.8970	-87.6420	449309	4971492	89.94	12.9	12.6	0.14	997	427.9	420.9	406.7	20.02
25-Oct	298	44.8990	-87.6270	450495	4971705	91.15	12.9	12.5	0.14	997	374.1	367.9	355.5	17.51
25-Oct	298	44.9010	-87.6090	451917	4971916	92.59	13.0	12.6	0.14	997	433.1	426.0	411.6	20.24
25-Oct	298	44.9020	-87.5960	452945	4972020	93.62	13.0	12.6	0.14	997	433.1	426.0	411.6	20.24
25-Oct	298	44.9030	-87.5810	454130	4972122	94.81	12.9	12.5	0.14	997	425.4	418.4	404.3	19.95

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
25-Oct	298	44.9050	-87.5680	455158	4972337	95.86	12.8	12.4	0.14	997	492.0	483.9	467.6	23.12
25-Oct	298	44.9070	-87.5520	456422	4972550	97.14	13.0	12.6	0.14	997	620.5	610.5	590.0	29.01
25-Oct	298	44.9080	-87.5440	457055	4972657	97.78	13.0	12.6	0.14	997	628.6	618.5	597.7	29.34
25-Oct	298	44.9090	-87.5310	458082	4972762	98.82	13.1	12.7	0.14	997	617.6	607.8	587.3	28.80
25-Oct	298	44.9100	-87.5230	458714	4972869	99.46	13.1	12.7	0.14	997	607.1	597.4	577.3	28.31
25-Oct	298	44.9130	-87.4980	460689	4973189	101.46	13.0	12.7	0.14	997	567.1	558.0	539.2	26.46
25-Oct	298	44.9140	-87.4940	461006	4973299	101.79	13.1	12.7	0.14	997	560.0	551.0	532.5	26.12
25-Oct	298	44.9160	-87.4770	462349	4973513	103.15	13.0	12.6	0.14	997	542.3	533.6	515.6	25.32
25-Oct	298	44.9160	-87.4670	463138	4973508	103.94	13.0	12.6	0.14	997	576.8	567.5	548.4	26.93
25-Oct	298	44.9160	-87.4590	463770	4973504	104.57	13.1	12.7	0.14	997	607.1	597.4	577.3	28.30
25-Oct	298	44.9090	-87.4470	464713	4972722	105.80	13.1	12.7	0.14	997	556.0	547.2	528.7	25.88
25-Oct	298	44.8990	-87.4310	465970	4971604	107.48	13.0	12.6	0.14	997	529.2	520.7	503.1	24.72
25-Oct	298	44.8920	-87.4210	466756	4970822	108.59	12.8	12.4	0.15	997	515.4	506.9	489.9	24.27
25-Oct	298	44.8890	-87.4170	467070	4970487	109.05	12.6	12.2	0.15	997	489.1	480.8	464.8	23.18
25-Oct	298	44.8810	-87.4130	467381	4969597	109.99	12.0	11.5	0.14	997	465.1	456.7	441.8	22.49
25-Oct	298	44.8770	-87.4120	467458	4969152	110.44	11.8	11.4	0.14	997	451.8	443.6	429.1	21.96
25-Oct	298	44.8690	-87.4080	467769	4968262	111.39	11.8	11.4	0.14	997	455.4	447.1	432.6	22.12
25-Oct	298	44.8590	-87.4020	468238	4967149	112.60	11.7	11.3	0.14	997	451.4	443.1	428.7	21.99
25-Oct	298	44.8510	-87.3950	468786	4966257	113.64	11.5	11.0	0.14	997	451.8	443.3	429.0	22.23
25-Oct	298	44.8360	-87.3820	469806	4964586	115.60	11.3	10.9	0.14	998	472.9	463.9	449.2	23.39
25-Oct	298	44.8310	-87.3790	470040	4964030	116.20	11.1	10.6	0.14	998	473.6	464.4	449.8	23.63
25-Oct	298	44.8290	-87.3790	470039	4963808	116.43	10.8	10.3	0.14	998	496.2	486.3	471.1	24.97
26-Oct	299	44.8920	-87.4150	467229	4970820	0	12.0	11.6	0.14	1003	505.4	496.4	482.8	24.57
26-Oct	299	44.9010	-87.4150	467234	4971820	1.00	12.3	11.9	0.15	1003	525.7	516.6	502.3	25.28
26-Oct	299	44.9070	-87.4160	467159	4972486	1.67	12.4	12.0	0.15	1003	538.4	529.3	514.6	25.79
26-Oct	299	44.9220	-87.4150	467246	4974152	3.34	12.7	12.3	0.14	1003	502.3	493.9	480.1	23.84
26-Oct	299	44.9380	-87.4080	467808	4975927	5.20	12.6	12.2	0.15	1003	498.9	490.5	476.8	23.74
26-Oct	299	44.9480	-87.4050	468050	4977037	6.34	12.6	12.2	0.14	1003	513.5	504.9	490.8	24.42
26-Oct	299	44.9610	-87.4010	468373	4978479	7.81	12.7	12.3	0.14	1003	507.4	499.0	485.0	24.08
26-Oct	299	44.9740	-87.3970	468695	4979922	9.29	12.7	12.3	0.14	1003	564.4	555.1	539.5	26.75
26-Oct	299	44.9880	-87.3930	469018	4981475	10.88	12.8	12.4	0.14	1003	555.7	546.5	531.2	26.29
26-Oct	299	45.0000	-87.3890	469340	4982807	12.25	12.9	12.5	0.14	1003	574.8	565.5	549.6	27.12
26-Oct	299	45.0160	-87.3840	469742	4984582	14.07	13.0	12.6	0.14	1004	611.2	601.4	584.9	28.75
26-Oct	299	45.0280	-87.3750	470458	4985912	15.58	13.1	12.7	0.14	1004	618.5	608.7	591.9	29.02
26-Oct	299	45.0530	-87.3570	471888	4988683	18.70	13.2	12.8	0.14	1004	643.2	633.1	615.6	30.02

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
26-Oct	299	45.0650	-87.3480	472602	4990013	20.21	13.2	12.9	0.14	1004	582.2	573.0	557.2	27.16
26-Oct	299	45.0780	-87.3390	473317	4991454	21.82	13.1	12.7	0.14	1004	584.4	575.1	559.2	27.43
26-Oct	299	45.0890	-87.3300	474030	4992673	23.23	13.0	12.7	0.14	1004	567.0	558.0	542.6	26.63
26-Oct	299	45.1080	-87.3200	474826	4994780	25.48	13.1	12.7	0.14	1004	574.6	565.5	549.9	26.94
26-Oct	299	45.1210	-87.3090	475697	4996221	27.16	12.9	12.5	0.14	1004	431.5	424.4	412.8	20.34
26-Oct	299	45.1290	-87.3020	476251	4997108	28.21	12.9	12.5	0.14	1004	416.2	409.3	398.1	19.64
26-Oct	299	45.1330	-87.2980	476567	4997551	28.75	12.9	12.5	0.14	1004	415.5	408.6	397.5	19.62
26-Oct	299	45.1410	-87.2920	477042	4998438	29.76	12.8	12.4	0.14	1004	416.6	409.7	398.5	19.73
26-Oct	299	45.1510	-87.2860	477517	4999547	30.97	12.8	12.4	0.14	1004	416.4	409.5	398.3	19.71
26-Oct	299	45.1630	-87.2800	477994	5000879	32.38	12.9	12.5	0.14	1004	415.3	408.4	397.4	19.58
26-Oct	299	45.1740	-87.2740	478469	5002099	33.69	12.9	12.6	0.14	1004	432.2	425.1	413.6	20.37
26-Oct	299	45.1830	-87.2690	478866	5003098	34.77	12.9	12.5	0.14	1004	432.4	425.3	413.9	20.39
26-Oct	299	45.1940	-87.2620	479420	5004318	36.11	12.9	12.5	0.14	1004	423.5	416.5	405.3	20.02
26-Oct	299	45.2000	-87.2570	479814	5004983	36.88	12.8	12.4	0.14	1004	464.0	456.3	444.1	22.01
26-Oct	299	45.2000	-87.2570	479814	5004983	36.88	12.8	12.4	0.14	1004	466.5	458.8	446.5	22.13
26-Oct	299	45.2000	-87.2570	479814	5004983	36.88	12.8	12.4	0.14	1004	459.7	452.1	440.0	21.80
26-Oct	299	45.2010	-87.2600	479579	5005095	37.14	12.7	12.3	0.14	1005	427.4	420.3	409.3	20.31
26-Oct	299	45.2080	-87.2700	478796	5005875	38.25	12.7	12.3	0.14	1005	435.6	428.3	417.1	20.68
26-Oct	299	45.2180	-87.2840	477701	5006990	39.81	12.6	12.2	0.14	1005	475.9	467.8	455.7	22.74
26-Oct	299	45.2260	-87.2960	476762	5007882	41.10	12.5	12.1	0.14	1005	457.2	449.4	437.8	21.89
26-Oct	299	45.2340	-87.3070	475902	5008774	42.34	12.5	12.1	0.14	1005	441.9	434.4	423.1	21.16
26-Oct	299	45.2430	-87.3210	474807	5009778	43.83	12.5	12.1	0.14	1005	431.7	424.4	413.3	20.65
26-Oct	299	45.2560	-87.3400	473322	5011228	45.90	12.5	12.1	0.14	1005	453.2	445.5	433.9	21.70
26-Oct	299	45.2660	-87.3550	472150	5012344	47.52	12.6	12.2	0.14	1005	464.4	456.6	444.7	22.16
26-Oct	299	45.2740	-87.3650	471369	5013236	48.71	12.6	12.2	0.14	1005	464.7	456.9	444.9	22.14
26-Oct	299	45.2840	-87.3800	470198	5014353	50.33	12.7	12.3	0.14	1005	442.1	434.8	423.3	20.99
26-Oct	299	45.2790	-87.3900	469411	5013801	51.29	12.8	12.4	0.14	1005	442.4	435.0	423.6	20.97
26-Oct	299	45.2640	-87.4000	468618	5012139	53.13	12.8	12.4	0.14	1005	442.1	434.8	423.4	20.95
26-Oct	299	45.2530	-87.4070	468063	5010919	54.47	12.8	12.4	0.14	1005	437.6	430.4	419.0	20.73
26-Oct	299	45.2300	-87.4230	466794	5008371	57.32	12.8	12.4	0.14	1005	431.5	424.4	413.2	20.44
26-Oct	299	45.2220	-87.4300	466240	5007485	58.36	12.8	12.4	0.14	1005	431.3	424.1	413.0	20.43
26-Oct	299	45.2130	-87.4360	465763	5006488	59.47	12.9	12.5	0.14	1005	476.1	468.3	456.0	22.50
26-Oct	299	45.2030	-87.4330	465993	5005375	60.60	13.0	12.6	0.14	1005	529.9	521.3	507.5	24.98
26-Oct	299	45.2000	-87.4450	465048	5005047	61.60	13.1	12.7	0.14	1005	555.2	546.3	531.8	26.05
26-Oct	299	45.2000	-87.4450	465048	5005047	61.60	13.1	12.7	0.14	1005	555.4	546.5	532.0	26.05
26-Oct	299	45.1850	-87.4460	464961	5003381	63.27	13.0	12.6	0.14	1005	592.4	582.8	567.5	27.90

1994 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	X(CO2)eq	X(CO2)w	f(CO2)w	[CO2]
26-Oct	299	45.1750	-87.4460	464955	5002270	64.38	13.0	12.6	0.14	1005	614.6	604.7	588.8	28.96
26-Oct	299	45.1660	-87.4460	464949	5001271	65.38	13.0	12.6	0.14	1005	586.2	576.7	561.6	27.61
26-Oct	299	45.1590	-87.4460	464945	5000493	66.16	13.0	12.6	0.14	1005	592.8	583.3	567.9	27.93
26-Oct	299	45.1370	-87.4460	464931	4998049	68.60	13.0	12.6	0.14	1005	556.5	547.5	533.1	26.24
26-Oct	299	45.1330	-87.4460	464929	4997605	69.05	13.0	12.6	0.14	1004	556.7	547.7	532.9	26.23
26-Oct	299	45.1280	-87.4460	464926	4997049	69.60	13.0	12.6	0.14	1004	549.1	540.2	525.7	25.87
26-Oct	299	45.1190	-87.4460	464920	4996049	70.60	13.0	12.6	0.14	1004	560.5	551.4	536.5	26.38
26-Oct	299	45.1060	-87.4460	464912	4994605	72.05	13.1	12.7	0.14	1004	569.8	560.7	545.5	26.76
26-Oct	299	45.0970	-87.4460	464907	4993605	73.05	13.1	12.7	0.14	1004	561.1	552.2	537.2	26.33
26-Oct	299	45.0860	-87.4470	464821	4992384	74.27	13.1	12.7	0.14	1004	560.7	551.7	536.8	26.31
26-Oct	299	45.0770	-87.4470	464816	4991384	75.27	13.1	12.7	0.14	1004	560.7	551.7	536.8	26.31
26-Oct	299	45.0680	-87.4470	464810	4990384	76.27	13.1	12.7	0.14	1004	571.3	562.2	547.0	26.81
26-Oct	299	45.0590	-87.4470	464805	4989385	77.27	13.1	12.7	0.14	1004	604.0	594.4	578.3	28.33
26-Oct	299	45.0490	-87.4470	464799	4988274	78.38	13.1	12.7	0.14	1004	631.3	621.3	604.5	29.61
26-Oct	299	45.0230	-87.4450	464940	4985385	81.27	13.0	12.7	0.14	1004	671.9	661.2	643.4	31.57
26-Oct	299	45.0190	-87.4460	464859	4984941	81.72	13.1	12.7	0.14	1004	667.8	657.2	639.4	31.34
26-Oct	299	45.0190	-87.4460	464859	4984941	81.72	13.1	12.7	0.14	1004	657.3	646.9	629.4	30.82
26-Oct	299	45.0190	-87.4460	464859	4984941	81.72	13.1	12.7	0.14	1004	667.3	656.8	639.0	31.29
26-Oct	299	45.0190	-87.4460	464859	4984941	81.72	13.1	12.7	0.14	1004	668.4	657.9	640.0	31.33
26-Oct	299	45.0190	-87.4460	464859	4984941	81.72	13.1	12.7	0.14	1004	657.5	647.1	629.6	30.81
26-Oct	299	45.0200	-87.4460	464860	4985052	81.84	13.1	12.8	0.14	1004	661.5	651.0	633.1	30.97
26-Oct	299	45.0190	-87.4460	464859	4984941	81.95	13.1	12.7	0.14	1004	661.9	651.4	633.5	31.00
26-Oct	299	44.9990	-87.4410	465241	4982717	84.20	13.1	12.7	0.14	1004	668.4	657.8	639.7	31.35
26-Oct	299	44.9850	-87.4370	465548	4981160	85.79	13.1	12.7	0.14	1004	657.3	646.9	629.1	30.85
26-Oct	299	44.9690	-87.4330	465854	4979381	87.59	13.0	12.6	0.14	1004	647.5	637.2	619.6	30.43
26-Oct	299	44.9530	-87.4300	466081	4977602	89.39	13.0	12.6	0.14	1004	646.6	636.2	618.8	30.44
26-Oct	299	44.9380	-87.4260	466388	4975934	91.08	12.9	12.5	0.14	1004	603.8	594.1	577.8	28.48
26-Oct	299	44.9200	-87.4230	466614	4973933	93.10	12.9	12.5	0.14	1004	581.7	572.3	556.6	27.49
26-Oct	299	44.9060	-87.4200	466843	4972377	94.67	12.8	12.4	0.14	1004	549.1	540.1	525.4	25.97
26-Oct	299	44.8900	-87.4170	467070	4970598	96.46	12.7	12.3	0.14	1004	532.0	523.1	508.9	25.30
26-Oct	299	44.8720	-87.4100	467613	4968596	98.54	12.0	11.5	0.14	1003	439.7	431.8	420.2	21.39
26-Oct	299	44.8640	-87.4050	468003	4967705	99.51	11.6	11.2	0.14	1003	394.8	387.4	377.2	19.44
26-Oct	299	44.8550	-87.3980	468552	4966703	100.65	11.4	11.0	0.14	1003	382.9	375.6	365.7	18.99
26-Oct	299	44.8430	-87.3890	469256	4965366	102.16	11.3	10.9	0.15	1003	394.6	387.0	376.9	19.62
26-Oct	299	44.8370	-87.3830	469727	4964698	102.98	11.2	10.7	0.15	1003	416.9	408.9	398.2	20.83
26-Oct	299	44.8310	-87.3790	470040	4964030	103.72	11.0	10.5	0.15	1003	439.0	430.4	419.2	22.08

1995 CARBON DIOXIDE DATA

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
18-Apr	108			470119	4963881	0.00	5.5	4.8	0.15	975	455.9	441.2	419.2	27.06
18-Apr	108			469818	4964437	0.63	5.3	4.5	0.15	975	428.2	414.1	393.5	25.61
18-Apr	108			469230	4965384	1.75	5.0	4.2	0.15	975	412.5	398.6	378.8	24.94
18-Apr	108			469046	4965756	2.16	4.8	4.0	0.15	975	406.7	392.8	373.3	24.76
18-Apr	108			467612	4968465	5.23	3.8	3.0	0.15	975	410.7	395.4	376.0	25.95
18-Apr	108			467351	4969060	5.88	4.0	3.1	0.15	975	392.7	378.2	359.6	24.68
18-Apr	108			467215	4970800	7.62	3.4	2.6	0.15	975	403.6	388.1	369.1	25.89
18-Apr	108			466933	4972228	9.08	3.1	2.2	0.15	975	410.9	394.7	375.4	26.74
18-Apr	108			466740	4973024	9.90	3.2	2.3	0.15	975	414.5	398.3	378.9	26.80
18-Apr	108			466470	4974230	11.13	3.1	2.2	0.15	975	400.0	384.3	365.6	25.95
18-Apr	108			466086	4976176	13.12	3.3	2.4	0.16	975	367.3	353.0	335.8	23.69
18-Apr	108			465732	4978788	15.75	3.0	2.1	0.16	975	378.1	363.0	345.4	24.67
19-Apr	109			470183	4963842	0.00	5.1	4.3	0.15	986	548.3	530.2	509.5	33.42
19-Apr	109			469870	4964419	0.66	4.9	4.1	0.15	986	436.9	422.1	405.7	26.87
19-Apr	109			469570	4964921	1.24	4.9	4.1	0.15	986	435.6	420.8	404.4	26.79
19-Apr	109			468996	4965868	2.35	5.0	4.2	0.15	986	420.1	405.9	390.1	25.72
19-Apr	109			467666	4968374	5.19	3.9	3.0	0.15	986	402.1	387.2	372.3	25.65
19-Apr	109			467438	4969559	6.39	4.2	3.4	0.15	986	391.5	377.4	362.8	24.69
19-Apr	109			467239	4970764	7.61	3.6	2.8	0.15	986	391.3	376.5	362.1	25.18
19-Apr	109			466907	4972068	8.96	3.4	2.6	0.15	986	402.1	386.7	371.9	26.07
19-Apr	109			466781	4972881	9.78	3.4	2.6	0.15	987	391.5	376.5	362.5	25.44
19-Apr	109			466564	4974311	11.23	3.4	2.6	0.16	987	366.0	351.9	338.8	23.76
19-Apr	109			466329	4976005	12.94	3.4	2.6	0.16	987	366.0	351.9	338.8	23.76
19-Apr	109			465926	4978904	15.87	3.1	2.2	0.15	987	401.8	386.0	371.8	26.41
19-Apr	109			465778	4979972	16.94	3.1	2.2	0.15	987	412.8	396.5	381.9	27.20
19-Apr	109			465421	4982160	19.16	3.1	2.2	0.15	987	398.6	382.9	368.7	26.20
19-Apr	109			465020	4985551	22.58	3.1	2.2	0.15	988	394.4	378.8	365.2	25.98
19-Apr	109			465020	4985568	22.59	3.1	2.2	0.15	988	393.7	378.2	364.5	25.95
19-Apr	109			465020	4985551	22.61	3.1	2.2	0.15	988	394.4	378.8	365.2	26.00
19-Apr	109			465140	4985919	23.00	3.3	2.4	0.15	989	398.6	383.1	369.6	26.10
19-Apr	109			465799	4986637	23.97	3.3	2.4	0.15	989	394.4	379.1	365.8	25.79
19-Apr	109			466289	4987155	24.69	3.3	2.4	0.15	989	393.9	378.6	365.3	25.77
19-Apr	109			470299	4991356	30.49	3.1	2.2	0.15	989	392.8	377.4	364.1	25.88
19-Apr	109			471089	4992130	31.60	3.0	2.1	0.15	989	404.5	388.4	374.8	26.76
19-Apr	109			472868	4993880	34.09	2.9	2.0	0.15	989	346.8	332.9	321.3	22.99

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
19-Apr	109			474145	4995208	35.94	3.2	2.3	0.15	989	384.0	369.0	356.1	25.22
19-Apr	109			474804	4995927	36.91	3.1	2.3	0.15	989	383.4	368.3	355.4	25.22
19-Apr	109			475172	4996370	37.49	3.0	2.1	0.15	990	378.1	363.1	350.7	25.03
19-Apr	109			476829	4997974	39.79	2.9	2.0	0.15	990	393.9	378.2	365.3	26.18
19-Apr	109			477133	4998327	40.26	3.4	2.5	0.15	990	393.9	378.7	365.8	25.73
19-Apr	109			477528	4999010	41.05	3.3	2.4	0.15	990	382.9	368.0	355.5	25.11
19-Apr	109			478137	5000914	43.05	3.1	2.2	0.15	990	382.9	367.9	355.3	25.23
19-Apr	109			479392	5004076	46.45	3.2	2.4	0.15	990	380.3	365.5	353.0	24.95
19-Apr	109			479748	5004779	47.24	3.1	2.2	0.15	991	382.9	367.8	355.7	25.29
19-Apr	109			479958	5005038	47.57	3.1	2.2	0.15	991	387.3	372.1	359.8	25.56
19-Apr	109			479958	5005018	47.59	3.1	2.2	0.15	991	379.9	364.9	352.8	25.06
19-Apr	109			479958	5005018	47.59	3.1	2.2	0.15	991	388.0	372.7	360.4	25.59
19-Apr	109			479945	5005018	47.60	3.1	2.3	0.15	991	379.4	364.5	352.4	25.02
19-Apr	109			479932	5005018	47.62	3.1	2.3	0.15	991	383.6	368.5	356.3	25.29
19-Apr	109			479945	5005018	47.63	3.1	2.2	0.15	991	383.2	368.1	355.9	25.27
19-Apr	109			479945	5005018	47.63	3.2	2.3	0.15	992	380.5	365.6	353.9	25.07
19-Apr	109			478419	5006543	49.79	3.2	2.4	0.15	993	379.3	364.5	353.1	24.97
19-Apr	109			477805	5007100	50.62	3.2	2.4	0.15	993	369.8	355.3	344.3	24.33
19-Apr	109			476723	5008084	52.08	3.0	2.1	0.15	993	378.9	363.8	352.5	25.19
19-Apr	109			475562	5009126	53.64	3.0	2.1	0.15	993	386.0	370.7	359.2	25.60
19-Apr	109			474441	5010130	55.14	3.0	2.1	0.15	993	391.2	375.7	364.0	25.97
19-Apr	109			472673	5009600	56.99	2.9	2.0	0.15	993	390.1	374.5	362.9	25.97
19-Apr	109			470995	5008590	58.95	2.9	2.0	0.15	993	402.9	386.7	374.7	26.87
19-Apr	109			469721	5007801	60.45	2.9	2.0	0.15	993	416.0	399.4	387.0	27.77
19-Apr	109			468225	5006937	62.17	3.0	2.1	0.15	993	414.1	397.6	385.3	27.55
19-Apr	109			466519	5005984	64.13	2.9	2.0	0.15	993	411.1	394.6	382.4	27.44
19-Apr	109			465034	5005047	65.88	2.9	2.0	0.15	993	411.9	395.5	383.2	27.42
19-Apr	109			465127	5005009	65.98	2.9	2.0	0.15	993	408.0	391.7	379.6	27.23
19-Apr	109			465139	5005009	66.00	2.9	2.0	0.15	993	405.2	389.0	376.9	27.03
19-Apr	109			465139	5005009	66.00	2.9	2.0	0.15	993	411.7	395.2	383.0	27.47
19-Apr	109			465127	5004991	66.02	2.9	2.0	0.15	993	415.2	398.6	386.2	27.68
19-Apr	109			464853	5002993	68.03	2.9	2.0	0.15	994	410.2	393.8	381.9	27.41
19-Apr	109			464784	5002456	68.58	2.9	2.0	0.15	994	401.1	385.1	373.5	26.78
19-Apr	109			464675	5001419	69.62	2.9	2.0	0.15	994	401.4	385.3	373.7	26.77
19-Apr	109			464563	5000217	70.83	2.9	2.0	0.15	994	400.5	384.5	372.9	26.70
19-Apr	109			464315	4998126	72.93	2.9	2.0	0.15	994	400.5	384.5	372.9	26.72

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
19-Apr	109			464149	4996627	74.44	2.9	2.0	0.15	994	390.5	374.9	363.6	26.08
19-Apr	109			463971	4995073	76.00	2.9	2.0	0.15	994	400.9	384.8	373.3	26.79
19-Apr	109			463778	4993463	77.63	2.9	2.0	0.15	994	400.7	384.6	373.1	26.78
19-Apr	109			463715	4991575	79.51	2.9	2.0	0.15	994	404.8	388.6	376.9	27.03
19-Apr	109			463862	4989796	81.30	2.8	1.9	0.15	994	411.7	395.2	383.3	27.54
19-Apr	109			463761	4988259	82.84	2.9	1.9	0.15	994	408.0	391.7	379.9	27.28
19-Apr	109			463543	4986892	84.22	2.9	2.0	0.15	994	405.9	389.6	377.9	27.09
19-Apr	109			462914	4984803	86.41	2.9	2.0	0.15	994	415.6	399.0	387.0	27.77
19-Apr	109			462564	4983323	87.93	2.9	2.0	0.15	994	411.7	395.2	383.4	27.50
19-Apr	109			462199	4981548	89.74	2.9	2.0	0.15	994	401.8	385.7	374.1	26.81
19-Apr	109			461428	4980219	91.28	3.0	2.1	0.15	994	401.6	385.6	374.0	26.75
19-Apr	109			459764	4978916	93.39	3.0	2.1	0.15	993	401.8	385.8	373.8	26.73
19-Apr	109			458747	4978034	94.73	3.0	2.1	0.15	993	376.7	361.7	350.4	25.04
19-Apr	109			456697	4976326	97.40	3.3	2.4	0.15	993	374.3	359.7	348.5	24.61
19-Apr	109			455269	4975131	99.27	3.1	2.2	0.15	993	358.3	344.1	333.4	23.68
19-Apr	109			454859	4974839	99.77	3.4	2.5	0.15	993	368.9	354.7	343.6	24.15
19-Apr	109			455949	4974700	100.87	3.3	2.4	0.15	996	380.0	365.1	354.8	25.06
19-Apr	109			457198	4974563	102.12	3.0	2.1	0.15	996	385.1	369.8	359.4	25.69
19-Apr	109			458251	4974445	103.18	3.1	2.2	0.15	996	391.0	375.6	365.0	25.92
19-Apr	109			460590	4974134	105.54	3.3	2.4	0.15	996	370.0	355.6	345.6	24.35
19-Apr	109			462430	4973919	107.40	3.6	2.7	0.16	997	350.3	336.9	327.7	22.87
19-Apr	109			464401	4973501	109.41	3.8	2.9	0.16	997	334.0	321.5	312.6	21.61
19-Apr	109			465580	4972457	110.98	3.4	2.6	0.15	997	380.4	365.8	355.8	24.95
19-Apr	109			466915	4971190	112.83	3.5	2.6	0.15	997	380.0	365.4	355.4	24.88
19-Apr	109			467637	4968336	115.77	4.4	3.6	0.15	997	347.0	334.7	325.3	21.94
19-Apr	109			468199	4967260	116.98	4.7	3.9	0.15	997	380.6	367.4	357.1	23.83
19-Apr	109			469610	4964865	119.76	5.1	4.4	0.15	997	411.7	398.0	386.8	25.32
19-Apr	109			470105	4963992	120.77	5.1	4.4	0.15	998	411.9	398.2	387.3	25.40
20-Apr	110	44.9302	-87.4099	467650	4975066	0.00	3.7	2.9	0.15	997	366.7	352.9	343.2	23.77
20-Apr	110	44.9254	-87.4426	465067	4974540	2.64	3.9	3.0	0.16	997	326.1	313.9	305.2	21.03
20-Apr	110	44.9197	-87.4705	462868	4973919	4.92	3.6	2.8	0.16	997	326.1	313.6	305.0	21.23
20-Apr	110	44.8908	-87.5417	457225	4970748	11.39	3.6	2.7	0.15	997	357.5	343.9	334.5	23.32
20-Apr	110	44.8838	-87.5563	456062	4969978	12.79	3.8	2.9	0.16	997	347.1	334.1	324.9	22.49
20-Apr	110	44.8757	-87.5737	454686	4969081	14.43	3.5	2.7	0.16	997	346.9	333.6	324.5	22.67
20-Apr	110	44.8668	-87.5935	453113	4968110	16.28	3.8	2.9	0.15	997	367.3	353.6	343.8	23.76

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
20-Apr	110	44.8553	-87.6205	450971	4966849	18.77	4.0	3.2	0.16	997	321.1	309.3	300.7	20.62
20-Apr	110	44.8457	-87.6388	449513	4965787	20.57	4.1	3.3	0.16	997	333.1	320.9	312.0	21.31
20-Apr	110	44.8305	-87.6627	447615	4964118	23.10	4.1	3.3	0.16	997	315.2	303.6	295.2	20.16
20-Apr	110	44.8140	-87.6868	445690	4962301	25.74	4.3	3.4	0.16	996	304.3	293.2	284.8	19.32
20-Apr	110	44.8090	-87.6940	445119	4961750	26.54	4.3	3.5	0.16	996	308.8	297.6	289.0	19.60
20-Apr	110	44.7992	-87.7073	444055	4960666	28.06	4.6	3.8	0.16	996	302.3	291.7	283.2	18.95
20-Apr	110	44.7780	-87.7367	441713	4958336	31.36	4.5	3.7	0.16	996	298.7	288.1	279.7	18.80
20-Apr	110	44.7613	-87.7593	439903	4956500	33.94	4.4	3.6	0.15	996	343.9	331.7	322.1	21.70
20-Apr	110	44.7485	-87.7762	438556	4955089	35.89	4.6	3.8	0.15	996	340.1	328.2	318.7	21.31
20-Apr	110	44.7353	-87.7943	437104	4953638	37.94	4.5	3.7	0.15	996	347.8	335.5	325.8	21.91
20-Apr	110	44.7207	-87.8170	435294	4952028	40.36	4.3	3.5	0.15	996	358.0	345.1	335.2	22.69
20-Apr	110	44.7077	-87.8372	433681	4950600	42.52	4.8	4.0	0.15	996	371.5	358.8	348.3	23.11
20-Apr	110	44.6915	-87.8595	431894	4948823	45.04	4.4	3.6	0.15	996	336.1	324.1	314.7	21.23
20-Apr	110	44.6747	-87.8790	430328	4946969	47.47	4.5	3.7	0.15	995	315.2	304.0	294.9	19.81
20-Apr	110	44.6603	-87.8922	429266	4945388	49.37	5.3	4.5	0.15	995	365.6	353.5	342.8	22.31
20-Apr	110	44.6492	-87.9032	428380	4944158	50.89	5.2	4.5	0.15	995	346.9	335.4	325.2	21.23
20-Apr	110	44.6322	-87.9182	427170	4942283	53.12	5.4	4.6	0.15	995	335.6	324.6	314.7	20.44
20-Apr	110	44.6182	-87.9307	426160	4940739	54.96	5.7	5.0	0.15	995	337.1	326.4	316.4	20.27
20-Apr	110	44.5975	-87.9495	424641	4938461	57.70	7.2	6.6	0.16	995	315.0	306.1	296.5	17.91
20-Apr	110	44.5902	-87.9605	423758	4937656	58.90	7.2	6.6	0.17	994	332.5	323.1	312.6	18.90
20-Apr	110	44.5833	-87.9755	422558	4936910	60.31	7.8	7.2	0.20	994	309.2	300.9	291.1	17.18
20-Apr	110	44.5655	-87.9900	421383	4934945	62.60	7.8	7.2	0.21	994	293.8	285.9	276.5	16.33
20-Apr	110	44.5455	-88.0005	420522	4932733	64.97	8.9	8.4	0.22	994	387.6	378.3	365.6	20.71
20-Apr	110	44.5352	-88.0058	420084	4931590	66.20	9.8	9.3	0.23	994	467.5	457.2	441.6	24.28
20-Apr	110	44.5292	-88.0078	419917	4930925	66.88	9.4	8.8	0.23	994	371.5	363.0	350.7	19.57
20-Apr	110	44.5232	-88.0095	419776	4930261	67.56	8.8	8.2	0.23	994	377.0	367.9	355.6	20.25
20-Apr	110	44.5215	-88.0093	419787	4930076	67.74	8.6	8.0	0.22	994	340.1	331.7	320.6	18.39
20-Apr	110	44.5213	-88.0095	419774	4930056	67.77	8.7	8.2	0.22	994	339.7	331.4	320.3	18.28
20-Apr	110	44.5213	-88.0100	419734	4930057	67.81	8.8	8.2	0.22	994	350.1	341.6	330.1	18.83
20-Apr	110	44.5450	-88.0012	420467	4932678	70.53	10.2	9.7	0.23	994	373.5	365.5	352.9	19.10
20-Apr	110	44.5540	-87.9965	420851	4933674	71.60	8.9	8.4	0.24	994	449.4	438.7	424.0	24.02
20-Apr	110	44.5642	-87.9908	421315	4934797	72.81	8.4	7.9	0.22	994	351.5	342.7	331.3	19.12
20-Apr	110	44.5777	-87.9825	421995	4936288	74.45	7.5	6.8	0.21	994	319.7	310.9	300.7	18.01
20-Apr	110	44.5877	-87.9663	423291	4937384	76.15	7.7	7.1	0.20	993	256.2	249.2	240.8	14.30
20-Apr	110	44.5932	-87.9543	424251	4937983	77.28	7.8	7.2	0.20	993	309.7	301.4	291.2	17.22
20-Apr	110	44.6122	-87.9363	425704	4940077	79.83	6.3	5.6	0.17	993	302.7	293.5	283.9	17.76

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
20-Apr	110	44.6437	-87.9077	428017	4943551	84.00	5.2	4.5	0.15	993	310.5	300.1	290.5	18.98
20-Apr	110	44.6517	-87.9003	428609	4944433	85.06	5.2	4.4	0.15	993	330.5	319.5	309.2	20.22
20-Apr	110	44.6672	-87.8858	429777	4946142	87.13	5.3	4.5	0.15	993	340.8	329.5	318.9	20.76
20-Apr	110	44.6913	-87.8617	431721	4948805	90.43	4.4	3.6	0.15	993	302.3	291.5	282.2	19.04
20-Apr	110	44.7077	-87.8420	433299	4950604	92.82	4.7	3.9	0.15	993	340.4	328.5	318.0	21.20
20-Apr	110	44.7207	-87.8265	434541	4952035	94.72	4.3	3.5	0.15	993	366.2	353.1	341.9	23.17
20-Apr	110	44.7462	-87.7947	437089	4954843	98.51	4.5	3.7	0.15	993	330.5	318.8	308.7	20.74
20-Apr	110	44.7677	-87.7687	439170	4957211	101.66	4.4	3.6	0.15	993	320.1	308.7	298.9	20.14
20-Apr	110	44.7738	-87.7615	439745	4957890	102.55	4.3	3.5	0.16	993	319.2	307.7	298.0	20.18
20-Apr	110	44.8287	-87.6762	446546	4963922	111.64	4.0	3.2	0.15	993	351.7	338.8	328.1	22.45
20-Apr	110	44.8333	-87.6668	447289	4964434	112.55	4.0	3.2	0.15	993	329.5	317.3	307.3	21.03
20-Apr	110	44.8408	-87.6515	448508	4965257	114.02	4.0	3.2	0.16	993	334.0	321.8	311.6	21.32
20-Apr	110	44.8550	-87.6207	450956	4966813	116.92	4.1	3.3	0.16	993	316.0	304.4	294.8	20.13
20-Apr	110	44.8658	-87.5903	453362	4967997	119.60	4.1	3.3	0.16	993	312.1	300.6	291.1	19.86
20-Apr	110	44.8718	-87.5745	454618	4968655	121.02	4.0	3.1	0.16	993	305.6	294.2	284.9	19.55
20-Apr	110	44.8815	-87.5523	456376	4969718	123.07	3.6	2.8	0.15	993	345.0	331.9	321.4	22.37
20-Apr	110	44.8895	-87.5323	457962	4970596	124.88	3.8	2.9	0.16	993	334.0	321.5	311.4	21.54
20-Apr	110	44.8972	-87.5140	459415	4971438	126.56	3.8	2.9	0.16	993	343.0	330.1	319.7	22.12
20-Apr	110	44.9073	-87.4875	461515	4972553	128.94	3.8	2.9	0.16	993	329.9	317.5	307.5	21.25
20-Apr	110	44.9153	-87.4573	463900	4973428	131.48	4.1	3.3	0.16	993	319.0	307.3	297.6	20.32
20-Apr	110	44.9008	-87.4325	465853	4971807	134.02	3.7	2.9	0.15	993	362.5	348.8	337.9	23.43
20-Apr	110	44.8848	-87.4137	467329	4970022	136.34	4.3	3.5	0.15	993	361.8	348.8	337.8	22.88
20-Apr	110	44.8723	-87.4117	467480	4968632	137.73	4.6	3.8	0.15	993	334.7	323.0	312.7	20.89
20-Apr	110	44.8542	-87.3985	468512	4966610	140.01	5.0	4.2	0.15	993	355.5	343.4	332.4	21.92
20-Apr	110	44.8422	-87.3883	469308	4965273	141.56	5.2	4.5	0.15	993	391.1	378.2	366.0	23.89
20-Apr	110	44.8357	-87.3828	469739	4964549	142.40	5.3	4.6	0.15	993	409.9	396.5	383.7	24.93
22-May	142	44.5207	-88.0105	419693	4929985	0.00	17.7	17.5	0.23	998	866.3	857.8	825.2	34.80
22-May	142	44.5207	-88.0105	419693	4929985	0.00	17.7	17.5	0.23	998	876.3	867.7	834.7	35.21
22-May	142	44.5207	-88.0105	419693	4929985	0.00	17.8	17.6	0.23	998	845.1	836.8	804.9	33.85
22-May	142	44.5207	-88.0105	419693	4929985	0.00	17.9	17.7	0.23	997	827.9	819.9	787.7	33.02
22-May	142	44.5310	-88.0080	419906	4931130	1.16	18.1	17.9	0.22	996	820.6	812.8	779.9	32.49
22-May	142	44.5448	-88.0010	420481	4932660	2.80	17.5	17.3	0.22	996	693.6	686.7	659.4	27.98
22-May	142	44.5655	-87.9898	421397	4934944	5.26	15.7	15.4	0.21	996	482.7	477.0	459.0	20.62
22-May	142	44.5762	-87.9833	421927	4936123	6.55	15.6	15.3	0.20	996	582.4	575.6	553.9	24.96
22-May	142	44.5895	-87.9615	423678	4937583	8.83	15.1	14.8	0.19	996	338.6	334.4	322.0	14.74

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
22-May	142	44.5985	-87.9480	424761	4938571	10.30	14.9	14.6	0.18	996	329.7	325.5	313.5	14.45
22-May	142	44.6113	-87.9463	424910	4939995	11.73	14.6	14.3	0.17	996	289.8	286.0	275.6	12.82
22-May	142	44.6325	-87.9458	424977	4942345	14.08	14.1	13.8	0.17	995	300.3	296.3	285.3	13.50
22-May	142	44.6595	-87.9257	426610	4945326	17.48	13.4	13.1	0.16	994	296.7	292.5	281.6	13.63
22-May	142	44.6585	-87.8877	429622	4945182	20.50	12.8	12.5	0.15	994	340.0	335.0	322.6	15.94
22-May	142	44.6588	-87.8832	429979	4945215	20.85	12.8	12.5	0.15	994	344.2	339.1	326.7	16.14
22-May	142	44.6588	-87.8828	430006	4945214	20.88	12.8	12.5	0.15	994	340.6	335.6	323.3	15.97
22-May	142	44.6773	-87.8563	432128	4947247	23.82	12.5	12.2	0.15	993	322.1	317.2	305.3	15.23
22-May	142	44.6900	-87.8382	433582	4948639	25.83	12.4	12.0	0.15	993	318.7	313.9	302.1	15.13
22-May	142	44.7002	-87.8235	434756	4949757	27.45	12.3	11.9	0.15	993	311.8	307.0	295.5	14.85
22-May	142	44.7165	-87.7998	436649	4951552	30.06	12.4	12.0	0.15	993	318.9	314.1	302.3	15.14
22-May	142	44.7377	-87.7692	439100	4953880	33.44	13.3	13.0	0.15	993	351.6	346.6	333.4	16.19
22-May	142	44.7483	-87.7545	440272	4955054	35.10	13.7	13.4	0.15	993	375.2	370.1	355.8	17.06
22-May	142	44.7612	-87.7368	441684	4956467	37.10	13.9	13.6	0.15	993	387.9	382.7	367.9	17.52
22-May	142	44.7693	-87.7253	442602	4957366	38.38	13.9	13.6	0.15	993	377.2	372.1	357.7	17.03
22-May	142	44.7858	-87.7007	444570	4959181	41.06	13.5	13.2	0.15	993	360.3	355.3	341.6	16.49
22-May	142	44.7983	-87.6818	446072	4960557	43.10	13.5	13.2	0.15	993	344.7	339.8	326.8	15.77
22-May	142	44.8115	-87.6623	447626	4962007	45.22	13.9	13.6	0.15	993	409.3	403.8	388.1	18.48
22-May	142	44.8213	-87.6485	448728	4963091	46.77	13.9	13.6	0.15	993	417.3	411.7	395.7	18.84
22-May	142	44.8383	-87.6233	450733	4964963	49.51	13.9	13.6	0.15	993	428.2	422.4	406.0	19.34
22-May	142	44.8513	-87.5988	452680	4966393	51.93	13.6	13.3	0.15	993	420.8	415.1	399.1	19.19
22-May	142	44.8598	-87.5827	453964	4967328	53.52	13.7	13.4	0.15	993	427.9	422.1	405.8	19.45
22-May	142	44.8683	-87.5672	455195	4968263	55.06	13.3	13.0	0.15	993	398.8	393.2	378.2	18.37
22-May	142	44.8788	-87.5455	456914	4969418	57.13	12.2	11.8	0.15	993	389.7	383.8	369.5	18.62
22-May	142	44.8855	-87.5310	458065	4970151	58.50	11.7	11.3	0.15	993	384.6	378.5	364.6	18.69
22-May	142	44.8940	-87.5113	459624	4971085	60.32	11.4	11.0	0.15	993	409.3	402.7	388.0	20.10
22-May	142	44.9062	-87.4860	461632	4972425	62.73	10.7	10.3	0.15	993	387.7	381.1	367.4	19.50
22-May	142	44.9167	-87.4655	463257	4973582	64.72	10.8	10.4	0.15	993	395.5	388.8	374.8	19.82
22-May	142	44.9133	-87.4535	464202	4973206	65.74	11.7	11.3	0.15	993	417.5	410.9	395.8	20.29
22-May	142	44.9033	-87.4373	465473	4972088	67.43	11.9	11.5	0.15	993	427.9	421.3	405.7	20.66
22-May	142	44.8943	-87.4233	466573	4971082	68.92	10.9	10.5	0.15	993	424.2	417.1	402.0	21.19
22-May	142	44.8838	-87.4142	467290	4969912	70.30	11.1	10.7	0.15	993	428.2	421.1	405.8	21.24
22-May	142	44.8692	-87.4095	467651	4968281	71.97	13.2	12.9	0.15	993	474.7	468.0	450.2	21.94
22-May	142	44.8510	-87.3957	468734	4966258	74.26	12.8	12.5	0.15	993	504.5	497.2	478.4	23.63
22-May	142	44.8387	-87.3855	469531	4964884	75.85	14.3	14.0	0.15	993	539.1	532.2	511.3	24.03
22-May	142	44.8330	-87.3807	469909	4964253	76.59	13.9	13.6	0.15	993	474.9	468.6	450.4	21.45

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
22-May	142	44.8278	-87.3782	470104	4963678	77.19	13.6	13.3	0.15	993	525.0	517.9	497.9	23.95
22-May	142	44.8278	-87.3782	470104	4963678	77.19	13.3	13.0	0.15	993	515.1	507.9	488.5	23.73
23-May	143			468459	4966739	0.00	13.4	13.1	0.15	991	520.7	513.5	492.8	23.86
23-May	143			467364	4969042	2.55	11.9	11.5	0.15	991	486.6	479.1	460.5	23.45
23-May	143			466232	4971603	5.35	12.0	11.6	0.15	991	455.1	448.1	430.6	21.85
23-May	143			464019	4973392	8.20	11.0	10.6	0.15	991	415.8	408.9	393.3	20.66
23-May	143			461072	4973594	11.15	10.3	9.9	0.14	991	391.0	384.2	369.7	19.90
23-May	143			458585	4973405	13.64	10.6	10.2	0.14	991	352.1	346.0	332.9	17.73
23-May	143			457493	4973339	14.74	10.5	10.1	0.14	991	396.2	389.4	374.7	20.02
23-May	143			455465	4973186	16.77	10.3	9.9	0.14	991	395.5	388.6	374.0	20.13
23-May	143			453742	4973069	18.50	11.0	10.6	0.14	991	379.1	372.7	358.5	18.83
23-May	143			449489	4972748	22.76	11.0	10.6	0.14	991	392.4	385.8	371.1	19.49
23-May	143			446554	4972550	25.71	11.2	10.8	0.14	991	374.3	368.1	354.0	18.47
23-May	143			444934	4972452	27.33	11.8	11.4	0.14	991	344.2	338.7	325.6	16.64
23-May	143			441933	4972350	30.33	11.8	11.4	0.14	991	318.5	313.4	301.3	15.39
23-May	143			440851	4972175	31.43	12.2	11.8	0.14	991	373.9	368.1	353.7	17.83
23-May	143			439626	4971982	32.67	12.4	12.0	0.14	991	329.9	324.9	312.1	15.62
23-May	143			438271	4971978	34.02	12.5	12.2	0.14	991	319.2	314.4	302.0	15.07
23-May	143			436821	4971861	35.48	13.0	12.7	0.14	991	306.9	302.4	290.3	14.25
23-May	143			438404	4969439	38.37	13.8	13.5	0.14	991	292.3	288.3	276.5	13.21
23-May	143			438650	4969085	38.80	13.5	13.2	0.14	991	200.4	197.6	189.6	9.15
23-May	143			439313	4968135	39.96	12.5	12.2	0.14	991	291.4	287.0	275.6	13.75
23-May	143			440562	4966492	42.02	11.8	11.4	0.14	992	291.8	287.2	276.3	14.12
23-May	143			442032	4964444	44.54	11.7	11.3	0.15	992	324.4	319.2	307.2	15.75
23-May	143			443488	4962282	47.15	11.5	11.1	0.15	992	341.0	335.5	322.9	16.67
23-May	143			444569	4960680	49.08	12.5	12.2	0.15	992	399.6	393.6	378.5	18.89
23-May	143			444960	4960159	49.73	13.1	12.8	0.15	992	399.4	393.7	378.3	18.50
23-May	143			444457	4959996	50.26	13.1	12.8	0.16	992	399.4	393.7	378.3	18.50
23-May	143			440359	4960162	54.36	11.0	10.6	0.15	992	402.8	396.1	381.3	20.03
23-May	143			438869	4960214	55.85	11.0	10.6	0.15	992	409.3	402.5	387.5	20.35
23-May	143			437262	4960396	57.47	11.5	11.1	0.15	992	392.2	385.9	371.3	19.17
23-May	143			435749	4960595	59.00	12.5	12.2	0.14	992	362.5	357.1	343.4	17.13
23-May	143			433587	4960673	61.16	13.4	13.1	0.14	992	322.1	317.6	305.1	14.77
23-May	143			432019	4960671	62.73	13.8	13.5	0.15	992	318.7	314.4	301.9	14.42
23-May	143			433281	4957881	65.79	12.8	12.5	0.14	992	313.0	308.4	296.5	14.64

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
23-May	143			434083	4956335	67.53	12.0	11.6	0.14	992	307.3	302.5	291.0	14.77
23-May	143			435648	4953228	71.01	11.5	11.1	0.15	991	352.1	346.4	333.1	17.19
23-May	143			436499	4951200	73.21	12.3	11.9	0.15	991	348.7	343.4	329.9	16.57
23-May	143			438186	4948038	76.80	13.2	12.9	0.15	991	362.5	357.4	343.1	16.72
23-May	143			438498	4947442	77.47	13.1	12.8	0.15	991	355.3	350.2	336.2	16.44
23-May	143			439688	4944858	80.31	14.2	13.9	0.16	991	402.3	397.0	380.7	17.95
23-May	143			438090	4944946	81.91	14.1	13.8	0.16	991	376.3	371.3	356.1	16.85
23-May	143			436743	4944997	83.26	14.0	13.7	0.16	991	381.1	376.0	360.6	17.12
23-May	143			434363	4944965	85.64	13.2	12.9	0.15	991	353.7	348.7	334.7	16.31
23-May	143			430215	4945137	89.79	12.7	12.4	0.15	991	337.1	332.1	319.0	15.81
23-May	143			430680	4946503	91.24	12.3	11.9	0.15	991	324.0	319.0	306.5	15.40
23-May	143			431485	4947623	92.62	12.1	11.7	0.14	991	312.8	307.9	295.9	14.97
23-May	143			433199	4949994	95.54	12.0	11.6	0.15	991	321.2	316.2	303.9	15.42
23-May	143			434340	4951686	97.58	11.9	11.5	0.15	991	335.8	330.6	317.7	16.18
23-May	143			435210	4952991	99.15	11.6	11.2	0.15	991	336.1	330.7	317.9	16.35
23-May	143			437998	4957260	104.25	11.2	10.8	0.15	992	358.2	352.3	339.1	17.69
23-May	143			439013	4958675	105.99	11.0	10.6	0.15	992	368.6	362.5	349.0	18.33
23-May	143			440043	4960220	107.85	11.3	10.9	0.15	992	379.8	373.6	359.6	18.69
23-May	143			440004	4960221	107.89	11.3	10.9	0.15	992	380.0	373.8	359.8	18.70
23-May	143			440070	4960202	107.96	11.3	10.9	0.15	992	380.5	374.2	360.2	18.73
23-May	143			440017	4960241	108.02	11.5	11.1	0.15	992	375.5	369.4	355.5	18.35
23-May	143			440683	4960974	109.01	11.5	11.1	0.15	992	369.3	363.4	349.7	18.05
23-May	143			442718	4963011	111.89	11.6	11.2	0.15	992	312.8	307.7	296.1	15.24
23-May	143			443356	4963634	112.78	11.8	11.4	0.15	992	357.5	351.8	338.5	17.30
23-May	143			444817	4965066	114.83	12.1	11.7	0.15	992	364.1	358.5	344.8	17.44
23-May	143			446848	4966975	117.62	12.3	11.9	0.15	992	357.7	352.3	338.8	17.02
23-May	143			448455	4968499	119.83	11.8	11.4	0.15	992	346.6	341.1	328.2	16.77
23-May	143			449809	4969822	121.72	11.2	10.8	0.15	992	346.3	340.6	327.9	17.10
23-May	143			451585	4971659	124.28	10.9	10.5	0.14	992	335.4	329.7	317.5	16.73
23-May	143			453043	4972981	126.25	10.9	10.5	0.14	992	324.2	318.7	306.9	16.17
23-May	143			453905	4973808	127.44	11.0	10.6	0.14	992	312.8	307.5	296.1	15.55
23-May	143			454249	4974156	127.93	10.9	10.5	0.14	992	313.5	308.2	296.7	15.64
23-May	143			454951	4974856	128.92	10.6	10.2	0.14	992	290.8	285.8	275.2	14.66
23-May	143			454912	4974929	129.01	10.4	10.0	0.14	992	324.2	318.5	306.8	16.46
23-May	143			454925	4974985	129.06	10.5	10.1	0.14	992	330.8	325.1	313.1	16.73
23-May	143			454964	4974949	129.12	10.6	10.2	0.14	992	340.4	334.5	322.2	17.16

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
23-May	143			461193	4973999	135.42	9.8	9.4	0.14	993	351.1	344.7	332.5	18.22
23-May	143			464098	4973392	138.39	9.6	9.2	0.14	993	361.8	355.1	342.6	18.90
23-May	143			464726	4972795	139.25	10.4	10.0	0.14	993	350.9	344.7	332.4	17.83
23-May	143			467253	4970466	142.69	12.4	12.0	0.15	993	447.1	440.4	423.9	21.22
23-May	143			467312	4968986	144.17	12.2	11.8	0.15	993	453.9	447.0	430.4	21.69
23-May	143			468120	4967316	146.02	12.4	12.0	0.15	993	458.0	451.1	434.2	21.74
23-May	143			469256	4965384	148.27	13.6	13.3	0.15	993	513.6	506.6	487.1	23.43
23-May	143			469713	4964587	149.18	13.2	12.9	0.15	993	534.7	527.3	507.2	24.72
23-May	143			470065	4963770	150.07	13.1	12.8	0.15	993	567.7	559.7	538.4	26.33
23-May	143			470104	4963696	150.16	13.1	12.8	0.15	994	568.2	560.2	539.4	26.38
24-May	144	44.8488	-87.3937	468890	4966015	0.00	12.9	12.6	0.15	998	545.4	537.6	519.8	25.59
24-May	144	44.8583	-87.4013	468289	4967073	1.22	12.6	12.3	0.15	998	491.6	484.4	468.5	23.30
24-May	144	44.8690	-87.4090	467690	4968262	2.55	12.0	11.6	0.15	998	491.6	484.1	468.5	23.77
24-May	144	44.8965	-87.4155	467192	4971320	5.65	11.9	11.5	0.15	998	462.7	455.5	440.9	22.45
24-May	144	44.9145	-87.4203	466821	4973321	7.68	10.9	10.5	0.15	998	413.3	406.3	393.7	20.75
24-May	144	44.9352	-87.4253	466438	4975618	10.01	11.6	11.2	0.15	998	446.7	439.6	425.6	21.90
24-May	144	44.9545	-87.4300	466082	4977769	12.19	11.3	10.9	0.15	998	440.4	433.2	419.6	21.81
24-May	144	44.9780	-87.4357	465648	4980382	14.84	9.0	8.6	0.15	998	390.8	383.3	371.9	20.96
24-May	144	44.9957	-87.4397	465343	4982345	16.83	8.6	8.1	0.15	999	396.1	388.2	377.1	21.56
24-May	144	45.0070	-87.4425	465127	4983606	18.11	8.4	7.9	0.15	999	396.7	388.8	377.7	21.75
24-May	144	45.0193	-87.4470	464780	4984977	19.52	8.5	8.0	0.15	999	396.7	388.8	377.8	21.68
24-May	144	45.0653	-87.4463	464861	4990086	24.63	8.6	8.1	0.15	999	396.4	388.6	377.5	21.58
24-May	144	45.0795	-87.4462	464882	4991661	26.20	8.3	7.8	0.15	999	396.7	388.6	377.6	21.83
24-May	144	45.0920	-87.4457	464929	4993050	27.59	8.7	8.2	0.15	999	396.7	388.9	377.7	21.52
24-May	144	45.1078	-87.4457	464939	4994807	29.35	9.2	8.8	0.15	999	392.8	385.3	374.2	20.94
24-May	144	45.1240	-87.4465	464884	4996605	31.15	9.6	9.2	0.15	999	388.9	381.8	370.6	20.44
24-May	144	45.1383	-87.4467	464879	4998196	32.74	9.8	9.4	0.15	999	393.3	386.1	374.8	20.53
24-May	144	45.1610	-87.4460	464946	5000715	35.26	9.6	9.2	0.15	999	372.1	365.3	354.6	19.56
24-May	144	45.1692	-87.4458	464964	5001622	36.17	9.8	9.4	0.15	999	377.4	370.5	359.6	19.70
24-May	144	45.1843	-87.4455	465000	5003306	37.85	9.7	9.3	0.15	999	396.4	389.2	377.8	20.77
24-May	144	45.2002	-87.4453	465022	5005065	39.61	9.4	9.0	0.15	999	394.8	387.5	376.2	20.90
24-May	144	45.2397	-87.4178	467204	5009442	44.50	9.5	9.1	0.14	999	406.3	398.7	387.1	21.43
24-May	144	45.2742	-87.3923	469225	5013264	48.83	9.3	8.9	0.14	999	365.7	358.8	348.4	19.43
24-May	144	45.2872	-87.3827	469989	5014705	50.46	9.2	8.8	0.14	999	365.3	358.3	347.9	19.47
24-May	144	45.2707	-87.3593	471811	5012863	53.05	8.7	8.2	0.14	999	388.4	380.7	369.8	21.07

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
24-May	144	45.2605	-87.3450	472931	5011730	54.64	8.7	8.2	0.14	999	406.7	398.8	387.3	22.07
24-May	144	45.2517	-87.3322	473933	5010744	56.05	10.0	9.6	0.15	999	397.8	390.7	379.1	20.62
24-May	144	45.2428	-87.3183	475015	5009757	57.51	9.6	9.2	0.15	999	402.8	395.4	383.8	21.18
24-May	144	45.2367	-87.3088	475758	5009070	58.52	9.3	8.9	0.15	999	391.8	384.4	373.3	20.81
24-May	144	45.2230	-87.2913	477127	5007547	60.57	10.6	10.2	0.15	999	388.6	381.9	370.4	19.73
24-May	144	45.2135	-87.2778	478183	5006488	62.07	11.1	10.7	0.15	999	436.5	429.3	416.2	21.78
24-May	144	45.2017	-87.2600	479579	5005168	63.99	11.2	10.8	0.15	999	444.0	436.7	423.4	22.08
24-May	144	45.1992	-87.2592	479643	5004890	64.27	11.2	10.8	0.15	999	438.5	431.3	418.2	21.81
24-May	144	45.1883	-87.2677	478971	5003688	65.65	11.3	10.9	0.15	999	474.2	466.5	452.2	23.51
24-May	144	45.1757	-87.2765	478274	5002284	67.22	10.8	10.4	0.15	999	439.9	432.5	419.4	22.18
24-May	144	45.1597	-87.2847	477625	5000509	69.11	10.9	10.5	0.15	999	417.1	410.1	397.7	20.96
24-May	144	45.1477	-87.2883	477332	4999177	70.47	11.4	11.0	0.15	999	433.3	426.3	413.2	21.41
24-May	144	45.1348	-87.2997	476435	4997754	72.15	11.4	11.0	0.15	999	439.9	432.8	419.5	21.73
24-May	144	45.1290	-87.3092	475686	4997110	73.14	11.5	11.1	0.15	999	455.6	448.3	434.5	22.43
24-May	144	45.1227	-87.3190	474911	4996409	74.19	11.5	11.1	0.15	999	439.9	432.8	419.5	21.66
24-May	144	45.1098	-87.3358	473581	4994988	76.13	9.9	9.5	0.15	999	423.7	416.1	403.8	22.04
24-May	144	45.1002	-87.3473	472671	4993918	77.54	11.0	10.6	0.15	999	406.3	399.5	387.4	20.35
24-May	144	45.0858	-87.3615	471550	4992330	79.48	10.7	10.3	0.15	999	414.1	407.0	394.8	20.95
24-May	144	45.0640	-87.3752	470462	4989911	82.13	11.2	10.8	0.15	999	388.4	382.0	370.3	19.32
24-May	144	45.0455	-87.3855	469640	4987860	84.34	11.4	11.0	0.15	999	410.6	404.0	391.6	20.29
24-May	144	45.0313	-87.3930	469042	4986288	86.03	11.1	10.7	0.15	999	425.3	418.3	405.5	21.23
24-May	144	44.9973	-87.4052	468063	4982515	89.92	11.2	10.8	0.15	999	440.5	433.3	420.1	21.91
24-May	144	44.9742	-87.4070	467907	4979943	92.50	11.4	11.0	0.15	999	414.3	407.6	395.1	20.47
24-May	144	44.9563	-87.4087	467764	4977962	94.49	11.6	11.2	0.15	999	417.3	410.7	398.0	20.48
24-May	144	44.9462	-87.4095	467694	4976834	95.62	11.8	11.4	0.15	999	439.8	432.9	419.5	21.43
24-May	144	44.9328	-87.4108	467581	4975353	97.10	11.8	11.4	0.15	999	470.9	463.6	449.2	22.95
24-May	144	44.9217	-87.4118	467496	4974113	98.34	11.6	11.2	0.15	999	417.6	410.9	398.3	20.49
24-May	144	44.9097	-87.4137	467344	4972781	99.68	11.9	11.5	0.15	999	448.4	441.4	427.7	21.78
24-May	144	44.8958	-87.4160	467153	4971244	101.23	12.4	12.0	0.15	999	448.4	441.7	427.8	21.42
24-May	144	44.8805	-87.4138	467314	4969542	102.94	12.7	12.4	0.15	999	460.0	453.3	438.9	21.75
24-May	144	44.8685	-87.4092	467676	4968207	104.33	12.8	12.5	0.15	999	479.5	472.5	457.5	22.60
24-May	144	44.8580	-87.4015	468277	4967038	105.64	13.0	12.7	0.15	999	505.3	498.1	482.1	23.66
24-May	144	44.8475	-87.3928	468955	4965868	106.99	13.5	13.2	0.15	999	486.2	479.5	463.9	22.39
24-May	144	44.8330	-87.3807	469909	4964253	108.87	13.5	13.2	0.15	999	520.0	512.9	496.2	23.94
24-May	144	44.8287	-87.3785	470079	4963770	109.38	13.5	13.2	0.15	999	531.5	524.2	507.1	24.47
24-May	144	44.8282	-87.3782	470104	4963714	109.44	13.5	13.2	0.15	999	560.6	553.0	535.0	25.82

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
18-Jul	199	44.8217	-87.3610	471459	4962986	0.00	22.1	21.9	0.15	991	622.6	617.6	586.2	21.75
18-Jul	199	44.8167	-87.3488	472418	4962426	1.11	22.0	21.8	0.15	991	671.4	666.0	632.2	23.50
18-Jul	199	44.8143	-87.3437	472825	4962164	1.59	22.0	21.8	0.15	991	701.3	695.7	660.3	24.55
18-Jul	199	44.8062	-87.3315	473784	4961254	2.92	22.4	22.2	0.15	991	578.3	573.7	544.2	20.02
18-Jul	199	44.8042	-87.3288	473993	4961031	3.22	22.3	22.1	0.15	991	589.8	585.1	555.1	20.47
18-Jul	199	44.8007	-87.3233	474427	4960640	3.81	22.0	21.8	0.15	991	750.3	744.3	706.4	26.23
18-Jul	199	44.7972	-87.3185	474808	4960250	4.35	22.0	21.8	0.15	991	845.0	838.2	795.7	29.61
18-Jul	199	44.7937	-87.3133	475215	4959860	4.92	21.9	21.7	0.15	991	884.5	877.5	833.0	31.04
18-Jul	199	44.7910	-87.3095	475517	4959563	5.34	21.9	21.7	0.15	991	955.3	947.7	899.7	33.53
18-Jul	199	44.7878	-87.3062	475779	4959209	5.78	20.1	19.8	0.15	991	816.7	809.6	770.8	30.31
18-Jul	199	44.7897	-87.3012	476175	4959412	6.22	19.1	18.9	0.14	991	567.0	561.7	535.5	21.64
18-Jul	199	44.7930	-87.2953	476638	4959781	6.82	18.2	18.0	0.14	991	418.8	414.5	395.6	16.43
18-Jul	199	44.7958	-87.2908	476995	4960093	7.29	18.4	18.1	0.14	991	411.4	407.2	388.6	16.08
18-Jul	199	44.7928	-87.2863	477350	4959759	7.78	18.3	18.0	0.14	991	397.1	393.1	375.2	15.57
18-Jul	199	44.7900	-87.2830	477613	4959444	8.19	18.4	18.1	0.14	991	396.9	392.9	374.9	15.50
18-Jul	199	44.7853	-87.2783	477980	4958923	8.83	18.5	18.3	0.14	991	387.0	383.1	365.5	15.05
18-Jul	199	44.7822	-87.2750	478243	4958571	9.27	18.6	18.3	0.14	991	385.8	382.0	364.4	14.98
18-Jul	199	44.7783	-87.2705	478598	4958144	9.82	18.6	18.4	0.14	991	386.7	382.9	365.2	14.98
18-Jul	199	44.7758	-87.2677	478820	4957865	10.18	18.7	18.4	0.14	991	374.7	371.0	353.9	14.50
18-Jul	199	44.7632	-87.2795	477880	4956462	11.87	18.6	18.4	0.14	991	374.7	371.0	353.9	14.52
18-Jul	199	44.7588	-87.2850	477443	4955981	12.52	18.6	18.4	0.14	991	392.2	388.3	370.4	15.21
18-Jul	199	44.7612	-87.2913	476942	4956243	13.08	18.5	18.2	0.14	991	374.5	370.7	353.7	14.58
18-Jul	199	44.7690	-87.2977	476443	4957116	14.09	18.7	18.5	0.14	991	414.3	410.2	391.3	16.02
18-Jul	199	44.7755	-87.3028	476038	4957839	14.92	18.7	18.4	0.14	991	469.3	464.7	443.3	18.16
18-Jul	199	44.7785	-87.3050	475868	4958173	15.29	18.6	18.4	0.14	991	458.1	453.6	432.7	17.77
18-Jul	199	44.7858	-87.3083	475607	4958987	16.14	19.0	18.7	0.14	991	498.6	493.8	470.9	19.13
18-Jul	199	44.7893	-87.3075	475675	4959376	16.54	19.6	19.4	0.14	991	600.4	594.9	566.7	22.56
18-Jul	199	44.7922	-87.3113	475372	4959693	16.98	21.3	21.1	0.15	991	760.8	754.6	717.0	27.15
18-Jul	199	44.7948	-87.3147	475109	4959989	17.37	21.6	21.4	0.15	991	965.8	958.0	909.9	34.19
18-Jul	199	44.7978	-87.3192	474755	4960324	17.86	21.8	21.6	0.15	991	979.2	971.4	922.4	34.51
18-Jul	199	44.8022	-87.3257	474242	4960808	18.57	21.8	21.6	0.15	991	962.8	955.2	906.9	33.87
18-Jul	199	44.8055	-87.3305	473863	4961180	19.10	21.9	21.7	0.15	991	896.2	889.0	844.0	31.47
18-Jul	199	44.8082	-87.3333	473639	4961477	19.47	22.0	21.8	0.15	991	814.4	807.9	766.9	28.52
18-Jul	199	44.8118	-87.3333	473641	4961883	19.88	22.0	21.8	0.15	991	696.1	690.5	655.4	24.34
18-Jul	199	44.8155	-87.3400	473117	4962294	20.54	21.9	21.7	0.15	991	674.7	669.3	635.3	23.65

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
18-Jul	199	44.8190	-87.3500	472327	4962692	21.43	21.9	21.7	0.15	991	721.7	715.9	679.7	25.35
18-Jul	199	44.8203	-87.3615	471419	4962834	22.35	21.9	21.7	0.15	991	715.8	710.1	674.1	25.11
18-Jul	199	44.8228	-87.3654	471114	4963114	22.76	22.0	21.8	0.15	991	619.7	614.7	583.6	21.72
18-Jul	199	44.8256	-87.3701	470742	4963425	23.24	21.9	21.7	0.15	991	642.6	637.4	605.1	22.53
18-Jul	199	44.8272	-87.3728	470529	4963602	23.52	21.8	21.6	0.15	991	704.1	698.4	663.1	24.77
18-Jul	199	44.8292	-87.3762	470262	4963825	23.87	21.8	21.6	0.15	991	718.9	713.1	677.0	25.28
18-Jul	199	44.8308	-87.3790	470040	4964010	24.16	21.9	21.7	0.15	991	697.8	692.2	657.2	24.52
19-Jul	200			448865	4963755	0.00	22.5	22.3	0.15	993	337.0	334.5	317.9	11.64
19-Jul	200			448308	4963297	0.72	22.4	22.2	0.15	993	313.5	311.1	295.8	10.86
19-Jul	200			447511	4962619	1.77	22.2	22.0	0.15	993	302.8	300.6	285.8	10.56
19-Jul	200			446556	4961812	3.02	21.9	21.7	0.15	993	281.3	279.2	265.6	9.89
19-Jul	200			445627	4961004	4.25	21.7	21.5	0.15	993	277.9	275.8	262.4	9.83
19-Jul	200			444537	4960089	5.67	21.5	21.3	0.15	993	270.5	268.3	255.4	9.63
19-Jul	200			443142	4958859	7.53	21.9	21.7	0.15	993	274.1	272.0	258.7	9.64
19-Jul	200			440656	4956660	10.85	22.3	22.1	0.15	993	301.9	299.7	284.9	10.49
19-Jul	200			439658	4955725	12.22	22.4	22.2	0.15	993	296.5	294.3	279.7	10.27
19-Jul	200			438432	4954514	13.94	22.4	22.2	0.15	993	310.8	308.5	293.2	10.77
19-Jul	200			436952	4952956	16.09	22.3	22.1	0.15	993	310.8	308.4	293.2	10.80
19-Jul	200			432932	4948404	22.16	21.7	21.5	0.15	993	287.0	284.8	271.0	10.15
19-Jul	200			432330	4947688	23.10	21.7	21.5	0.15	993	282.0	279.8	266.3	9.98
19-Jul	200			430967	4946167	25.14	21.7	21.5	0.15	993	269.3	267.2	254.3	9.53
19-Jul	200			430257	4945359	26.22	21.7	21.5	0.15	993	277.7	275.5	262.2	9.82
19-Jul	200			428411	4943324	28.96	22.1	21.9	0.15	993	312.4	310.0	294.8	10.92
19-Jul	200			426161	4940756	32.38	22.9	22.7	0.15	993	280.0	277.9	264.0	9.56
19-Jul	200			425272	4939360	34.03	23.2	23.0	0.15	993	331.4	329.0	312.3	11.22
19-Jul	200			424533	4938331	35.30	23.5	23.3	0.15	993	340.7	338.3	320.9	11.43
19-Jul	200			422958	4937110	37.29	23.6	23.4	0.16	993	340.7	338.3	320.9	11.40
19-Jul	200			421081	4934171	40.78	23.7	23.5	0.18	993	703.3	698.6	662.6	23.46
19-Jul	200			420356	4932180	42.90	26.6	26.4	0.22	993	564.7	561.3	529.3	17.33
19-Jul	200			420152	4931738	43.39	26.5	26.3	0.22	993	756.9	752.4	709.7	23.30
19-Jul	200			419906	4931074	44.09	26.5	26.3	0.23	993	890.3	885.0	834.8	27.40
19-Jul	200			419779	4930445	44.74	26.5	26.3	0.23	993	842.4	837.4	789.9	25.93
19-Jul	200			419668	4930078	45.12	26.5	26.3	0.24	993	919.0	913.5	861.7	28.29
19-Jul	200			419453	4929858	45.43	26.6	26.4	0.24	993	837.8	832.9	785.5	25.72
19-Jul	200			419426	4929858	45.45	26.6	26.4	0.24	993	951.1	945.5	891.6	29.19

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
19-Jul	200			419865	4930982	46.66	26.4	26.2	0.24	992	991.1	985.2	928.5	30.56
19-Jul	200			420153	4931793	47.52	26.2	26.0	0.23	992	868.4	863.2	813.9	26.93
19-Jul	200			420768	4933397	49.24	24.9	24.7	0.21	992	450.4	447.4	423.0	14.49
19-Jul	200			421341	4934779	50.73	23.8	23.6	0.20	992	600.7	596.7	565.2	19.96
19-Jul	200			421735	4935680	51.72	23.8	23.6	0.17	991	479.2	476.0	450.4	15.90
19-Jul	200			422583	4936874	53.18	23.6	23.4	0.16	991	338.5	336.1	318.2	11.30
19-Jul	200			423810	4937655	54.64	23.5	23.3	0.16	991	327.0	324.7	307.4	10.95
19-Jul	200			425097	4939084	56.56	23.3	23.1	0.16	991	338.2	335.8	318.1	11.39
19-Jul	200			425779	4942447	59.99	22.9	22.7	0.15	991	259.5	257.6	244.1	8.84
19-Jul	200			425469	4943576	61.16	22.7	22.5	0.15	991	248.5	246.6	233.8	8.52
19-Jul	200			425478	4945176	62.76	22.6	22.4	0.15	991	275.3	273.3	259.2	9.46
19-Jul	200			426623	4945171	63.91	22.3	22.1	0.15	991	281.5	279.4	265.1	9.76
19-Jul	200			427470	4945167	64.75	22.3	22.1	0.15	991	269.8	267.8	254.1	9.36
19-Jul	200			429264	4945160	66.55	21.8	21.6	0.15	991	267.5	265.5	252.0	9.42
19-Jul	200			430096	4945156	67.38	21.8	21.6	0.15	991	267.3	265.2	251.8	9.41
19-Jul	200			430123	4945138	67.41	21.8	21.6	0.15	991	277.0	274.8	260.9	9.75
19-Jul	200			431971	4944896	69.28	21.7	21.5	0.15	991	292.5	290.2	275.6	10.33
19-Jul	200			432843	4944887	70.15	21.8	21.6	0.15	991	292.5	290.2	275.6	10.30
19-Jul	200			433820	4944859	71.13	21.8	21.6	0.15	991	300.8	298.5	283.4	10.59
19-Jul	200			434375	4944854	71.68	21.9	21.7	0.15	991	295.8	293.5	278.7	10.38
19-Jul	200			435421	4944899	72.73	22.1	21.9	0.15	991	315.7	313.3	297.4	11.01
19-Jul	200			436835	4945051	74.15	22.5	22.3	0.15	991	307.0	304.7	289.0	10.58
19-Jul	200			438065	4945113	75.38	22.9	22.7	0.16	991	347.4	344.9	326.9	11.84
19-Jul	200			439715	4944931	77.04	23.5	23.3	0.16	991	653.7	649.3	614.7	21.89
19-Jul	200			439808	4944985	77.15	23.5	23.3	0.16	991	801.8	796.4	754.0	26.85
19-Jul	200			439446	4945749	77.99	23.2	23.0	0.16	991	741.0	735.9	697.1	25.03
19-Jul	200			438890	4946994	79.36	22.5	22.3	0.15	990	335.4	332.9	315.4	11.55
19-Jul	200			438346	4948203	80.68	22.2	22.0	0.15	990	335.1	332.6	315.3	11.64
19-Jul	200			437620	4949654	82.31	22.2	22.0	0.15	990	319.0	316.6	300.1	11.09
19-Jul	200			436778	4951346	84.20	22.1	21.9	0.15	990	324.0	321.5	304.8	11.29
19-Jul	200			436442	4951961	84.90	22.1	21.9	0.15	990	297.2	295.0	279.6	10.36
19-Jul	200			435570	4953376	86.56	22.2	22.0	0.15	990	288.7	286.5	271.6	10.03
19-Jul	200			434947	4954364	87.73	22.0	21.8	0.15	990	280.4	278.2	263.8	9.80
19-Jul	200			434676	4954996	88.41	21.6	21.4	0.15	990	260.4	258.4	245.1	9.21
19-Jul	200			434035	4956724	90.26	21.5	21.3	0.15	990	283.7	281.5	267.1	10.07
19-Jul	200			432882	4958756	92.59	21.6	21.4	0.15	990	290.4	288.1	273.3	10.27

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
19-Jul	200			432481	4959500	93.44	21.7	21.5	0.15	989	277.3	275.1	260.7	9.77
19-Jul	200			432094	4960282	94.31	21.7	21.5	0.15	989	311.9	309.5	293.3	10.99
19-Jul	200			433807	4960246	96.03	21.6	21.4	0.15	989	301.3	298.9	283.3	10.65
19-Jul	200			435257	4960193	97.48	21.8	21.6	0.15	989	289.2	286.9	271.9	10.16
19-Jul	200			436970	4960121	99.19	21.6	21.4	0.15	989	279.9	277.7	263.2	9.89
19-Jul	200			439092	4960027	101.32	21.6	21.4	0.15	989	288.9	286.7	271.7	10.21
19-Jul	200			440108	4960184	102.34	21.7	21.5	0.15	989	282.5	280.3	265.6	9.95
19-Jul	200			440083	4960184	102.37	21.7	21.5	0.15	989	288.7	286.4	271.5	10.17
19-Jul	200			441230	4960209	103.52	21.7	21.5	0.15	988	286.5	284.2	269.1	10.08
19-Jul	200			442481	4960163	104.77	21.7	21.5	0.15	988	287.8	285.6	270.4	10.13
19-Jul	200			443761	4960151	106.05	21.5	21.3	0.15	988	280.6	278.4	263.6	9.93
19-Jul	200			444972	4960085	107.26	21.4	21.2	0.15	987	249.6	247.6	234.3	8.85
19-Jul	200			444481	4961069	108.36	21.4	21.2	0.15	987	254.8	252.8	239.1	9.04
19-Jul	200			443960	4961927	109.36	21.4	21.2	0.15	987	254.8	252.8	239.1	9.04
19-Jul	200			443206	4963044	110.71	21.3	21.1	0.15	987	258.6	256.6	242.8	9.20
19-Jul	200			442503	4964068	111.95	21.3	21.1	0.15	987	243.3	241.3	228.3	8.65
19-Jul	200			441841	4965112	113.19	21.4	21.2	0.15	987	238.5	236.6	223.9	8.46
19-Jul	200			440436	4967087	115.61	21.2	21.0	0.15	987	234.4	232.5	220.1	8.37
19-Jul	200			440034	4967646	116.30	21.2	21.0	0.15	987	249.1	247.1	233.9	8.89
19-Jul	200			439623	4968890	117.61	21.1	20.9	0.15	987	295.3	292.9	277.3	10.57
19-Jul	200			439629	4969483	118.21	21.1	20.9	0.15	987	278.3	276.1	261.3	9.96
19-Jul	200			437229	4971765	121.52	21.0	20.8	0.15	987	291.4	289.1	273.7	10.46
19-Jul	200			437861	4971739	122.15	21.0	20.8	0.15	987	282.8	280.5	265.6	10.15
19-Jul	200			439546	4971854	123.84	21.1	20.9	0.15	987	284.7	282.3	267.3	10.19
19-Jul	200			441062	4972025	125.36	21.1	20.9	0.15	987	287.6	285.3	270.0	10.29
19-Jul	200			443906	4972239	128.22	21.2	21.0	0.15	987	299.4	297.0	281.1	10.68
19-Jul	200			445629	4972317	129.94	21.2	21.0	0.15	987	313.9	311.3	294.7	11.20
19-Jul	200			447525	4972395	131.84	21.2	21.0	0.15	987	313.9	311.3	294.7	11.20
19-Jul	200			448579	4972533	132.90	21.1	20.9	0.15	987	325.0	322.3	305.1	11.63
19-Jul	200			449844	4972690	134.18	21.1	20.9	0.15	987	321.3	318.7	301.7	11.50
19-Jul	200			451766	4972713	136.10	21.2	21.0	0.15	987	310.2	307.7	291.3	11.07
19-Jul	200			455332	4972871	139.67	21.0	20.8	0.15	987	321.8	319.2	302.2	11.55
19-Jul	200			456703	4973215	141.08	21.0	20.8	0.15	987	337.9	335.1	317.3	12.13
19-Jul	200			457960	4973233	142.34	20.9	20.7	0.14	987	343.8	341.0	322.9	12.38
19-Jul	200			459033	4973311	143.41	20.8	20.6	0.15	987	313.9	311.3	294.8	11.34
19-Jul	200			460744	4973613	145.15	20.9	20.7	0.15	987	299.1	296.7	280.9	10.77

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
19-Jul	200			462614	4974029	147.07	21.0	20.8	0.15	987	299.6	297.2	281.3	10.76
19-Jul	200			465409	4972680	150.17	21.9	21.7	0.15	987	313.9	311.4	294.4	10.97
19-Jul	200			466508	4971508	151.78	21.9	21.7	0.15	987	291.4	289.2	273.4	10.19
19-Jul	200			467343	4969893	153.60	22.0	21.8	0.15	986	269.3	267.2	252.3	9.37
19-Jul	200			467597	4968318	155.19	21.8	21.6	0.15	986	276.3	274.1	258.9	9.67
19-Jul	200			468106	4967316	156.31	21.5	21.3	0.15	986	266.6	264.4	249.9	9.42
19-Jul	200			468536	4966499	157.24	21.2	21.0	0.15	986	376.6	373.6	353.3	13.43
19-Jul	200			468889	4965886	157.95	21.4	21.2	0.15	986	497.0	493.2	466.1	17.62
19-Jul	200			469242	4965311	158.62	21.4	21.2	0.15	986	795.9	789.8	746.5	28.21
19-Jul	200			469712	4964531	159.53	21.5	21.3	0.15	986	1036.7	1028.9	972.4	36.64
19-Jul	200			469987	4964030	160.10	21.5	21.3	0.15	986	1078.4	1070.4	1011.5	38.12
25-Jul	206	44.8420	-87.3883	469308	4965255	0.00	23.0	22.8	0.15	989	605.1	600.8	568.2	20.52
25-Jul	206	44.8457	-87.3922	469006	4965663	0.51	23.1	22.9	0.15	989	543.0	539.2	509.8	18.36
25-Jul	206	44.8503	-87.3958	468720	4966182	1.10	23.3	23.1	0.15	989	450.2	447.1	422.5	15.13
25-Jul	206	44.8562	-87.4005	468355	4966833	1.85	23.3	23.1	0.15	989	337.7	335.3	316.9	11.35
25-Jul	206	44.8693	-87.4100	467611	4968298	3.49	23.3	23.1	0.15	989	291.7	289.6	273.8	9.80
25-Jul	206	44.8875	-87.4133	467358	4970319	5.53	23.7	23.5	0.15	989	263.0	261.1	246.6	8.73
25-Jul	206	44.9020	-87.4123	467445	4971930	7.14	24.2	24.0	0.15	989	258.1	256.3	241.9	8.45
25-Jul	206	44.9097	-87.4120	467476	4972780	7.99	24.0	23.8	0.15	989	304.7	302.6	285.6	10.03
25-Jul	206	44.9245	-87.4095	467682	4974428	9.65	24.0	23.8	0.15	989	305.4	303.3	286.3	10.06
25-Jul	206	44.9325	-87.4080	467805	4975316	10.55	24.2	24.0	0.15	989	296.1	294.1	277.5	9.69
25-Jul	206	44.9360	-87.4075	467846	4975704	10.94	24.2	24.0	0.15	989	273.2	271.3	256.0	8.94
25-Jul	206	44.9440	-87.4062	467955	4976593	11.83	24.1	23.9	0.15	989	250.6	248.9	234.9	8.23
25-Jul	206	44.9563	-87.4052	468040	4977961	13.20	23.7	23.5	0.15	989	262.3	260.4	246.0	8.71
25-Jul	206	44.9613	-87.4048	468070	4978516	13.76	23.8	23.6	0.15	989	261.6	259.7	245.3	8.66
25-Jul	206	44.9763	-87.4043	468118	4980182	15.43	23.3	23.1	0.15	989	261.3	259.5	245.2	8.78
25-Jul	206	44.9822	-87.4042	468134	4980831	16.08	23.3	23.1	0.15	989	250.4	248.6	235.0	8.41
25-Jul	206	44.9918	-87.4037	468178	4981904	17.15	23.6	23.4	0.15	989	261.6	259.7	245.3	8.71
25-Jul	206	44.9970	-87.4035	468195	4982479	17.72	23.5	23.3	0.15	989	262.0	260.2	245.8	8.75
25-Jul	206	45.0098	-87.4032	468228	4983903	19.15	23.6	23.4	0.15	989	252.3	250.5	236.6	8.40
25-Jul	206	45.0243	-87.4003	468460	4985513	20.78	23.7	23.5	0.15	989	261.6	259.7	245.3	8.69
25-Jul	206	45.0393	-87.3910	469203	4987175	22.60	23.7	23.5	0.15	989	273.4	271.5	256.4	9.08
25-Jul	206	45.0512	-87.3840	469761	4988488	24.02	23.4	23.2	0.15	989	284.3	282.3	266.8	9.53
25-Jul	206	45.0573	-87.3837	469789	4989172	24.71	23.1	22.9	0.15	989	277.6	275.6	260.5	9.38
25-Jul	206	45.0667	-87.3833	469821	4990210	25.75	22.8	22.6	0.15	989	262.0	260.1	246.0	8.94

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
25-Jul	206	45.0745	-87.3688	470967	4991075	27.18	22.8	22.6	0.15	989	261.3	259.4	245.4	8.91
25-Jul	206	45.0783	-87.3548	472070	4991495	28.36	22.9	22.7	0.14	989	261.8	259.9	245.8	8.90
25-Jul	206	45.0482	-87.3748	470481	4988151	32.06	23.0	22.8	0.15	991	268.2	266.3	252.3	9.11
25-Jul	206	45.0373	-87.3838	469766	4986951	33.46	23.5	23.3	0.15	991	268.9	267.0	252.8	9.00
25-Jul	206	45.0233	-87.3950	468880	4985400	35.25	23.3	23.1	0.15	991	256.7	254.9	241.4	8.64
25-Jul	206	45.0138	-87.4012	468388	4984347	36.41	23.0	22.8	0.15	991	261.3	259.4	245.8	8.88
25-Jul	206	45.0087	-87.4023	468293	4983774	36.99	22.9	22.7	0.15	991	244.5	242.7	230.0	8.33
25-Jul	206	44.9903	-87.4052	468059	4981738	39.04	22.8	22.6	0.15	991	240.3	238.5	226.1	8.21
25-Jul	206	44.9795	-87.4063	467962	4980536	40.25	23.0	22.8	0.15	991	238.2	236.5	224.1	8.09
25-Jul	206	44.9660	-87.4070	467902	4979037	41.75	23.4	23.2	0.15	991	239.2	237.4	224.8	8.03
25-Jul	206	44.9537	-87.4082	467802	4977667	43.12	23.5	23.3	0.15	991	239.6	237.9	225.2	8.02
25-Jul	206	44.9403	-87.4088	467743	4976185	44.60	23.3	23.1	0.15	991	238.5	236.8	224.2	8.03
25-Jul	206	44.9248	-87.4100	467643	4974464	46.33	23.0	22.8	0.15	991	250.5	248.6	235.6	8.51
25-Jul	206	44.9208	-87.4103	467613	4974019	46.77	23.1	22.9	0.15	991	251.4	249.6	236.4	8.51
25-Jul	206	44.9102	-87.4113	467529	4972836	47.96	22.9	22.7	0.15	991	274.0	272.0	257.8	9.33
25-Jul	206	44.8982	-87.4127	467416	4971503	49.30	23.5	23.3	0.15	991	307.6	305.4	289.1	10.30
25-Jul	206	44.8883	-87.4135	467346	4970410	50.39	23.4	23.2	0.15	991	296.5	294.4	278.8	9.96
25-Jul	206	44.8750	-87.4138	467311	4968931	51.87	23.8	23.6	0.15	991	274.9	273.0	258.3	9.12
25-Jul	206	44.8567	-87.4010	468315	4966888	54.15	24.0	23.8	0.15	991	285.5	283.5	268.2	9.42
25-Jul	206	44.8450	-87.3915	469060	4965590	55.64	23.9	23.7	0.15	991	408.3	405.5	383.7	13.51
25-Jul	206	44.8402	-87.3873	469386	4965050	56.27	23.8	23.6	0.15	991	364.0	361.5	342.0	12.08
25-Jul	206	44.8350	-87.3832	469712	4964476	56.94	23.6	23.4	0.15	991	363.1	360.5	341.3	12.12
25-Jul	206	44.8273	-87.3785	470078	4963621	57.87	23.0	22.8	0.15	991	509.3	505.7	479.2	17.30
25-Jul	206	44.8275	-87.3785	470078	4963641	57.89	23.0	22.8	0.15	991	475.7	472.3	447.6	16.16
26-Jul	207	44.9272	-87.6090	451939	4974822	0.00	22.7	22.5	0.15	993	222.4	220.7	209.7	7.64
26-Jul	207	44.9250	-87.5850	453832	4974568	1.91	22.8	22.6	0.15	993	265.9	264.0	250.7	9.11
26-Jul	207	44.9242	-87.5697	455040	4974466	3.12	22.9	22.7	0.15	993	260.3	258.3	245.4	8.89
26-Jul	207	44.9235	-87.5582	455947	4974387	4.03	22.8	22.6	0.15	993	238.0	236.3	224.4	8.15
26-Jul	207	44.9228	-87.5420	457224	4974302	5.31	22.6	22.4	0.15	993	239.9	238.1	226.2	8.26
26-Jul	207	44.9222	-87.5243	458617	4974220	6.71	22.6	22.4	0.15	993	232.6	230.9	219.4	8.01
26-Jul	207	44.9218	-87.5122	459576	4974176	7.67	22.6	22.4	0.15	993	271.6	269.6	256.1	9.35
26-Jul	207	44.9207	-87.4947	460957	4974039	9.06	22.7	22.5	0.15	993	260.5	258.6	245.6	8.95
26-Jul	207	44.9188	-87.4808	462048	4973828	10.17	22.7	22.5	0.15	993	248.9	247.1	234.7	8.55
26-Jul	207	44.9177	-87.4727	462691	4973695	10.82	22.7	22.5	0.15	993	256.2	254.3	241.6	8.80
26-Jul	207	44.9125	-87.4542	464148	4973114	12.39	22.4	22.2	0.15	993	226.2	224.5	213.4	7.84

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
26-Jul	207	44.9075	-87.4467	464737	4972555	13.20	22.4	22.2	0.15	993	226.2	224.5	213.4	7.84
26-Jul	207	44.8995	-87.4348	465667	4971661	14.49	21.6	21.4	0.15	993	260.5	258.4	246.0	9.24
26-Jul	207	44.8868	-87.4165	467108	4970245	16.51	22.4	22.2	0.15	993	288.6	286.4	272.2	10.00
28-Jul	209	44.9118	-87.5587	455899	4973089	0.00	23.4	23.2	0.15	990	224.9	223.2	211.2	7.54
28-Jul	209	44.9248	-87.5432	457132	4974525	1.89	23.5	23.3	0.15	990	280.4	278.4	263.3	9.38
28-Jul	209	44.9292	-87.5385	457504	4975005	2.50	23.4	23.2	0.15	990	258.5	256.7	242.8	8.67
28-Jul	209	44.9358	-87.5313	458074	4975741	3.43	23.5	23.3	0.15	990	253.3	251.5	237.9	8.47
28-Jul	209	44.9408	-87.5260	458499	4976294	4.13	23.5	23.3	0.15	990	258.8	256.9	243.0	8.65
28-Jul	209	44.9492	-87.5170	459215	4977216	5.30	23.4	23.2	0.15	990	247.2	245.4	232.1	8.29
28-Jul	209	44.9650	-87.4987	460671	4978966	7.57	23.4	23.2	0.15	990	246.5	244.7	231.5	8.27
28-Jul	209	44.9707	-87.4918	461215	4979592	8.40	23.3	23.1	0.15	990	246.9	245.2	231.9	8.31
28-Jul	209	44.9768	-87.4838	461850	4980272	9.33	23.5	23.3	0.15	990	235.3	233.6	221.0	7.87
28-Jul	209	44.9812	-87.4773	462365	4980751	10.04	23.3	23.1	0.15	990	239.6	237.9	225.1	8.06
28-Jul	209	44.9903	-87.4662	463251	4981764	11.38	23.4	23.2	0.15	990	243.1	241.3	228.3	8.15
28-Jul	209	44.9985	-87.4557	464083	4982668	12.61	23.4	23.2	0.15	990	246.7	244.9	231.7	8.27
28-Jul	209	45.0043	-87.4480	464692	4983311	13.50	23.6	23.4	0.15	990	221.7	220.1	208.1	7.39
28-Jul	209	45.0115	-87.4387	465431	4984104	14.58	23.6	23.4	0.15	990	235.8	234.1	221.4	7.86
28-Jul	209	45.0170	-87.4325	465921	4984713	15.36	23.6	23.4	0.15	990	230.3	228.7	216.2	7.68
28-Jul	209	45.0350	-87.4133	467441	4986704	17.87	23.7	23.5	0.15	990	235.3	233.7	220.9	7.82
28-Jul	209	45.0465	-87.4013	468393	4987977	19.46	23.6	23.4	0.14	990	236.7	235.0	222.2	7.89
28-Jul	209	45.0568	-87.3918	469147	4989120	20.82	23.3	23.1	0.14	990	220.8	219.2	207.4	7.43
28-Jul	209	45.0652	-87.3883	469427	4990045	21.79	23.7	23.5	0.14	990	231.0	229.4	216.9	7.68
28-Jul	209	45.0743	-87.3775	470285	4991059	23.12	23.6	23.4	0.14	990	220.1	218.5	206.6	7.34
28-Jul	209	45.0908	-87.3563	471959	4992884	25.60	23.6	23.4	0.14	990	219.6	218.1	206.2	7.32
28-Jul	209	45.1042	-87.3392	473315	4994360	27.60	23.6	23.4	0.15	990	219.8	218.3	206.4	7.33
28-Jul	209	45.1080	-87.3342	473710	4994785	28.18	23.6	23.4	0.15	990	220.1	218.5	206.6	7.34
28-Jul	209	45.1147	-87.3247	474461	4995522	29.23	23.3	23.1	0.14	990	235.1	233.4	220.8	7.91
28-Jul	209	45.1250	-87.3113	475514	4996666	30.79	23.2	23.0	0.14	990	242.8	241.1	228.1	8.19
28-Jul	209	45.1447	-87.2895	477240	4998844	33.57	23.2	23.0	0.14	990	267.6	265.7	251.4	9.03
28-Jul	209	45.1580	-87.2818	477847	5000324	35.17	22.9	22.7	0.14	990	264.2	262.3	248.3	8.99
28-Jul	209	45.1832	-87.2647	479205	5003114	38.27	23.1	22.9	0.14	990	275.8	273.8	259.2	9.33
28-Jul	209	45.1928	-87.2520	480205	5004184	39.73	23.2	23.0	0.14	990	246.7	244.9	231.8	8.32
28-Jul	209	45.1808	-87.2238	482413	5002845	42.32	22.8	22.6	0.14	990	287.6	285.5	270.4	9.82
28-Jul	209	45.1760	-87.2160	483028	5002307	43.13	23.0	22.8	0.14	990	329.2	326.9	309.4	11.17
28-Jul	209	45.1750	-87.2157	483052	5002196	43.25	22.7	22.5	0.14	990	295.4	293.2	277.7	10.11

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
28-Jul	209	45.1750	-87.2157	483052	5002196	43.25	22.9	22.7	0.14	990	306.7	304.5	288.3	10.44
28-Jul	209	45.1742	-87.2112	483406	5002102	43.61	22.9	22.7	0.14	990	303.1	301.0	285.0	10.32
29-Aug	241	44.5357	-88.0058	420084	4931645	0.00	24.7	24.5	0.19	999	274.9	273.1	260.1	8.96
29-Aug	241	44.5413	-88.0027	420343	4932271	0.68	27.0	26.8	0.19	999	304.5	302.7	287.0	9.30
29-Aug	241	44.5470	-88.0002	420549	4932900	1.34	24.8	24.6	0.20	999	321.2	319.1	303.9	10.44
29-Aug	241	44.5545	-87.9960	420892	4933729	2.24	24.6	24.4	0.19	999	291.5	289.5	275.8	9.53
29-Aug	241	44.5645	-87.9898	421394	4934833	3.45	24.5	24.3	0.19	999	336.6	334.3	318.6	11.04
29-Aug	241	44.5740	-87.9847	421817	4935884	4.58	23.9	23.7	0.18	999	347.5	345.2	329.3	11.60
29-Aug	241	44.5802	-87.9805	422157	4936564	5.34	23.6	23.4	0.18	999	313.9	311.7	297.5	10.56
29-Aug	241	44.5880	-87.9632	423542	4937418	6.97	23.5	23.3	0.18	999	258.4	256.6	244.9	8.72
29-Aug	241	44.5917	-87.9555	424157	4937818	7.70	23.5	23.3	0.18	999	251.7	249.9	238.6	8.50
29-Aug	241	44.5950	-87.9507	424544	4938184	8.24	23.5	23.3	0.18	999	241.4	239.7	228.8	8.15
29-Aug	241	44.5987	-87.9493	424655	4938590	8.66	23.5	23.3	0.17	999	213.0	211.5	201.9	7.19
29-Aug	241	44.6087	-87.9488	424707	4939700	9.77	23.4	23.2	0.17	999	195.3	193.9	185.1	6.61
29-Aug	241	44.6167	-87.9485	424745	4940588	10.66	23.4	23.2	0.17	999	200.6	199.2	190.1	6.79
29-Aug	241	44.6225	-87.9483	424765	4941237	11.31	23.5	23.3	0.17	999	162.5	161.3	154.0	5.48
29-Aug	241	44.6273	-87.9482	424784	4941772	11.84	23.4	23.2	0.17	999	143.7	142.7	136.2	4.86
29-Aug	241	44.6332	-87.9483	424779	4942421	12.49	23.3	23.1	0.17	999	161.3	160.1	152.9	5.48
29-Aug	241	44.6458	-87.9487	424768	4943828	13.90	23.2	23.0	0.16	999	150.0	148.9	142.2	5.11
29-Aug	241	44.6587	-87.9413	425367	4945247	15.44	23.2	23.0	0.15	1000	150.5	149.3	142.8	5.13
29-Aug	241	44.6580	-87.9260	426582	4945160	16.66	23.4	23.2	0.16	1000	162.9	161.8	154.6	5.52
29-Aug	241	44.6575	-87.9017	428510	4945083	18.58	23.4	23.2	0.16	1000	196.0	194.6	186.0	6.64
29-Aug	241	44.6580	-87.8852	429818	4945124	19.89	23.5	23.3	0.15	1000	194.8	193.4	184.8	6.58
29-Aug	241	44.6580	-87.8832	429977	4945122	20.05	23.5	23.3	0.15	1000	204.7	203.3	194.3	6.92
29-Aug	241	44.6577	-87.8802	430214	4945082	20.29	23.8	23.6	0.15	999	173.6	172.3	164.4	5.81
29-Aug	241	44.6578	-87.8478	432779	4945072	22.86	23.9	23.7	0.15	999	194.2	192.8	183.9	6.48
29-Aug	241	44.6580	-87.8377	433584	4945084	23.66	24.0	23.8	0.15	999	191.6	190.3	181.5	6.38
29-Aug	241	44.6582	-87.8248	434603	4945091	24.68	24.0	23.8	0.15	999	183.4	182.1	173.7	6.10
29-Aug	241	44.6583	-87.8097	435805	4945097	25.88	24.1	23.9	0.15	999	172.9	171.7	163.7	5.73
29-Aug	241	44.6583	-87.7955	436929	4945086	27.01	24.3	24.1	0.15	999	160.0	158.9	151.5	5.28
29-Aug	241	44.6583	-87.7760	438475	4945071	28.55	24.6	24.4	0.15	999	158.4	157.3	149.9	5.18
29-Aug	241	44.6582	-87.7638	439439	4945044	29.52	24.6	24.4	0.15	999	328.3	326.1	310.7	10.73
29-Aug	241	44.6588	-87.7618	439598	4945116	29.69	24.1	23.9	0.16	999	474.4	471.2	449.4	15.74
29-Aug	241	44.6692	-87.7688	439054	4946270	30.97	24.5	24.3	0.15	999	239.2	237.6	226.4	7.84
29-Aug	241	44.6852	-87.7795	438226	4948055	32.94	24.4	24.2	0.15	999	148.1	147.1	140.2	4.87

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
29-Aug	241	44.6960	-87.7867	437669	4949265	34.27	24.0	23.8	0.15	999	160.0	158.9	151.6	5.32
29-Aug	241	44.7035	-87.7923	437228	4950102	35.21	23.8	23.6	0.15	999	191.2	189.8	181.1	6.40
29-Aug	241	44.7118	-87.7985	436749	4951031	36.26	23.7	23.5	0.15	999	217.0	215.5	205.7	7.28
29-Aug	241	44.7223	-87.8065	436127	4952204	37.59	23.6	23.4	0.15	999	243.6	241.9	230.8	8.20
29-Aug	241	44.7353	-87.8162	435375	4953656	39.22	23.5	23.3	0.15	999	239.5	237.8	227.0	8.08
29-Aug	241	44.7447	-87.8233	434819	4954699	40.40	23.3	23.1	0.15	999	306.2	304.0	290.3	10.40
29-Aug	241	44.7818	-87.8480	432909	4958847	44.97	23.4	23.2	0.15	999	251.3	249.6	238.3	8.51
29-Aug	241	44.7910	-87.8562	432273	4959873	46.18	23.2	23.0	0.15	999	243.6	241.8	231.0	8.29
29-Aug	241	44.7925	-87.8438	433251	4960030	47.17	23.0	22.8	0.15	999	266.4	264.5	252.7	9.13
29-Aug	241	44.7910	-87.8252	434725	4959848	48.65	23.3	23.1	0.15	999	226.9	225.3	215.1	7.70
29-Aug	241	44.7910	-87.8007	436663	4959828	50.59	23.1	22.9	0.15	999	272.1	270.2	258.1	9.29
29-Aug	241	44.7922	-87.7900	437509	4959949	51.45	23.2	23.0	0.15	999	280.8	278.8	266.3	9.56
29-Aug	241	44.7933	-87.7772	438525	4960068	52.47	23.2	23.0	0.15	999	262.5	260.7	249.0	8.94
29-Aug	241	44.7940	-87.7613	439778	4960132	53.72	23.3	23.1	0.15	999	247.7	245.9	234.8	8.41
29-Aug	241	44.7925	-87.7578	440054	4959963	54.05	23.3	23.1	0.15	999	236.0	234.3	223.8	8.01
29-Aug	241	44.7925	-87.7583	440014	4959963	54.09	23.3	23.1	0.15	999	221.2	219.6	209.7	7.51
29-Aug	241	44.8055	-87.7072	444073	4961370	58.38	23.5	23.3	0.00	998	204.9	203.5	194.0	6.92
29-Aug	241	44.8112	-87.7131	443614	4962012	59.17	23.2	23.0	0.00	998	215.7	214.1	204.3	7.34
29-Aug	241	44.8241	-87.7262	442586	4963446	60.94	23.0	22.8	0.00	998	226.4	224.8	214.5	7.75
29-Aug	241	44.8337	-87.7361	441815	4964523	62.26	22.9	22.7	0.00	998	227.8	226.1	215.9	7.82
29-Aug	241	44.8622	-87.7637	439660	4967704	66.10	23.1	22.9	0.00	998	233.5	231.8	221.2	7.97
29-Aug	241	44.8760	-87.7766	438661	4969248	67.94	23.0	22.8	0.00	998	239.0	237.3	226.5	8.18
29-Aug	241	44.8933	-87.7815	438290	4971181	69.91	22.9	22.7	0.00	998	234.9	233.2	222.6	8.07
29-Aug	241	44.8990	-87.7957	437176	4971822	71.20	23.0	22.8	0.00	998	241.9	240.2	229.2	8.28
29-Aug	241	44.8987	-87.7885	437743	4971778	71.76	22.9	22.7	0.00	998	250.7	248.9	237.6	8.61
29-Aug	241	44.8982	-87.7665	439479	4971706	73.50	23.0	22.8	0.00	998	239.3	237.5	226.7	8.19
29-Aug	241	44.8983	-87.7468	441032	4971709	75.05	22.9	22.7	0.00	998	246.6	244.7	233.6	8.47
29-Aug	241	44.8988	-87.7060	444257	4971736	78.28	22.9	22.7	0.00	998	237.5	235.8	225.1	8.16
29-Aug	241	44.8982	-87.6843	445966	4971648	79.99	23.0	22.8	0.00	998	231.4	229.7	219.2	7.92
29-Aug	241	44.8982	-87.6630	447651	4971634	81.68	23.0	22.8	0.00	998	220.2	218.5	208.6	7.54
29-Aug	241	44.8993	-87.6461	448988	4971752	83.02	22.9	22.7	0.00	998	221.5	219.9	209.9	7.61
29-Aug	241	44.9015	-87.6123	451654	4971974	85.69	22.9	22.7	0.00	998	208.3	206.8	197.4	7.15
29-Aug	241	44.9050	-87.5880	453579	4972348	87.65	23.0	22.8	0.00	998	213.8	212.2	202.5	7.32
29-Aug	241	44.9122	-87.5425	457176	4973119	91.33	22.9	22.7	0.00	998	209.8	208.3	198.8	7.21
29-Aug	241	44.9160	-87.5085	459863	4973528	94.05	22.9	22.7	0.00	998	209.2	207.6	198.2	7.18
29-Aug	241	44.9180	-87.4848	461732	4973739	95.93	22.8	22.6	0.00	998	230.1	228.4	218.0	7.92

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
29-Aug	241	44.9170	-87.4590	463771	4973616	97.97	22.6	22.4	0.00	998	274.5	272.5	260.2	9.51
29-Aug	241	44.9063	-87.4417	465131	4972422	99.78	22.5	22.3	0.00	998	274.7	272.7	260.5	9.55
29-Aug	241	44.8972	-87.4278	466218	4971398	101.28	22.2	22.0	0.00	998	317.2	314.8	300.9	11.12
29-Aug	241	44.8873	-87.4135	467345	4970299	102.85	22.9	22.7	0.00	998	284.8	282.8	269.9	9.78
29-Aug	241	44.8713	-87.4107	467559	4968521	104.64	23.0	22.8	0.00	998	274.9	272.9	260.5	9.42
29-Aug	241	44.8553	-87.3995	468433	4966739	106.63	23.1	22.9	0.00	998	307.1	304.9	290.9	10.49
29-Aug	241	44.8407	-87.3875	469374	4965106	108.51	22.4	22.2	0.00	998	652.5	647.8	618.9	22.75
29-Aug	241	44.8342	-87.3822	469791	4964382	109.35	22.4	22.2	0.00	998	713.6	708.4	676.8	24.88
29-Aug	241	44.8283	-87.3787	470064	4963732	110.05	22.6	22.4	0.00	998	761.4	756.0	722.0	26.39
29-Aug	241	44.8273	-87.3780	470118	4963621	110.18	22.6	22.4	0.00	998	949.3	942.6	900.3	32.91
06-Oct	279	44.8405	-87.3872	469399	4965088	0.00	14.5	14.2	0.14	983	560.4	553.3	526.1	24.57
06-Oct	279	44.8432	-87.3893	469230	4965384	0.34	14.5	14.2	0.14	983	563.8	556.6	529.3	24.72
06-Oct	279	44.8485	-87.3935	468904	4965979	1.02	14.4	14.1	0.14	983	553.4	546.3	519.5	24.34
06-Oct	279	44.8540	-87.3978	468564	4966592	1.72	14.7	14.4	0.14	983	564.2	557.2	529.7	24.57
06-Oct	279	44.8595	-87.4020	468238	4967204	2.41	14.9	14.6	0.14	983	553.6	546.8	519.7	23.96
06-Oct	279	44.8823	-87.4142	467289	4969744	5.13	14.8	14.5	0.14	983	515.0	508.6	483.4	22.36
06-Oct	279	44.9077	-87.4193	466897	4972561	7.97	15.2	14.9	0.14	983	567.6	560.8	532.8	24.32
06-Oct	279	44.9187	-87.4221	466683	4973784	9.21	15.2	14.9	0.14	983	623.4	615.9	585.2	26.71
06-Oct	279	44.9167	-87.4243	466508	4973563	9.49	15.2	14.9	0.14	983	640.1	632.4	600.9	27.43
06-Oct	279	44.9333	-87.4268	466320	4975415	11.35	15.2	14.9	0.14	983	629.0	621.5	590.5	26.96
06-Oct	279	44.9698	-87.4345	465738	4979473	15.45	15.3	15.0	0.14	983	580.7	573.8	545.1	24.80
06-Oct	279	44.9938	-87.4395	465356	4982141	18.15	15.2	14.9	0.14	983	520.2	513.9	488.3	22.29
06-Oct	279	44.9983	-87.4405	465280	4982641	18.66	15.2	14.9	0.14	983	509.4	503.2	478.1	21.83
06-Oct	279	45.0027	-87.4420	465164	4983124	19.15	15.2	14.9	0.14	983	508.5	502.3	477.3	21.79
06-Oct	279	45.0120	-87.4448	464946	4984162	20.21	15.2	14.9	0.14	983	516.4	510.1	484.7	22.13
06-Oct	279	45.0212	-87.4470	464781	4985181	21.25	15.2	14.9	0.14	983	552.7	546.1	518.8	23.68
06-Oct	279	45.0223	-87.4475	464743	4985310	21.38	15.2	14.9	0.14	983	564.7	557.9	530.0	24.20
06-Oct	279	45.0178	-87.4523	464359	4984812	22.01	15.2	14.9	0.14	982	560.6	553.9	525.7	24.00
06-Oct	279	45.0082	-87.4655	463316	4983745	23.50	15.2	14.9	0.14	982	549.1	542.5	514.9	23.51
06-Oct	279	44.9962	-87.4817	462033	4982419	25.35	15.3	15.0	0.14	982	549.1	542.5	514.9	23.43
06-Oct	279	44.9817	-87.5010	460500	4980818	27.56	15.3	15.0	0.14	981	527.0	520.7	493.6	22.46
06-Oct	279	44.9750	-87.5100	459786	4980083	28.59	15.3	15.0	0.14	981	525.0	518.7	491.7	22.38
06-Oct	279	44.9562	-87.5338	457892	4978002	31.40	15.3	15.0	0.14	981	483.4	477.6	452.8	20.60
06-Oct	279	44.9445	-87.5483	456739	4976714	33.13	15.2	14.9	0.14	981	500.4	494.3	468.7	21.40
06-Oct	279	44.9355	-87.5613	455707	4975721	34.56	15.1	14.8	0.14	981	505.8	499.6	473.7	21.70

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
06-Oct	279	44.9270	-87.5717	454884	4974783	35.81	15.1	14.8	0.14	981	487.5	481.5	456.6	20.91
06-Oct	279	44.9262	-87.5750	454622	4974691	36.09	15.1	14.8	0.14	981	504.9	498.7	472.9	21.66
06-Oct	279	44.9245	-87.5622	455632	4974500	37.12	15.2	14.9	0.14	981	488.1	482.1	457.1	20.87
06-Oct	279	44.9228	-87.5457	456933	4974304	38.43	15.3	15.0	0.14	981	490.2	484.3	459.1	20.89
06-Oct	279	44.9205	-87.5212	458865	4974034	40.38	15.2	14.9	0.14	981	580.2	573.2	543.5	24.81
06-Oct	279	44.9198	-87.5030	460299	4973949	41.82	15.2	14.9	0.14	981	619.2	611.8	580.0	26.48
06-Oct	279	44.9188	-87.4822	461942	4973828	43.47	15.3	15.0	0.15	981	550.9	544.3	516.0	23.48
06-Oct	279	44.9180	-87.4693	462955	4973731	44.48	15.2	14.9	0.15	981	566.2	559.4	530.4	24.21
06-Oct	279	44.9112	-87.4487	464582	4972962	46.28	15.3	15.0	0.14	981	590.9	583.8	553.5	25.19
06-Oct	279	44.9047	-87.4380	465421	4972236	47.39	15.2	14.9	0.14	981	618.7	611.3	579.6	26.46
06-Oct	279	44.8950	-87.4223	466651	4971156	49.03	15.2	14.9	0.14	981	528.5	522.1	495.0	22.60
06-Oct	279	44.8865	-87.4132	467370	4970208	50.22	15.1	14.8	0.14	981	493.0	487.0	461.7	21.15
06-Oct	279	44.8663	-87.4075	467807	4967964	52.51	15.0	14.7	0.14	981	538.5	531.9	504.4	23.18
06-Oct	279	44.8450	-87.3905	469139	4965589	55.23	14.5	14.2	0.14	981	562.0	554.9	526.5	24.59
06-Oct	279	44.8392	-87.3860	469491	4964939	55.97	14.5	14.2	0.14	981	562.0	554.9	526.5	24.59
09-Oct	282	44.9178	-87.4137	467348	4973687	0.00	14.5	14.2	0.14	995	603.5	595.9	573.5	26.78
09-Oct	282	44.9272	-87.4125	467447	4974724	1.04	14.8	14.5	0.14	995	587.3	580.0	558.1	25.81
09-Oct	282	44.9383	-87.4108	467584	4975964	2.29	14.8	14.5	0.14	995	576.9	569.7	548.2	25.35
09-Oct	282	44.9515	-87.4083	467788	4977427	3.77	14.8	14.5	0.14	995	610.2	602.6	579.9	26.82
09-Oct	282	44.9622	-87.4067	467925	4978610	4.96	14.7	14.4	0.14	995	553.6	546.7	526.1	24.41
09-Oct	282	44.9807	-87.4038	468160	4980664	7.02	14.8	14.5	0.14	995	546.2	539.4	519.1	24.00
09-Oct	282	44.9930	-87.4020	468311	4982034	8.40	14.8	14.5	0.14	995	599.1	591.7	569.4	26.33
09-Oct	282	45.0090	-87.3993	468530	4983811	10.19	14.8	14.5	0.14	995	587.1	579.8	557.9	25.80
09-Oct	282	45.0268	-87.3915	469157	4985787	12.27	14.6	14.3	0.14	995	530.6	523.9	504.2	23.47
09-Oct	282	45.0413	-87.3795	470110	4987393	14.13	14.6	14.3	0.14	995	531.5	524.8	505.1	23.51
09-Oct	282	45.0488	-87.3728	470639	4988224	15.12	14.6	14.3	0.14	995	545.7	538.8	518.6	24.14
09-Oct	282	45.0603	-87.3630	471419	4989498	16.61	14.7	14.4	0.14	995	519.4	512.9	493.6	22.90
09-Oct	282	45.0773	-87.3483	472582	4991381	18.83	14.7	14.4	0.14	995	542.5	535.7	515.5	23.92
09-Oct	282	45.0868	-87.3398	473255	4992434	20.08	14.7	14.4	0.14	995	534.8	528.1	508.2	23.58
09-Oct	282	45.0947	-87.3330	473797	4993303	21.10	14.6	14.3	0.14	995	513.0	506.6	487.6	22.69
09-Oct	282	45.1058	-87.3230	474589	4994539	22.57	14.5	14.2	0.14	995	516.3	509.8	490.7	22.91
09-Oct	282	45.1243	-87.3065	475895	4996589	25.00	14.4	14.1	0.14	995	470.1	464.1	446.8	20.93
09-Oct	282	45.1367	-87.2957	476751	4997957	26.61	14.6	14.3	0.14	995	454.4	448.6	431.8	20.10
09-Oct	282	45.1482	-87.2878	477372	4999232	28.03	14.3	14.0	0.14	995	408.1	402.7	387.7	18.23
09-Oct	282	45.1585	-87.2832	477742	5000380	29.24	14.3	14.0	0.14	995	396.2	391.0	376.5	17.70

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
09-Oct	282	45.1747	-87.2740	478470	5002172	31.17	14.1	13.8	0.14	995	420.8	415.3	399.9	18.92
09-Oct	282	45.1877	-87.2650	479182	5003614	32.78	14.0	13.7	0.14	995	417.5	412.0	396.8	18.83
09-Oct	282	45.1978	-87.2578	479748	5004741	34.04	14.1	13.8	0.14	995	420.1	414.6	399.2	18.89
09-Oct	282	45.2000	-87.2592	479643	5004984	34.30	14.1	13.8	0.14	995	411.9	406.4	391.4	18.52
09-Oct	282	45.2015	-87.2595	479619	5005150	34.47	14.1	13.8	0.14	995	411.6	406.2	391.1	18.51
09-Oct	282	45.2013	-87.2500	480365	5005128	35.22	14.1	13.8	0.14	995	416.1	410.6	395.4	18.71
09-Oct	282	45.2013	-87.2598	479593	5005130	35.99	14.1	13.8	0.14	994	401.4	396.1	381.0	18.03
09-Oct	282	45.2077	-87.2693	478848	5005837	37.02	14.2	13.9	0.14	994	392.4	387.2	372.5	17.56
09-Oct	282	45.2183	-87.2745	478447	5007023	38.27	14.2	13.9	0.14	994	395.7	390.4	375.6	17.71
09-Oct	282	45.2323	-87.2715	478688	5008577	39.84	14.2	13.9	0.14	994	384.2	379.2	364.7	17.20
09-Oct	282	45.2430	-87.2703	478783	5009763	41.03	14.2	13.9	0.14	994	384.5	379.4	364.9	17.21
09-Oct	282	45.2617	-87.2803	478005	5011839	43.25	14.4	14.1	0.14	994	411.2	405.9	390.4	18.29
09-Oct	282	45.2643	-87.2858	477575	5012136	43.77	14.5	14.2	0.14	994	395.2	390.1	375.1	17.52
09-Oct	282	45.2672	-87.2960	476779	5012454	44.63	14.7	14.4	0.14	994	411.0	405.8	390.1	18.10
09-Oct	282	45.2715	-87.3148	475303	5012942	46.18	14.7	14.4	0.14	994	418.2	412.9	397.0	18.42
09-Oct	282	45.2780	-87.3397	473357	5013672	48.26	14.7	14.4	0.14	994	440.9	435.3	418.5	19.42
09-Oct	282	45.2832	-87.3598	471778	5014252	49.94	14.6	14.3	0.14	994	456.5	450.7	433.4	20.17
09-Oct	282	45.2878	-87.3812	470107	5014778	51.69	14.6	14.3	0.14	994	456.3	450.5	433.1	20.16
09-Oct	282	45.2838	-87.3882	469556	5014336	52.40	14.5	14.2	0.14	994	429.5	424.0	407.7	19.04
09-Oct	282	45.2758	-87.3937	469120	5013449	53.39	14.6	14.3	0.14	994	445.2	439.6	422.6	19.67
09-Oct	282	45.2663	-87.4002	468605	5012396	54.56	14.5	14.2	0.14	994	445.2	439.5	422.7	19.74
09-Oct	282	45.2563	-87.4072	468050	5011288	55.80	14.3	14.0	0.14	994	425.6	420.1	404.0	18.99
09-Oct	282	45.2445	-87.4155	467391	5009978	57.27	14.3	14.0	0.14	994	384.0	379.0	364.5	17.13
09-Oct	282	45.2287	-87.4263	466531	5008223	59.22	14.2	13.9	0.14	994	371.6	366.7	352.7	16.63
09-Oct	282	45.2187	-87.4333	465975	5007115	60.46	14.5	14.2	0.14	994	399.6	394.5	379.3	17.71
09-Oct	282	45.2092	-87.4400	465447	5006063	61.64	14.7	14.4	0.14	994	422.1	416.8	400.7	18.59
09-Oct	282	45.2025	-87.4447	465075	5005325	62.46	14.7	14.4	0.14	994	434.6	429.1	412.6	19.14
09-Oct	282	45.1997	-87.4455	465009	5005010	62.79	14.7	14.4	0.14	994	433.7	428.2	411.7	19.10
09-Oct	282	45.1757	-87.4698	463082	5002354	66.07	14.7	14.4	0.14	994	404.3	399.2	383.8	17.81
09-Oct	282	45.1690	-87.4758	462606	5001617	66.95	14.7	14.4	0.14	994	394.4	389.4	374.3	17.37
09-Oct	282	45.1457	-87.4915	461359	4999032	69.82	14.6	14.3	0.14	994	377.1	372.3	357.9	16.66
09-Oct	282	45.1293	-87.5007	460626	4997221	71.77	14.8	14.5	0.14	994	383.4	378.5	363.9	16.83
09-Oct	282	45.1212	-87.5055	460242	4996317	72.75	15.0	14.7	0.14	994	394.6	389.7	374.5	17.21
09-Oct	282	45.1017	-87.5225	458891	4994159	75.30	15.0	14.7	0.14	994	458.3	452.6	435.0	19.99
09-Oct	282	45.0928	-87.5295	458334	4993181	76.42	14.9	14.6	0.14	994	414.9	409.7	393.8	18.15
09-Oct	282	45.0752	-87.5437	457204	4991226	78.68	14.7	14.4	0.14	994	401.3	396.2	380.9	17.67

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
09-Oct	282	45.0685	-87.5480	456859	4990489	79.49	14.7	14.4	0.14	994	371.9	367.2	353.0	16.38
09-Oct	282	45.0573	-87.5472	456916	4989246	80.74	14.7	14.4	0.14	994	382.9	378.1	363.5	16.86
09-Oct	282	45.0430	-87.5363	457759	4987650	82.54	14.6	14.3	0.14	994	404.3	399.2	383.8	17.86
09-Oct	282	45.0320	-87.5265	458526	4986423	83.99	14.6	14.3	0.14	994	440.9	435.3	418.5	19.48
09-Oct	282	45.0235	-87.5188	459123	4985475	85.11	14.9	14.6	0.14	994	403.4	398.4	382.9	17.65
09-Oct	282	45.0118	-87.5078	459981	4984172	86.67	14.9	14.6	0.14	994	458.5	452.8	435.2	20.06
09-Oct	282	45.0038	-87.5022	460422	4983280	87.67	15.0	14.7	0.14	994	468.7	462.9	444.9	20.44
09-Oct	282	44.9920	-87.4952	460966	4981964	89.09	15.0	14.7	0.14	994	521.4	515.0	495.0	22.74
09-Oct	282	44.9832	-87.4887	461472	4980979	90.20	14.9	14.6	0.14	994	507.2	500.9	481.5	22.19
09-Oct	282	44.9747	-87.4820	461993	4980031	91.28	14.9	14.6	0.14	994	462.2	456.4	438.7	20.22
09-Oct	282	44.9645	-87.4728	462709	4978898	92.62	14.9	14.6	0.14	994	451.3	445.7	428.4	19.75
09-Oct	282	44.9582	-87.4668	463178	4978191	93.47	14.9	14.6	0.14	994	437.2	431.8	415.0	19.13
09-Oct	282	44.9485	-87.4588	463803	4977115	94.71	14.9	14.6	0.14	994	458.5	452.8	435.2	20.06
09-Oct	282	44.9390	-87.4510	464416	4976056	95.94	14.8	14.5	0.14	994	484.8	478.7	460.2	21.28
09-Oct	282	44.9257	-87.4398	465288	4974569	97.66	14.8	14.5	0.15	994	564.4	557.4	535.9	24.78
09-Oct	282	44.9173	-87.4333	465796	4973640	98.72	14.8	14.5	0.15	994	579.1	571.9	549.8	25.42
09-Oct	282	44.9045	-87.4232	466591	4972212	100.35	14.8	14.5	0.14	994	547.2	540.4	519.4	24.02
09-Oct	282	44.8943	-87.4157	467177	4971078	101.63	14.6	14.3	0.15	994	564.6	557.5	536.1	24.95
09-Oct	282	44.8867	-87.4147	467252	4970226	102.48	14.5	14.2	0.14	994	611.8	604.1	580.9	27.12
09-Oct	282	44.8657	-87.4070	467846	4967891	104.89	14.4	14.1	0.14	994	536.0	529.2	508.9	23.84
09-Oct	282	44.8563	-87.3998	468407	4966850	106.08	14.1	13.8	0.14	994	547.2	540.0	519.5	24.58
09-Oct	282	44.8453	-87.3910	469100	4965625	107.48	13.8	13.5	0.14	994	673.0	664.1	639.0	30.53
09-Oct	282	44.8402	-87.3870	469413	4965050	108.14	13.9	13.6	0.14	994	608.1	600.0	577.3	27.50
09-Oct	282	44.8340	-87.3817	469830	4964364	108.94	13.2	12.9	0.14	994	611.6	603.1	580.7	28.30
09-Oct	282	44.8295	-87.3785	470079	4963863	109.50	12.9	12.6	0.14	994	618.2	609.4	586.9	28.89
09-Oct	282	44.8277	-87.3778	470130	4963658	109.71	12.9	12.6	0.14	994	607.2	598.5	576.5	28.38
10-Oct	283	44.5970	-87.9494	424650	4938409	0.00	13.6	13.3	0.16	997	628.5	620.0	598.6	28.79
10-Oct	283	44.5922	-87.9568	424055	4937878	0.80	13.5	13.2	0.16	997	650.8	641.9	619.8	29.91
10-Oct	283	44.5821	-87.9723	422813	4936771	2.46	13.4	13.1	0.17	997	710.3	700.6	676.5	32.75
10-Oct	283	44.5722	-87.9858	421722	4935680	4.00	14.0	13.7	0.18	997	940.2	928.2	895.7	42.51
10-Oct	283	44.5537	-87.9967	420837	4933636	6.23	14.7	14.4	0.19	997	288.7	285.0	274.8	12.75
10-Oct	283	44.5460	-88.0008	420496	4932789	7.14	15.0	14.7	0.18	997	265.4	262.0	252.6	11.60
10-Oct	283	44.5377	-88.0043	420206	4931866	8.11	14.5	14.2	0.18	997	253.9	250.6	241.7	11.28
10-Oct	283	44.5310	-88.0078	419919	4931130	8.90	14.3	14.0	0.18	997	232.4	229.3	221.2	10.39
10-Oct	283	44.5237	-88.0102	419723	4930317	9.74	14.3	14.0	0.18	997	241.7	238.5	230.1	10.81

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
10-Oct	283	44.5198	-88.0140	419414	4929894	10.26	14.3	14.0	0.18	997	238.4	235.2	226.9	10.66
10-Oct	283	44.5198	-88.0142	419400	4929894	10.28	14.3	14.0	0.18	997	237.9	234.7	226.4	10.64
10-Oct	283	44.5198	-88.0142	419400	4929894	10.28	14.3	14.0	0.18	997	235.7	232.6	224.4	10.54
10-Oct	283	44.5197	-88.0135	419454	4929876	10.33	14.3	14.0	0.18	997	244.4	241.2	232.7	10.93
10-Oct	283	44.5240	-88.0098	419751	4930354	10.90	14.4	14.1	0.18	997	247.8	244.6	235.9	11.05
10-Oct	283	44.5297	-88.0082	419890	4930981	11.54	14.3	14.0	0.18	997	247.8	244.5	235.9	11.09
10-Oct	283	44.5395	-88.0022	420380	4932068	12.73	14.7	14.4	0.18	997	244.4	241.3	232.6	10.79
10-Oct	283	44.5443	-88.0013	420454	4932603	13.27	15.5	15.2	0.18	997	266.5	263.3	253.7	11.47
10-Oct	283	44.5570	-87.9945	421014	4934005	14.78	15.0	14.7	0.19	997	270.2	266.8	257.2	11.81
10-Oct	283	44.5688	-87.9873	421599	4935311	16.21	14.7	14.4	0.18	997	304.1	300.2	289.5	13.43
10-Oct	283	44.5787	-87.9812	422101	4936398	17.41	13.7	13.4	0.18	997	893.6	881.8	851.2	40.80
10-Oct	283	44.5863	-87.9683	423131	4937237	18.74	13.8	13.5	0.17	997	750.4	740.5	714.8	34.15
10-Oct	283	44.5912	-87.9580	423958	4937765	19.72	13.8	13.5	0.16	997	661.1	652.3	629.6	30.08
10-Oct	283	44.5973	-87.9493	424653	4938441	20.69	14.0	13.7	0.16	997	586.2	578.5	558.2	26.49
10-Oct	283	44.6080	-87.9477	424799	4939626	21.88	14.1	13.8	0.16	997	568.1	560.7	541.0	25.59
10-Oct	283	44.6202	-87.9470	424868	4940976	23.23	14.2	13.9	0.15	997	393.3	388.1	374.5	17.66
10-Oct	283	44.6307	-87.9465	424921	4942142	24.40	14.3	14.0	0.15	997	359.8	355.1	342.5	16.10
10-Oct	283	44.6408	-87.9460	424974	4943270	25.53	14.3	14.0	0.15	997	359.5	354.8	342.3	16.09
10-Oct	283	44.6493	-87.9457	425010	4944214	26.47	14.2	13.9	0.15	997	336.7	332.3	320.6	15.12
10-Oct	283	44.6588	-87.9450	425077	4945268	27.53	14.3	14.0	0.15	997	337.9	333.4	321.7	15.12
10-Oct	283	44.6588	-87.9347	425895	4945259	28.35	14.4	14.1	0.15	997	354.8	350.1	337.7	15.82
10-Oct	283	44.6583	-87.9230	426820	4945193	29.28	14.6	14.3	0.15	997	377.3	372.5	359.3	16.72
10-Oct	283	44.6565	-87.9075	428047	4944977	30.52	14.7	14.4	0.15	997	422.5	417.2	402.3	18.66
10-Oct	283	44.6547	-87.8942	429101	4944761	31.60	14.7	14.4	0.15	997	415.4	410.2	395.5	18.35
10-Oct	283	44.6580	-87.8820	430071	4945121	32.63	14.7	14.4	0.15	997	441.2	435.6	420.1	19.49
10-Oct	283	44.6583	-87.8817	430096	4945156	32.68	14.7	14.4	0.15	997	434.1	428.7	413.4	19.18
10-Oct	283	44.6583	-87.8817	430096	4945156	32.68	14.7	14.4	0.15	996	433.4	428.0	412.3	19.13
10-Oct	283	44.6583	-87.8817	430096	4945156	32.68	14.6	14.3	0.15	996	457.2	451.4	434.9	20.24
10-Oct	283	44.6583	-87.8817	430096	4945156	32.68	14.5	14.2	0.15	996	459.9	454.0	437.5	20.43
10-Oct	283	44.6578	-87.8793	430281	4945099	32.87	14.6	14.3	0.15	996	440.7	435.1	419.2	19.51
10-Oct	283	44.6575	-87.8715	430902	4945057	33.49	14.5	14.2	0.15	996	453.6	447.8	431.5	20.15
10-Oct	283	44.6582	-87.8470	432846	4945109	35.44	14.2	13.9	0.15	996	495.4	488.9	471.3	22.22
10-Oct	283	44.6585	-87.8363	433691	4945139	36.28	14.2	13.9	0.15	996	538.3	531.3	512.1	24.15
10-Oct	283	44.6585	-87.8273	434405	4945131	37.00	14.3	14.0	0.15	996	507.6	501.1	482.9	22.70
10-Oct	283	44.6582	-87.8198	434999	4945087	37.59	14.3	14.0	0.15	996	499.7	493.3	475.4	22.34
10-Oct	283	44.6578	-87.8097	435804	4945042	38.40	14.4	14.1	0.15	996	491.8	485.5	467.8	21.92

1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
10-Oct	283	44.6575	-87.7957	436914	4944995	39.51	14.3	14.0	0.15	996	483.2	476.9	459.6	21.60
10-Oct	283	44.6578	-87.7863	437655	4945024	40.25	14.3	14.0	0.15	996	511.5	504.9	486.6	22.87
10-Oct	283	44.6582	-87.7702	438936	4945049	41.53	14.2	13.9	0.16	996	625.5	617.5	595.1	28.06
10-Oct	283	44.6585	-87.7615	439625	4945080	42.22	14.2	13.9	0.16	996	734.2	724.8	698.6	32.94
10-Oct	283	44.6613	-87.7627	439534	4945394	42.55	14.2	13.9	0.16	996	771.6	761.8	734.2	34.62
10-Oct	283	44.6712	-87.7697	438990	4946493	43.78	14.3	14.0	0.15	996	565.7	558.4	538.2	25.29
10-Oct	283	44.6827	-87.7778	438355	4947776	45.21	14.3	14.0	0.15	996	533.9	527.0	507.9	23.87
10-Oct	283	44.6945	-87.7862	437707	4949098	46.68	14.4	14.1	0.15	996	573.7	566.4	545.8	25.57
10-Oct	283	44.7027	-87.7922	437240	4950009	47.70	14.4	14.1	0.15	996	585.9	578.4	557.4	26.11
10-Oct	283	44.7132	-87.7998	436645	4951181	49.02	14.5	14.2	0.15	996	530.3	523.6	504.5	23.56
10-Oct	283	44.7218	-87.8063	436139	4952148	50.11	14.6	14.3	0.15	996	491.8	485.6	467.8	21.77
10-Oct	283	44.7325	-87.8145	435505	4953341	51.46	14.7	14.4	0.15	996	448.1	442.5	426.2	19.78
10-Oct	283	44.7502	-87.8278	434469	4955313	53.69	14.7	14.4	0.14	996	414.0	408.7	393.8	18.27
10-Oct	283	44.7630	-87.8368	433771	4956747	55.28	14.6	14.3	0.14	996	378.7	373.8	360.2	16.76
10-Oct	283	44.7725	-87.8430	433294	4957807	56.44	14.6	14.3	0.14	996	382.9	378.0	364.2	16.95
10-Oct	283	44.7828	-87.8500	432752	4958959	57.72	14.6	14.3	0.14	996	337.3	333.0	320.8	14.93
10-Oct	283	44.7883	-87.8540	432442	4959574	58.41	14.5	14.2	0.14	996	329.9	325.6	313.7	14.65
10-Oct	283	44.7952	-87.8580	432134	4960337	59.23	14.5	14.2	0.15	996	307.1	303.2	292.1	13.64
10-Oct	283	44.7948	-87.8432	433306	4960287	60.40	14.6	14.3	0.14	996	303.2	299.3	288.4	13.42
10-Oct	283	44.7940	-87.8133	435665	4960172	62.76	14.5	14.2	0.14	996	363.7	359.0	345.9	16.15
10-Oct	283	44.7943	-87.8010	436642	4960197	63.74	14.5	14.2	0.14	996	364.1	359.4	346.3	16.17
10-Oct	283	44.7948	-87.7900	437512	4960244	64.61	14.5	14.2	0.14	996	371.9	367.1	353.7	16.52
10-Oct	283	44.7950	-87.7755	438659	4960253	65.76	14.7	14.4	0.14	996	371.2	366.4	353.0	16.38
10-Oct	283	44.7938	-87.7615	439766	4960112	66.88	14.8	14.5	0.14	996	446.9	441.3	425.1	19.66
10-Oct	283	44.7947	-87.7585	440004	4960203	67.13	14.8	14.5	0.14	996	441.0	435.5	419.4	19.40
10-Oct	283	44.7960	-87.7582	440030	4960352	67.28	14.8	14.5	0.14	996	442.4	436.9	420.8	19.46
10-Oct	283	44.7960	-87.7582	440030	4960352	67.28	14.8	14.5	0.14	996	452.9	447.2	430.8	19.92
10-Oct	283	44.7958	-87.7580	440044	4960331	67.31	14.8	14.5	0.14	996	452.6	447.0	430.5	19.91
10-Oct	283	44.7958	-87.7578	440057	4960331	67.32	14.8	14.5	0.14	996	456.2	450.5	433.9	20.07
10-Oct	283	44.7940	-87.7275	442455	4960107	69.73	14.8	14.5	0.14	996	459.0	453.3	436.6	20.19
10-Oct	283	44.7938	-87.7187	443153	4960081	70.42	14.8	14.5	0.14	996	440.9	435.3	419.3	19.39
10-Oct	283	44.7938	-87.7068	444089	4960073	71.36	14.8	14.5	0.14	996	440.6	435.1	419.1	19.38
10-Oct	283	44.7938	-87.6962	444932	4960066	72.20	14.8	14.5	0.14	996	447.3	441.7	425.5	19.68
10-Oct	283	44.7968	-87.6963	444923	4960399	72.54	14.8	14.5	0.14	996	451.0	445.3	429.0	19.84
10-Oct	283	44.8048	-87.7032	444389	4961292	73.58	14.8	14.5	0.14	996	440.6	435.1	419.1	19.38
10-Oct	283	44.8123	-87.7107	443803	4962130	74.60	14.8	14.5	0.14	996	428.9	423.5	408.0	18.87

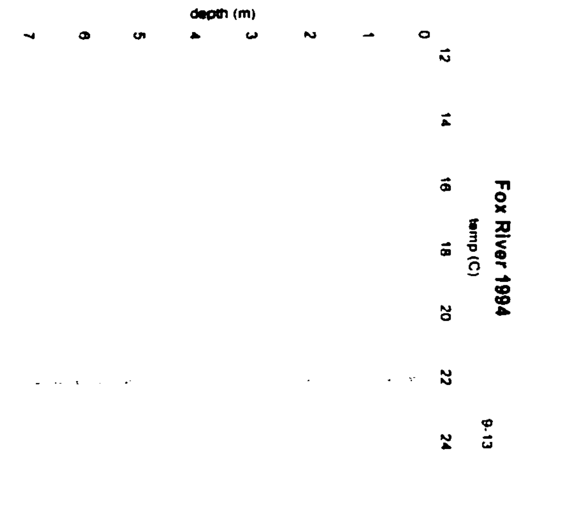
1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
10-Oct	283	44.8195	-87.7187	443178	4962934	75.62	14.8	14.5	0.14	996	432.3	426.9	411.2	19.02
10-Oct	283	44.8287	-87.7287	442396	4963958	76.91	14.8	14.5	0.14	996	440.2	434.7	418.7	19.36
10-Oct	283	44.8367	-87.7368	441759	4964853	78.01	14.8	14.5	0.14	996	451.2	445.6	429.2	19.85
10-Oct	283	44.8457	-87.7460	441044	4965859	79.24	14.8	14.5	0.14	996	474.5	468.5	451.3	20.87
10-Oct	283	44.8523	-87.7527	440523	4966604	80.15	14.8	14.5	0.14	996	485.3	479.2	461.6	21.35
10-Oct	283	44.8610	-87.7602	439940	4967573	81.28	14.8	14.5	0.14	996	496.3	490.2	472.1	21.83
10-Oct	283	44.8677	-87.7663	439460	4968318	82.17	14.8	14.5	0.14	996	511.6	505.2	486.6	22.50
10-Oct	283	44.8733	-87.7718	439031	4968951	82.93	14.7	14.4	0.14	996	428.7	423.3	407.7	18.92
10-Oct	283	44.8783	-87.7775	438590	4969510	83.64	14.5	14.2	0.14	996	418.1	412.7	397.7	18.57
10-Oct	283	44.8815	-87.7812	438302	4969866	84.10	14.2	13.9	0.14	996	383.8	378.8	365.1	17.22
10-Oct	283	44.8862	-87.7860	437927	4970388	84.74	14.2	13.9	0.14	996	294.1	290.2	279.7	13.19
10-Oct	283	44.8912	-87.7912	437523	4970947	85.43	14.2	13.9	0.14	996	297.5	293.6	282.9	13.34
10-Oct	283	44.8975	-87.7968	437083	4971656	86.27	13.8	13.5	0.15	996	309.0	304.8	293.9	14.04
10-Oct	283	44.9013	-87.7988	436929	4972082	86.72	13.7	13.4	0.15	996	286.5	282.6	272.5	13.06
10-Oct	283	44.9015	-87.7920	437470	4972096	87.26	14.0	13.7	0.15	996	294.1	290.1	279.7	13.28
10-Oct	283	44.9017	-87.7838	438114	4972108	87.91	14.1	13.8	0.14	997	339.3	334.8	323.0	15.28
10-Oct	283	44.9018	-87.7730	438970	4972117	88.76	14.7	14.4	0.14	997	362.5	357.9	345.1	16.01
10-Oct	283	44.9017	-87.7615	439878	4972091	89.67	14.8	14.5	0.14	997	406.4	401.3	386.9	17.89
10-Oct	283	44.9015	-87.7452	441164	4972061	90.96	14.8	14.5	0.14	997	443.2	437.6	422.0	19.51
10-Oct	283	44.9022	-87.7325	442166	4972126	91.96	14.8	14.5	0.14	997	474.0	468.1	451.3	20.87
10-Oct	283	44.9028	-87.7187	443262	4972189	93.06	14.8	14.5	0.14	997	471.9	466.0	449.4	20.78
10-Oct	283	44.9037	-87.6984	444860	4972268	94.66	14.8	14.5	0.14	997	511.6	505.2	487.1	22.53
10-Oct	283	44.9043	-87.6833	446051	4972332	95.85	14.8	14.5	0.14	997	528.2	521.6	502.9	23.26
10-Oct	283	44.9052	-87.6724	446918	4972418	96.72	14.9	14.6	0.14	997	530.0	523.5	504.7	23.26
10-Oct	283	44.9058	-87.6619	447742	4972484	97.55	14.8	14.5	0.14	997	511.8	505.4	487.3	22.54
10-Oct	283	44.9063	-87.6535	448413	4972533	98.22	14.8	14.5	0.14	997	485.5	479.5	462.3	21.38
10-Oct	283	44.9067	-87.6447	449101	4972573	98.91	14.8	14.5	0.14	997	461.1	455.3	439.1	20.30
10-Oct	283	44.9077	-87.6246	450689	4972667	100.50	14.7	14.4	0.14	997	492.4	486.2	468.9	21.75
10-Oct	283	44.9081	-87.6150	451453	4972712	101.27	14.7	14.4	0.14	997	496.6	490.3	472.9	21.94
10-Oct	283	44.9084	-87.6083	451980	4972743	101.79	14.7	14.4	0.14	997	485.3	479.2	462.1	21.44
10-Oct	283	44.9090	-87.5967	452897	4972798	102.71	14.6	14.3	0.14	997	432.6	427.1	411.9	19.17
10-Oct	283	44.9098	-87.5828	453990	4972881	103.81	14.6	14.3	0.14	997	440.4	434.8	419.3	19.52
10-Oct	283	44.9110	-87.5680	455162	4973004	104.99	14.9	14.6	0.14	997	466.6	460.9	444.3	20.48
10-Oct	283	44.9120	-87.5555	456150	4973108	105.98	15.0	14.7	0.14	997	496.8	490.7	473.1	21.74
10-Oct	283	44.9130	-87.5410	457295	4973211	107.13	15.0	14.7	0.14	997	496.3	490.3	472.6	21.72
10-Oct	283	44.9138	-87.5257	458505	4973294	108.34	15.0	14.7	0.14	997	516.4	510.1	491.7	22.59

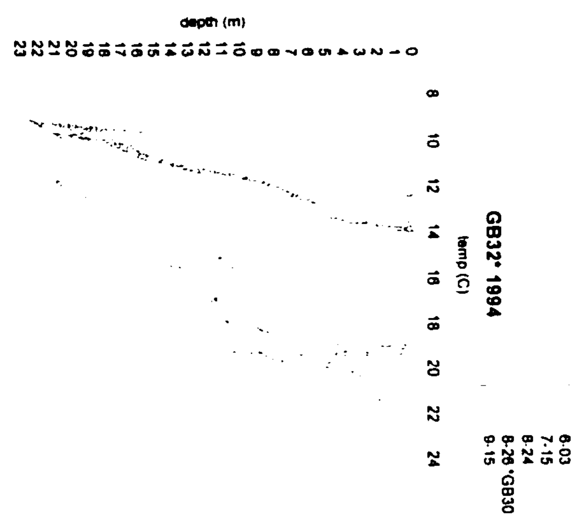
1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
10-Oct	283	44.9147	-87.5117	459611	4973381	109.45	15.0	14.7	0.14	997	515.0	508.7	490.4	22.53
10-Oct	283	44.9152	-87.5005	460494	4973431	110.34	15.0	14.7	0.14	997	494.3	488.2	470.6	21.62
10-Oct	283	44.9157	-87.4897	461348	4973481	111.19	15.0	14.7	0.14	997	462.7	457.0	440.6	20.24
10-Oct	283	44.9165	-87.4728	462678	4973566	112.53	14.9	14.6	0.14	997	439.9	434.5	418.9	19.31
10-Oct	283	44.9170	-87.4633	463428	4973618	113.28	14.8	14.5	0.14	997	455.1	449.4	433.4	20.04
10-Oct	283	44.9133	-87.4507	464425	4973203	114.36	14.8	14.5	0.15	997	595.5	588.2	567.1	26.23
10-Oct	283	44.9078	-87.4415	465146	4972588	115.31	14.8	14.5	0.15	997	585.8	578.6	557.9	25.80
10-Oct	283	44.9022	-87.4318	465906	4971955	116.29	14.8	14.5	0.14	997	544.8	538.0	518.7	23.99
10-Oct	283	44.8952	-87.4212	466743	4971173	117.44	14.9	14.6	0.14	997	496.3	490.2	472.6	21.79
10-Oct	283	44.8873	-87.4140	467306	4970299	118.48	14.8	14.5	0.15	997	519.6	513.2	494.8	22.88
10-Oct	283	44.8787	-87.4137	467326	4969337	119.44	14.7	14.4	0.15	997	550.1	543.2	523.8	24.30
10-Oct	283	44.8700	-87.4095	467651	4968374	120.46	14.5	14.2	0.14	997	474.0	468.0	451.4	21.08
10-Oct	283	44.8620	-87.4042	468067	4967483	121.44	14.3	14.0	0.14	997	563.0	555.7	536.1	25.20
10-Oct	283	44.8525	-87.3967	468655	4966425	122.65	14.3	14.0	0.14	997	508.6	502.0	484.3	22.76
10-Oct	283	44.8453	-87.3905	469139	4965625	123.59	14.0	13.7	0.14	997	575.0	567.4	547.6	25.99
10-Oct	283	44.8403	-87.3867	469438	4965068	124.22	13.8	13.5	0.14	997	654.9	646.2	623.8	29.80
10-Oct	283	44.8348	-87.3820	469805	4964455	124.93	13.8	13.5	0.14	997	664.9	656.0	633.2	30.26
10-Oct	283	44.8318	-87.3790	470041	4964121	125.34	13.7	13.4	0.14	997	671.6	662.6	639.6	30.66
09-Nov	313	44.8498	-87.3932	468930	4966126	0	4.5	3.8	0.14	995	410.8	396.5	384.6	25.79
09-Nov	313	44.8578	-87.3995	468435	4967017	1.02	5.4	4.7	0.14	995	410.8	397.4	385.4	24.99
09-Nov	313	44.8642	-87.4043	468056	4967723	1.82	5.9	5.2	0.14	994	399.4	386.9	374.7	23.85
09-Nov	313	44.8728	-87.4107	467560	4968687	2.91	5.6	4.9	0.14	994	385.7	373.4	361.6	23.22
09-Nov	313	44.8810	-87.4135	467342	4969597	3.84	5.3	4.6	0.14	994	389.1	376.4	364.6	23.71
09-Nov	313	44.8848	-87.4137	467329	4970022	4.27	5.6	4.8	0.14	994	378.4	366.2	354.7	22.85
09-Nov	313	44.8893	-87.4133	467359	4970521	4.77	6.5	5.8	0.14	994	388.5	376.9	364.8	22.70
09-Nov	313	44.8930	-87.4170	467072	4970932	5.27	7.1	6.5	0.14	994	377.3	366.6	354.8	21.52
09-Nov	313	44.8982	-87.4252	466429	4971508	6.13	7.5	6.9	0.14	994	377.0	366.8	354.8	21.21
09-Nov	313	44.9025	-87.4323	465866	4971993	6.87	7.5	6.9	0.14	994	376.8	366.6	354.6	21.19
09-Nov	313	44.9085	-87.4425	465068	4972664	7.92	7.5	6.8	0.14	993	388.5	377.9	365.2	21.86
09-Nov	313	44.9108	-87.4468	464727	4972924	8.34	7.4	6.8	0.14	993	378.0	367.6	355.2	21.31
09-Nov	313	44.9142	-87.4525	464282	4973297	8.93	7.5	6.8	0.14	993	382.1	371.6	359.1	21.51
09-Nov	313	44.9195	-87.4630	463456	4973895	9.94	7.4	6.7	0.14	993	385.5	374.9	362.3	21.77
09-Nov	313	44.9207	-87.4770	462352	4974030	11.06	7.6	6.9	0.14	993	384.8	374.4	361.8	21.59
09-Nov	313	44.9220	-87.4917	461194	4974186	12.23	7.6	7.0	0.14	993	393.7	383.1	370.2	22.03
09-Nov	313	44.9230	-87.5038	460235	4974303	13.19	7.9	7.3	0.14	992	393.5	383.2	369.8	21.76

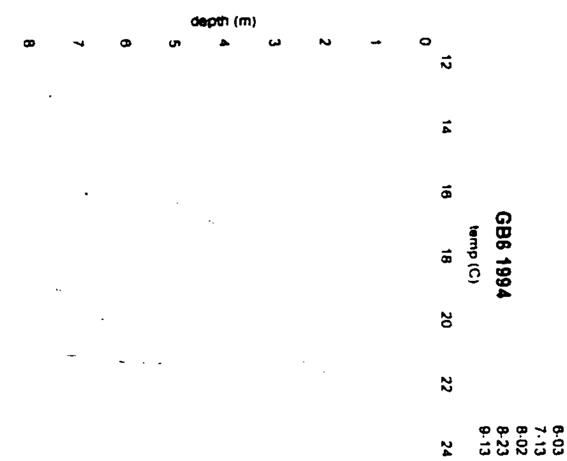
1995 Date	Day	Latitude	Longitude	UTM (E)	UTM (N)	Dist (km)	T eq	T w	PSU	P hPa	x(CO2)eq	x(CO2)w	f(CO2)w	[CO2]
09-Nov	313	44.9242	-87.5167	459223	4974438	14.21	8.1	7.5	0.14	992	407.9	397.4	383.5	22.40
09-Nov	313	44.9260	-87.5368	457633	4974653	15.82	8.1	7.6	0.14	992	393.3	383.2	369.7	21.59
09-Nov	313	44.9270	-87.5475	456793	4974770	16.67	8.0	7.4	0.14	992	393.3	383.0	369.6	21.72
09-Nov	313	44.9288	-87.5722	454846	4974985	18.62	6.4	5.7	0.14	992	325.8	316.0	305.3	19.02
09-Nov	313	44.9288	-87.5720	454861	4974985	18.64	6.4	5.7	0.14	992	329.7	319.7	308.9	19.25
09-Nov	313	44.9288	-87.5712	454925	4974985	18.70	6.5	5.8	0.14	991	329.7	319.8	308.6	19.20
09-Nov	313	44.9288	-87.5712	454925	4974985	18.70	6.5	5.8	0.14	991	332.0	322.0	310.8	19.32
09-Nov	313	44.9288	-87.5715	454900	4974985	18.73	6.5	5.8	0.14	991	326.2	316.5	305.4	18.98
09-Nov	313	44.9288	-87.5722	454846	4974985	18.78	6.7	6.0	0.14	990	325.8	316.2	304.8	18.80
09-Nov	313	44.9282	-87.5718	454873	4974912	18.86	6.6	5.9	0.14	990	324.3	314.7	303.3	18.77
09-Nov	313	44.9277	-87.5705	454978	4974856	18.98	6.6	5.9	0.14	990	324.5	314.9	303.5	18.79
09-Nov	313	44.9260	-87.5590	455884	4974665	19.91	7.1	6.5	0.14	989	347.0	337.2	324.7	19.69
09-Nov	313	44.9253	-87.5500	456594	4974584	20.62	7.8	7.2	0.14	989	368.9	359.1	345.6	20.44
09-Nov	313	44.9247	-87.5400	457383	4974506	21.41	8.1	7.5	0.14	989	375.9	366.2	352.3	20.58
09-Nov	313	44.9237	-87.5267	458433	4974388	22.47	8.1	7.6	0.14	989	386.6	376.7	362.4	21.16
09-Nov	313	44.9228	-87.5132	459498	4974288	23.54	8.0	7.4	0.14	988	391.7	381.5	366.7	21.55
09-Nov	313	44.9218	-87.4990	460617	4974170	24.66	7.8	7.2	0.14	988	390.6	380.3	365.6	21.62
09-Nov	313	44.9210	-87.4905	461287	4974074	25.34	7.7	7.1	0.14	988	378.8	368.6	354.4	21.05
09-Nov	313	44.9200	-87.4667	463166	4973952	27.22	7.6	7.0	0.14	988	379.7	369.4	355.2	21.16
09-Nov	313	44.9160	-87.4478	464658	4973500	28.78	7.4	6.8	0.14	987	379.4	369.0	354.5	21.27
09-Nov	313	44.9114	-87.4432	465017	4972985	29.41	7.3	6.7	0.14	987	379.4	369.0	354.4	21.32
09-Nov	313	44.9007	-87.4330	465813	4971797	30.84	7.5	6.9	0.14	987	387.3	376.8	361.9	21.61
09-Nov	313	44.8930	-87.4211	466752	4970930	32.12	7.1	6.5	0.14	987	373.6	363.1	348.8	21.17
09-Nov	313	44.8896	-87.4163	467124	4970556	32.65	6.6	5.9	0.14	986	379.7	368.4	353.8	21.91
09-Nov	313	44.8830	-87.4133	467355	4969819	33.42	5.6	4.9	0.14	986	401.6	388.7	373.4	24.03
09-Nov	313	44.8802	-87.4137	467327	4969504	33.73	5.4	4.7	0.14	986	380.1	367.7	353.3	22.86
09-Nov	313	44.8580	-87.4003	468368	4967037	36.41	5.7	4.9	0.14	985	380.3	368.2	353.3	22.68
09-Nov	313	44.8525	-87.3953	468760	4966424	37.14	5.1	4.3	0.14	985	401.4	387.9	372.4	24.45
09-Nov	313	44.8450	-87.3897	469204	4965589	38.09	4.1	3.2	0.14	985	391.1	376.8	362.0	24.74
09-Nov	313	44.8322	-87.3793	470014	4964159	39.73	4.7	3.9	0.14	985	391.1	377.5	362.5	24.18

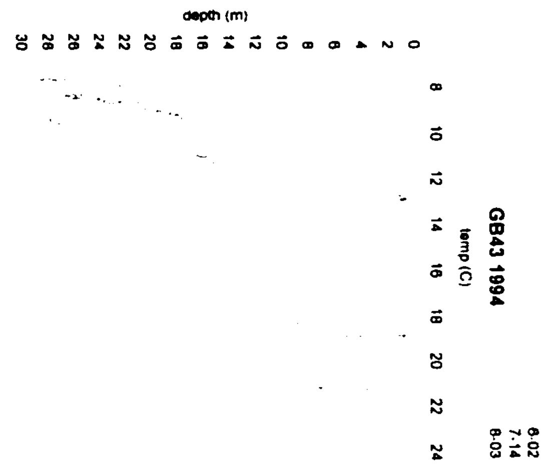
Appendix 4

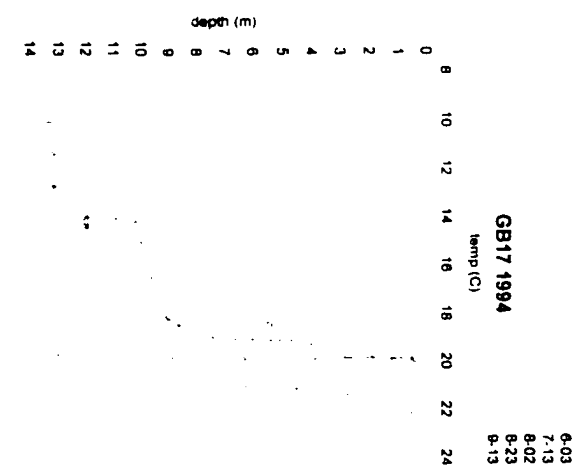
Green Bay Temperature Profiles

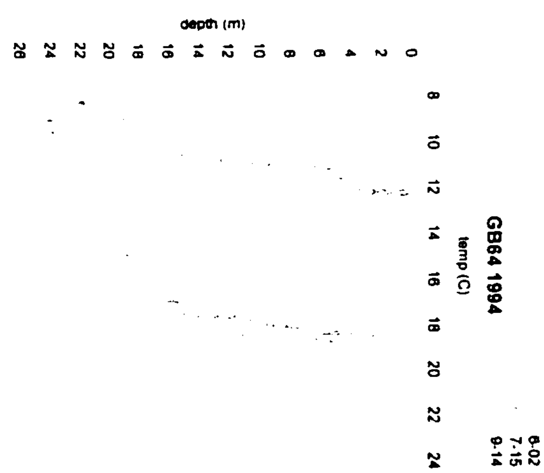

Fox River 1994
temp (C)
depth (m)
9-13

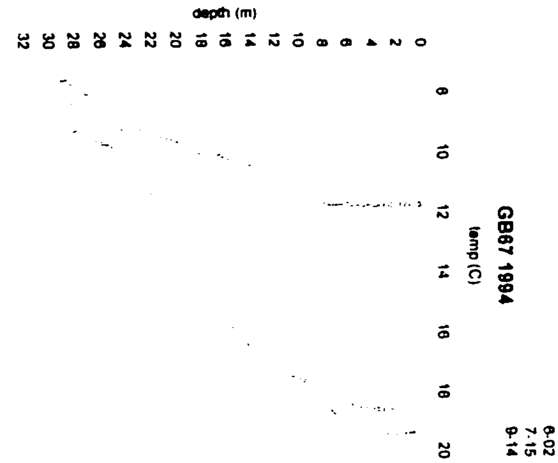

GB32* 1994
temp (C)
depth (m)
6-03
7-15
8-24
8-28 *GB30
9-15

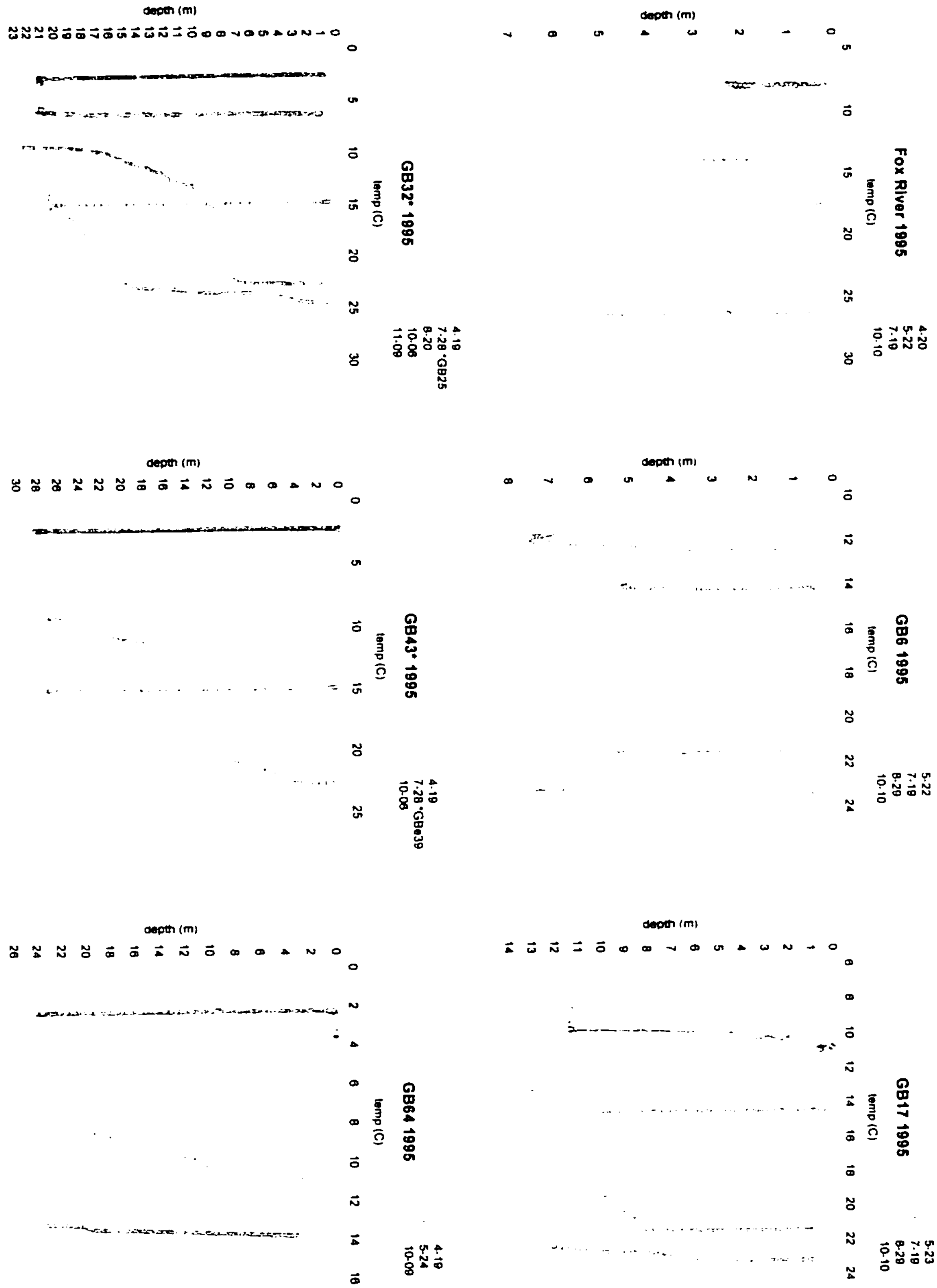

GB6 1994
temp (C)
depth (m)
6-03
7-13
8-02
8-23
9-13

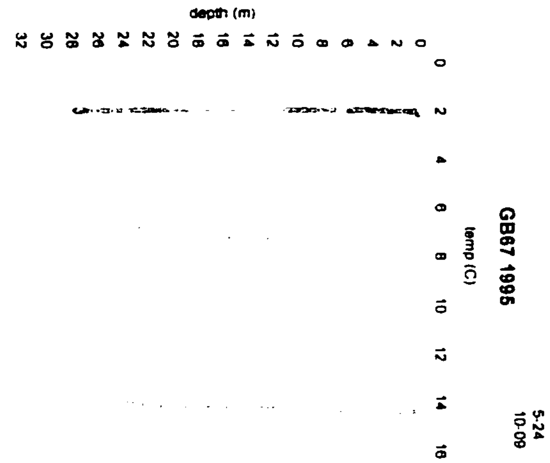

GB43 1994
temp (C)
depth (m)
6-02
7-14
8-03

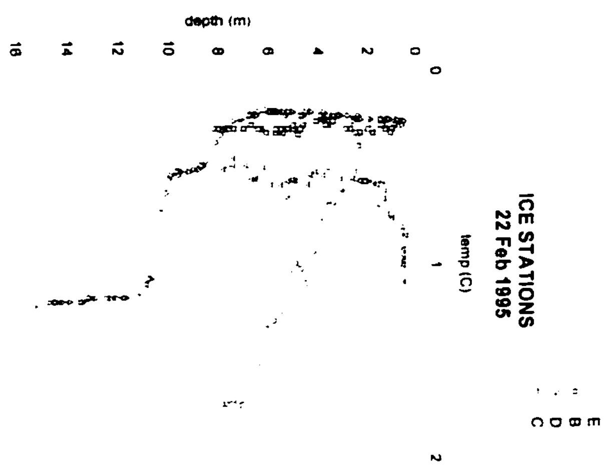

GB17 1994
temp (C)
depth (m)
6-03
7-13
8-02
8-23
9-13


GB64 1994
temp (C)
depth (m)
6-02
7-15
9-14


GB67 1994
temp (C)
depth (m)
6-02
7-15
9-14


Fox River 1995
temp (C)
depth (m)
4-20
5-22
7-19
10-10
GB6 1995
temp (C)
depth (m)
5-22
7-19
8-29
10-10
GB17 1995
temp (C)
depth (m)
5-23
7-19
8-29
10-10
GB32* 1995
temp (C)
depth (m)
4-19
7-28 *GB25
8-20
10-06
11-09
GB43* 1995
temp (C)
depth (m)
4-19
7-28 *GBe39
10-06
GB64 1995
temp (C)
depth (m)
4-19
5-24
10-09


GB67 1995
temp (C)
depth (m)
4-19
5-24
10-09


ICE STATIONS
22 Feb 1995
temp (C)
depth (m)
E
B
D
C

Appendix 5

Green Bay ΣCO_2 Stable Isotope Ratios

The following pages contain all measurements of ^{13}C for ΣCO_2 collected during the Green Bay transect cruises of 1995. Sampling, extraction and analysis methods are given in Chapter 2. The results are expressed using $\delta^{13}C$ (‰) notation where

$$\delta^{13}C\ (‰) = [\ (R_{sample} - R_{standard}) / R_{standard}\ ] \times 10^3. \qquad \text{(A5-1)}$$

R = the mass 44/45 ratio of the sample and standard relative to that of the PDB carbonate standard. The $\delta^{13}C$ value of PDB is defined as 0 ‰ with an absolute $^{13}C/^{12}C$ ratio (R_{PDB}) of 0.0112372 (Boutton 1991).

The absolute $^{13}C/^{12}C$ ratio of the sample can be calculated as:

$$R_{sample} = [\ (\delta^{13}C/1000) + 1\ ] \times R_{PDB}. \qquad \text{(A5-2)}$$

The fractional abundance (F) of the ^{13}C isotope can be calculated as:

$$F = {}^{13}C / ({}^{13}C + {}^{12}C) = R / (R + 1). \qquad \text{(A5-3)}$$

The molarity of each ΣCO_2 sample was determined manometrically on the isotope extraction line. Preliminary comparisons of the manometrically determined concentrations to concurrently measured samples using coulometry (n = 6) show a negative bias in the manometrically determined concentrations. A preliminary correction factor is given as:

$\Sigma CO_{2CORRECTED}$ (mM) = 0.31057 + 0.90149 [ΣCO_{2RAW}] (r^2 = 0.998).

Station coordinates are given in Appendix 1.

sample#	station	depth m	collected	calendar day	del 13C (‰)	DIC (raw) mM	DIC (corr) mM
73	6	1	22-May-95	142	0.03	2.11	2.21
79	6	7.2	22-May-95	142	-0.23	2.08	2.19
102	6	2.2	19-Jul-95	200	-0.56	2.23	2.32
125	6	2.1	29-Aug-95	241	-0.87	2.18	2.27
124	6	7.3	29-Aug-95	241	-1.26	2.22	2.31
150	6	2	10-Oct-95	283	-1.05	2.24	2.33
160	6	5	10-Oct-95	283	-1.06	2.21	2.30
68	17	2	20-Apr-95	110	-1.17	2.19	2.29
64	17	2	20-Apr-95	110	-1.25	2.31	2.39
90	17	0.7	23-May-95	143	-0.42	2.09	2.19
74	17	0.7	23-May-95	143	-0.93	2.15	2.25
80	17	11.3	23-May-95	143	-0.6	2.07	2.18
104	17	2	19-Jul-95	200	-0.64	2.22	2.31
103	17	2	19-Jul-95	200	-0.69	2.22	2.31
105	17	5.1	19-Jul-95	200	-0.74	2.22	2.31
106	17	10.2	19-Jul-95	200	-0.99	2.21	2.30
107	17	13.2	19-Jul-95	200	-2.73	2.31	2.39
123	17	2	29-Aug-95	241	-0.97	2.14	2.24
133	17	5.3	29-Aug-95	241	-0.3	2.11	2.21
138	17	8.2	29-Aug-95	241	-0.49	2.15	2.25
139	17	12.1	29-Aug-95	241	-1.36		
149	17	2	10-Oct-95	283	-0.61	2.16	2.26
155	17	10	10-Oct-95	283	-0.7	2.16	2.26
126	21	0.5	22-Aug-95	234	-0.33	2.14	2.24
127	21	3.1	22-Aug-95	234	-0.2	2.14	2.24
141	21	3.1	22-Aug-95	234	-0.27	2.15	2.25
128	21	6.2	22-Aug-95	234	-0.47	2.16	2.26
140	21	9.1	22-Aug-95	234	-0.39	2.15	2.25
137	21	12.1	22-Aug-95	234	-1.26	2.23	2.32
136	21	15.2	22-Aug-95	234	-3.08	2.30	2.38
108	25	2	28-Jul-95	209	-0.35	2.21	2.30
109	25	22.5	28-Jul-95	209	-2.12	2.37	2.44
56	32	1	19-Apr-95	109	-0.19	2.13	2.23
57	32	21.2	19-Apr-95	109	-0.02	2.14	2.24
75	32	0.9	23-May-95	143	-0.18	2.04	2.15
86	32	5.1	23-May-95	143	-0.24	2.00	2.12
87	32	10	23-May-95	143	0.09	2.01	2.12
81	32	21.6	23-May-95	143	-0.55	2.10	2.21
120	32	2.3	20-Aug-95	232	-0.33	2.10	2.20
121	32	5.2	20-Aug-95	232	-0.35	2.12	2.22
143	32	5.2	20-Aug-95	232	-0.39	2.11	2.21
134	32	7.8	20-Aug-95	232	-0.64	2.12	2.22
132	32	10.1	20-Aug-95	232	-0.6	2.05	2.16
142	32	12.7	20-Aug-95	232	-0.72	2.12	2.22
130	32	15.1	20-Aug-95	232	-0.92	2.15	2.25
135	32	17.7	20-Aug-95	232	-1.58	2.20	2.29
131	32	20.3	20-Aug-95	232	-2.89	2.26	2.35

sample#	station	depth m	collected	calendar day	del 13C (‰)	DIC (raw) mM	DIC (corr) mM
151	32	2	06-Oct-95	279	-0.76	2.13	2.23
168	32	5	06-Oct-95	279	-0.59	2.13	2.23
156	32	10	06-Oct-95	279	-0.72	2.11	2.22
164	32	20	06-Oct-95	279	-0.6	2.09	2.20
170	32	2	09-Nov-95	313	-1.15	2.18	2.28
172	32	5	09-Nov-95	313	-1.15	2.15	2.25
175	32	10	09-Nov-95	313	-1.16	2.17	2.27
171	32	20.7	09-Nov-95	313	-1.36	2.17	2.27
112	33	2	26-Jul-95	207	-0.34	2.20	2.30
113	33	12.2	26-Jul-95	207	-1.72	2.31	2.39
58	43	1	19-Apr-95	109	-0.6	2.20	2.30
59	43	28.1	19-Apr-95	109	-0.11	2.20	2.29
78	43	0.9	24-May-95	144	-0.66	2.21	2.30
88	43	14.8	24-May-95	144	0.08	2.06	2.17
82	43	28	24-May-95	144	-0.89	2.25	2.34
148	43	2	06-Oct-95	279	-0.56	2.14	2.24
157	43	10	06-Oct-95	279	-0.58	2.12	2.22
163	43	15	06-Oct-95	279	-0.56	2.14	2.24
159	43	20	06-Oct-95	279		2.13	2.23
162	43	27	06-Oct-95	279	-0.46	2.13	2.23
60	64	1	19-Apr-95	109	0.56	2.14	2.24
61	64	24.2	19-Apr-95	109	-0.03	2.14	2.24
89	64	1.2	24-May-95	144	-1.26	2.15	2.25
76	64	1.2	24-May-95	144	-1.58	2.30	2.39
84	64	19	24-May-95	144	-0.09	2.09	2.19
146	64	2	09-Oct-95	282	-0.27	2.15	2.24
167	64	5	09-Oct-95	282	-0.06	2.10	2.20
154	64	10	09-Oct-95	282	0.3	2.03	2.14
166	64	20	09-Oct-95	282	-0.59	2.11	2.21
169	64	23	09-Oct-95	282	-0.06	2.10	2.21
62	67	0.8	19-Apr-95	109	-0.56	2.16	2.26
63	67	27.7	19-Apr-95	109	-0.5	2.16	2.26
77	67	1	24-May-95	144	0.54	2.09	2.19
91	67	1	24-May-95	144	-0.13	2.10	2.21
85	67	15	24-May-95	144	0.19	2.18	2.27
83	67	27.7	24-May-95	144	0.36	2.06	2.16
161	67	2	09-Oct-95	282	-0.27	2.12	2.22
147	67	2	09-Oct-95	282	-0.35	2.18	2.27
158	67	10	09-Oct-95	282	-0.32	2.12	2.22
165	67	20	09-Oct-95	282	0.06	2.08	2.18
152	67	27	09-Oct-95	282	-0.05	2.11	2.21
34	D	1	21-Feb-95	52	-1.8	2.58	2.64
38	D	7	21-Feb-95	52	-5.99	3.24	3.23
43	D	7	21-Feb-95	52	-6.09	3.28	3.27
114	E39	2	25-Jul-95	206	0.13	2.18	2.27

sample#	station	depth m	collected	calendar day	del 13C (‰)	DIC (raw) mM	DIC (corr) mM
115	E39	10	25-Jul-95	206	-0.29	2.22	2.31
116	E39	14.9	25-Jul-95	206	-1.62	2.29	2.38
117	E39	20.2	25-Jul-95	206	-1.77	2.29	2.38
119	E39	27.1	25-Jul-95	206	-2.23	2.31	2.39
35	EJ	1	22-Feb-95	53	-1.4	2.37	2.45
40	EJ	7	22-Feb-95	53	-1.1	2.27	2.36
39	EJ	7	22-Feb-95	53	-0.96	2.22	2.31
46	EJ	11	22-Feb-95	53	-1.63	2.33	2.41
45	EJ	15	22-Feb-95	53	-2	2.47	2.54
55	FR	1	14-Mar-95	73	-7.7	2.91	2.93
53	FR	1	14-Mar-95	73	-7.53	2.89	2.91
50	FR	1	14-Mar-95	73	-6.31	2.71	2.75
65	FR	2	20-Apr-95	110	-5.83	3.27	3.25
72	FR	1	22-May-95	142	-5.96	3.16	3.15
101	FR	2	19-Jul-95	200	-5.65	3.41	3.39
100	FR	2	19-Jul-95	200	-5.61	3.39	3.37
122	FR	1	29-Aug-95	241	-5.07	3.00	3.02
153	FR	2	10-Oct-95	283	-4.92	2.78	2.82
51	GB	1	14-Mar-95	73	-0.65	1.86	1.99
52	GB	1	14-Mar-95	73	-0.61	1.70	1.84
37	H	1	21-Feb-95	52	-0.63	2.30	2.38
44	H	7	21-Feb-95	52	0.44	1.89	2.01
42	H	7	21-Feb-95	52	-0.17	2.14	2.24
36	SB	1	22-Feb-95	53	-1.41	2.38	2.45
41	SB	7	22-Feb-95	53	-1.34	2.31	2.39
129	SB	5.1	23-Aug-95	235	-0.51	2.12	2.22
145	T2	2	28-Jul-95	209	-0.18	2.11	2.22
110	T3	2	28-Jul-95	209	0.05	2.18	2.27
111	T4	2	28-Jul-95	209	0.05	2.16	2.26

Appendix 6

Wind Speed Computer Program

by Arlindo da Silva

(reprinted with permission)

```
* file: density.for - last update: 2/14/93   (c) 1993 A. da Silva
*
*    This program computes converts wind and temperature observations
* from a given height z to the standard 10 m reference level.
* The full stability of the surface layer is taken into consideration.
*
*
*              *** COPY FREELY BUT DO NOT SELL ***
*
* ALGORITHM: Based on surface layer similarity theory. For details
*        see Large & Pond (1981).

      program Z_to_10m

*.....................................................................

      print *
      print *, ' (( Observations Convertion to 10 m ))'
      print *

      print *, 'Options: '
      print *, '    1. Dew-point (Td) as moisture variable'
      print *, '    2. Relative humidity (RH) as moisture variable'
      print *, 'Which?'
      read  *, iopt
      print *, iopt


      print *, 'Enter nz, z1 & z2 (m) for profile: '
      read  *, nz, z1, z2
      print *, nz, z1, z2

      dz = (z2-z1) / (nz-1)


*     Initialize L&P package
*     ----------------------
      call INILP


      iu = 10
      mu = 20
      open(iu,file='z_to_10m.out',form='formatted',status='unknown')
      open(mu,file='profile.out',form='formatted',status='unknown')

      write(iu,*)
     .'  W(10m)  Z/L    Ts_ta  Qs-Q    CD     CT     CE (x1000)'

 1    continue


*     Read observations
*     -----------------
      if ( iopt .eq. 1 ) then
```

```
        print *
        print *, 'Enter z (m), W (m/s), p (mb), Ta, Ts, Td (C): '
        read(*,*,end=999) z, W, p, Ta, Ts, Td
        print *, z, W, p, Ta, Ts, Td

      else

        print *
        print *, 'Enter z (m), W (m/s), p (mb), Ta, Ts (C), RH (%): '
        read(*,*,end=999) z, W, p, Ta, Ts, rh
        print *, z, W, p, Ta, Ts, RH

        Td = DEWPT ( Ta, RH )

      end if

*     Do the calculation
*     ------------------
      TaK = Ta + 273.
      dT = Ts - Ta
      Qa = SSH( p, Td )
      Qs = SSH( p, Ts )
      dQ = Qs - Qa
      call LPZ ( CD, CT, CE, zdl, w10, ta10, dth10, dq10,
     .           z, w, TaK, dT, dQ )


*     print out results
*     -----------------
      write(iu,100) w10, zdl, dth10, dq10,
     .              1000*CD, 1000*CT, 1000*CE
 100  format(1x,f8.2,f8.4,5f8.2)

      print *
      print *, '          Wind speed at 10 m: ', w10
      print *, '                 Z/L at 10 m: ', zdl
      print *, '               Ts-Ta at 10 m: ', dth10
      print *, '               Qs-Q  at 10 m: ', dq10
      print *, '  CD, CT & CE (x1000) at 10 m: ',
     .        1000*CD, 1000*CT, 1000*CE


      print *
      do 20 i = 1, nz
        z = z1 + dz * (i-1)
        zlnz = alog(z/10.)
        Wz = w10 * RM ( cd, zdl, z, zlnz )

        write(mu,*) z, Wz

 20   continue
```

```
      go to 1

999  continue
      close(iu)
      close(mu)

      stop
      end
```

```
* large-pond.f - last update: 09/13/92 (ams/ccy)
*
*    This file contains routines for computation of transfer
* coefficients and other surface layer quantities using Large
* & Pond formulation.
*

      subroutine INILP

      include 'lp.h'

      deltaz = ( zdlb - zdla )/float(nzdl - 1)

*     Calculate psi's
*     ---------------
      do 10 i = 1, nzdl
        zfit(i) = float(i - 1) * deltaz + zdla
        zfit(i) = zfit(i)
        psim(i) = EXPSIM ( zfit(i) )
        psit(i) = EXPSIT ( zfit(i) )
 10   continue

*     Calculate spline fit
*     --------------------
      call SPLINE ( bbm, ccm, ddm, nzdl, zfit, psim )
      call SPLINE ( bbt, cct, ddt, nzdl, zfit, psit )


      return
      end

*.......................................................................

      subroutine LPZ ( CD, CT, CE, zdl, w10, ta10, dth10, dq10,
     .                 z, w, ta, dth, dq )

*     This routine calculates the corrected values for
*     CD, CT, CE, w, ta, dth, and dq from height z to 10m.
*     The routine assumes that dth is theta(sea) - theta(air).
*     Upon input, however, dth may be t(sea) - t(air) if one
*     does not need the accuracy that the theta values provide.
*     Units for input/output: w in m/s, ta in K, dth in K, dq
*     in g/kg. Upon output zdl is actually 10/L.
*
*     Notice that CD = CD(z=10), CT = CT(z=10), etc...
*

*     No. of iteration and tolerance
*     ------------------------------
      parameter ( itmax = 100, eps = 1. E -4, gamma = 0.01 )

      common / lpneut / CDN, fofzdl

      real zlnz
```

```
      zlnz = alog( z / 10. )
      m = 0

*     First guess
*     -----------
      w10 = w
      ta10 = ta
      dth10 = dth
      dq10 = dq

      Ts = dth + ta + gamma * z
      Tsg10 = Ts - gamma * 10.

*     ------------------------------------
*     NOTE: zdl below actually means 10 / L
*     ------------------------------------

*     Trivial case: z = 10. No height adjustment
*     -----------------------------------------
      if ( z .eq. 10. ) then
        call LP10 ( CD, CT, CE, zdl, w, ta, dth, dq )
        return
      end if

*     Otherwise, iterations are needed
*     Find first guess zdl
*     -------------------------------
      call LP10 ( CD, CT, CE, ozdl, w10, ta10, dth10, dq10 )

*     Adjust values
*     -------------
      w10   = w   / RM ( CD,     ozdl, z, zlnz )
      dth10 = dth / RT ( CD, CT, ozdl, z, zlnz )
      dq10  = dq  / RE ( CD, CE, ozdl, z, zlnz )
      ta10  = Tsg10 - dth10

*     Iterate...
*     ----------
      do 10 i = 1, itmax

*     Calculate a z/l
*     ---------------
        call LP10( CD, CT, CE, zdl, w10, ta10, dth10, dq10 )

*     Find adjusted values
*     --------------------
        w10   = w   / RM( CD,     zdl, z, zlnz )
        fofzdl = CD / CDN
        dth10 = dth / RT( CD, CT, zdl, z, zlnz )
        dq10  = dq  / RE( CD, CE, zdl, z, zlnz )
        ta10  = Tsg10 - dth10
        m = m + 1
```

```
*     If zdl and ozdl are close enough, we're done
*     ------------------------------------------
        if ( abs( zdl - ozdl ) .le. abs(eps * ozdl) ) then
          return
        end if

*     If not, we must iterate again
*     ----------------------------
        ozdl = zdl

 10   continue

*     Failure to converge
*     ------------------
      print *, 'zdl didnt converge after 100 iter: w, w10, dt = ',
     .      w, w10, dth
      if ( w * w10 .lt. 0. ) then
        print *,'bad correction:w w10 dth dth10 dq dq10 ta ta10'
        print *, w, w10, dth, dth10, dq, dq10, ta, ta10
      end if

      return
      end

*.......................................................................

      subroutine LP10 ( CD, CT, CE, ZDL, Winput, Ta, DT, DQ )

      real  CD, CT, CE, ZDL, Winput, Ta, DT, DQ

*       This subroutine returns the drag coefficient computed using
*     the Large and Pond (1981,1982) formulation.  This version
*     iterates the drag coefficients/stability correction.
*     Units:  Winput in m/s, Ta in K, DT in K, DQ in g/kg

*
      parameter ( cappa = 0.4, g = 9.81, Z = 10., cgZ = cappa * g * Z )
      parameter ( pi = 3.1415926, pid2 = 0.5 * pi )

*     maximum number of iterations and fractional error
*     ------------------------------------------------
      parameter ( ITMAX = 15, EPS = 1.e-4 )

      common / lpneut / CDN, fofzdl

*     lower bound on W (1 m/s) to avoid singularities
*     (consistent with Tremberth et al., 1989)
*     ---------------------------------------------
      W = amax1 ( 1., Winput )

*     first compute neutral drag coefficient
*     (for now uses L&P original formula; same as
*      Harrison 1989).  The number below also
*      comes from Harrison's paper.
```

```
*    ------------------------------------
ccc     if ( W .ge. 11. ) then
ccc        CDN = ( 0.49 + 0.065 * W ) * 1. E -3
ccc     else
ccc        CDN = 1.205 * 1. E -3
ccc     end if

*    Trenberth et al. dependence.
*    --------------------------
      if ( W .ge. 10. ) then
         CDN = ( 0.49 + 0.065 * W ) * 1. E -3
      else if ( W .ge. 3. ) then
         CDN = 1.14 * 1. E -3
      else
         CDN = ( 0.62 + 1.56 / W ) * 1. E -3
      end if

*    Neutral Dalton number
*    -------------------
      CEN = 1.2 * 1. E -3

*    neutral Stanton number (Pond's notes)
*    -----------------------------------
      sguess = - DT
      iter = 0
 1000 continue
      if ( sguess .lt. 0. ) then
         CTN = 1.2 * 1. E -3
      else
         CTN = 0.75 * 1. E -3
      end if

*    stability independent part of ZDL
*    -------------------------------
      S  = - ( cgZ / ( W**2. * Ta ) )
     .      * ( DT + (1.72 E -6) * (Ta**2.) * DQ )


*    first guess for ZDL
*    -----------------
      oZDL = S * CTN / CDN**1.5

*    now iterate to find stability parameter
*    --------------------------------------
      do 10 it = 1, ITMAX

*       CD/CT with previous ZDL
*       ---------------------
        call FORMCD ( CD, f, oZDL, CDN )
        call FORMCT ( CT, oZDL, CTN, CDN, f )
        call FORMCE ( CE, oZDL, CEN, CDN, f )

*       update ZDL
*       ----------
```

```
      ZDL = S * CT / CD**1.5

*      good enough?
*      ----------
      if ( abs(oZDL-ZDL) .le. abs(EPS*oZDL) ) go to 11

      oZDL = ZDL

 10  continue
     print *, 'CDLP: W, Ta, DT, DQ, Z/L: ', W, Ta, DT, DQ, ZDL
     print *,  'CDLP: ZDL iteration did not converge.'

 11  continue


*    consistency check (the first guess is sign(Z/L) = sign(-DT),
*     if not, iterate just once)
*    ----------------------------------------------------
     if ( ZDL * sguess .lt. 0. ) then
        iter = iter + 1
        if ( iter .gt. 1 ) stop 'CDLP: too many steps.'
        sguess = ZDL
        go to 1000
     end if


*    compute CD with final ZDL estimate
*    ------------------------------
     call FORMCD ( CD, f, ZDL, CDN )
     call FORMCT ( CT, ZDL, CTN, CDN, f )
     call FORMCE ( CE, ZDL, CEN, CDN, f )

ccc  print *, 'W CD CDN f ', W, f*CDN, CDN, f, it

     return
     end

*.........................................................................

     subroutine FORMCD ( CD, f, ZDL, CDN )

*      Given the stabilititility parameter ZDL and the neutral
*    drag coefficient CDN, this function returns the full CD
*    and the stability correction f.

     parameter ( cappa = 0.4 )

*    compute stability correction
*    -------------------------
     psi = SPSIM( ZDL )

     f = 1. / ( 1. - sqrt(CDN) * psi / cappa ) ** 2.

*    form the drag coefficeint
```

```
*    ------------------------
     CD = CDN * f

     return
     end

*.......................................................................

     subroutine FORMCT ( CT, ZDL, CTN, CDN, f )

*      Given the stabilititility parameter ZDL, the neutral
*    drag coefficient CDN, this subroutine returns the full CT
*    including the stability correction.

     parameter ( cappa = 0.4 )

*    compute stability correction
*    ----------------------------
     psi = SPSIT( ZDL )

     g = f / ( 1. - psi * CTN / ( cappa * sqrt(CDN) ) )

*    form the coefficeint
*    --------------------
     CT = CTN * g

     return
     end

*.......................................................................

     subroutine FORMCE ( CE, ZDL, CEN, CDN, f )

*    Given the stability ZDL, CDN, CEN, and the ratio f,
*    this routine returns CE with stability correction.

     parameter ( cappa = 0.4 )

*    compute stability correction
*    ----------------------------
     psi = SPSIT( ZDL )

     g = f / ( 1. - psi * CEN / ( cappa * sqrt(CDN) ) )

*    Form the coefficient
*    --------------------
     CE = CEN * g

     return
     end

*.......................................................................

     function RM ( CD, z10dl, z, zlnz )
```

```
      real zlnz

      cappa = 0.4

      s = zlnz - SPSIM ( z / 10. * z10dl  ) + SPSIM( z10dl )
      RM = 1. + ( sqrt( CD ) / cappa ) * s

      return
      end

*.................................................................

      function RT ( CD, CT, z10dl, z, zlnz )

      real zlnz

      sig = zlnz - SPSIT( z / 10. * z10dl ) + SPSIT( z10dl )
      RT = 1. + ( CT / sqrt( CD ) ) * sig

      return
      end

*.................................................................

      function RE ( CD, CE,  z10dl, z, zlnz )

      real zlnz

      sig = zlnz - SPSIT( z / 10. * z10dl ) + SPSIT( z10dl )
      RE = 1. + ( CE / sqrt( CD ) ) * sig

      return
      end

*.................................................................

      function SPSIM ( zdl )

      include 'lp.h'

      if ( zdl .le. zdla .or. zdl .ge. zdlb ) then
        SPSIM = EXPSIM ( zdl )
      else
        SPSIM = SEVAL( zdl, zfit, psim, nzdl, bbm, ccm, ddm )
      end if

      return
      end

*.................................................................

      function SPSIT ( zdl )
```

```
      include 'lp.h'

      if ( zdl .le. zdla .or. zdl .ge. zdlb ) then
        SPSIT = EXPSIT ( zdl )
      else
        SPSIT =  SEVAL( zdl, zfit, psit, nzdl, bbt, cct, ddt )
      end if

      return
      end

*.......................................................................

      function EXPSIM ( zdl )

      parameter ( pid = 3.14159 / 2.0 )

      if ( zdl .gt. 0. ) then
        EXPSIM = -7. * zdl
      else
        x = ( 1. - 16. * zdl )**0.25
        EXPSIM = 2. * alog( 0.5 * ( 1. + x ) )
     .          + alog( 0.5 * ( 1.0 + x**2. ) )
     .          - 2.0 * atan(x) + pid
      end if

      return
      end

*.......................................................................

      function EXPSIT( zdl )

      if ( zdl .gt. 0. ) then
        EXPSIT = -7. * zdl
      else
        x = ( 1. - 16. * zdl )**0.25
        EXPSIT = 2.0 * alog( 0.5 * ( 1.0 + x**2. ) )
      end if

      return
      end
```

```
C Software for calculation of moisture variables in COADS        14 Jun 1991
C
C
=======================================================================
=
C
C The following is excerpted from "Comprehensive Ocean-Atmosphere Data Set:
C Release 1," pg. A18.
C -----------------------------------------------------------------
C
C 4.4  Moisture Variables
C
C     The derived moisture variables (Q, R, and QS) are computed using the
C FORTRAN functions that are given in [10] and referenced as follows:
C       Q  = SSH(P,A - DP)
C       R  = HUM(A,A - DP)
C       QS = SSH(P,S)
C Inside SSH the mixing ratio is approximated by function WMR.  The method
C of computing vapor pressure differs in the untrimmed and trimmed
C summaries.  Function ESLO was used in the untrimmed summaries.
C Unfortunately, ESLO is unreliable at physically unrealistic conditions,
C although tests have demonstrated that, at least, no R exceeded 100%.
C Function ES was used instead in the trimmed summaries.  These algorithms
C were chosen because of their accuracy and computational efficiency.  For
C more detailed information including the original source of these
C techniques see [10].
C
C [10]  Schlatter, T. W., and D. V. Baker, 1981: Algorithms for thermodynamic
C        calculations. NOAA/ERL PROFS Program Office, Boulder, CO, 34 pp.
C
C
=======================================================================
=
C
C The following text and code is extracted from a later version of [10],
C which differs for these routines only in that some comment lines have
C been updated.  In addition, the original code used functions ESAT and
C ESW in HUM and WMR, respectively.  The COADS (trimmed) implementation
C substituted ES for ESAT or ESW.
C -----------------------------------------------------------------
C
C These algorithms were collected, edited, commented, and tested by Thomas W.
C Schlatter and Donald V. Baker from August to October 1981 in the PROFS Program
C Office, NOAA Environmental Research Laboratories, Boulder, Colorado.  Where
C possible, credit has been given to the original author of the algorithm and a
C reference provided.
C

*.....................................................................

      FUNCTION ESLO(T)

C       INCLUDE 'LIB_DEV:[GUDOC]EDFVAXBOX.FOR/LIST'
C       Baker, Schlatter  17-MAY-1982     Original version.
```

```
C  THIS FUNCTION RETURNS THE SATURATION VAPOR PRESSURE OVER LIQUID
C  WATER ESLO (MILLIBARS) GIVEN THE TEMPERATURE T (CELSIUS). THE
C  FORMULA IS DUE TO LOWE, PAUL R.,1977: AN APPROXIMATING POLYNOMIAL
C  FOR THE COMPUTATION OF SATURATION VAPOR PRESSURE, JOURNAL OF APPLIED
C  METEOROLOGY, VOL 16, NO. 1 (JANUARY), PP. 100-103.
C  THE POLYNOMIAL COEFFICIENTS ARE A0 THROUGH A6.

      DATA A0,A1,A2,A3,A4,A5,A6
     1 /6.107799961,     4.436518521E-01, 1.428945805E-02,
     2  2.650648471E-04, 3.031240396E-06, 2.034080948E-08,
     3  6.136820929E-11/
      ES = A0+T*(A1+T*(A2+T*(A3+T*(A4+T*(A5+A6*T)))))
      IF (ES.LT.0.) ES = 0.
      ESLO = ES
      RETURN
      END

*...........................................................................

      FUNCTION ES(T)

C  THIS FUNCTION RETURNS THE SATURATION VAPOR PRESSURE ES (MB) OVER
C  LIQUID WATER GIVEN THE TEMPERATURE T (CELSIUS). THE FORMULA APPEARS
C  IN BOLTON, DAVID, 1980: "THE COMPUTATION OF EQUIVALENT POTENTIAL
C  TEMPERATURE," MONTHLY WEATHER REVIEW, VOL. 108, NO. 7 (JULY),
C  P. 1047, EQ.(10). THE QUOTED ACCURACY IS 0.3% OR BETTER FOR
C  -35 < T < 35C.

C     INCLUDE 'LIB_DEV:[GUDOC]EDFVAXBOX.FOR/LIST'
C     Baker, Schlatter  17-MAY-1982     Original version.

C  ES0 = SATURATION VAPOR PRESSURE OVER LIQUID WATER AT 0C

      DATA ES0/6.1121/
      ES = ES0*EXP(17.67*T/(T+243.5))
      RETURN
      END

*...........................................................................

      FUNCTION HUM(T,TD)

C     INCLUDE 'LIB_DEV:[GUDOC]EDFVAXBOX.FOR/LIST'
C     G.S. Stipanuk     1973          Original version.
C     Reference Stipanuk paper entitled:
C         "ALGORITHMS FOR GENERATING A SKEW-T, LOG P
C         DIAGRAM AND COMPUTING SELECTED METEOROLOGICAL
C         QUANTITIES."
C         ATMOSPHERIC SCIENCES LABORATORY
C         U.S. ARMY ELECTRONICS COMMAND
C         WHITE SANDS MISSILE RANGE, NEW MEXICO 88002
C         33 PAGES
C     Baker, Schlatter  17-MAY-1982
```

```
C  THIS FUNCTION RETURNS RELATIVE HUMIDITY (%) GIVEN THE
C  TEMPERATURE T AND DEW POINT TD (CELSIUS).  AS CALCULATED HERE,
C  RELATIVE HUMIDITY IS THE RATIO OF THE ACTUAL VAPOR PRESSURE TO
C  THE SATURATION VAPOR PRESSURE.

      HUM= 100.*(ES(TD)/ES(T))
      RETURN
      END

*..........................................................................

      FUNCTION SSH(P,T)

C     INCLUDE 'LIB_DEV:[GUDOC]EDFVAXBOX.FOR/LIST'
C     Baker, Schlatter  17-MAY-1982     Original version.

C  THIS FUNCTION RETURNS SATURATION SPECIFIC HUMIDITY SSH (GRAMS OF
C  WATER VAPOR PER KILOGRAM OF MOIST AIR) GIVEN THE PRESSURE P
C  (MILLIBARS) AND THE TEMPERATURE T (CELSIUS). THE EQUATION IS GIVEN
C  IN STANDARD METEOROLOGICAL TEXTS. IF T IS DEW POINT (CELSIUS), THEN
C  SSH RETURNS THE ACTUAL SPECIFIC HUMIDITY.
C  COMPUTE THE DIMENSIONLESS MIXING RATIO.

      W = .001*WMR(P,T)

C  COMPUTE THE DIMENSIONLESS SATURATION SPECIFIC HUMIDITY.

      Q = W/(1.+W)
      SSH = 1000.*Q
      RETURN
      END

*..........................................................................

      FUNCTION WMR(P,T)

C  THIS FUNCTION APPROXIMATES THE MIXING RATIO WMR (GRAMS OF WATER
C  VAPOR PER KILOGRAM OF DRY AIR) GIVEN THE PRESSURE P (MB) AND THE
C  TEMPERATURE T (CELSIUS). THE FORMULA USED IS GIVEN ON P. 302 OF THE
C  SMITHSONIAN METEOROLOGICAL TABLES BY ROLAND LIST (6TH EDITION).

C     INCLUDE 'LIB_DEV:[GUDOC]EDFVAXBOX.FOR/LIST'
C     Baker, Schlatter  17-MAY-1982     Original version.

C  EPS = RATIO OF THE MEAN MOLECULAR WEIGHT OF WATER (18.016 G/MOLE)
C        TO THAT OF DRY AIR (28.966 G/MOLE)

      DATA EPS/0.62197/

C  THE NEXT TWO LINES CONTAIN A FORMULA BY HERMAN WOBUS FOR THE
C  CORRECTION FACTOR WFW FOR THE DEPARTURE OF THE MIXTURE OF AIR
C  AND WATER VAPOR FROM THE IDEAL GAS LAW. THE FORMULA FITS VALUES
C  IN TABLE 89, P. 340 OF THE SMITHSONIAN METEOROLOGICAL TABLES.
```

```
C  BUT ONLY FOR TEMPERATURES AND PRESSURES NORMALLY ENCOUNTERED IN
C  IN THE ATMOSPHERE.

      X = 0.02*(T-12.5+7500./P)
      WFW = 1.+4.5E-06*P+1.4E-03*X*X
      FWESW = WFW*ES(T)
      R = EPS*FWESW/(P-FWESW)

C  CONVERT R FROM A DIMENSIONLESS RATIO TO GRAMS/KILOGRAM.

      WMR = 1000.*R
      RETURN
      END

*
* Routines below added by Arlindo da Silva - November 1993.
*
*   Routines to obtain dew point temperature from air temperature
* and relative humidity.  Uses COAS termodynamic package.
*
*.........................................................................

     function DEWPT ( T, RH )
*
*     Given the temperature (in C) and the relative humidity in %,
*     this function returns the dew point temperature (in C).
*
     external ZHUM

     parameter ( tol = 0.0001 )
     common / dewprm / rhum, Ta

     rhum = rh
     Ta = T
     Td1 = T
     Td2 = -200.

     DEWPT = ZBRENT ( ZHUM, Td1, Td2, tol )

     return
     end

*
*.........................................................................

     function ZHUM ( Td )
     common / dewprm / rhum, Ta
     ZHUM = rhum - HUM(Ta,Td)
     return
     end

*.........................................................................

     function ZBRENT ( func, x1, x2, tol )
```

```
parameter (itmax=100,eps=3.e-8)
a=x1
b=x2
fa=func(a)
fb=func(b)
if(fb*fa.gt.0.) then
  print *, 'Root must be bracketed for ZBRENT.'
  call exit(1)
end if
fc=fb
do 11 iter=1,itmax
 if(fb*fc.gt.0.) then
   c=a
   fc=fa
   d=b-a
   e=d
 endif
 if(abs(fc).lt.abs(fb)) then
   a=b
   b=c
   c=a
   fa=fb
   fb=fc
   fc=fa
 endif
 tol1=2.*eps*abs(b)+0.5*tol
 xm=.5*(c-b)
 if(abs(xm).le.tol1 .or. fb.eq.0.)then
   zbrent=b
   return
 endif
 if(abs(e).ge.tol1 .and. abs(fa).gt.abs(fb)) then
   s=fb/fa
   if(a.eq.c) then
     p=2.*xm*s
     q=1.-s
   else
     q=fa/fc
     r=fb/fc
     p=s*(2.*xm*q*(q-r)-(b-a)*(r-1.))
     q=(q-1.)*(r-1.)*(s-1.)
   endif
   if(p.gt.0.) q=-q
   p=abs(p)
   if(2.*p .lt. min(3.*xm*q-abs(tol1*q),abs(e*q))) then
     e=d
     d=p/q
   else
     d=xm
     e=d
   endif
 else
   d=xm
   e=d
```

```
        endif
        a=b
        fa=fb
        if(abs(d) .gt. tol1) then
          b=b+d
        else
          b=b+sign(tol1,xm)
        endif
        fb=func(b)
11      continue
      print *, 'ZBRENT exceeding maximum iterations.'
      call exit(1)
      zbrent=b
      return
      end
```

```
* ******************************************************************
* *  FILE SPLINE - LAST CHANGE: 06/06/88 (AMS)                      *
* *_____________________________________________________________*
* *                                                             *
* *    THIS FILE CONTAINS ROUTINES TO COMPUTE CUBIC SPLINES. THE    *
* *  ROUTINES ARE BASED ON:                                     *
* *                                                             *
* *  FORSYTHE, G. E., M. A. MALCOLN AND C. B. MOLER (1977):          *
* *  "COMPUTER METHODS FOR MATHEMATICAL COMPUTATIONS". Prentice-Hall.  *
* *                                                             *
* ******************************************************************

      subroutine spline ( b, c, d, n, x, y )

      integer  n
      real     b(n), c(n), d(n), x(n), y(n)

* ******************************************************************
* *  FIRST VERSION: 02/13/86 (AMS)   CURRENT VERSION: 02/13/86 (AMS)  *
* *_____________________________________________________________*
* *                                                             *
* *    THIS ROUTINE COMPUTES THE COEFFICIENTS  B(I), C(I), D(I),      *
* *  I = 1, ...., N FOR A CUBIC INTERPOLATING SPLINE.              *
* *                                                             *
* *   S(X) = Y(I) + B(I) * ( X - X(I) ) + C(I) * ( X - X(I) )**2      *
* *            + D(I) * ( X - X(I) )**3                         *
* *                                                             *
* *_____________________________________________________________*
* *                                                             *
* *  ON INPUT                                                   *
* *  --------                                                   *
* *  N  ---  NUMBER OF DATA POINTS OR KNOTS ( N .GE. 2 )            *
* *  X  ---  THE ABSCISSAS OF THE KNOTS IN STRICTLY INCREASING       *
* *          ORDER                                              *
* *  Y  ---  THE ORDINATES OF THE KNOTS                             *
* *                                                             *
* *  ON OUTPUT                                                  *
* *  ---------                                                  *
* *  B, C, D  ---  ARRAYS OF SPLINE COEFFICIENTS AS DEFINED ABOVE.  *
* *                                                             *
* *_____________________________________________________________*
* *                                                             *
* *  INTERPRETAION:                                             *
* *  -------------                                              *
* *                                                             *
* *  Y(I)  ---  S   ( X(I) )                                    *
* *  B(I)  ---  S'  ( X(I) )                                    *
* *  C(I)  ---  S"  ( X(I) ) / 2                                *
* *  D(I)  ---  S"' ( X(I) ) / 6  ( DERIVATIVE FROM THE RIGHT )     *
* *                                                             *
* *  WHERE ' DENOTES DIFFERENTIATION. THE ACCOMPANYING SUBPROGRAM     *
* *  FUNCTION  SEVAL  CAN BE USED TO EVALUATE THE SPLINE.           *
* *                                                             *
* ******************************************************************
```

```
*
      integer  nm1, ib, i
      real     t
*
      nm1 = n - 1
      if( n .lt. 2 )  return
      if( n .lt. 3 )  go to 50
*
*     SET UP TRIDIAGONAL SYSTEM
*     -------------------------
*
*     B = DIAGONAL, D = DIAGONAL, C = RIGHT HAND SIDE
*     ----------------------------------------------
      d(1) = x(2) - x(1)
      c(2) = ( y(2) - y(1) ) / d(1)
      do 10 i = 2, nm1
        d(i)   = x(i+1) - x(i)
        b(i)   = 2.0 * ( d(i-1) + d(i) )
        c(i+1) = ( y(i+1) - y(i) ) / d(i)
        c(i)   = c(i+1) - c(i)
 10   continue
*
*     END CONDITIONS. THIRD DERIVATIVES AT  X(1)  AND  X(N)
*     OBTAINED FROM DIVIDED DIFFERENCES
*     ---------------------------------------------------
      b(1) = - d(1)
      b(n) = - d(n-1)
      c(1) = 0.0
      c(n) = 0.0
      if( n .eq. 3 )  go to 15
      c(1) = c(3)   / ( x(4) - x(2)   )
     1     - c(2)   / ( x(3)   - x(1)   )
      c(n) = c(n-1) / ( x(n) - x(n-2) )
     1     - c(n-2) / ( x(n-1) - x(n-3) )
      c(1) = c(1) * d(1)**2 / ( x(4) - x(1) )
      c(n) = -c(n) * d(n-1)**2 / ( x(n) - x(n-3) )
*
*     FORWARD ELIMINATION
*     -------------------
 15   do 20 i = 2, n
        t    = d(i-1) / b(i-1)
        b(i) = b(i)  -  t * d(i-1)
        c(i) = c(i)  -  t * c(i-1)
 20   continue
*
*     BACK SUBSTITUTION
*     -----------------
      c(n) = c(n) / b(n)
      do 30 ib = 1, nm1
        i = n - ib
        c(i) = ( c(i) - d(i) * c(i+1) ) / b(i)
 30   continue
*
*     C(I) NOW CONTAINS SIGMA(I)
```

```
*    ------------------------
*
*    COMPUTE POLYNOMIAL COEFFICIENTS
*    ----------------------------
     b(n) = ( y(n) - y(nm1) ) / d(nm1)
    1     + d(nm1) * ( c(nm1) + 2.0 * c(n) )
     do 40 i = 1, nm1
        b(i) = ( y(i+1) - y(i) ) / d(i)
    1         - d(i) * ( c(i+1) + 2.0 * c(i) )
        d(i) = ( c(i+1) - c(i) ) / d(i)
        c(i) = 3.0 * c(i)
 40  continue
     c(n) = 3.0 * c(n)
     d(n) = d(n-1)
*
     return
*
 50  b(1) = ( y(2) - y(1) ) / ( x(2) - x(1) )
     c(1) = 0.0
     d(1) = 0.0
     b(2) = b(1)
     c(2) = 0.0
     d(2) = 0.0
*
     return
*
*    LAST CARD OF SPLINE
*-------------------------------------------------------------------
     end
     real function seval ( u, x, y, n, b, c, d )
*
     integer  n
     real     u, x(n), y(n), b(n), c(n), d(n)
*
*
* *********************************************************************
* *  FIRST VERSION: 02/13/86 (AMS)   CURRENT VERSION: 02/13/86 (AMS)  *
* *-----------------------------------------------------------------*
* *                                                                 *
* *    THIS ROUTINE  RETURNS THE CUBIC SPLINE FUNCTION              *
* *                                                                 *
* *   SEVAL = Y(I) + B(I) * ( U - X(I) ) + C(I) * ( U - X(I) )**2    *
* *             + D(I) * ( U - X(I) )**3                            *
* *                                                                 *
* *   WHERE  X(I) .LT. U .LT. X(I+1), USING HORNER'S RULE.          *
* *     IF U .LT. X(1) THEN I=1 IS USED, IF U .GE. X(N) THEN I=N    *
* *   IS USED.                                                      *
* *                                                                 *
* *-----------------------------------------------------------------*
* *                                                                 *
* *  ON INPUT                                                       *
* *  --------                                                       *
* *  N      ---  NUMBER OF DATA POINTS OR KNOTS ( N .GE. 2 )         *
* *  U      ---  ABSCISSA AT WHICH THE SPLINE IS TO BE EVALUATED    *
```

```
**  X, Y    —  THE ARRAYS OF ABSCISSAS AND ORDINATES.          *
**  B, C, D —  ARRAYS OF SPLINE COEFFICIENTS AS DEFINED ABOVE.  *
**                                                               *
**    IF  U  IS NOT IN THE SAME INTERVAL AS THE PREVIOUS CALL,    *
**  THEN A BINARY SEARCH IS PERFORMED TO DETERMINE THE PROPER      *
**  INTERVAL.                                                      *
**                                                               *
* ******************************************************************
*
      save i
      integer  i, j, k
      real     dx
*
      data i / 1 /
*
      if ( i .ge. n      ) i = 1
      if ( u .lt. x(i)   ) go to 10
      if ( u .le. x(i+1) ) go to 30
*
*     BINARY SEARCH
*     -------------
 10   i = 1
      j = n + 1
 20   k = ( i + j ) / 2
      if ( u .lt. x(k) )  j = k
      if ( u .ge. x(k) )  i = k
      if ( j .gt. i+1  )  go to 20
*
*     EVALUATE SPLINE
*     ---------------
 30   dx    = u - x(i)
      seval = y(i)
     .      + dx * ( b(i) + dx * ( c(i) + dx * d(i) ) )
*
      return
*
*     LAST CARD OF SEVAL
*-------------------------------------------------------------------
      end
      subroutine speval1 ( s, sp, spp, u, x, y, n, b, c, d )
*
      integer  n
      real     s, sp, spp, u, x(n), y(n), b(n), c(n), d(n)
*
*
* ******************************************************************
**  FIRST VERSION: 02/17/87 (AMS)   CURRENT VERSION: 02/17/87 (AMS)  *
**-----------------------------------------------------------------*
**                                                               *
**     THIS ROUTINE  RETURNS THE CUBIC SPLINE FUNCTION              *
**                                                               *
**   S(U)  = Y(I) + B(I) * ( U - X(I) ) + C(I) * ( U - X(I) )**2    *
**              + D(I) * ( U - X(I) )**3                           *
**                                                               *
```

```
* *   AND ITS RESPECTIVE FIRST AND SECOND DERIVATIVES:          *
* *                                             *
* *          SP = S'(U)   AND   SPP = S"(U)          *
* *                                             *
* *   WHERE X(I) .LT. U .LT. X(I+1), USING HORNER'S RULE.       *
* *     IF U .LT. X(1) THEN I=1 IS USED. IF U .GE. X(N) THEN I=N   *
* *   IS USED.                                         *
* *                                             *
* *---------------------------------------------------------------*
* *                                             *
* *   ON INPUT                                         *
* *   --------                                        *
* *   N       ---  NUMBER OF DATA POINTS OR KNOTS ( N .GE. 2 )      *
* *   U       ---  ABSCISSA AT WHICH THE SPLINE IS TO BE EVALUATED  *
* *   X, Y     ---  THE ARRAYS OF ABSCISSAS AND ORDINATES.         *
* *   B, C, D ---  ARRAYS OF SPLINE COEFFICIENTS AS DEFINED ABOVE.  *
* *                                             *
* *     IF U IS NOT IN THE SAME INTERVAL AS THE PREVIOUS CALL,     *
* *   THEN A BINARY SEARCH IS PERFORMED TO DETERMINE THE PROPER      *
* *   INTERVAL.                                           *
* *                                             *
* ***********************************************************************
*
      integer  i, j, k
      real     dx
*
      data i / 1 /
*
      if ( i .ge. n      ) i = 1
      if ( u .lt. x(i)   ) go to 10
      if ( u .le. x(i+1) ) go to 30
*
*     BINARY SEARCH
*     -------------
 10   i = 1
      j = n + 1
 20   k = ( i + j ) / 2
      if ( u .lt. x(k) )  j = k
      if ( u .ge. x(k) )  i = k
      if ( j .gt. i+1  )  go to 20
*
*     EVALUATE SPLINE
*     ---------------
 30   dx = u - x(i)
      s   = y(i) + dx * ( b(i) + dx * ( c(i) + dx * d(i) ) )
      sp  = b(i) + dx * ( 2.0 * c(i) + 3.0 * d(i) * dx )
      spp = 2.0 * c(i) + 6.0 * d(i) * dx
*
      return
*
*     LAST LINE OF SEVAL1
*-----------------------------------------------------------------
      end
```

```
      subroutine bicspl ( a1, x1, y1, nx1, ny1,
     1                   a2, x2, y2, nx2, ny2,
     2                   b, c, d )
*
*                       A2 contains input array; A1 receives output
*                        dim ( A2 ):   max(NX1,NX2) x max(NY1,NY2)
*                        dim ( A1 ):   max(NX1,NX2) x max(NY1,NY2)

      real  a1(*), a2(*)

      real  x1(nx1), x2(nx2), y1(ny1), y2(ny2)
*
*                            these vectors must have dimension
*                             >= max ( nx2, ny2 )
      real  b(*), c(*), d(*)

* ******************************************************************
* *  FIRST VERSION: 06/06/88        CURRENT VERSION: 06/06/88      *
* *-------------------------------------------------------------*
* *                                                                *
* *   THIS ROUTINE COMPUTES INTRPOLATES THE BI-DIMENSIONAL FIELD  A2 *
* *  GIVEN ON A GRID  X2 x Y2  TO A FIELD  A1  DEFINED ON A GRID    *
* *  X1 x Y1.                                                      *
* *                                                                *
* *      A1, A2 should not share storage.   No attempt is made to  *
* *  save storage.  A2 is overwritten.                             *
* *                                                                *
* ******************************************************************


*   X-INTERPOLATION
*   ---------------
      do 10 j = 1, ny2
        l1j = ( j - 1 ) * nx2 + 1
        call spline ( b, c, d, nx2, x2, a2(l1j) )
        do 20 i = 1, nx1
          lij = ( j - 1 ) * nx1 + i
          a1(lij) = seval ( x1(i), x2, a2(l1j), nx2, b, c, d )
 20     continue
 10   continue

*   TRANSPOSITION
*   -------------
      do 30 i = 1, nx1
        do 30 j = 1, ny2
          lij = ( j - 1 ) * nx1 + i
          lji = ( i - 1 ) * ny2 + j
          a2(lji) = a1(lij)
 30   continue

*   Y-INTERPOLATION
*   ---------------
```

```
      do 40 i = 1, nx1
        l1i = ( i - 1 ) * ny2 + 1
        call spline ( b, c, d, ny2, y2, a2(l1i) )
        do 50 j = 1, ny1
          lij = ( j - 1 ) * nx1 + i
          a1(lij) = seval ( y1(j), y2, a2(l1i), ny2, b, c, d )
 50     continue
 40   continue

      return

*     LAST LINE OF BICSPL
*------------------------------------------------------------------
      end
```

Vita

Air-water gas exchange and the carbon cycle of Green Bay, Lake Michigan

Full Name: James Touchstone Waples

Place of Birth: London, ENGLAND

Universities:
1980-1985 University of Wisconsin - Madison, B.S.
1991-1998 University of Wisconsin - Milwaukee, Ph.D.

Positions Held:
1988-1990 Commissioned Officer, NOAA Corps
1991 Teaching Assistant, Water Analysis, UW-Madison
1991-1997 Research Assistant, Center for Great Lakes Studies

Member: American Geophysical Union

Abstracts:

Waples, J. T., and J. V. Klump. (1998) The dynamics of surface water methane in Green Bay, Lake Michigan. AGU/ASLO Ocean Sciences Meeting, San Diego, CA.

Waples, J. T., B. J. Eadie and J. V. Klump. (1996) Autotrophy, Heterotrophy and the Temporal and Spatial Variability in Isotopic Fractionation of Inorganic Carbon in Green Bay, Lake Michigan. ASLO Annual Meeting, Milwaukee, WI.

Reimers, C. E., S. E. Boehme, J. V. Klump, D. Lovalvo and J. T. Waples. (1996) ROV Controlled, *In Situ* Microelectrode Measurements in Lake Michigan. ASLO Annual Meeting, Milwaukee, WI.

Anderson, P. D., B. J. Eadie, D. C. Szmania, J. T. Waples and J. V. Klump. (1996) Stable Isotope Patterns in the Food Web of Green Bay, Lake Michigan. ASLO Annual Meeting, Milwaukee, WI.

Waples, J. T. and J. V. Klump. (1996) Air-Water Exchange of Carbon in Green Bay, Lake Michigan. AGU/ASLO Ocean Sciences Meeting, San Diego, CA.

Klump, J. V. and J. T. Waples. (1996) Estimates and Direct Measurements of Methane Exchange Across the Sediment-Water and Air-Water Interfaces: Implications for the Carbon Budget of Green Bay, Lake Michigan. AGU/ASLO Ocean Sciences Meeting, San Diego, CA.

Reimers, C. E., S. E. Boehme, J. V. Klump, D. Lovalvo and J. T. Waples. (1996) ROV Controlled, *In Situ* pH and pCO_2 Microelectrode Measurements. ACS Spring Meeting. #GEOC-038A.

Paddock, R. W., J. V. Klump, P. D. Anderson, J. T. Waples, D. Szmania and D. Lovalvo. (1995) Sediment-Water Fluxes in a Freshwater Estuary Using ROV Deployed *In Situ* Benthic Chambers. Amer. Chem. Soc. Div. Environ. Chem. Abst. 35: 68-70.

Waples, J. T., E. Rubin and J. V. Klump. (1994) Methane Evasion From Two Large Freshwater Lakes. AGU/ASLO Ocean Sciences Meeting, San Diego, CA.

Paddock, R., P. Anderson, D. Lovalvo, D. Szmania, J. T. Waples and J. V. Klump. (1994) *In Situ* Measurements of Sediment-Water Chemical Exchange Rates in a Freshwater Estuary Using an ROV Deployed Benthic Chamber System (BESS). Great Lakes CoOP Workshop, Milwaukee, WI.

Waples, J. T. and J. V. Klump. (1994) Carbon Dioxide and Oxygen in Southern Green Bay. Great Lakes CoOP Workshop, Milwaukee, WI.

Waples, J. T., B. J. Eadie and J. V. Klump. (1993) An Isotopic Mass Balance for Sedimentary Carbon Diagenesis in Green Bay, Lake Michigan. IAGLR Annual Meeting, De Pere, WI.

Keough, J. R., D. Bolgrien and J. T. Waples. (1989) Material Exchange Between a Coastal Wetland and Lake Michigan. IAGLR Annual Meeting, Madison, WI.

Keough, J. R., D. Bolgrien and J. T. Waples. (1989) Nutrient and Chlorophyll a Patterns at the Interface Between a Coastal Wetland and Lake Michigan. ASLO Annual Meeting, Fairbanks, AK.

Major Department: Committee Directed Ph.D. Program in Biogeochemistry

Signed: ______________________________

Major Professor in Charge of Dissertation

IMAGE EVALUATION TEST TARGET (QA-3)

150mm

6″

APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989