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Characterization Of Nucleation And Ultrafine Particle Growth In Rural Continental Environments

Robert Lesley Bullard
University of Iowa

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CHARACTERIZATION OF NUCLEATION AND ULTRAFINE PARTICLE GROWTH IN RURAL CONTINENTAL ENVIRONMENTS

by

Robert Lesley Bullard

A thesis submitted in partial fulfillment of the
requirements for the Doctor of Philosophy
degree in Chemical and Biochemical Engineering
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The University of Iowa

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Thesis Supervisor: Associate Professor Charles O. Stanier

Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

PH.D. THESIS

This is to certify that the Ph.D. thesis of

Robert Lesley Bullard

has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Chemical and Biochemical Engineering at the May 2015 graduation.

Thesis Committee: ______________________
Charles O. Stanier, Thesis Supervisor

____
C. Allan Guymon

____
Gregory D. Carmichael

____
Vicki H. Grassian

____
Thomas M. Peters

To Ashley, Luciana, Frank, Bruce, Rachel, and Ayers Bullard; for their patience, love, and support

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ABSTRACT

Aerosols are ubiquitous throughout Earth's atmosphere and their size, chemical composition, and concentration cause varying degrees of impact on climate and human health. Atmospheric aerosols can affect climate by their varied interactions with incoming solar radiation and their role in cloud formation and microphysics. Nucleation of fresh particles plays a significant role in the number of boundary layer cloud condensation nuclei (CCN). Elevated sulfuric acid concentration from power production has long been shown to contribute to new particle formation, but is not present in all instances where nucleation is observed. A third component has long been hypothesized and different studies in different locations have shown evidence of either ammonia, amines, or organics acting in conjunction with sulfuric acid and water to initiate new particle formation under certain meteorological conditions. While atmospheric nucleation has been examined world-wide in many urban as well as remote forested locations, it has not been studied extensively in the non-forested Midwestern United States, where sulfuric acid from coal-fired power plants and ammonia from agricultural activity are prevalent. For this doctoral dissertation work, instruments were designed, built, and tested for the purpose of investigating the concentration, size distribution, and volatility of atmospheric aerosols in non-forested rural continental environments in the Midwestern United States. An impact assessment of the University of Iowa Power Plant on air quality in Johnson County, IA highlights the ability to field test the emission ratios of fine particulates emissions to other gaseous

emissions. Analysis on 20 years of climatically relevant aerosol properties in the rural Midwestern location of Bondville, IL reveals enhancement of particle number in the Spring and Fall seasons. Bondville is also the location of a three-year aerosol vertical profiling field campaign, where ultra-fine particles were found to be enhanced in the planetary boundary layer. The long standing records are compared with current full aerosol size distribution particle measurements for a period of $\sim$ 10 months in Bondville, where the seasonality of high particle number concentrations are verified and attributed to nucleation. Nucleation is observed to varying degrees in all seasons at this location, but is most prevalent and intense in the Spring and Fall months under otherwise clean atmospheric conditions. This work paves the way for a more in depth examination of the volatility of fine particle matter during nucleation and the development of a Midwestern chemical nucleation model to investigate numerous nucleation conditions and mechanisms. This work will contribute important information to the atmospheric science community on the process controlling the particle number size distribution in the region.

PUBLIC ABSTRACT

An aerosol is defined as a liquid or solid particle suspended in a gas. Each cubic centimeter of air contains several thousand particles; and depending on how big they are, how many there are, and what they are made of – they can cause different impacts on climate and human health. An aerosol, for example can absorb or deflect incoming sunlight and can change the amount of solar energy that heats the atmosphere or reaches Earth's surface. Fine aerosols, also called fine particulate matter, smaller than 2.5 μm ($PM_{2.5}$) have been shown to have negative effects on the human respiratory system. The sources, sizes, and types of particles from different natural and human activities are well characterized, but many particles in the atmosphere are not released directly into the atmosphere. Instead, they form within the atmosphere itself from gas molecules that cluster together (or nucleate) to form particles under certain atmospheric conditions. Sulfuric acid, which originates mainly from coal burnt in power plants, has long been known to cause formation of new particles in the atmosphere. Scientific studies have shown that the presence of ammonia, amines, and organic carbon may contribute to the formation and early growth of particles.

This thesis dissertation discusses evidence of new particle formation in the Midwestern United States, where sulfuric acid from coal-fired power plants and ammonia from agricultural activities are both prevalent. Instruments were designed, built, and tested for the purpose of investigating the amount, size, and composition of atmospheric aerosols in a rural environment in the Midwestern United States. An

assessment of the impact of the University of Iowa Power Plant on the air quality in Johnson County, IA, determined that the power plant increases the concentration of NO_x, NO, SO_2 & PM, but that SO_2 and $PM_{2.5}$ are also influenced by other sources in the region. Analysis of 20 years of particle concentration data in the rural Midwestern location of Bondville, IL, reveals enhancement of the number of particles in the Spring and Fall. Bondville is also the location of a three-year aerosol aircraft data set, where fine particles were found to be enhanced at ground level. The long standing data records are compared with additional particle sizing information for a period of $\sim$ 10 months in Bondville, where the seasonality of high particle number concentrations are verified and attributed to the formation of new particles by nucleation. Nucleation is observed to varying degrees in all seasons at this location, but is most prevalent and intense in the Spring and Fall months under otherwise clean atmospheric conditions. This work contributes important information to the atmospheric science community in understanding the factors that control aerosol concentrations in the Midwest.

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CHAPTER 1
INTRODUCTION

1.1 Background

1.1.1 Aerosols and Climate

"An aerosol is defined in its simplest form as a collection of solid or liquid particles suspended in a gas" [27]. Aerosols have an effect on climate due to a number of direct and indirect radiative forcing effects as well as cloud albedo and microphysical effects [55, 57]. Increasing atmospheric aerosols affects climate by decreasing the solar radiation reaching Earth's surface. In addition, certain chemical species of aerosols are more efficient at scattering (e.g. sulfate aerosol) or absorbing (e.g. black carbon) incoming solar radiation and therefore exhibit competing heating and cooling effects on the atmosphere [55, 58]. Aerosols can also affect the atmosphere indirectly by a number of physical processes that allow a portion of aerosols to grow sufficiently to act as cloud condensation nuclei (CCN), which can then affect the number of cloud droplets present, leading to increased cloud albedo by enhanced multiple scattering of light, yet smaller cloud droplets, thereby affecting both the radiation balance and the microphysics of cloud formation and precipitation [55, 58]. These competing heating and cooling effects of aerosols, along with the relatively low level of scientific understanding causes the uncertainties associated with their contribution to global climate change to remain large according to the IPCC's fourth and fifth assessment reports [67, 41, 62, 57]. Despite the growing body of research on the effects of aerosols on human health and climate, the relative effects of different chemical components of particulate matter on human health is still highly uncertain as is the magnitude to which aerosols participate in climate forcing [22]. Fuzzi et al. 2015 discusses an improved understanding of the formation of new particles in the atmosphere and their subsequent growth as a major pathway to better understanding the interaction of aerosols with clouds and therefore the effects on climate [22].

1.1.2 Secondary Aerosols

An aerosol that is emitted directly into the atmosphere, either from an anthropogenic or a natural source is defined as a primary aerosol [58]. Secondary aerosols are aerosols produced within the atmosphere itself from anthropogenic and natural precursors by gas-to-particle conversion [58, 12, 69]. Nucleation is the first step in the phase change from gas molecules into solid or liquid clusters, which can then undergo growth by condensation as well as coagulation with other particles [71, 58]. Nucleation leading to fresh particles in the planetary boundary layer has been shown to produce a significant portion of climate relevant CCN active particles [64, 56]. Models have shown the ability to accurately reproduce the observations of several month-long field campaigns with a significant portion of the global aerosol loading coming from secondary sources [56, 21, 74]. Models and measurements in a recent study in Europe concluded that nucleation increased total aerosol number concentrations by 20 times, and that 50% of particles larger then 10 nm came from secondary sources [21]. An additional study concluded that the contribution of ultra fine particles (5 nm - 100

nm) in the regional background from new particle formation is 30% on average and as high as 46% on new particle formation event days [39].

1.1.3 Nucleation

Nucleation is known to occur in the presence of sunlight with low cloud cover [71, 30, 60, 68, 51]. Nucleation has been found to occur aloft, near temperature inversions when the planetary boundary layer is well mixed [60, 68], although some studies report that nucleation occurs first at ground level and mixes upward [47]. Researchers have linked nucleation to periods of entrainment of free tropospheric pollution layers by the destabilization of the boundary layer and turbulent vertical mixing [46, 51].

1.1.4 Chemistry of Growth

A large number of observations and theories regarding nucleation cite the presence of gaseous sulfuric acid (H_2SO_4) as a precursor to nucleation activity [51, 45, 53, 66]. Multiple studies involving measurements coupled with modeling have also linked nucleation activity to the presence of ammonia (NH_3) [18, 66, 44, 29, 8]. In addition, evidence is mounting for the role of organics in new particle formation [43, 36, 73]. Zhang et al. 2004 observed the chemistry of the early growth of nucleation using an aerosol mass spectrometer (AMS) [73]. They observed increases in aerosol mass from 33 - 60 nm in sulfate, followed by ammonia, then organics [73]. Secondary organics played a substantial role in the chemistry of growth, especially at the later stages of growth [73].

1.1.5 Long Term Measurements

The presence of a new particle formation event is categorized by a sharp increase in the number of ultrafine particles, followed by their growth into larger size regimes. Long-term measurement of nucleation and growth requires significant effort for maintaining instruments; therefore, short duration campaigns (weeks long) are more common than year-long or multi-year monitoring. Shorter campaigns cannot resolve seasonal patterns. Some long term ground-based studies have examined nucleation in rural, forested locations [5, 6, 53, 51], some of which are supplemented by co-located short-term vertical information [56, 26, 5, 21, 51].

Standalone condensation particle counter (CPC) data have been used in combination with microphysics models and estimates of primary ultrafine particle emissions to quantify new particle formation in many locations throughout the world [65, 4]. CPCs can be much easier to deploy than SMPS systems and long-term CPC data exist in the United States [4]. NOAA has deployed ground-based CPCs in a number of locations throughout the U.S. and Canada. One such location is in Bondville, IL, a rural continental location with surrounding farmland, but little forest cover. The site is especially attractive for data analysis focused on new particle formation because of (1) limited primary particle emissions in the immediate vicinity of the sampler; and (2) collocation with the Airborne Aerosol Observatory (AAO). The AAO is a dedicated light aircraft with a payload focused on aerosol optical properties, which is primarily used for climate-aerosol measurements and satellite validation [59, 20]. The AAO is equipped with CPC and SMPS and flew over 400 flights spanning more than three years. Previous work in Bondville concluded that the location is strongly impacted by transported, aged, secondary aerosols [13]. A large fraction of organic aerosols are from secondary sources and there is also secondary sulfate in the area [37]. A short field campaign in September 2005 confirmed that nucleation was occurring in Bondville on 25% of the days sampled [50].

Full size distribution data over 10 months in a year, supplemented with volatility information during nucleation events will enable new discoveries about the conditions, seasonality, and chemical precursors (e.g., sulfate, amines, organics) of nucleation events. The size distribution information from this field campaign can be compared to ongoing CPC measurements, which can then be used to infer past and future conditions at the site from twenty years of ongoing CPC data records in that location. This exercise will also give ample opportunity to refine the techniques for finding nucleation indicators in the long-term data and using those indicators to give researchers and modelers information about the evolution of yearly, seasonal, and diurnal patterns. The application of chemical transport models run in the same location will allow different chemical precursors and nucleation mechanisms that are not, or cannot be measured at the site, to be tested to account for the observations. As shown by the preceding discussion, models are becoming increasingly important tools in understanding the underlying mechanisms to atmospheric nucleation [35, 64, 44, 29, 8].

CHAPTER 2
OBJECTIVES

2.1 Objective 1

Develop custom instrumentation and associated software for unattended measurement of the atmospheric size distribution.

Commercial instrumentation designed to measure the atmospheric size distribution are widely used and distributed among the scientific and industrial community. The accuracy and reliability of the instruments is well documented. While the instruments and software can be adapted for use in long term measurements, it can be difficult to modify the functionality of the instrument to meet specific scientific objectives. In this thesis work, it was necessary to have the ability to modify the size selection of aerosols and to have data collection and feedback control interface with other instruments in the system.

2.2 Objective 2

Contribute to the comprehensive assessment of the impact of a Midwestern power plant on local air quality by intercepting the plume at ground level and measuring its SO_2, NO_x, CO_2, and particle size distribution.

Estimating the impact on emissions from a power plant is difficult to assess spatially due to the complicated interactions between various boilers and fuel types, and the spatial variability imposed by meteorological conditions. By combining modeling with empirical measurements coupled with known fuel usage and boilers in operation, will allow for future assessment of the spatial and temporal impact of a power plant on the surrounding community.

2.3 Objective 3

Infer seasonal, diurnal, and vertical properties of atmospheric particle number, as well as long-term trends in particle number from a 20-year data record of aerosol species and gas phase concentrations .

Measurements that are climatically relevant must take place over long periods of time. There is value in this dataset of measurements that can be used to assess climatic properties of the atmosphere in a marginally undisturbed rural background location.

2.4 Objective 4

Evaluate the inter-comparability between the particle number from a multi-year standalone CPC and the particle number integrated from size distribution measurements

Many facets of atmospheric aerosols relating to climate are dependent on their size and composition. By providing an inter-comparison of total particle measurements and full size distribution measurements a better assessment of the uncertainty associated with long-term measurements is made more available.

2.5 Objective 5

Identify atmospheric aerosol size distribution characteristics in a rural continental Midwestern location.

2.6 Objective 6

Summarize the seasonality and frequency of nucleation in a Midwestern background location.

With the importance of understanding how uncertainties in climate are related to the effects of aerosols, especially secondary aerosols it is important to understand the magnitude of these effects in different environments. Secondary particle formation has been studied in urban areas where it is driven by vehicle emissions and in rural forested areas where it is aided by the emissions from low volatility organics of the trees themselves. The Midwestern United States is a unique place to study the impact of new particles formed in non-forested agricultural locations.

CHAPTER 3
FIELD INSTRUMENTATION: DESIGN, CONSTRUCTION, AND CONTROL

3.1 A Brief Description of Aerosol Instrumentation

In the atmosphere there are ultrafine secondary particles (on the order of one nanometer), freshly nucleated from gas phase precursors, and coarse primary dust particles (on the order of tens of microns). Techniques for measuring particles are dependent on the physical properties of those aerosols, which are strongly related to size. Particles greater than 0.5 μm in diameter can be classified by their aerodynamic relaxation time. This technology is implemented by the aerodynamic particle sizer (APS [7], TSI[1] 3321). The APS allows continuous monitoring of particles ranging from 0.5 μm to 20 μm.

To measure smaller particles, different techniques for classifying and binning the particles are needed. If an ensemble of particles are exposed to a β-radioactive source [38], the emitted electrons bombarding the particles are capable of adding a predictable distribution of positive and negative charges to the molecules on the surface of those particles. After applying a charge distribution, particles can be introduced to an electrical field where their movement is driven by their charge and is inversely proportional to size, a concept known as electrical mobility.

A differential mobility analyzer (DMA) [15] is a device where particles can be sized by applying a varying voltage to a concentric rod enclosed by a grounded

[1] TSI Inc., Shoreview, MN

stainless steel cylinder. By scanning through an array of voltages to serially size select particles in a poly-disperse aerosol stream, one can make a determination of the full size distribution of the entering poly-disperse aerosol by counting the number of particles at different sizes with a condensation particle counter (CPC) [1]. A particle classifier grows particles by supersaturation to a size where light scattering makes optical particle counting possible (1 μm to 10 μm). A particle classifier in conjunction with a DMA and CPC is called a scanning mobility particle sizer (SMPS) [33]. The range of particles that may be sized by an SMPS is dependent on the geometry of the DMA, the intake flow rate of the CPC, the "working fluid" used to supersaturate the particles in the CPC, and the laminar sheath flow of air through the DMA provided by the classifier. To modify the range of particles that may be sampled, some research groups have constructed DMAs with special geometries and CPCs with different working fluids (e.g. diethylene glycol, DEG) [28, 53], all of which require construction of custom electrostatic classifiers. Using a commercial particle classifier functioning as an SMPS in conjunction with an APS, the size distribution can be measured from 3 nm to 2.5 μm or greater.

Aerosols exhibit hygroscopic growth under conditions of high relative humidity and may experience shrinkage if they are made up of volatile compounds or if hydration leads to morphology changes. This must be taken into account when measuring or reporting aerosol size distributions. This problem is remedied by the drying of all particles before sizing. Tandem differential mobility analysis (TDMA) is a technique that allows the size distribution to be measured in the dry condition, then exposed to ambient relative humidity or heated chambers to examine how the aerosol size distribution changes due to the volatility and hygroscopicity of the aerosol [17, 54, 42].

3.2 Instrument Design

The operation of the TDMAs necessary for studying aerosol chemical properties and the aerosol size distribution requires the use of multiple particle classifiers with full scanning capability. The decision was made to construct three electrostatic classifiers that could be easily adaptable to sizing modifications such as the DEG working fluid CPC charger [28]. The first of the three classifiers was completed in Spring of 2012. The other two classifiers were completed simultaneously in the Fall of 2013. For a full description of the electrical configurations and components in both generations of classifiers, see Appendix A and Appendix B.

3.2.1 Voltage Control

These systems are capable of providing an accurately controlled voltage of ∼10 V - 10 kV, which controls the electric field strength in the DMA and therefore the size of particles classified. In the first constructed classifier, in order to obtain full voltage control throughout the entire range, it was necessary to use a simple power supply (B&K[2] 1787B) for low voltages (10 - 64 V) and a high voltage power supply (Bertan[3] 605C) for all remaining voltages (65 V - 10 kV). The low voltage power supply is accurate throughout its entire range (2 - 64 V) and the high voltage power supply is

[2] B&K Precision Corp., Yorba Linda, CA

[3] Spellman High Voltage, Hauppage, NY

slightly offset, albeit predictably so, producing a significant error below 400 V. This inaccuracy was corrected by the use of a calibration curve obtained by measuring the voltages with a standard lab volt meter (Fluke[4] 289) with a supplemental high voltage probe (Fluke[4] 80K-40). The second generation classifiers featured a newer version of the high voltage power supply (Spellman[3] V6-DC), where voltages are accurate down to ∼7 V. This allowed for voltage control over the full range of voltages, eliminating the need for a secondary, low-voltage power supply. In the first generation design, high voltage relays are in place for surge protection when switching between voltages.

3.2.2 Sheath Air Control

A continuous laminar flow of sheath air through the DMA defines a residence time for particles within the DMA, which is then figured into the counting statistics of the instrument. The sheath air moves the particles in a continuous stream vertically and allows them to move horizontally by the balance of the electric field strength acting on the charged particle. The inlet and outlet of sheath air into the system must be exactly balanced and the air must be particle free. This is accomplished by using high efficiency particulate-free air (HEPA[5] 12144) filters to remove particulates that may be introduced into the system either from the blowers, ambient air, or the excess large particles not passing through the classifier based on size. The system can run in a "once-through" or "recirculation" mode (See Figure 3.1). The "recirculation" mode is exactly balanced by definition if the system is completely leak free. The

[4] Fluke Corporation, Everett, WA

[5] Pall Corporation, Port Washington, NY

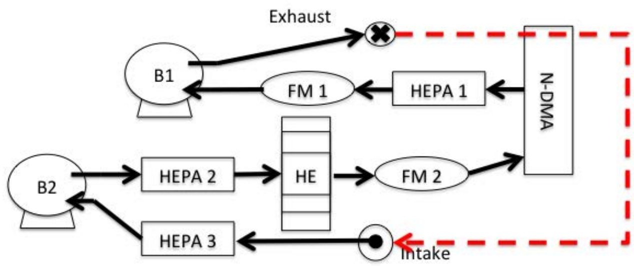

Figure 3.1: Flow diagram for the sheath air delivery system on the Stanier-Classifier. The red dashed lines represent the additional tubing necessary for "recirculation" mode in the second generation classifier. The first generation system operates only in "once-through" mode and has intake and exhaust to room air.

first generation classifier blowers (Ametek[6] SE12RE21-038700) had encasements and fitting that were not leak free, limiting the first generation classifier to operation in "once-through" mode only. The second generation classifiers included blowers (Ametek[6] SE12RE21SA-081795), that featured a sealed fan-blade and fitting case. Despite the presence of these added features, it was still necessary to use silicone sealant (RTV[7] -732) and manufacture plastic front-face blower encasements in the University of Iowa's engineering machine shop to fully ensure leak free operation.

[6] Ametek Precision Motion Control, Saugerties, NY

[7] Dow Corning, Midland, MI

3.2.3 Software

A number of LabVIEW[8] 2013 software packages were developed for this and other field campaign objectives. See Appendix C for a more complete description of the major virtual instruments (VIs) developed and the functions they can perform. The following sections describe the software developments relevant to the measurement of properties of aerosols in the atmosphere.

3.2.3.1 Particle Classifier

LabVIEW software was developed for feedback control of the sheath air delivery system to a specified flow set-point. The blowers turn on and off by activating and deactivating an electrical relay switch, which governs the flow of electrical current to the blowers. The relay can be switched on an off programatically with LabVIEW by sending a "square wave" of voltages to the relay switch. Feedback control is obtained by using proportion integration (PI) control to measure the flow rate through the blowers and adjust the percentage of time that the square wave is high vs. low (duty cycle) to achieve the desired flow delivery for the system. This LabVIEW virtual instrument (VI) software also adjusts the voltage going to the DMA and has subVIs that can determine the voltage needed to size a particle of a specific size, based on the sheath flow and the dimensions of the DMA:

$$V = \frac{3\mu D_p q_{sh} ln(\frac{r_2}{r_1})}{2eCL} \tag{3.1}$$

[8] National Instruments Corporation, Austin, TX

where μ is the gas viscosity of air, D_p is the desired particle diameter, q_{sh} is the sheath flow through the DMA in lpm and r_2 and r_1 represent the outer and inner radii of the concentric cylinder DMA column, respectively. e is the elementary charge of a particle in Coulombs, C is the cunningham slip correction factor (dependent on D_p), and L is the length of the DMA column.

3.2.3.2 Scanning Mobility Particle Sizer

Portions of the voltage classifier program are used in a scanning mode to scan through a range of particle sizes corresponding to voltages from 10 V to 10 kV. This scan is made through the voltages incrementally every tenth of a second in logarithmically spaced voltage intervals. Simultaneously, the particle classifier communicates with a CPC, obtaining particle counts in 0.1 second intervals. Particle counts and voltages vs. time are mathematically inverted [25, 70] using MATLAB to obtain the size distribution of aerosols as a function of time.

3.2.3.3 Volatility Tandem Differential Mobility Analyzer

LabVIEW VIs simultaneously controlling a classifier and a scanning mobility particle sizer were made possible by the placement of two classifiers on one LabVIEW card in the second generation classifiers (See Appendix A. This program also controls the temperature of a section of copper tubing and a number of pressurized valves. The heated section of tubing is a thermal denuder, which removes the volatile components of atmospheric particles at different temperatures. The valve switching operations allow incoming aerosol to pass alternatively through heated and ambient sections of

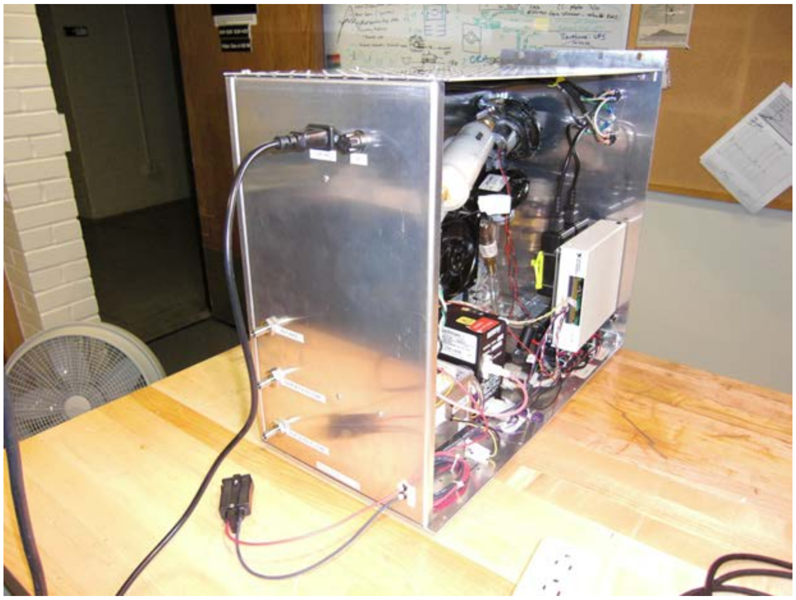

Figure 3.2: The Stanier-classifier was built in-house with programming written in LabVIEW

tubing. When samples are passing through the ambient section, feedback controls are working with temperature controllers and sensors to achieve the next set of user-specified conditions in the heated section. In summary, this software allows the instrument to cycle through a series of three particle sizes, coupled with a series of five temperatures at each particle size, repeating the operation ∼ every hour. This allows the volatility of particulates to be investigated at a number of different sizes and temperatures with a time resolution that allows the fast changing atmospheric conditions associated with nucleation to be captured.

3.3 Validation

3.3.1 First Generation Classifier

For validation of the functionality of the constructed electrostatic classifier (Stanier-classifier), it was operated with nano-DMA (TSI[1] 3085) and was placed in series with a commercial classifier (TSI[1] 3080) in scanning-mode with an additional nano-DMA and butanol CPC[1] (3025). To test the ability of the instrument to produce a mono-disperse aerosol stream from a poly-disperse aerosol sample, a 1.2 g L^{-1} solution of NaCl in ultra-pure water (Fischer[9] Optima W74) was injected at 1 mL hr^{-1} into an aerosol atomizer (TSI[1] 3076). The particles were then dried using a diffusion drier and passed through a Kr-85 radioactive neutralizer (TSI[1] 3077) then through a nano-DMA controlled by the newly constructed classifier to produce a mono-disperse aerosol stream, which was then scanned using the commercial SMPS (TSI[1] 3936N25). The butanol CPC was run in high-flow mode (1.5 lpm) and low-flow mode (0.3 lpm). Sheath flow through each DMA was run at 10× the aerosol flow (15 lpm and 3 lpm respectively). The Stanier-classifier was used to size-select particles at two different sizes (15 nm and 30 nm) on low-flow and three sizes (10 nm, 30 nm, and 100 nm) on high-flow. Three scans were performed at each size and the results were averaged and plotted (See Figure 3.4). The differences between the scan sizes and the classified sizes are 2% – 5%.

The ability of the Stanier-Classifier to scan through a range of voltages and detect a known particle size was tested by running the previous experiment in reverse.

[9]Thermo Fischer Scientific Inc., Waltham, MA

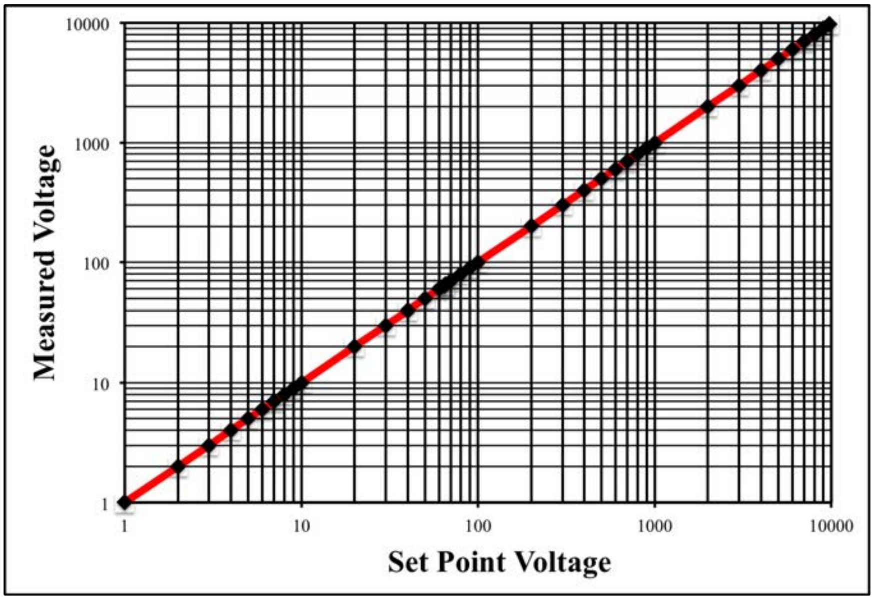

Figure 3.3: The difference between the set-point and measured voltages of the classifier is less than 0.5% across four orders of magnitude.

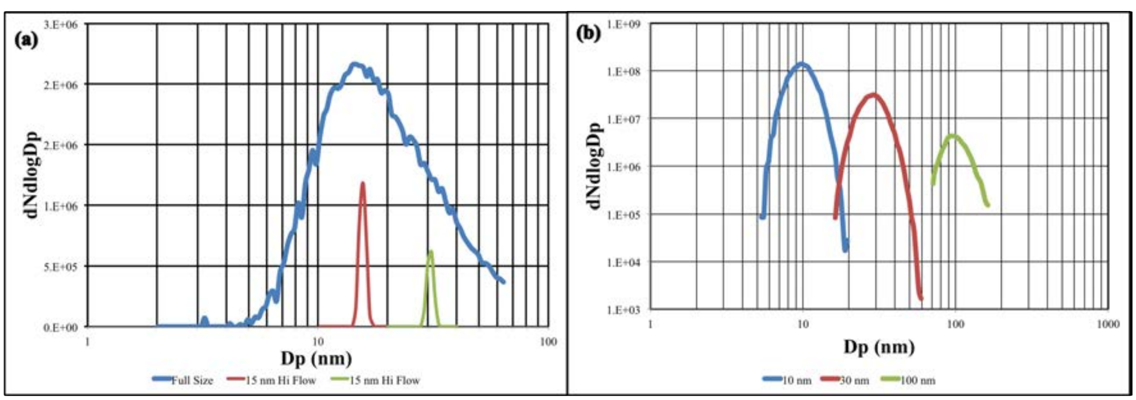

Figure 3.4: This shows the ability of the classifier to size-select particles of a specific size from a poly-disperse aerosol stream. In high-flow mode (Figure 3.4a) the size selection is slightly off the desired values (15 *nm* (red) and 30 *nm* (green)) by 4.7% and 3.7% respectively. In low-flow mode (Figure 3.4b) the size selection is also off of the 10 *nm* (blue), 30 *nm* (red), and 100 *nm* (green) particle sizes by 1.8%, 3.7%, and 5.3% respectively.

After the NaCl aerosol was created and passed through a diffusion drier and Kr-85 radioactive source, it passed through the TSI classifier with voltages set appropriately to produce mono-disperse aerosol streams of 15 *nm* and 30 *nm* on two different trial runs of three samples per trial run. These mono-disperse streams were then run into the Stanier-classifier in scanning mode with sheath air at 15 *lpm* and into a butanol CPC in high-flow mode. The same experiment was run with the CPC in low-flow mode with the sheath air of the Stanier-classifier held at 3 *lpm* for an additional three trial runs at particle sizes of 10 *nm*, 30 *nm*, and 100 *nm*. Plots for these runs are shown in Figure 3.6 with the exception of the 10 *nm* case, which did not produce enough counts to distinguish peaks.

In addition to these tests, a special run was made at each of the flow settings of the CPC to test the time delay of the instrument setup. With the CPC reporting particle counts every tenth of a second, and some distance of tubing between the outlet of the nano-DMA and the location inside the CPC where particles are counted, there is some time delay between the particles that are being counted currently and the particles that are being sized. As a result, the particles being counted at any given time are the particles that passed through the DMA in the previous few seconds and if the particle size has changed during that time, the particle counts would be misaligned with the correct particle size. The time delay can be calculated based on the length and diameter of tubing between the CPC and the nano-DMA or can be measured by making the classifier scan up through the full voltage range and immediately scan down through the full voltage range. A plot of the particle counts

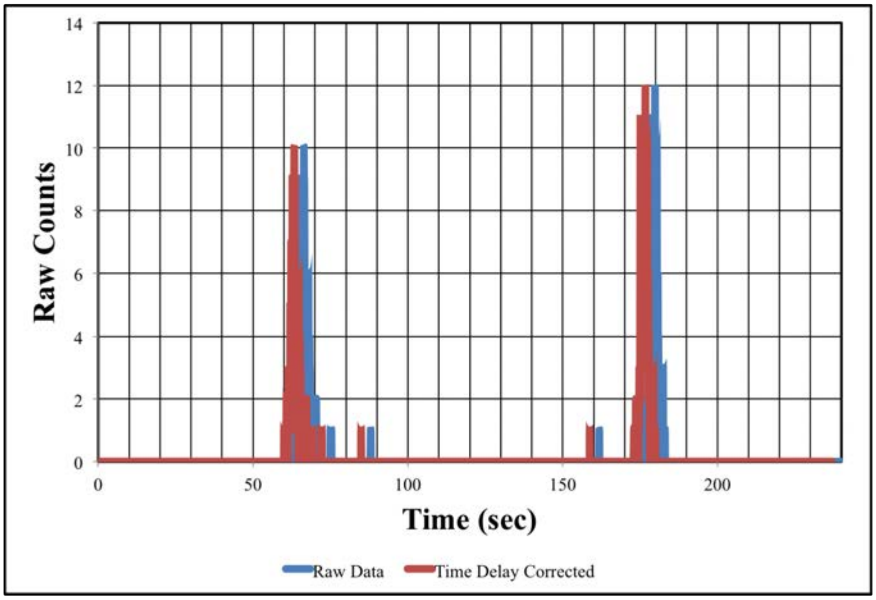

Figure 3.5: This figure shows the time delay adjustment on the low-flow mode only. The time delay is calculated by finding the difference in time between the peak count time and the center time at the end of the up-scan and the start of the down scan. This time difference should be the same as the time from the center time to the peak time in the down-scan. These times are adjusted until the two time differences are equal. The time delay was 1.0 seconds in high-flow mode and 3.1 seconds in low-flow mode.

vs. time should show a mirror image over the center position between up and down scans (See Figure 3.5). To the extent that this mirror image is shifted from the center, the time delay can be determined. The time delay improved the ability of the Stanier-classifier to determine the particle size associated with peak counts, effectively reducing the difference between the measured size and the 30 *nm* classified size from 4.0% to 1.2% in high-flow mode. In low-flow mode the difference was reduced from 10.0% to 0.14%. The time delay for this particular setup was 1.0 seconds in high-flow mode and 3.1 seconds in low-flow mode.

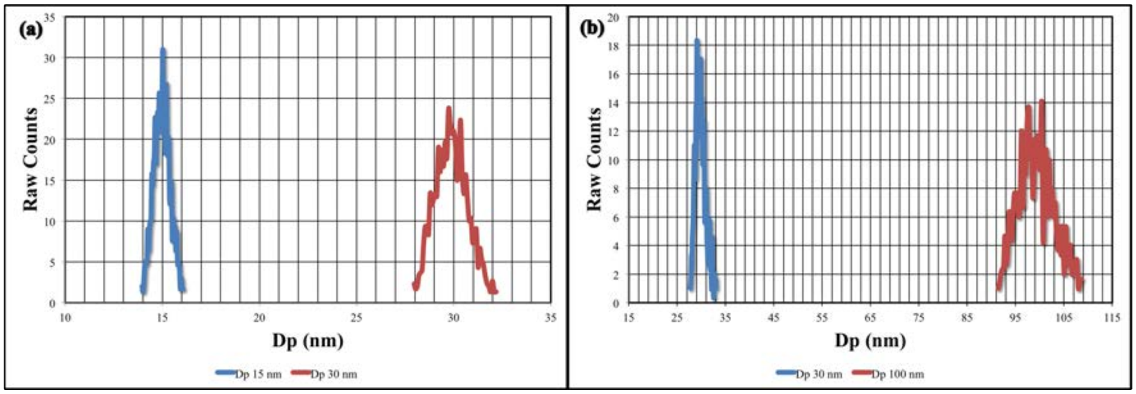

Figure 3.6: This shows the ability of the Stanier-classifier to scan a mono-disperse aerosol stream and show peaks in raw counts at the size classified by the TSI classifier. In high-flow mode (a) the scanner showed raw counts peaking at sizes only 0.13% and 0.97% different (on average) from the desired sizes of 15 nm (blue) and 30 nm (red), after time delay corrections were implemented. In low-flow mode (b) the scanner showed peaks 0.47% and 0.42% different (on average) from the 30 nm (blue) and 100 nm (red) sizes.

3.3.2 Second Generation Classifiers

For validation of the second generation classifiers, the same general setup and aerosol generation techniques were used. The second generation Stanier-classifiers were used to size-select particles at three different sizes (15 nm, 30 nm, and 50 nm). Figure 3.7 shows the sizes selected with the second generation Stanier classifiers in black and the TSI Classifier's dNdlogDp magnitudes in color. In Figure 3.7a, Classifier 2 shows classification accuracy to within one size bin on a commercial TSI classifier. In Figure 3.7b, the exact diameter midpoints of the TSI size bins were chosen (15.1 nm, 31.1 nm, and 51.4 nm) and perfect modal agreement is obtained when scanned by the TSI SMPS.

The second generation classifiers were also verified in their ability to scan through a range of voltages and detect a known particle size. The aerosol was sized

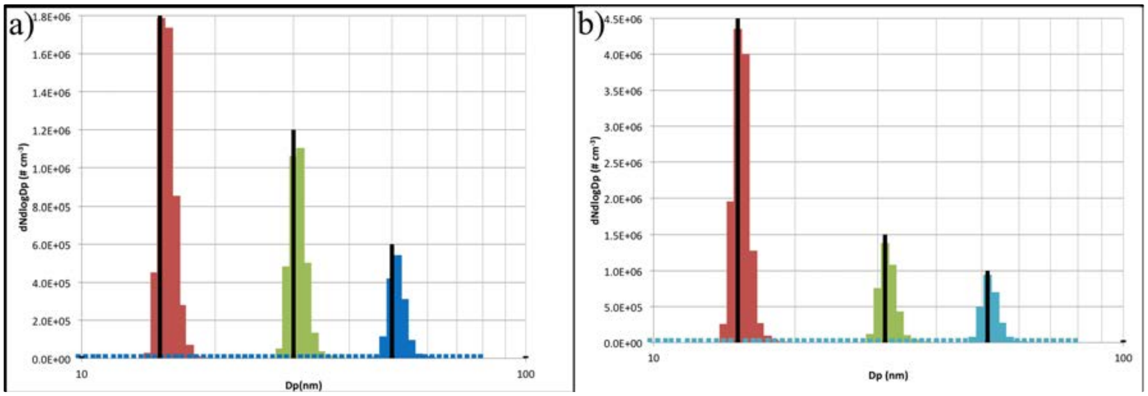

Figure 3.7: a) Classifier 2. Sizes of 15 nm, 30 nm, and 50 nm were chosen. The TSI SMPS detected modes to within one size bin of the selected value. b) Classifier 3. Sizes of 15.1 nm, 31.1 nm, and 51.4 nm were chosen to correspond to the exact size bins of the TSI SMPS. This approach shows perfect agreement between the size classified by the Stanier Classifer and the mode detected by a commercial SMPS.

in the TSI classifier at sizes of 15 nm, 30 nm, and 50 nm as before. The aerosol was then scanned and detected using the second generation Stanier-Classifiers and the TSI CPC as a detector. The same time delay used in the TSI SMPS system setup wad input into the Stanier Classifier user settings. Figure 3.8 shows the ability of the classifier to scan through a range of sizes and accurately detect the mode of particles classified by the commercial instrument. It should be noted that Figure 3.8b is slightly off due to a less optimal voltage calibration at the time this test was performed. An updated voltage calibration would provide accuracy comparable to Figure 3.8a.

Details on operation of the second generation classifiers and how they are used as particle electrostatic classifiers and scanning mobility particle sizers are included in this body of work (see Appendix C).

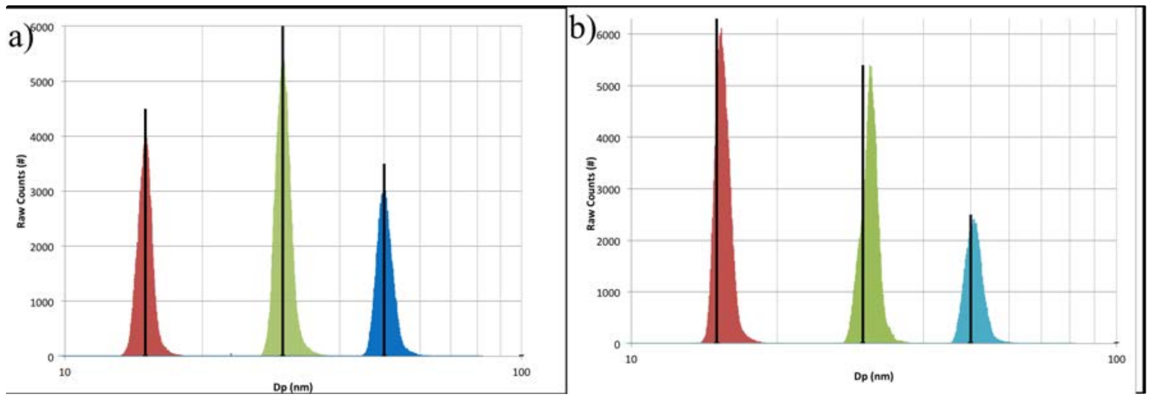

Figure 3.8: a) Classifier 2. The classifier is able to scan through a range of sizes and detect the mode of particle sizes selected by a commercial TSI Classifier. b) Classifier 3. This classifier shows the same ability, with the exception that the voltages were slightly offset due to an outdated voltage calibration.

3.4 Sampling Trailer

For the execution of the field campaign in Bondville, IL it was necessary to have a research trailer to house all of the instrumentation. The trailer was modified by electricians at Advanced Electric in Iowa City, IA to receive electricity from two different circuits at once (See Figure 3.9a). This provides a full instrument suite with 30 *Amps* of current, which can be drawn from separate power sources of 15 *Amps* (See Figure 3.9b). An inlet was constructed to house an elevated PM_{10} head with a $PM_{2.5}$ cyclone which offers rain and bug protection as well as the removal of coarse particles from the sample stream (See Figure 3.9c). Furthermore, this device is supplemented by an inline dryer (TSI[1] 3062). The air is pulled into the trailer by the 5 *lpm* pump on the APS and is supplemented by another pump (Gast[10] DOA-704-AA) drawing 11.7 *lpm* so as to achieve isokinetic sampling into the APS [27, 48].

[10]Gast Manufacturing Inc., Benton Harbor, MI

This supplemental 11.7 *lpm* of flow will then provide the sample stream for the fine mode particle instrumentation. This trailer was used with various combinations of instrumentation for the Iowa City Landfill Tire Fire [19, 61] and the Iowa City Power Plant field campaigns (see Figure 3.9).

3.5 Conclusion

Instruments have been constructed for the purpose of sizing and measuring the volatility of atmospheric aerosols. These instruments are capable of accurately controlling the voltage in a differential mobility analyzer over four orders of magnitude, accounting for time delay in unique plumbing configurations, and ultimately for examining the volatility of ultra-fine particulate matter under a number of different conditions. The components and software lend themselves easily to modification for ever-changing research interests. These instruments can be programmed to interface with a number of other scientific instruments to meet specific scientific objectives. Future work on the CPC includes the programming of a robust inversion algorithm for recovering the atmospheric size distribution from the raw outputs of applied voltage and particle counts.

Figure 3.9: The electrical setup in Figure 3.9a allows for two 15A circuits to feed one electrical panel. Circuits with 30A capacity are often not available in remote field locations, where multiple circuits with a lower amperage may exist. This setup allows some versatility in getting enough power to run the instruments in the trailer. Figure 3.9b shows the capacity of the trailer to house gas and particle instrumentation with appropriate aerosol inlets for minimized particle loss and the use of inert materials for gas inlet lines. Figure 3.9c shows the inlet borrowed from the Peters lab, it allows isokinetic, real time sampling of $PM_{2.5}$. The inline drier and extended mast are additions by the Stanier lab to ensure sampling of dry aerosol and representative sampling of the atmosphere by minimizing disturbance of the sample stream by the trailer. Figure 3.9d shows the full trailer setup used during the power plant field campaign. The front features a weather station with a wifi hotspot to sync data to Dropbox.

CHAPTER 4
A STUDY OF AIR QUALITY IN JOHNSON COUNTY, IA

4.1 Introduction

Iowa City is the county seat of Johnson County, IA, which is home to ~133,000 people [63]. This area is home to a major university and three hospitals. The University of Iowa Hospitals and Clinics is one of the premier hospitals in the U.S. and is closely tied to The University of Iowa. When counted as separate entities, the hospital and university represent the two largest employers in Johnson County, Iowa. The University of Iowa also owns and operates its own power plant. The combined heat and electricity from the University of Iowa Power Plant meets a sizable portion of the heating and cooling needs for university and hospital facilities. The University of Iowa Power Plant (See Figure 4.1) is located in downtown Iowa City, at the center of the University of Iowa Campus.

The air quality in Johnson County, IA is representative of other Midwest communities of commensurate size. The area has shown a reduction in $PM_{2.5}$ over the years and has maintained compliance with National Ambient Air Quality Standards (NAAQS), but the local area $PM_{2.5}$ monitor has measured 24-hour averages on occasion that exceed 35 $\mu g\ m^{-3}$ (See Figure 4.2).

4.2 Motivation

Awareness of public health concerns related to air quality and the value of clean energy technologies has instilled a desire to continue to reduce criteria pollutants in

Figure 4.1: The University of Iowa Power plant, located on campus in downtown Iowa City on the Iowa River. From the Little Village article on the University of Iowa's Power Plant [10]

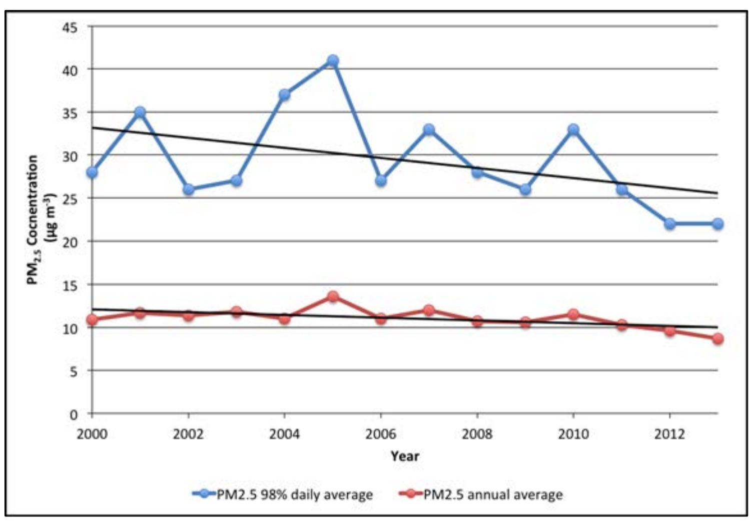

Figure 4.2: This figure shows the annual average $PM_{2.5}$ as well at the 98th percentile of 24-hour averages, some of which exceed 35 $\mu g\ m^{-3}$.

the area. Due to its proximity to the major center for both recreation and work-related activities in downtown Iowa City, the University of Iowa Power Plant is a very publicly visible source of particulate pollution. The downtown existence of the University of Iowa and its reliance on coal-fired boilers has come under scrutiny in an opinion article in a local newspaper [10]. In recent years The University of Iowa has added boilers with better pollution controls and alternative fuel mixtures, including natural gas and biomass from oat hulls. The oat hulls are an unwanted by-product in nearby food industries. In an effort to address concerns and aid in decision making, the Johnson County Air Quality Study (JoCAQS) was undertaken to meet the following specific objectives:

1. Quantify the impact of the University of Iowa Power Plant on air quality in Johnson County, IA
2. Use source apportionment to identify largest contribution sectors to $PM_{2.5}$ mass
3. Support the University's decision-making process for meeting present and future energy needs

Accomplishing these objectives involves filter sampling at an urban as well as a background representative location (See Figure 4.3). The urban location is located near Hoover elementary school, where the Iowa department of natural resources has a $PM_{2.5}$ monitoring station equipped with hourly $PM_{2.5}$ time resolution using a beta attenuation mass monitor (BAMM [40]).

A valuable tool in meeting the aforementioned objectives is a high resolution urban scale model using CMAQ [14]. The model helps evaluate impacts and potential

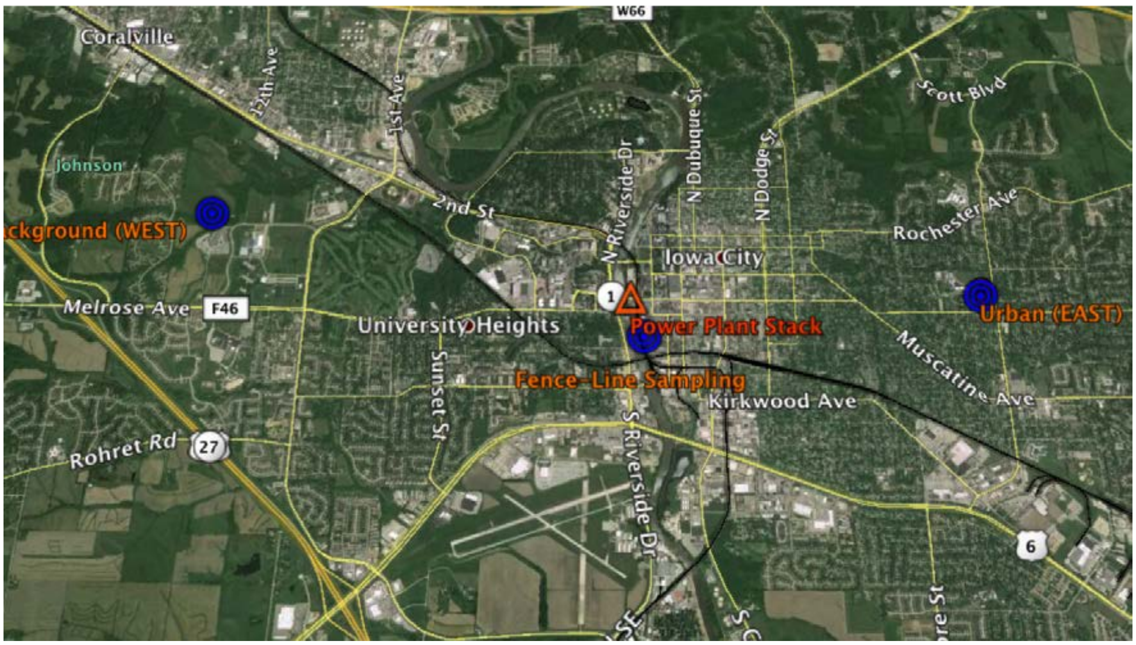

Figure 4.3: A map of Iowa City, IA. A triangle symbol is in the location of the University of Iowa Power Plant. The continuous $PM_{2.5}$ monitor from Iowa DNR is located on the campus of Hoover Elementary School, an Iowa City urban representative location. Filter samples were taken in this location in addition to a background location, west of Iowa City. The fence-line sampling is located near-field to the power plant and took place in the Stanier research trailer from 7/27 - 8/5. The Stanier trailer was also located at the background West site from 7/16 - 7/27

sources in all locations, not just the locations where measurements exist. Developing a strong model of the system will also give testing capability to a wide array of scenarios like fuel use, pollution control, and even compliance with future air quality regulatory standards. Ground measurements are a necessary component of model calibration and verification, and represent the focus of this work. Specifically, ground measurements are used to evaluate the ratio of $PM_{2.5}$ concentrations in $\mu g\ m^{-3}$ to gas concentrations of NO_x or SO_2 in *ppb*.

4.3 Methods

The Stanier research trailer was deployed in two locations in close proximity to the University of Iowa Power Plant (See Figure 4.3). The sampling suite included an SMPS, stand-alone CPC, and a Teledyne[1] 100 EU SO_2 monitor as well as a Thermo[2] 42i NO_x monitor. Meteorology variables were recorded using a Davis[3] weather station. The first sampling location (7/16 - 7/27) is the same as the West background site where filter based samples were taken (See Figure 4.3) and was situated 3.1 *km* west (102°) of the power plant. The other site was chosen near-field to the power plant at ∼0.5 *km* south (343°) of the power plant. The near-field site is also located at a University Campus bus garage and may be subject to local NO_x sources, but care was taken in evaluating times where winds were coming from the University of Iowa Power Plant.

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[1] Teledyne API, San Diego, CA

[2] Thermo Fisher Scientific, Waltham, MA

[3] Davis Instruments Corp., Hayward, CA

4.3.1 Wind Direction Analysis

Wind roses were developed for the sampling dates in both the West background and near-field location. These helped determine the degree to which the sites were influenced by winds from the power plant. The 95th percentile of NO_x, SO_2, PM, and NO were evaluated as a function of area by the conditional probability function [32]. This method helped identify how large an impact the power plant had on the 95th percentile threshold of each pollutant. Time series analysis of pollutants with shading during periods of power plant wind influence were used to identify periods for closer examination.

4.3.2 Fuel Usage and Boiler Information

The percentage contribution of each type of fuel to the total thermal power in kW is determined. This calculation is made by multiplying the flow rate of fuel weight into the boiler by the higher heating values of the fuel. The fuel flow rate is available at 10-minute time resolution for all boilers except Boiler #10, where daily amounts of coal consumption are given. 10-minute steam data is available for Boiler #10 and the relationship of daily coal consumption to integrated daily steam flow is used as a proxy for 10-minute fuel flow. The fractional contribution of each fuel and boiler type are used to calculate the weighted average emission factors and emission ratios for time periods of interest. These ratios are compared to the increase in $PM_{2.5}$ to NO_x and SO_2 above background for the entire period.

4.3.3 Emission Factors and Emission Ratios

Also available from the power plant is information on the emission factors (See Table 4.1) for each fuel type used with each boiler. Some of these factors are based on actual continuous emission monitoring (CEM), while others are based on boilers of similar size and fuel use according to the AP-42. Emission factors will later be used with modeling techniques to test *"What If?"* scenarios, but must first have some ground truth with atmospheric measurements. The ratio of emission factors from AP-42 and CEM data for $PM_{2.5}$ and gas-phase emissions (NO_x and SO_2) are used to predict relative atmospheric ratios, which can be tested against actual atmospheric ratios. This can help establish the accuracy of emissions for implementation in future modeling work testing fuel usage and pollution control scenarios.

Boiler #	Boiler Fuel	EF Units	$PM_{2.5}$ EF	NO_x EF	SO_2 EF	$PM_{2.5}$ NO_x ER (μgm^{-3} ppb^{-1})	$PM_{2.5}$ NO_2 ER (μgm^{-3} ppb^{-1})
7	Natural Gas	#/MMCF	7.6	**82.4**	0.6	0.18	33
8	Natural Gas	#/MMCF	7.6	**73.1**	0.6	0.2	33
10	Natural Gas	#/MMCF	7.6	100	0.6	0.15	33
11	Natural Gas	#/MMCF	7.6	100	0.6	0.15	33
10	Coal	#/TON	0.76	<u>11.5</u>	**32.7**	0.13	0.06
11	Coal	#/TON	0.11	**3.92**	**7.13**	0.05	0.04
11	Oat Hulls	#/TON	0.07	**2.48**	**4.51**	0.05	0.04
10	Wood Pellets	#/MMBTU	0.45	0.49	0.03	1.74	47
11	Wood Pellets	#/TON	0.08	**2.59**	**4.71**	0.06	0.04

Table 4.1: Emission factors for different boilers and the fuels they use. All values are based on AP-42 emission factors unless denoted by bolded or underlined text. Bold text indicates that continuous emissions monitoring (CEM) data is available in addition to AP-42 values and underlined values indicate that the emission factor is based on a stack test.

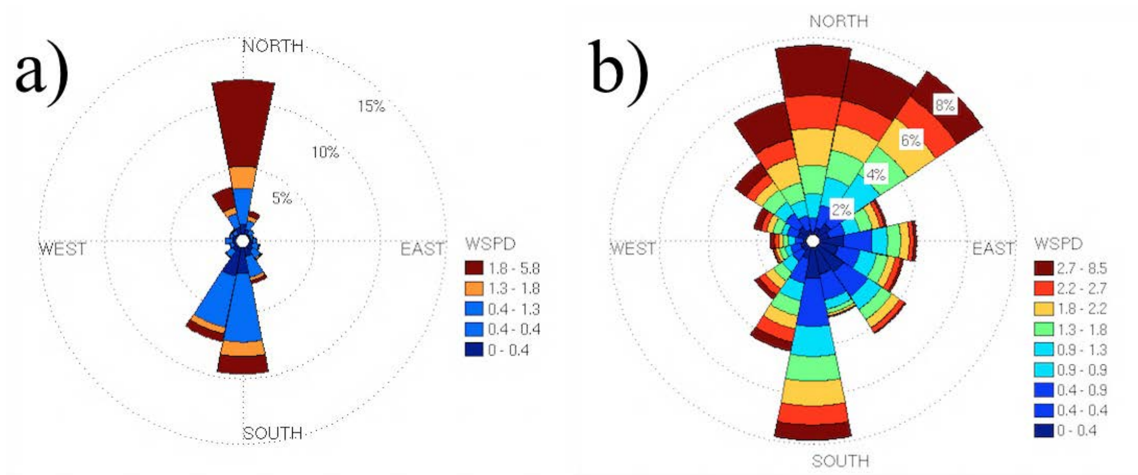

Figure 4.4: These wind roses show the wind vectors for the duration of sampling at both the West background (07/16 - 07/27) and the near-field (07/27 - 08/05) sites. The background site did not receive a heavy influence of wind from the power plant during that period, but it did receive some impacted air during the last days of the Iowa City Landfill Fire [19, 61].

4.4 Results

4.4.1 Wind Direction Analysis

Figure 4.4 shows the magnitude and direction of wind as measured at our sampling location. The West location (Figure 4.4 a) received minimal winds from the direction of the power plant during the duration of our sampling in that location (07/16- 07/27), however it was influenced by wind from the power plant during a two day period at the end of the landfill fire in Iowa City only one month prior [19, 61].The near-field location (Figure 4.4 b) received substantial winds from the power plant during sampling from 07/27 - 08/05.

Looking at the presence of NO_x, SO_2, CN, and NO as a function of wind direction (See Figure 4.5) reveals that winds are most likely to be coming from the

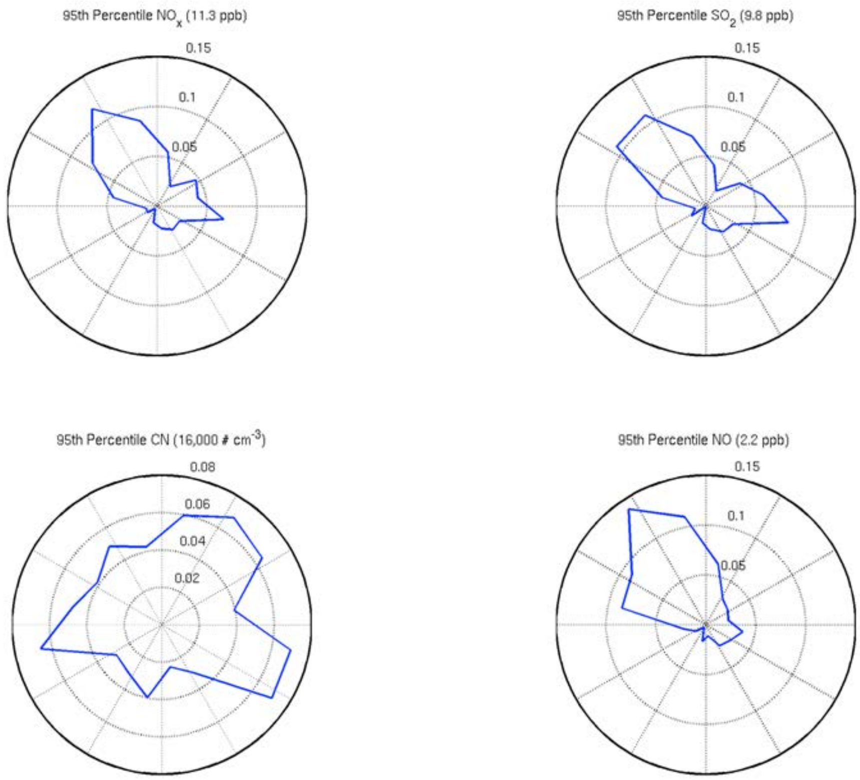

Figure 4.5: This shows the conditional probability function [32] of PM, SO_2, and NO_x at the near field location. More than 10% of the time the wind blew from the direction of the power plant, the 95th percentile threshold was exceeded for NO_x and NO. SO_2 and PM show other directional influences.

direction of the power plant when NO_x and NO measurements exceed the 95th percentile of all measurements. Approximately 12 - 15% of power plant winds coincided with NO and NO_x measurements in exceedance of the 95th percentile threshold. Some high threshold SO_2 concentrations came from the power plant, but had strong sources from the ESE direction as well. High particle number (CN) values come from a number of locations, with no specific direction producing a high percentage of 95th percentile concentrations.

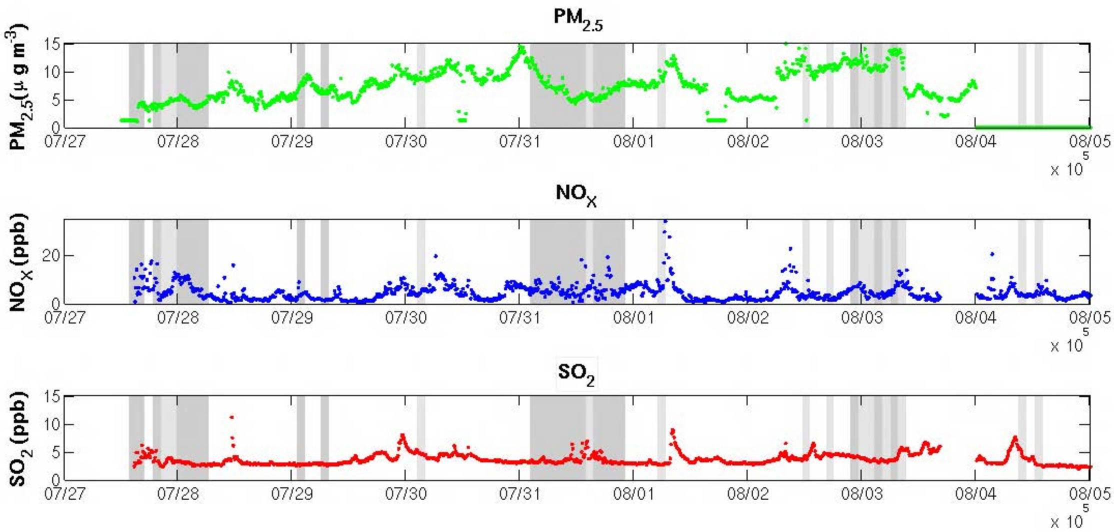

Figure 4.6: The shading on these plots indicates times in which winds were impacting the site from the power plant. During 7/31/2012, the CAMBUS site was down-wind of the power plant the entire day. Interestingly, the concentration of $PM_{2.5}$ went down on that day. Note: $PM_{2.5}$ data is derived from the sum of all the size bins with the assumption that particles are spherical and have a density of $\sim$1.8 $g\ cm^{-3}$.

Examining the time series for wind direction shows times when wind was coming from the power plant and the associated concentrations from power plant influenced air. Figure 4.6 shows time series of three criteria pollutants ($PM_{2.5}$, NO_x, and SO_2), with shaded regions denoting times when winds were coming directly from the power plant within the range of certainty of the instrument divisions of 22.5°.

The shaded time series plot (Figure 4.6) has a number of continuous time periods where the instruments were sampling airstreams influenced by the power plant. We examine 07/31 in more depth, which had power plant winds continuously for $\sim$21 hours that day. The full size distribution for this period shows nucleation bursts heavily influencing particle number, but there are not many large particulates

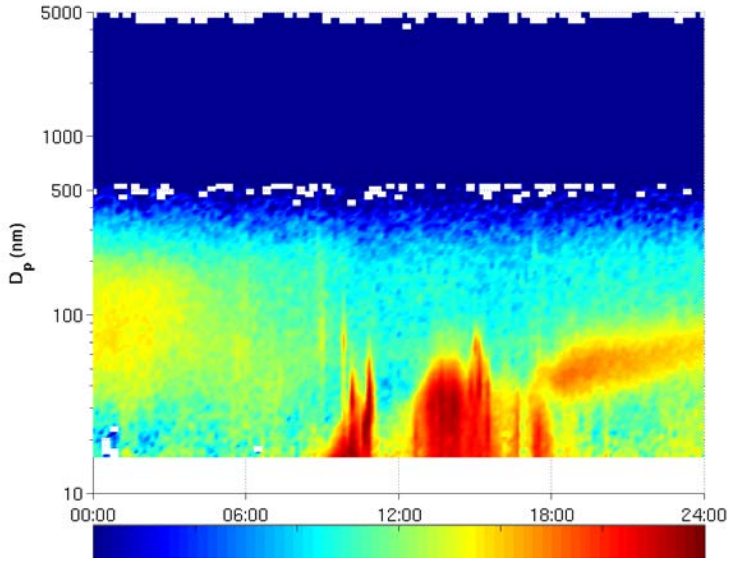

Figure 4.7: This shows the full number size distribution for 07/31/2012, a day where the sampling location was heavily influenced by the power plant.

during this time period.

4.4.2 Fuel Usage and Boiler Information

The relationships between daily coal consumption and daily integrated 10-minute steam mass output from Boiler #10 gives the linear relationship in Figure 4.8. The flow rate of coal in thousands of pounds per hour is equal to the flow rate of steam in thousands of pounds per hour multiplied by a factor of 0.115.

The fraction of thermal energy by fuel type is shown for 06/03 - 06/04 and 07/31 in Figure 4.9. For most of the period in Figure 4.9a, coal accounts for more than 90% of thermal energy. A larger fraction of thermal energy comes from natural gas and oat hulls in Figure 4.9b on 07/31. Figure 4.10 shows the percentage of thermal energy coming from each Boiler. On 06/03 - 06/04 (a) Boiler #10 and Boiler #11 are

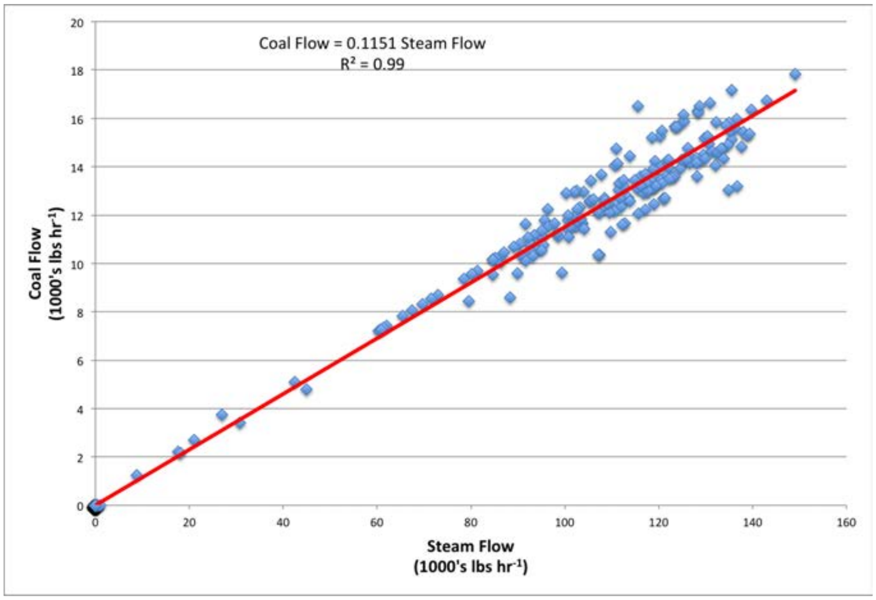

Figure 4.8: The relationships between daily steam rates and daily coal flow rates.

each providing ~50% of thermal energy. Boiler #11 is newer and has better pollution controls in place than Boiler #10. On 07/31 (b) the energy mix came from Boilers #s 7, 8, and 11, all of which have more modern pollution control technologies.

4.4.3 Emission Factors and Emission Ratios

The relative fractions of total thermal energy contributions from Figures 4.9 and 4.10 were used with the emission factors in Table 4.1 to establish an average overall emission factor ratios for 06/03 - 06/04 and 07/31. The overall emission factor ratio for 06/03 - 06/04 was 0.05 $\mu g\ m^{-3}\ PM_{2.5}$ per 1 ppb of SO_2. The overall emission factor ratio of 0.11 $\mu g\ m^{-3}$ of $PM_{2.5}$ to 1 ppb of NO_x was established for the period of 07/31.

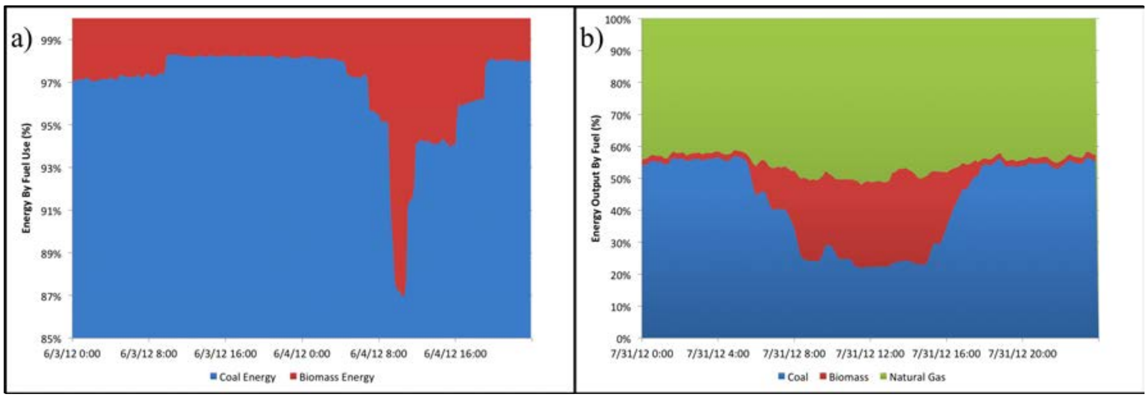

Figure 4.9: a) 06/03 - 06/04, the power plant was burning a mixture of biomass, and coal. The fraction of biomass is minuscule (y-axis scale). b) The fraction of thermal energy coming from biomass is substantially larger on 07/31,but is still small in comparison to coal and natural gas.

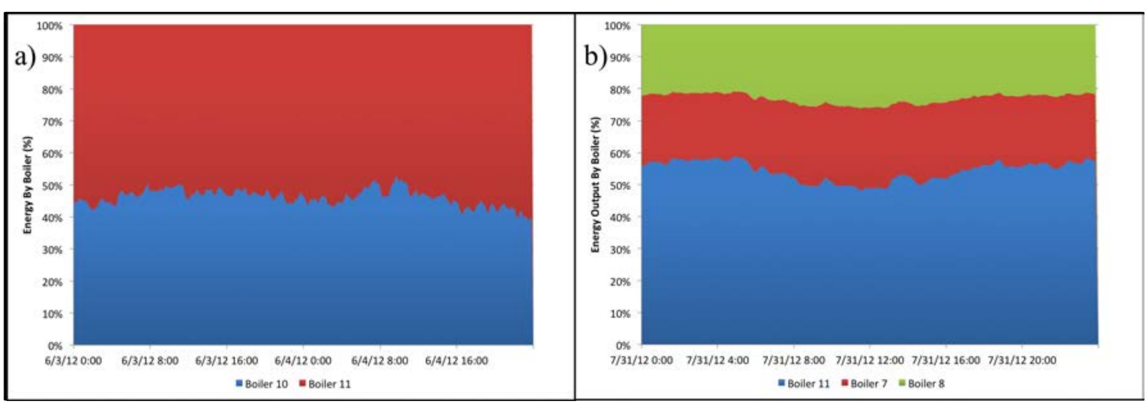

Figure 4.10: a) Boiler #10 and #11 are both producing ∼50% of the thermal energy on 06/03. b) Thermal energy is split between Boiler #11 and Boilers #7 and #8.

4.4.3.1 June 3rd - June 4th 2012

The plume impaction of the Iowa City landfill tire fire produced high concentrations of criteria pollutants directly down-wind, with concentrations dropping sharply with small direction shifts away from the landfill fire [19, 61]. During a period on 06/03 - 06/04, the winds shifted to the direction of the power plant and a number of spikes in SO_2 and particle mass concentrations were measured. $PM_{2.5}$ to SO_2 emission ratios were measured during three plume impaction periods and were 0.46, 0.23, and 0.15 $\mu g\ m^{-3}$ per *ppb* of SO_2, respectively. The ratios of the power plant EFs for that day were roughly 0.05 $\mu g\ m^{-3}$ per *ppb* of SO_2, which is lower than the measured value by a factor of 10, but the method does have uncertainties in how much SO_2 above background is attributable to the power plant and not to other sources.

4.4.3.2 July 31st, 2012

A comparison of the distribution of concentrations of NO_x and $PM_{2.5}$ background vs. the distribution of concentrations on the power plant influence day (07/31) shows a 2.5 *ppb* enhancement of NO_x and a 0.88 $\mu g\ m^{-3}$ enhancement of $PM_{2.5}$ (See Figure 4.11). The emission factor ratio of $PM_{2.5}$ to NO_x is 0.26 $\mu g\ m^{-3}$ for $PM_{2.5}$ for the power plant fuel. Atmospheric ratios of $PM_{2.5}$ to NO_x are slightly higher (0.88 $\mu g\ m^{-3}$).

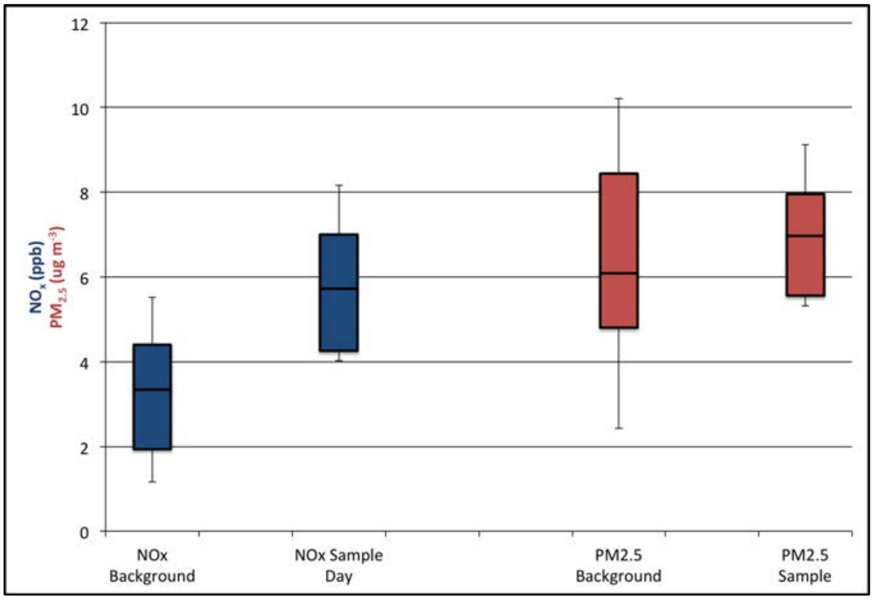

Figure 4.11: The NO_x concentration is enhanced by 2.4 *ppb* on a day heavily influenced by the power plant. The emission factor ratio predicts that the $PM_{2.5}$ concentration will be enhanced by 0.26 $\mu g\ m^{-3}$. The actual enhancements was 0.88 $\mu g\ m^{-3}$.

4.5 Conclusion

The Johnson County Air Quality study examined periods where the sampling equipment was influenced by the power plant plume. During the study period, a high percentage of the winds coming from the direction of the power plant showed elevated levels of NO_x, SO_2, and PM. Data from a landfill fire plume impaction study showed emission ratios of 0.46 $PM_{2.5}$ to SO_2, which is higher than the ratio of EF's, but it is difficult to attribute the extent to which the concentration of SO_2 or NO_x is raised above background by the power plant, vs. other regional sources in so small a sample size. Samples taken on 07/31/2012 were above background, but actually decreased from the previous day (See Figure 4.6), showing the possible significance of other sources to $PM_{2.5}$ in Johnson County. The emission ratios of $PM_{2.5}$ to NO_x are higher than predicted but differences may be negligible with uncertainty considerations. Evaluation of more plume impacts is needed.

CHAPTER 5
PARTICLE MICROPHYSICAL PROPERTIESS IN BONDVILLE, IL (1994-2012)

5.1 Background

The influence of secondary aerosol formation on total aerosol concentrations has been investigated since the late 1970's [33, 71] . Initially, study focused in and around coal-fired power plants, where the emission of sulfuric acid (H_2SO_4) from coal combustion was known to form new particles with sufficient atmospheric water content by binary homogeneous nucleation. Nucleation has since been seen to occur in locations and at concentrations not supported by the H_2SO_4 - H_2O mechanism alone. The complete mix of mechanisms surrounding nucleation (Amines, Ammonia, Organics) are becoming better understood, but some have been seen to vary by location.

Nucleation has been studied extensively in the boreal forests of Southern Finland [5, 6, 12, 69, 47, 45]. In the U.S., nucleation has been examined in urban and forested rural locations [52, 51], but has only received limited attention in the sparsely forested agricultural lands of the Midwestern United States (See Figure 5.1).

Bondville, IL is an ideal location for the study of nucleation in rural continental environments due to the availability of electricity for instrumentation, distance from sources of primary particle emissions, and meteorologic access to regional influences on nucleation (See Figures 5.2 and 5.3). The site is home to the Bondville environmental and atmospheric research site (BEARS), where a large array of measurement

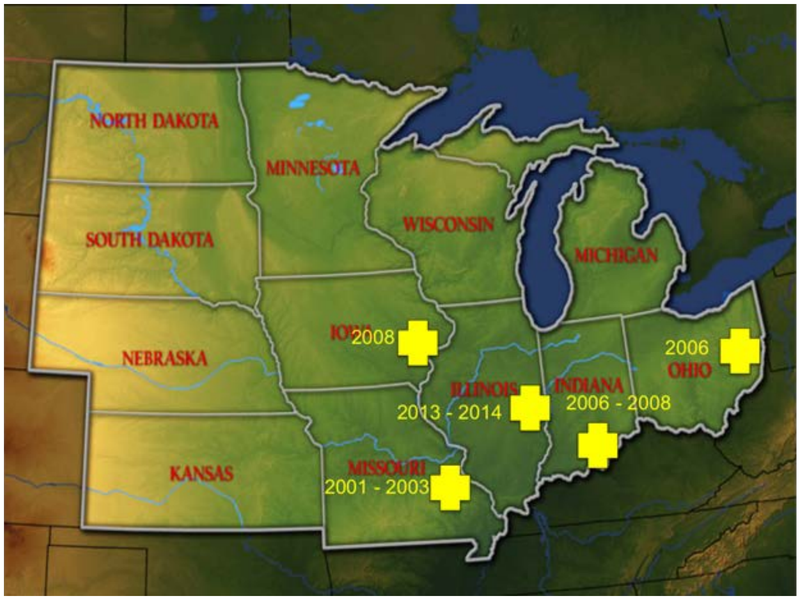

Figure 5.1: This figure shows locations and year ranges where nucleation studies have been conducted in the Midwestern United States.

networks from a number of state and federal agencies (See Table 5.1) are located and managed by personel from the Illinois State Water Survey (ISWS). Some parameters in Bondville have been sampled for more than 20 years. A short-term pilot study on nucleation in Bondville was undertaken in the fall of 2005. Nucleation was seen on 25% of the days sampled in September 2005 [50].

5.2 GMD ESRL Particle Data and AAO Particle Data

The ground-based CPC (TSI[1] 3760) reports number concentration for particles greater than 14 *nm*. Twenty years (1994 - 2014) of hourly averaged particle number concentration data are available from Bondville, IL. Of these 20 years of aerosol data, there are five years (2006 - 2010) where one-minute data were available and were analyzed for information consistent with nucleation activity. The 30-minute time

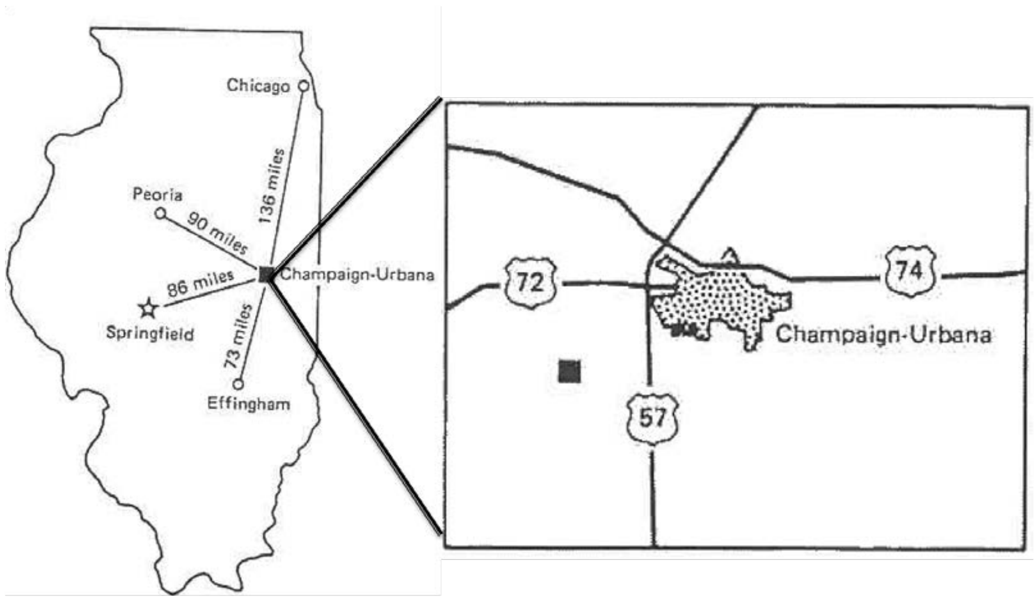

Figure 5.2: Map of the are surrounding the Bondville Environmental and Atmospheric Research Site (BEARS)

averages of the five years (2006 – 2010) of ground-based data, were binned by time of day, month, and season. The seasons were chosen so as to bin months with similar particle number concentrations. As a result, there are five unconventional seasons described in Table 5.3.

The ground-based CPC data are supplemented by the Airborne Aerosol Observatory (AAO) campaign, which contains vertical CPC and SMPS data for more than 400 flights spanning three years (2006 - 2009). The AAO CPC (TSI[1] 3010) reports particles greater than 10 *nm* in diameter. The AAO SMPS (Brechtel,[1] SEMS) reports particles from 20 *nm* to 500 *nm* [59]. The flights take place along recurring paths in the A-train satellite constellation, which also includes the CALIPSO satellite, used

[1] Scanning Electrical Mobility Sizer (SEMS), Brechtel Manufacturing Inc., Hayward, CA

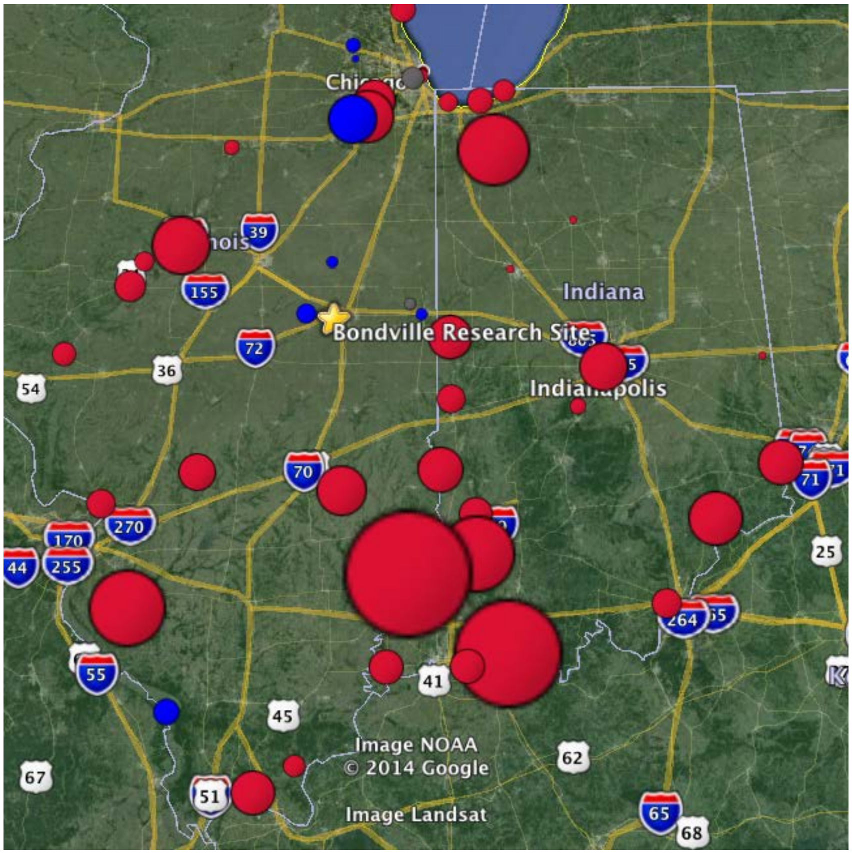

Figure 5.3: This figure shows a list of power plants in Illinois and Indiana, the states surrounding the research site in Bondville, IL. The relative plot size, is scaled from each power plants energy output. The energy output of power plants ranges from 14.5 kW at the Jasper Power Plant in Illinois to 3125 kW from the Gibson Generating Station in Indiana. Blue symbols are indicative of natural gas only power plants. The red symbols represent coal-fired power plants and the grey symbols represent power plants no longer in operation.

Network	Agency	Measurement	Duration
NTN	NADP	Precipitation Chemistry (Weekly)	1979 - 2014
AIRMoN	NADP	Precipitation Chemistry (Daily)	1992 - 2014
AIRMoN - Dry	NOAA	Dry Deposition and Speciation of Aerosol	1992 - 2014
WARM	ICN	Weather and Soil Data	1989 - 2014
GMD ESRL	NOAA	Particle Number, Aerosol Scattering	1994 - 2014
SURFRAD	NOAA	Surface Radiation, Cloud Cover	1995 - 2014
UVMRP	USDA	Photosynthetically Active Radiation	2004 - 2014
AERONET	NASA	Aerosol Optical Thickness	1995 - 2014
CASTNET	EPA	Atmospheric Gases, and Aerols	2008 - 2014
IMPROVE	Multiple	Filter Based Particulate Chemistry, Adsorption	1988 - 2014
RPM	IL-EPA	Federal Reference $PM_{2.5}$	1999 - 2014
GPIC	ISWS	Gases, including Ammonia	2007 - 2014
AAO	NOAA	Aerosol Size Distribution, Aerosol Scattering	2009 - 2011

Table 5.1: A summary of Networks and Agencies operating at the Bondville Environmental and Atmospheric Research Site (BEARS). For a full description of acronyms, see Table 5.2.

for LIDAR measurements [59, 20]. This study uses 368 of the 401 AAO flights so as to include only the flights made in close proximity to the Bondville, IL ground-based CPC location (40.053 N, -88.372 W). The AAO flights are approximately three hours in length, on average. The altitude binning was based on 10 pressure altitude ranges above seal level which are described in Table 5.4.

5.3 Analysis and Results

5.3.1 Monthly and Seasonal Averages in Particle Number

The hourly CPC data (1994 - 2012), one-minute CPC data (2006 - 2010), and the AAO CPC (2006 - 2009) data at low altitudes were averaged by month to determine which months have the highest ground-level particle number concentrations on average. Figure 5.4 shows high number concentrations reported in the spring and fall among all three data sets, with the highest average concentrations coming from

Acronym	Description
EPA	Environmental Protection Agency
ICN	Illinois Climate Network
ISWS	Illinois State Water Survey
NADP	National Acid Deposition Program
NASA	National Aeronautics and Space Agency
NOAA	National Oceanic and Atmospheric Administration
USDA	United States Department of Agriculture
AAO	Airborne Aerosol Observatory
AERONET	Aerosol Robotic Network
AIRMoN	Atmospheric Integrated Research Monitoring Network
CASTNET	Clean Air Status and Trends Network
GMD ESRL	Global Monitoring Division of Earth Systems Research Laboratory
GPIC	Semi-Continuous Monitoring of Gases and Particulates
IMPROVE	Interagency Monitoring of Protected Visual Environments
NCORE	National Core Network
NTN	National Trends Network
RPM	Rural Particulate Monitoring
SURFRAD	Surfrace Radiation Network
UVMRP	UV Monitoring and Resarch Program
WARM	Water and Atmospheric Resources Monitoring

Table 5.2: A list of descriptive acronyms for the multiple monitoring networks and agencies operating in Bondville, IL

the AAO data set. The higher averages in the AAO CPC may be due to the smaller cutoff diameter of the instrument (10 *nm* vs. 14 *nm*) or may be biased high due to the extra combustion sources present in the vicinity of the aircraft taking off and landing. In addition, flights were chosen on sunny cloudless days, where particle number may have additional enhancements due to nucleation.

5.3.2 Long-Term Trends in Particle Number and Gas Species

EPA's clean air act status and trends network (CASTNet) dry deposition data set is easily accessible and publicly available online (http://views.cira.colostate.edu/web/)

Season	Description	Months
1	Winter Months	Nov., Dec., Jan. (NDJ)
2	Early Spring Months	Feb., Mar. (FM)
3	Late Spring Months	Apr., May, Jun. (AMJ)
4	Summer Months	Jul., Aug. (JA)
5	Fall Months	Sep., Oct. (SO)

Table 5.3: Seasons Used in all Seasonal Data Analysis

Lower	Upper	Center	Range
225	460	342.5	235
460	610	535.0	150
610	920	765.0	310
920	1,220	1,070	300
1,220	1,520	1,370	300
1,520	1,830	1,675	310
1,830	2,440	2,135	610
2,440	3,050	2,745	610
3,050	3,660	3,355	610
3,660	4,580	4,120	920

Table 5.4: AAO Pressure Bands (*m asl*)

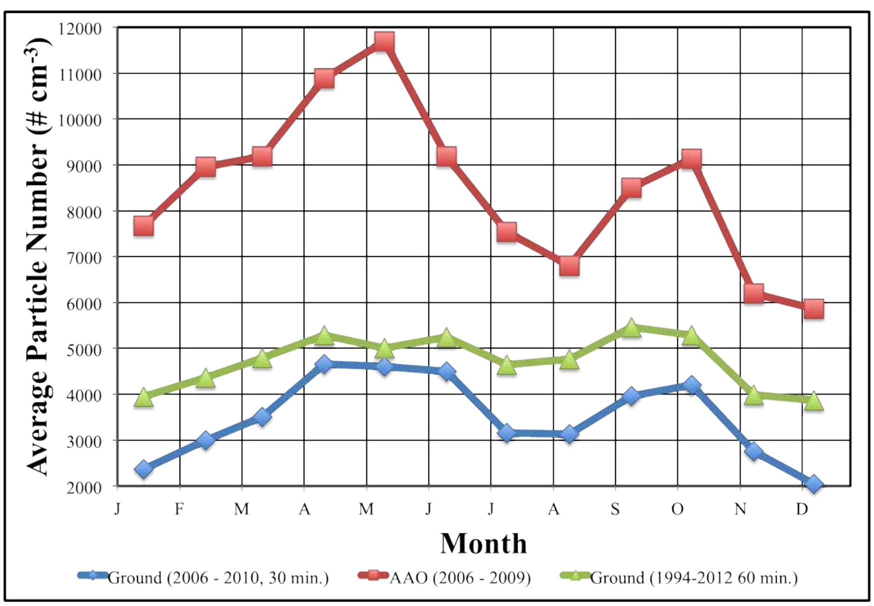

Figure 5.4: The ground and low altitude flight particle number concentration averages show peaks in the late spring (April, May, June) and in the fall (September, October). The AAO CPC averages are higher, but can also detect smaller particles.

with time series information for multiple years [16]. The dry deposition of sulfur dioxide (SO_2) was downloaded from 1988–present and shows a steady decline during that period (See Figure 5.5a), likely due to reductions in the sulfur content of coal in coal-fired power plants throughout the Midwest. The monthly averages plotted sequentially over 20 years in the one-hour CPC record revealed a decreasing slope in particle concentration as well (See Figure 5.5 b). A month by month breakdown of the decrease in particle number concentration reveals that while some months are showing a visible linear decline, some months don't have statistically significant trends to their slopes, and some months are even increasing. These same conclusions and observations were made by Asmi et al. 2013 for a number of sites throughout the United States, including Bondville, IL [4]. Despite the decrease in sulfur dioxide concentrations over time, the late spring season season (AMJ) containing the highest average particle number concentrations, shows a non-statistically significant slight increase. If nucleation is occurring at Bondville, IL in these late spring months, this pattern may be indicative of other mechanisms making a contribution to nucleation besides H_2SO_4.

If other data assets in Bondville, IL are tapped for information on possible mechanisms, some possible hypotheses can be made about other gas-phase precursors to nucleation, such as ammonia. Figure 5.6 re-examines the trends in SO_2 and particle number on a scale of percent change per decade, with the error bars indicating error in the slope. Also plotted in Figure 5.6 is NTN wet deposition of NH_3, which has been used as a proxy for total NH_3 [23, 24], and Particulate NH_3 from IMPROVE.

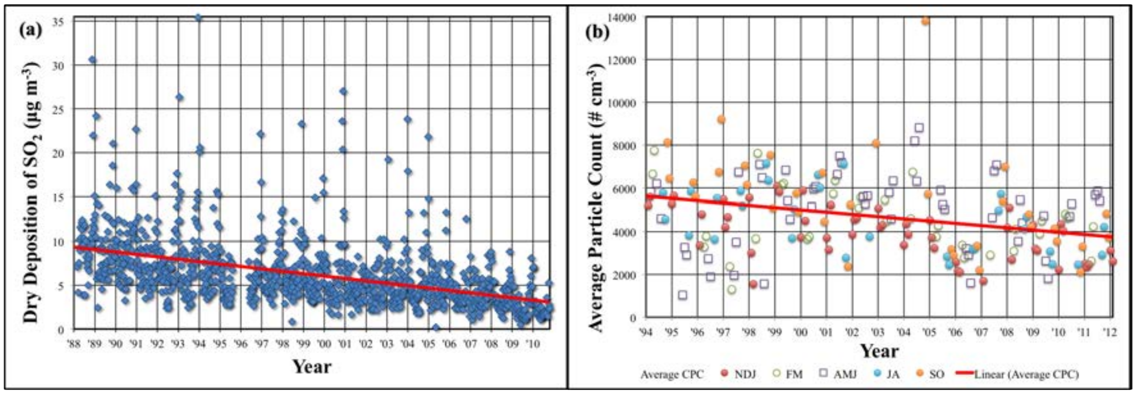

Figure 5.5: The decline of sulfur and particle count over time (a). The sulfur decline is constant and easily noticeable with an R^2 value of 0.23. The particle number concentration also shows some decline although not as noticeably as sulfur dioxide (R^2 = 0.1). Figure 5.5(b) contains symbols with different colors for each season. Symbols that are circular indicate a decrease in average particle number concentration while square symbols indicate an increase. Filled shapes denote an R^2 value in the trend of greater than 0.25, while empty shapes denote an R^2 value of less than 0.1.

Trends are shown for all data points, as well as the trends in each season. Gas-phase SO_2 and particle number are decreasing, as discussed in Figure 5.5. Particulate NH_3 is decreasing, but total NH_3 remains constant, suggesting that gas phase NH_3 may be increasing with time.

5.3.3 Diurnal Averages

The one-minute, ground-based CPC data were further averaged diurnally to fall upon 48 equally spaced 30-minute time slots throughout the day. This diurnal average was further calculated separately for each season to examine variations in diurnal patterns by season. Figure 5.7 shows diurnal trends exhibiting varying seasonal intensity as well as mid-day peak patterns. These observations are consistent with those of other long-term nucleation studies [9, 72, 66, 53].

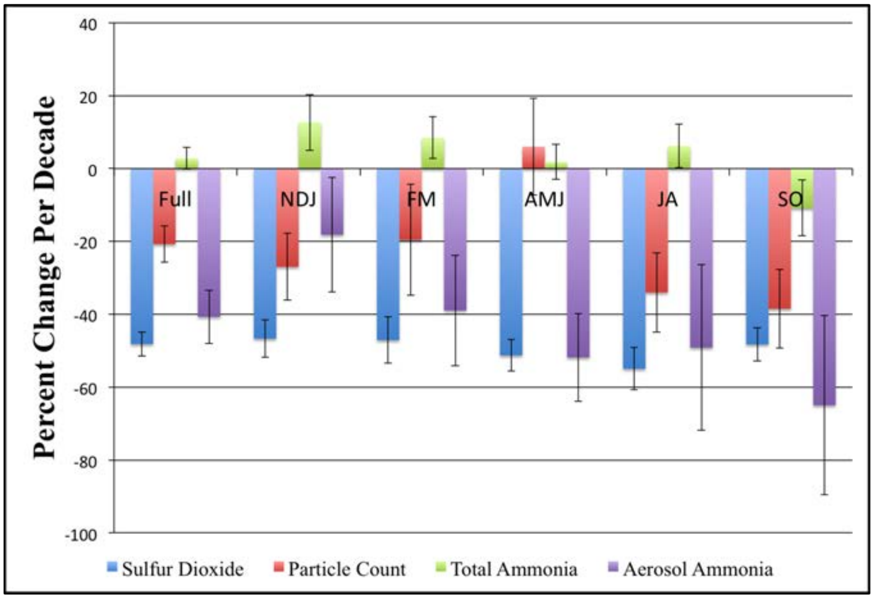

Figure 5.6: These plots show the percent change per decade of gas-phase SO_2, particle number, particulate NH_3 and wet deposition of NH_3, which acts as a tracer for total NH_3 [23, 24]. The total NH_3 is not trending up or down over time, but the particulate NH_3 is decreasing, suggesting that the gas-phase NH_3 (not measured) is increasing during this period.

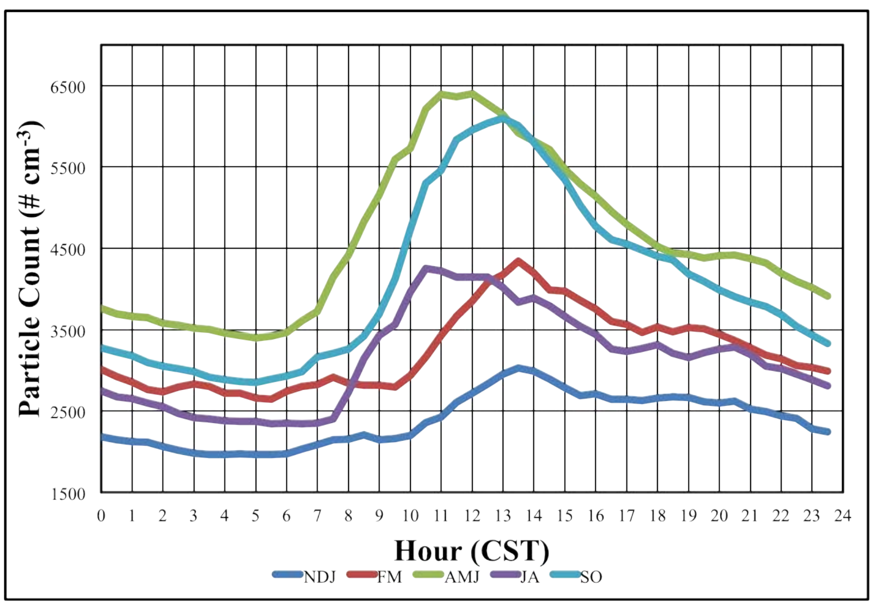

Figure 5.7: This shows the seasonal average particle number concentration as a function of time of day. Each series is based on a season defined in Table 5.3. The spring and fall peaks are evident with the highest concentrations occurring near mid day. The peak time is later in colder months and earlier in warmer months.

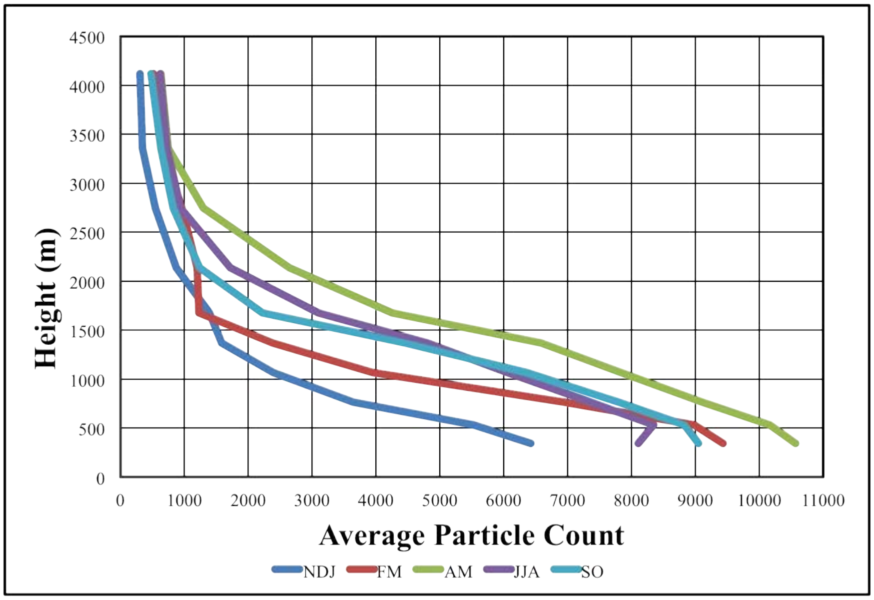

Figure 5.8: The vertical profile shows the seasonal average of particle number concentration as a function of altitude. See series definitions in table 5.3. The peak spring and fall [53, 66, 72, 9] effect is evident as well as the presence of a sharp concentration decrease at different altitudes in different seasons. This sharp decrease occurs higher in warmer months and lower in colder months.

5.3.4 Seasonal Average Vertical Profile

Binning the data from all flights into the 10 altitude bands shown in Table 5.4 and examining the seasonal averages for each of those bins shows a decrease in particle count with increasing altitude (See Figure 5.8). Once again, particle number concentration is highest in the spring and fall. Each season exhibits a sharp decrease in particle counts over a small range of altitudes. The range of altitude at which this occurs is higher in the warmer seasons and lower in the colder seasons. This sharp decrease in particle count has been observed in other aircraft studies [26, 56].

In addition to long-term evidence of enhancement in the boundary layer, Figure 5.9 shows an analysis of the size resolved vertical profile for a sample day in

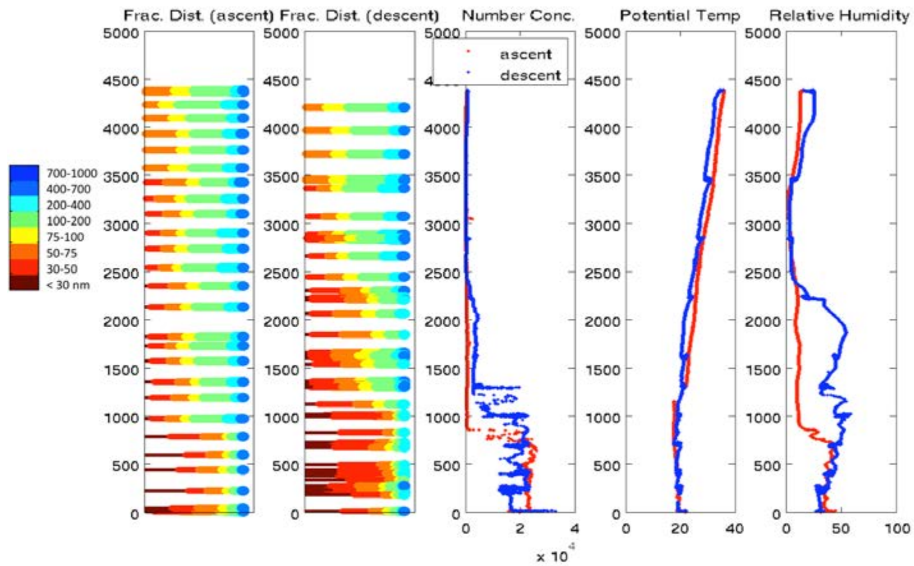

Figure 5.9: The first panel shows the fraction (color coded) of particles from each size bin as a function of height. The second panel shows the same thing on the flight descent. There is a point at which the finest mode of particles drops off. This is correlated to regions in which the relative humidity drops and the potential temperature rises, suggesting that ultra fine particles are enhanced in the boundary layer.

which regional nucleation was observed at a nearby site in Indiana. This plot shows an enhancement of small particles in the boundary layer at the same levels where other markers such as relative humidity and potential temperature exhibit evidence of stable atmospheric layers.

5.4 Conclusion

Particle number concentration averages show peaks in the spring and fall months. From 1994 - 2012 the average monthly particle number is trending downward in all seasons except the spring according to our analysis and Asmi et. al. 2013 [4]. The decreasing levels of SO_2 from 1988 - 2012 is likely responsible for decreases in particle number. NTN wet deposition data suggests that total NH_3 concentrations are not trending up or down, while particulate NH_3 is trending downward. This indicates a probable increase in gas-phase NH_3. These results suggest that despite some gas-phase precursors (SO_2, NO_3^-) to nucleation decreasing with industry controls, other gas-phase precursors (NH_3) are still prevalent and are likely increasing. Diurnal averages show mid-day peaks in particle number that become earlier in warmer months and later in colder months further demonstrate the contribution of solar radiation and plant biogenic activity. The vertical profile shows an enhancement of particles in the boundary layer with a specific size enhancement in the smallest particles (15 - 30 nm). No evidence in this analysis leads to a strong conclusion that nucleation is occurring aloft and mixing down. Future enhancements to the understanding of this data set would be greatly aided by a long-term measurement of ammonia or improved methods for resolving the seasonal trends in atmospheric ammonia concentrations. Vertical profile measurements are rare and the conclusions drawn about the vertical nature of nucleation can be difficult due to the fast turbulent mixing mechanisms of the atmospheric boundary layer. An extensive analysis of the size distribution particle number in aircraft, balloon, or tall tower study could help answer more questions as to the vertical profile of new particle formation.

CHAPTER 6
INTERCOMPARISON BETWEEN SHORT- AND LONG-TERM PARTICLE NUMBER RECORDS

6.1 Background

The data assets in Bondville, IL include a long-term record of aerosol optical properties. The integrating nephelometer has been running since 1994 in that location and has collected data featured in a number of scientific publications [4, 57, 65, 34]. The total scattering at three wavelengths is measured using the principles of Mie theory [11, 3, 2]. These systems were installed in a number of remote locations, where power had to be generated on-site by diesel generators. In an attempt to prevent misreporting of aerosol properties in these remote environments, condensation particle counters (TSI 3760) were put in place to identify times when the instruments might be sampling the exhaust of the electrical generation system. The Bondville site included a CPC as well, despite having electricity readily available on-site. As an auxiliary instrument, the particle number counts may not have been subjected to the same scrutiny in calibration and verification that a CPC for the dedicated purpose of reporting the ambient particle number might have been. Nonetheless, the data from the CPC's have been used by a number of modelers to try to understand the atmospheric particle number historically [4, 65]. This information is important to understand the historical effects of aerosols on climate. The TSI 3760 was eventually replaced by the TSI 3760a, which itself has been discontinued. NOAA has purchased a number of these instruments to preserve the historical nature of the measurement, but is now reporting data to the scientific community using the Brechtel, mixing CPC (MCPC) since 2012.

6.2 Benefits of Co-Comparison

An additional benefit to the year long study of the atmospheric size distribution in Bondville, IL is the comparison it can offer to the total particle number, now coming from the Brechtel MCPC. A comparison of the MCPC with our size distribution measurement can provide benefits of quality assurance to our data set as well as provide the scientific community information on the size resolution of the NOAA CPCs. In the future, co-sampling of the size distribution with the particle number will likely provide useful information on the size distribution for the 20 years when size distribution information is not available.

6.3 Counting Efficiency and Diffusional Losses

We attempt to compare a CPC sampling in one trailer (See Figure 6.1) with our particle sizing instruments sampling in another trailer. This comparison introduces at least the following three challenges:

1. The atmospheric size distribution seen by our sizing instruments is changed as losses occur through the inlets to our system.
2. The particles seen by the CPC in the NOAA trailer have also experienced losses through that inlet system
3. The comparison of total particle counts in all size bins to particle counts by the CPC may be different due to different counting efficiency at different sizes in

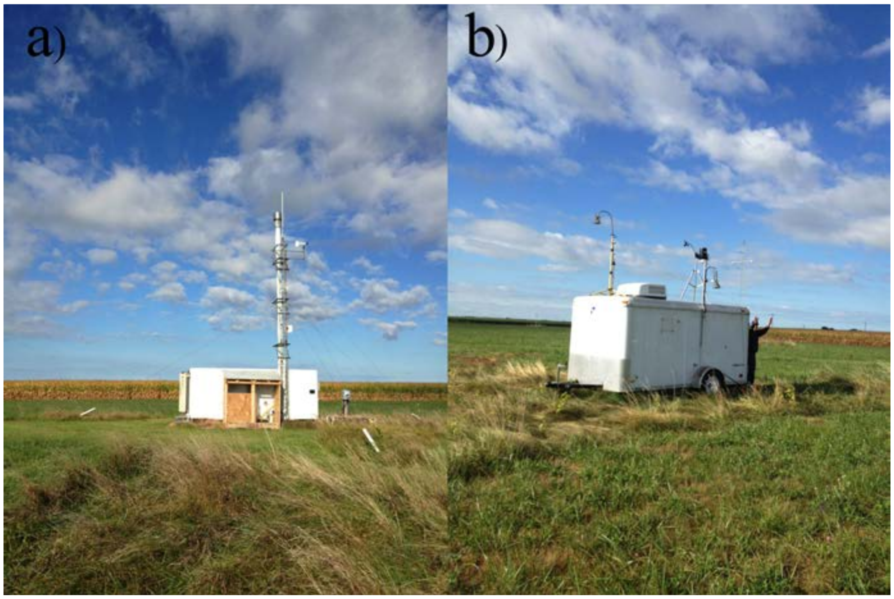

Figure 6.1: The NOAA research trailer (a) and the Stanier lab research trailer (b) co-located in Bondville, IL during the 2013 - 2014 Bondville field campaign.

the MCPC

A certain fraction of particles are lost when passing through sections of tubing. There are different loss mechanisms which affect different sizes of particles to different degrees making the reporting of losses to particle instruments complicated. Detailed measurements of lengths, diameters, and volumetric flows through all sections of tubing to our sampling instruments were made (See Table 6.1 and Figure 6.2). Descriptions of bends in tubing are also described. A counting efficiency curve was developed for all sizes of particles passing into our system, allowing us to correct for the number of particles lost and giving the ability to report a more correct depiction of the size distribution of the atmosphere (See Figure 6.3). The plumbing was changed to accommodate different instruments at different times during the campaign

(See Tables D.1 and D.2), corresponding transmission efficiency curves were used in our data processing algorithms. The complication of comparing our instrument to an instrument in another research trailer is that the losses through that system must also be taken into account. A transmission efficiency curve has also been developed for the inlet to the NOAA CPC (See Figure 6.4).

Section	Description	Material	Flow (lpm)	ID	Length	Angle
N1	System Inlet	TSI	1.5	1/4”	53.0	Vert.
N2	Outer Wall	TSI	1.5	1/4”	3.0	Horiz.
N3	Splitter, Nano and Long	Brass	1.5	1/4”	N/A	Vert.
N4	Splitter to Dryer	TSI	1.5	1/4”	5.0	Horiz.
N5	TSI Dryer	Plexi	1.5	3/8”	17.0	Horiz.
N6	Elbow into Dryer	SS	1.5	3/8”	N/A	Vert.
N7	Dryer to RH	TSI	1.5	3/8”	3.0	Horiz.
N8	RH Sensor	Brass	1.5	3/8”	3.0	Vert.
N9	Reduction	TSI	1.5	3/8”	1.5	Vert.
N10	RH to Neutralizer	TSI	1.5	1/4”	1.0	Vert.
N11	Reduction	TSI	1.5	1/4”	0.5	Vert.
N12	Neutralizer to DMA	TSI	1.5	3/8”	1.0	Vert.
L1	System Inlet	TSI	0.6	1/4”	53.0	Vert.
L2	Outer Wall	TSI	0.6	1/4”	3.0	Horiz.
L3	Splitter, Nano and Long	Brass	0.6	1/4”	2.0	Horiz.
L4	Splitter to Dryer	TSI	0.6	1/4”	2.0	Horiz.
L5	Nafion Dryer	SS	0.6	1/4”	27.0	Horiz.
L6	Dryter to RH	TSI	0.6	1/4”	7.0	Horiz.
L7	RH Sensor	Brass	0.6	1/4”	2.0	Horiz.
L8	RH to Neutralizer	TSI	0.6	3/8”	8.0	Diag.
L9	Neutralizer to DMA	TSI	0.6	1/4”	5.5	Horiz.
A1	System Inlet	Copper	5.0	5/8”	82.0	Vert.
A2	Outer Ceiling	Copper	5.0	5/8”	1.5	Vert.
A3	From Ceiling	Copper	5.0	5/8”	7.0	Vert.
A4	Copper to Brass Adapter	Brass	5.0	3/8”	2.0	Vert.
A5	Adapter to Dryer	TSI	5.0	3/8”	2.0	Vert.
A6	Dryer Fitting	Brass	5.0	3/8”	2.0	Vert.
A7	TSI Diffusion Dryer	Plexi	5.0	3/8”	103.1	Vert.

Table 6.1: This table gives the detailed tubing and flow information for the most common configuration during the Bondville Field Campaign. This information is used to correct for diffusion losses within the system. Other configurations and the dates associated with them are listed in Tables D.1 and D.2.

The comparison of two CPC's side by side can be difficult due to the different counting efficiencies of each instrument. During the Bondville field campaign, there are four different CPC's that are compared with the size distribution measurement at one time or another, all with different counting efficiencies. Related to the counting efficiency is the d_{50} size cut, which is the diameter at which the counting efficiency of the instrument is 50% (See d_{50} size cuts in Figure 6.4 for all compared instruments). The full counting efficiency curves are listed in Figure 6.5 for the TSI 3775 and Brechtel MCPC. With all these challenges in mind, we undertake to evaluate the accuracy of both the TSI 3775 CPC and the Brechtel MCPC by the following method:

1. Apply the Stanier trailer efficiency corrections for all specific particle instrument configurations to arrive at the theorized atmospheric size distribution
2. Apply the appropriate size-specific losses to the proposed atmospheric size distribution that would pass through the inlet to the NOAA trailer.
3. Apply the size-specific counting efficiencies to the inlet loss corrected size distribution to evaluate what portion of the full size distribution the CPC being compared to the size distribution is able to detect
4. Integrate the size distribution bins on the CPC detectable size distribution for an accurate comparison with the NOAA MCPC

6.4 Results

During an approximately 24-hour period where a TSI 3775 CPC was co-sampling with the Brechtel MCPC and the TSI 3760 CPC, a comparison of the

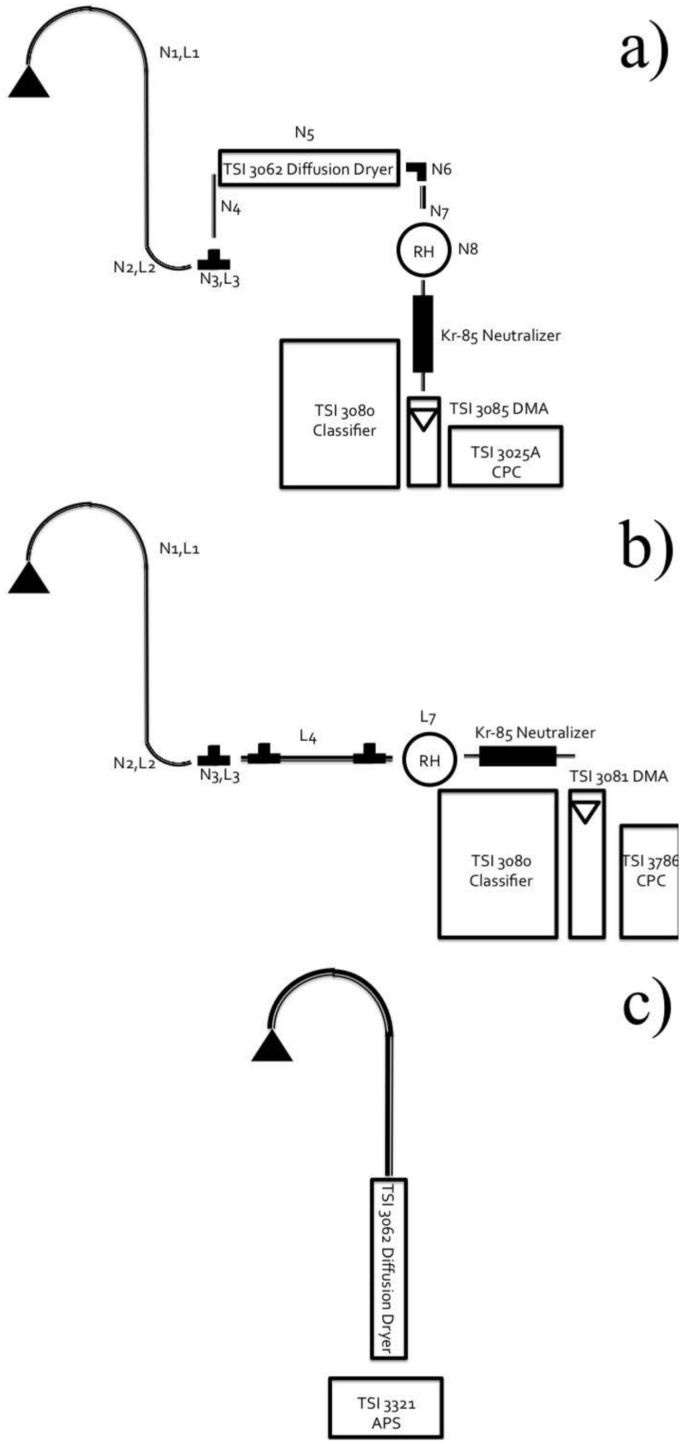

Figure 6.2: P&ID Diagram for nano- and long-SMPS sampling configurations. The nano- and long-SMPS share a common inlet, but are dryed using different techniques and receive charge from different neutralizers.

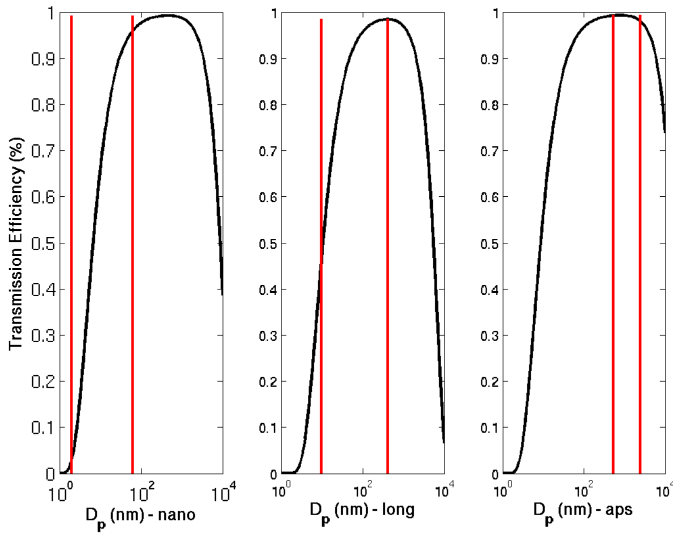

Figure 6.3: The transmission efficiency of particles at all sizes passing through our inlet to our three particle sizing instruments. The size ranges of each instrument for the most common configuration used during the Bondville field campaign are highlighted in red.

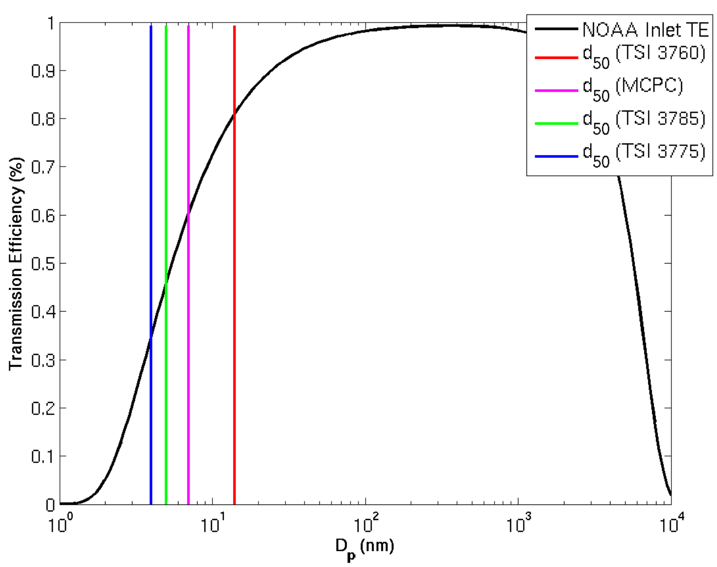

Figure 6.4: The transmission efficiency of particles at all sizes passing through the inlet to the NOAA research trailer. The d_{50} cut size for four standalone CPC configurations are shown. Only the TSI 3775 and Brechtel MCPC are evaluated in this study

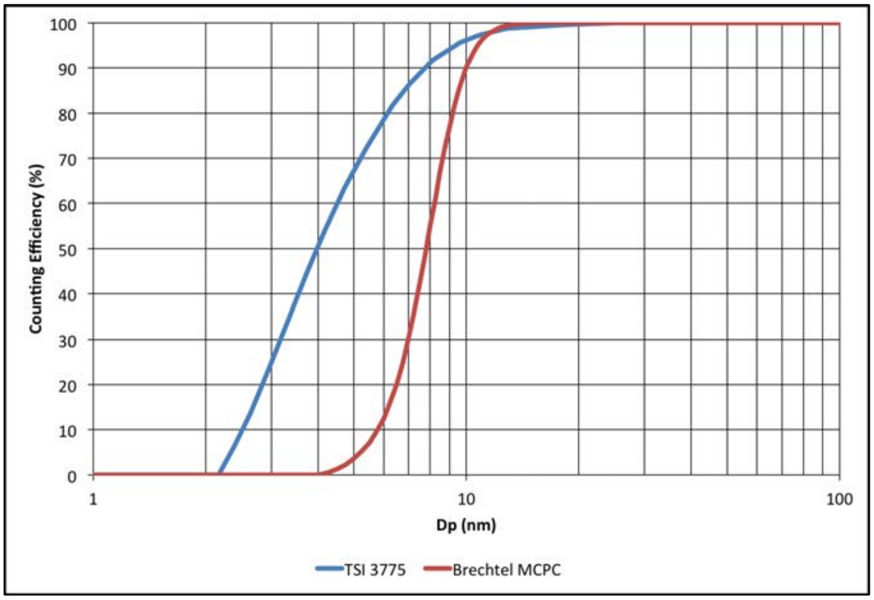

Figure 6.5: The counting efficiency curves for the TSI 3775 CPC and the Brechtel MCPC are shown. The curves have some differences in small sizes, but for particles above 10 nm, they should report similar counts.

relative counts seen by all instruments was made. Figure 6.6 shows the size distribution color plot as a time series at the same time as the TSI 3775 CPC and Brechtel MCPC are plotted. Not shown here, but with lower values even then the Brechtel MCPC, is the TSI 3760. This plot shows an apparent discrepancy in the particles seen by the TSI 3775 and the long-standing NOAA instruments, but the influence of the different size cuts of the instruments must still be accounted for.

Taking the CPC efficiency curves into account for both instruments (See Figures 6.7 and 6.8) results in fairly good agreement between the TSI 3775 and the total particle counts from the sum of the sizing bins. However, the MCPC does appear to be significantly lower than both the TSI 3775 and the total SMPS. This is confirmed in Figure 6.8 where the total particle number from the Stanier research trailer shows

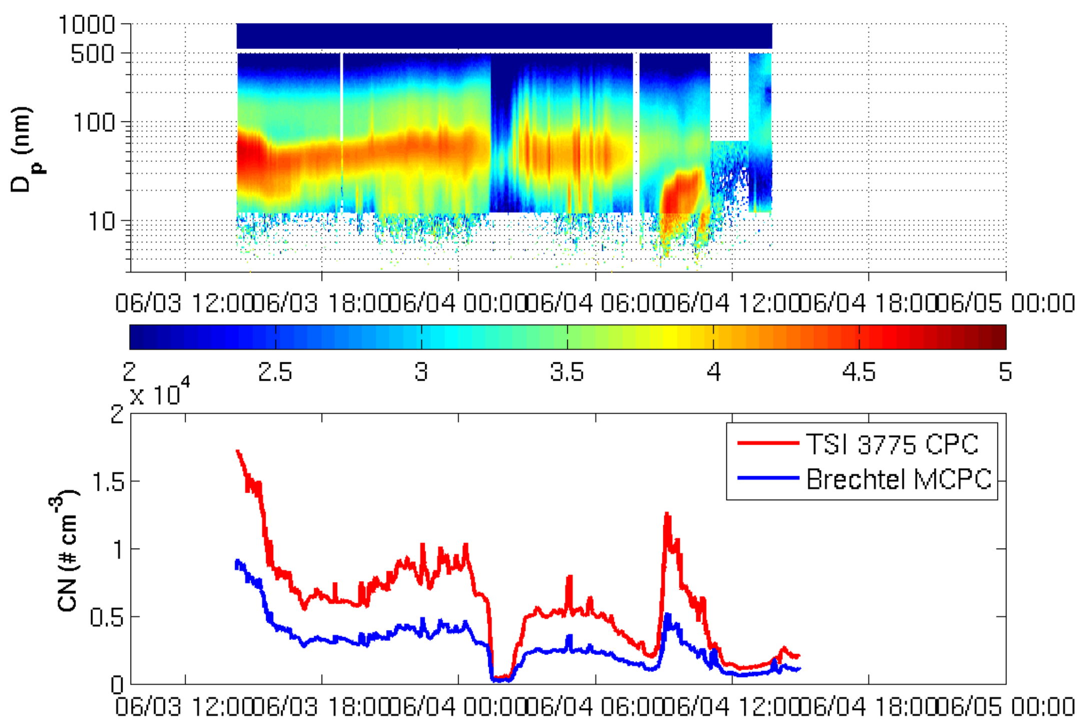

Figure 6.6: The full size distribution and the particle counts from two different particle counting instruments are shown during the period of inter-comparison. The instruments seem to be tracking peaks and valleys qualitatively.

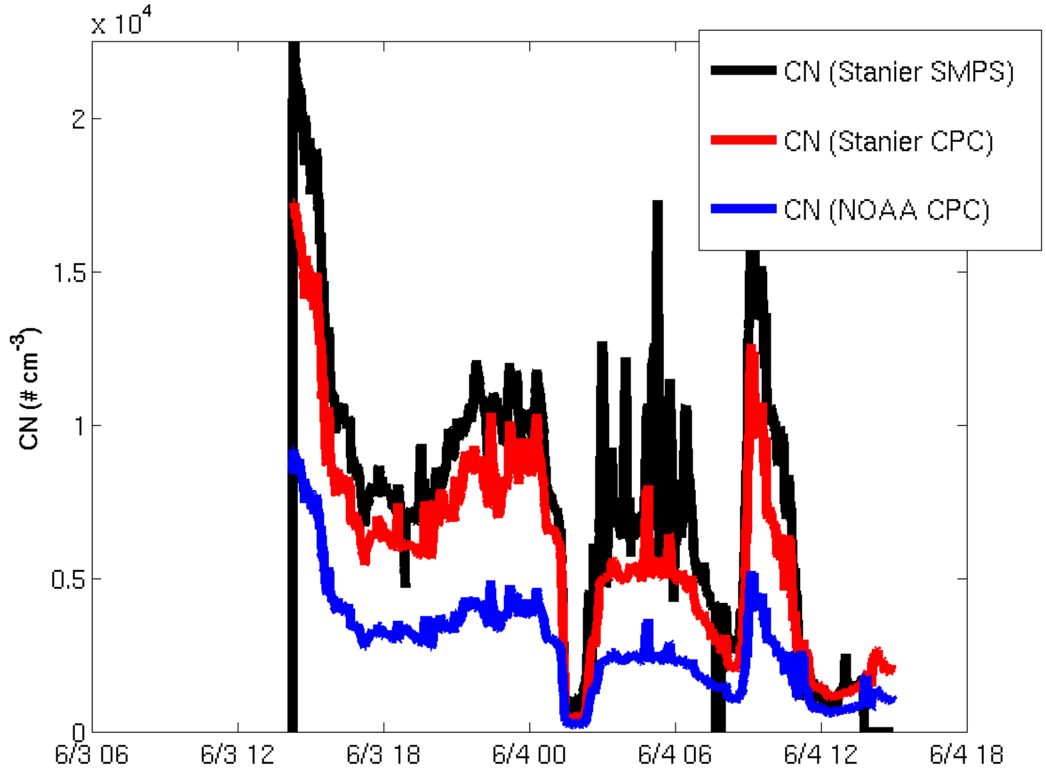

Figure 6.7: The total counts from the sum of the size bins seem to trace the particle counts reported by the 3775 CPC closely. There are certain periods where new particle formation seems to elevate the SMPS measurements relative to the CPC. There is also a notable period where heavy rains impacted the site, which was characterized by a sharp drop in particles at both instruments followed by a period of noisy size distributions unique to the scanning instrument.

a significant enhancement, even when NOAA trailer inlet losses and MCPC counting efficiencies are evaluated.

Like the sample days discussed in Figure 6.8, a detailed side-by-side time series comparison of the Stanier particle instruments and the NOAA Brechtel CPC for the length of the field campaign shows and enhancement in the Stanier record (See Figure 6.9). There are some periods where the Stanier record reports lower values than the

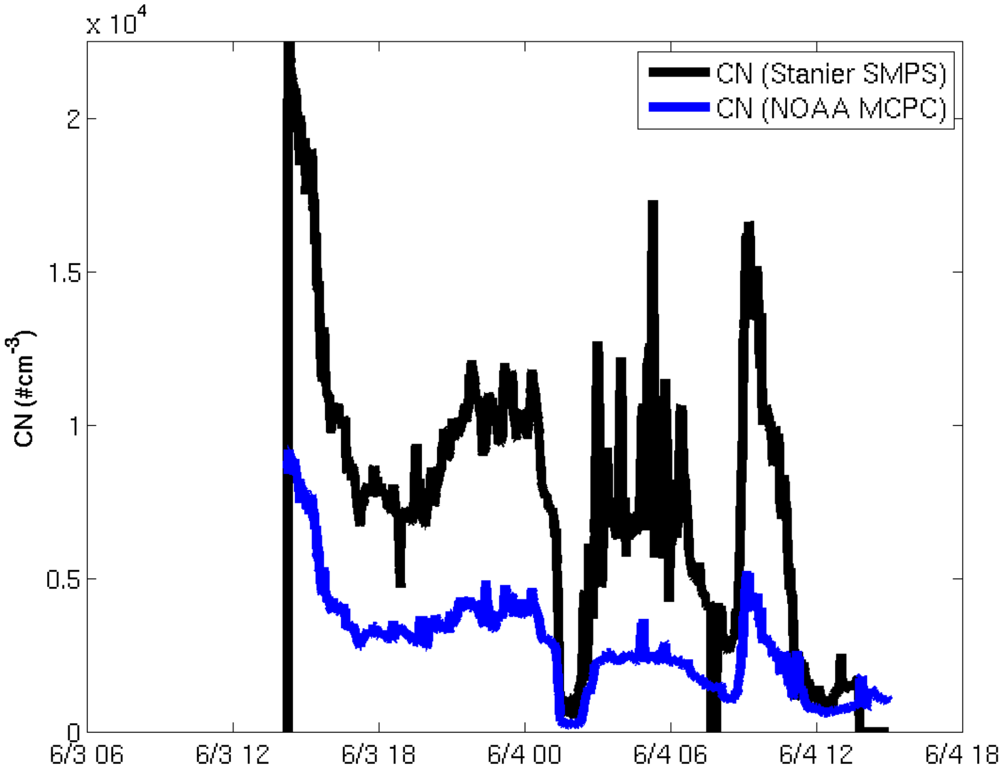

Figure 6.8: The MCPC does not seem to trace the total particle number well, even when CPC counting and inlet transmission efficiencies are applied to the sum of size distribution bins.

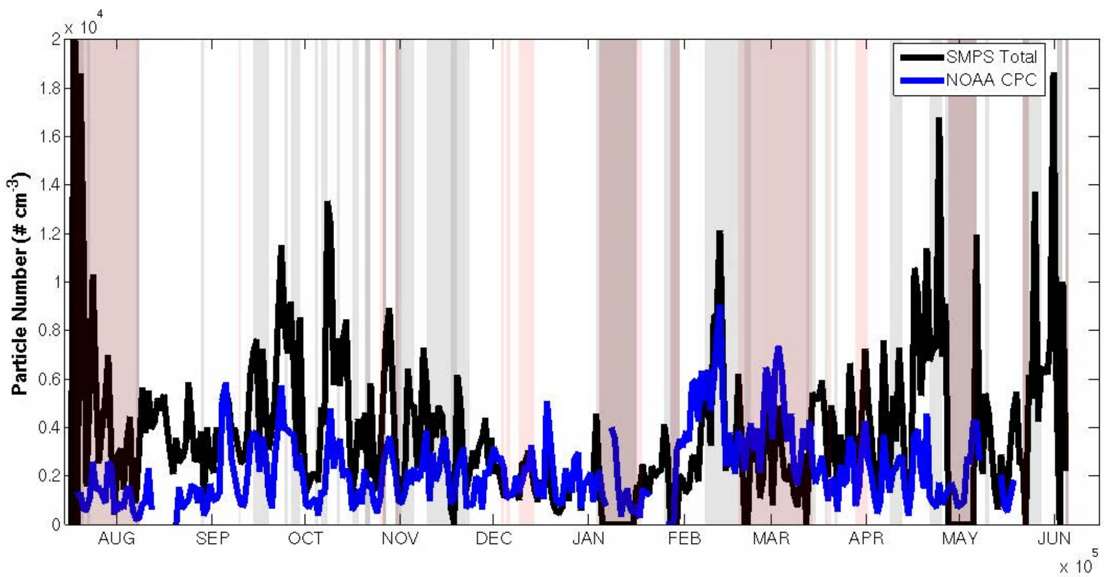

Figure 6.9: A time series comparison of the NOAA MCPC and the sum of SMPS size distribution bins. The time series appear to coincide, but the particle number as measured by the Stanier suite of aerosol instruments seems to report higher values in most regions. Shaded regions denote times when one or more Stanier particle instruments were not sampling and are therefore not contributing to the total particle number.

NOAA CPC, but they seem to occur during time periods where one or more of the Stanier particle instruments were not operating, and therefore under reporting the number of particles in the atmosphere (See shaded regions in Figure 6.9).

The monthly averages confirm the enhancement of the Stanier particle instruments in all months, with all exceptions coming in the months of December through March (See Figure 6.10). An examination of all months vs. instrument up time shows that the months of July, January, February, March and June had a low percentage of total operation time. July and June were the first and last months of the field campaign, where sampling occurred on less than 50% of all days. The other months with low up time all occur in the interval of months where the NOAA CPC shows

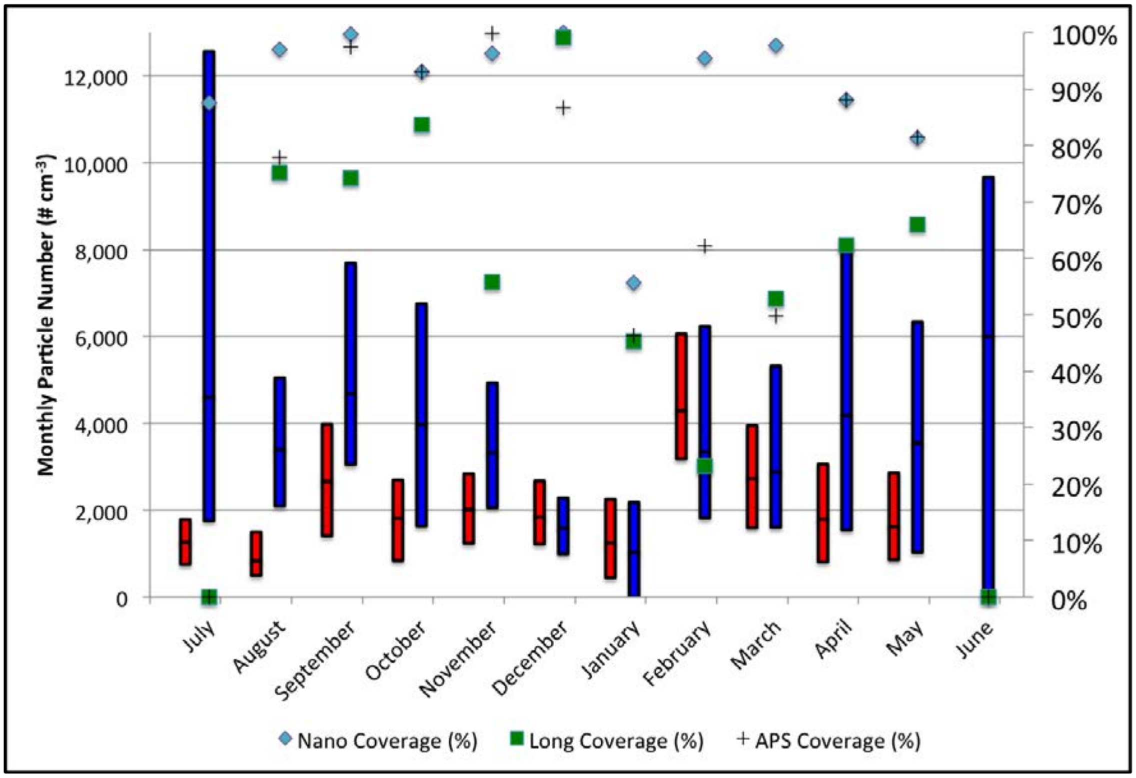

Figure 6.10: A monthly box plot comprising side by side median, 25th, and 75th percentiles for the NOAA MCPC (red) and the Stanier Particle Instruments (blue). The SMPS total particle number is significantly enhanced in most months, with lower values in December through March. The secondary axis shows the percentage of uptime for each Stanier particle instrument. The percentage of uptime is very low in the first and last months of sampling (July 2013 and June 2014). There is also a large portion of invalid data for all of the lower value months, except for December, where agreement was good between the two records.

higher counts than the Stanier particle instruments.

6.5 Conclusion

We conclude that even when counting efficiencies and losses are taken into account, that the long-standing data records in Bondville, IL are reporting less particles than exist in the atmosphere. The sources of this error are unknown, but confirmation of low bias in this data record is important to the scientific community who routinely use these data for ground-truth of global climate models. In months with high new particle formation activity, the enhancement in the Stanier total particle number is even more pronounced than in the winter months. Cooler months that feature less nucleation activity have closer agreement. The errors are likely due to the size-dependent counting efficiency of the MCPC. In addition errors could be introduced by an inlet flow rate of the MCPC that is lower than assumed in the instruments particle number concentration calculations. This could result in lower concentrations due to lower flow rate into the instrument.

CHAPTER 7
AN OVERVIEW OF NUCLEATION AND GROWTH IN BONDVILLE

7.1 Data Quality

7.1.1 Data Coverage

The Stanier research trailer was deployed from Iowa City, IA to the BEARS site in mid July 2013. Sampling commenced with a nano-DMA, SO_2 monitor, and meteorology information on July 17, 2013. On August 7, 2013 additional particle instruments were added. Sampling of the full size distribution took place from August 7, 2013 - June 4, 2014, a period of roughly 10 months. During the span of the field campaign, periods of downtime and equipment failures necessitated the use of multiple instruments and configurations. A summary of the data coverage of all particle instruments is given in Figure 7.1. The percentage of uptime of the three instruments covering the full size distribution of particles is counted from August 7, 2013 - June 4, 2014 and is given in Table 7.1.

7.1.2 Instrument Down Time

There are some notable regions of instrument downtime. During the month of January, temperatures dropped well below seasonal averages due to the influence of polar vortex winds. During these periods the potential damage to the water based CPC was especially high, due to inability to keep the trailer above freezing. The sampling was stopped from 01/05 - 01/14 and again on 01/27/- 01/28. In addition to meteorological challenges, there was a significant amount of downtime to the long-

	nano-DMA	long-DMA	APS
JUL	88%	0%	0%
AUG	93%	77%	78%
SEP	95%	78%	97%
OCT	70%	86%	93%
NOV	95%	58%	100%
DEC	100%	100%	87%
JAN	56%	45%	47%
FEB	96%	31%	62%
MAR	98%	53%	50%
APR	88%	74%	88%
MAY	76%	68%	82%
JUN	68%	62%	90%
Study Total	86%	69%	80%

Table 7.1: Percentage of Instrument Up Time

SMPS from February to March when a dacron filter on the long-DMA developed a leak. The error was not noticed because the data collection seemed to be running fine, but plots of the data were not being produced at that time to show the large numbers of particles at all sizes indicative of a leak in the system. During this same period a silica dryer bead entered the APS inlet and becomes an obstruction in the flow path, not allowing atmospheric particles to pass through. This problem was also rectified and normal sampling resumed in mid March. Another pause in sampling came in late April and early May when the laser counting system on the CPC in the long-SMPS stopped functioning properly. When the laser in the CPC associated with the long-SMPS stopped working, it was replaced with a 3775 CPC. The size distributions from this CPC did not align well with other instruments. There is a possibility that the flow rate used during the sampling period and the size distributions were shifted

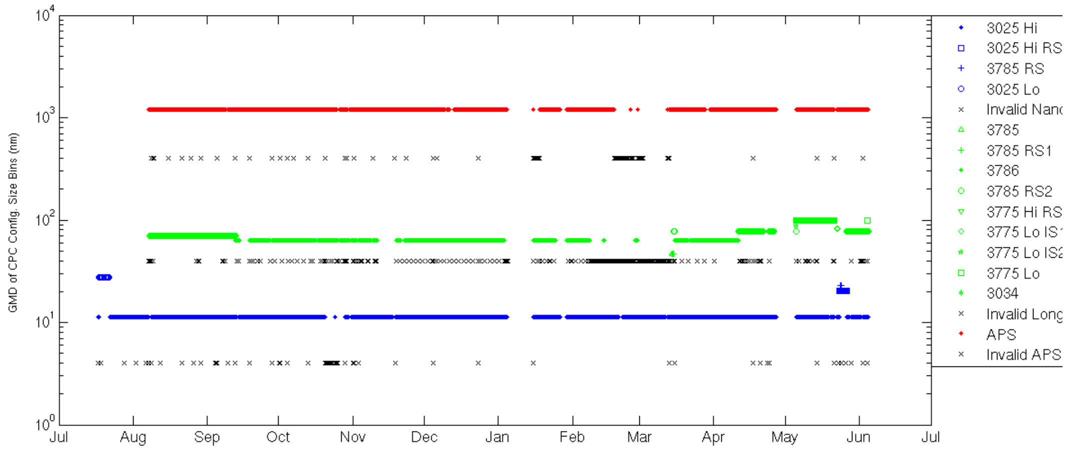

Figure 7.1: This figure shows the data coverage of particle sizing instruments for the duration of the study. The vertical axis is the Geometric Mean Diameter of all particle sizes for a particular instrument configuration, thus showing different configurations on slightly different levels. Blue time series are indicative of sampling in the "nano-" range (~3 - 100 nm), Green time series are in the "long-" range (~10 - 450 nm), and red time series are in the "pas" range (~550 nm - 10 μ m). A time series of "x"markers is listed below each series to show periods of missing data. For monthly data coverage, See Appendix F

towards larger sizes. The data from this time period may still be useful but needs further analysis.

7.1.2.1 Data Flagging and Quality Assurance

Data was flagged extensively for issues regarding quality assurance, local meteorology, calibration checks, dryer changes, and even exceptional local events or unusual operating conditions. Table 7.2 gives a summary of the format of actual flagged data. An extensive record of all flags applied to data is located in AppendixI. Scripts were developed for reading a *".csv"* file containing all flag information and then applying the invalidation to specific instruments at specified times. A color plot of the size distribution for the entire period is shown in Figure 7.4. Not all flags necessitated invalidation of data, but rather may assist in explaining peculiarities in the data under unusual sampling conditions (e.g. intense thunderstorm, etc.).

Date	**Local Flag**	**Narsto Flag**	**Description**
07/17/13	MIS	M1	MISSING DATA
07/17/13	INL	M2	NOT SAMPLING THROUGH INLET
07/19/13	GLI	M2	TEMPORARY GLITCH IN SAMPLING
08/03/13	HEP	M2	HEPA FILTER ON INLET
08/03/13	VOL	V6	VOLATILITY TDMA MODE
07/23/13	DIS	V6	DISCONTINUOUS SIZE DISTRIBUTION
08/07/13	HEP	M2	HEPA FILTER TEST
08/08/13	FLO	M2	FLOW TEST
08/09/13	DRY	M2	DRYER CHANGE
08/09/13	EXT	V6	LOW FLYING CROP DUSTING AIRCRAFT
08/14/13	PAT	V6	PATTERN CHANGE
08/17/13	LOC	V6	POSSIBLE LOCAL SOURCE
09/04/13	LEA	M2	APPARENT LEAK
09/04/13	LOW	V6	LOW COUNTS
09/15/13	RAI	V6	RAINFALL
09/27/13	DRN	M2	CPC DRAINED
10/29/13	ZER	V6	ZERO OF SO2 MONITOR
12/14/13	DIS	M2	DISCONTINUOUS SIZE DISTRIBUTION
01/15/14	OBS	M2	OBSTRUCTION
05/05/14	SIZ	V5	INVALID DATA AT SMALL SIZES
06/01/14	BUT	M2	DEPLETED BUTANOL RESERVOIR

Table 7.2: A summary of different local flags developed for data quality assurance in Bondville, IL. Narsto flags are included. Many flags exist where data does not need to be invalidated. The MATLAB script that applies data flags can reprocess the flags quickly if it is determined that some of these invalidation flags need to be changed. An extensive list of data flags is contained in Appendix I

7.1.2.2 Instrument Overlap

The nano-DMA and long-DMA in our system ranged from ∼3 - 70 *nm* and ∼10 - 200 *nm*, respectively. It is important to examine the region of overlap for quality assurance. We compared the hourly averaged $\frac{dN}{dlogD_p}$ values at 30 *nm* for both instruments. The overlap is good in most cases, but there are certain times where we have reason to believe either instrument was sampling low, possibly due to water saturated butanol reservoir, impending instrument failure, or problems with CPC optics (See Table H.1 in Appendix H). Table H.1 serves as a rough overview of overlap issues, but is not exhaustive. An exhaustive library of overlap plots between particle sizing instrument exists, but is too extensive to include in the Appendix of this thesis. This record was used to identify and remove additional data features that don't appear visually in size distributions, but cause spikes in the data averaging and therefore misreporting of average size distributions.

For the first month of the campaign (08/07/2013 - 09/13/2013) a stand alone particle sizing instrument (TSI 3034) was used to size particles from 10 *nm* – 400 *nm* in place of the TSI 3996 SMPS with TSI 3080 Electrostatic Classifer with a TSI 3081 long column DMA and a 3786 Condensation Particle Counter. There was a brief period on 09/13/2013 that all four sizing instruments were running simultaneously. This period is plotted in Figure 7.2 and shows the size distribution plotted by number and volume in both log and linear vertical scales. The agreement between all four instruments at this time is good on both logarithmic and linear scales.

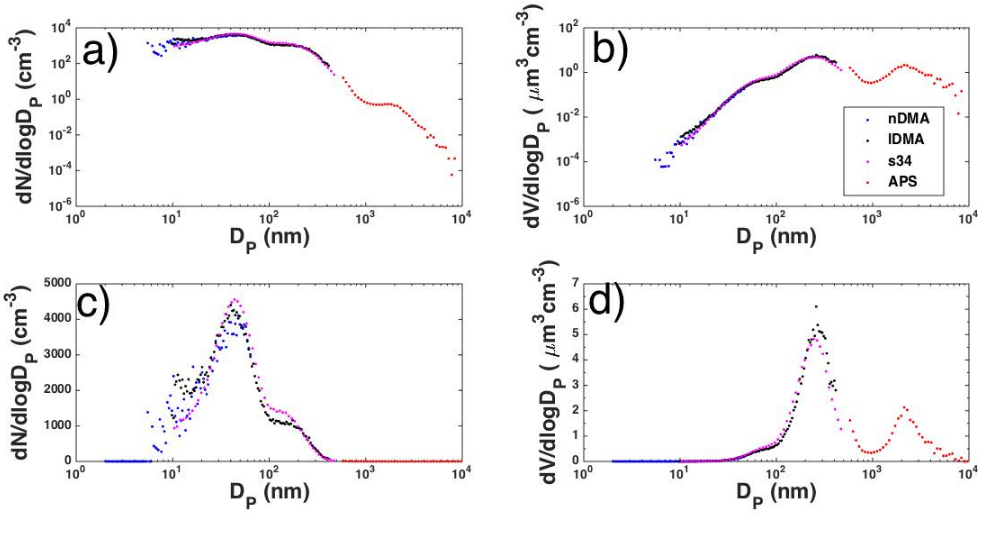

Figure 7.2: The size distribution for all four instruments from 5 AM to 6 AM on 09/13/2013. a) Number size distribution comparison on a log scale. b) Volume size distribution comparison on a log scale. c) Number comparison on a linear scale. d) Volume comparison on a linear scale

7.1.2.3 Aerodynamic vs. Mobility Diameter

The operating principle to the Aerodynamic Particle Sizer assumes a particle density of 1 $g\ cm^{-3}$ and a dynamic shape factor (χ) of 1. We adjusted the poly size distribution of aerosols in the APS according to Khlystov et. al. 2004 [31] to be more representative of the mobility diameter by assuming a particle density of 1.8 $g\ cm^{-3}$. We also made adjustments to the size distribution based upon the size-dependent counting efficiency of the APS according to Peters et al. 2003 [49]. There is a small region where the sizing capabilities of the long-DMA and APS do not overlap, we have used a logarithmic fit function to interpolate values for this missing region. The aerodynamic corrected size distribution with interpolated gap filling is then compared to the 24-hour time resolution EPA FRM $PM_{2.5}$ sample. The

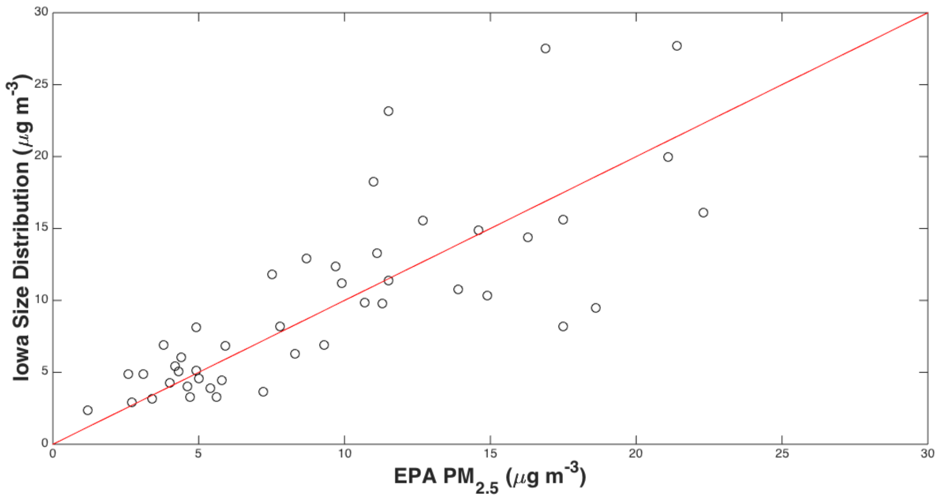

Figure 7.3: This figure shows the correlation between the mass concentration from Iowa instrumentation size distributions compared with the EPA federal reference method 24-hour samples. There are 45 days where there was at least 18 hourly averages of both APS and long column DMA SMPS measurements for valid comparison. Plots of the comparison times are listed in Appendix E.

results of this comparison are in Figure 7.3 and extensive plots of comparison days are available in Appendix E.

7.2 Results

Hourly averages of all three sizing instruments were produced and then merged to make a plot of the full size distribution for the field campaign (See Figure 7.4).

7.2.1 Average Size Distribution and Modes

The average size distribution by number, surface area, and volume was calculated based on hourly averaged size distribution for the entire study period. The results are shown in Figure 7.5, where the average number mode is at ∼37 nm. The surface and volume distributions are bimodal with modes at 250 nm and 2 μm and

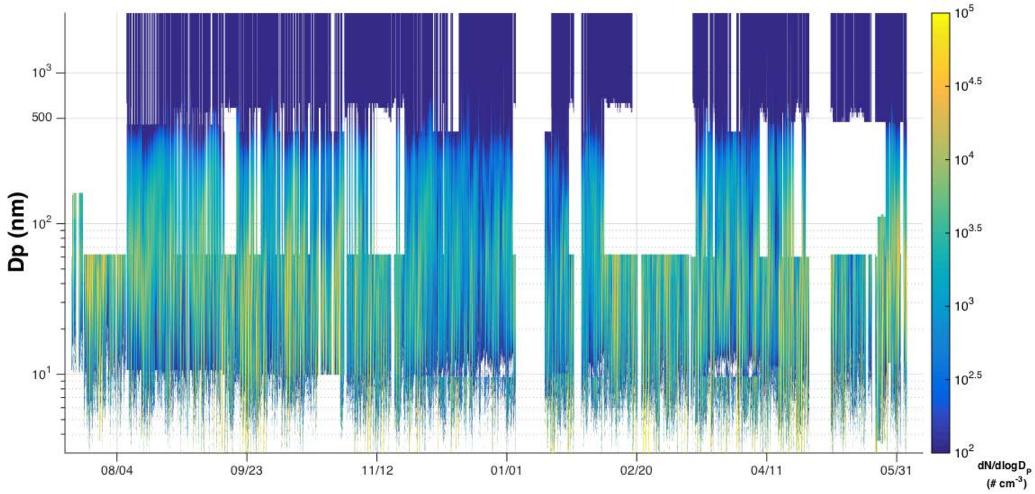

Figure 7.4: This Figure shows the size distribution color plot for the entire study period. Gaps in the data exist due to missing samples or data removed for quality assurance.

310 *nm* and 2.5 μm for the surface and volume modes, respectively. This data is also plotted in Figure 7.6 on a linear scale.

7.2.2 Monthly and Diurnal Particle Number Patterns

A plot of the median values of particle number size bins for the whole period as a function of the time of day (See Figure 7.7) reveals a peak at ∼11:00 CST that persists until ∼20:00 CST, then drops off in the night and early morning hours. The size distribution is dominated by sub 50 *nm* particles, with 20 - 50 *nm* particles making up the largest fraction of total particles among all size ranges. The diurnal pattern indicates an influence of photochemistry on particle production during the daytime hours.

To examine this data set for seasonality, the monthly median particle number

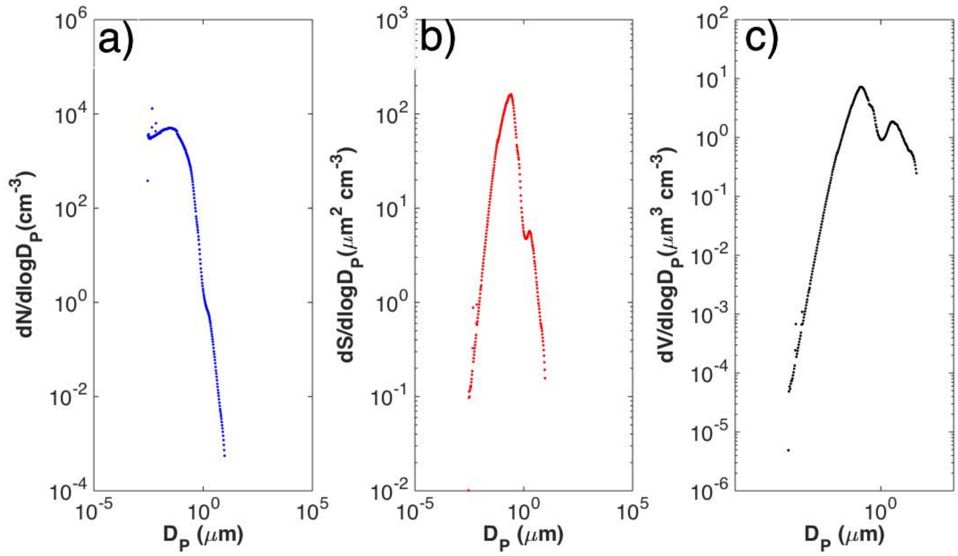

Figure 7.5: This figure shows the period average size distribution by Number (a) , Surface Area (b), and Volume (c), respectively.

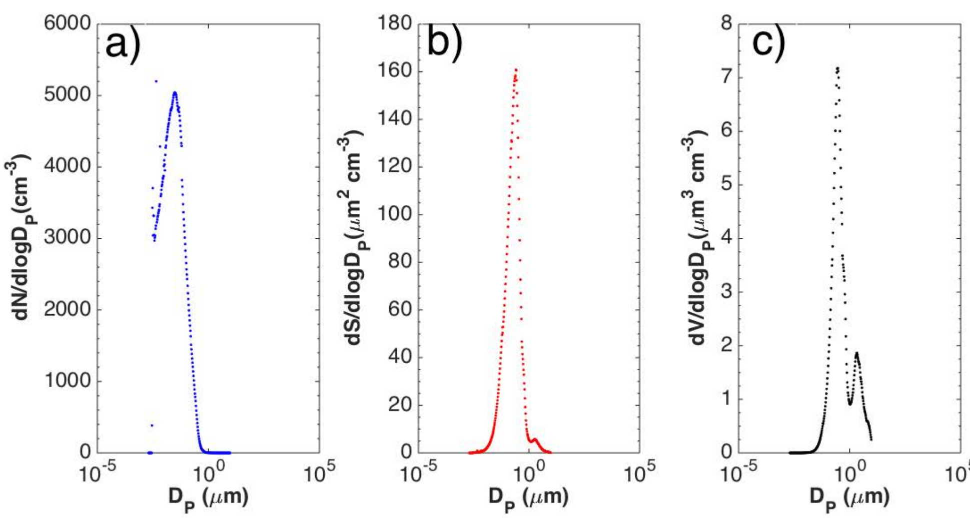

Figure 7.6: This figure shows the period average size distribution by Number (a) , Surface Area (b), and Volume (c) on a linear y-axis.

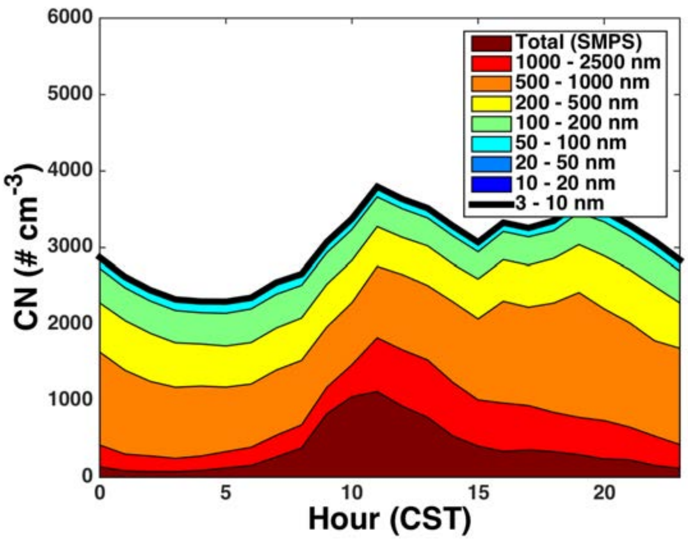

Figure 7.7: This figure shows the diurnal median values for the entire period of sampling from all instruments. (August 7, 2013 – June 4, 2014). The size distributions are binned into eight size bins ranging from 3 *nm* to 2.5 *μm*. The peak in the diurnal average is at ∼11 AM CST.

was binned by size for all months in the study (See Figure 7.8). Large distinctions start to become evident when analyzing the seasonality of sub 50 *nm* particles. This seasonality persists for the overall number and shows a peak in particle number in the fall (September, October) and in the Spring (April, May, June). More analysis is needed to rule out the representativeness of data in June, July, January, February, and March; due to the large amounts of down time which occurred during those months. The largest fraction of particles exist in the 20 *nm* - 50 *nm* region.

It should be noted that the use of median values may result in some apparent inconsistencies between Figures 7.8 and 7.11. Using average values for the monthly and diurnal size bins provides more consistency. A comparison of the mean and median diurnal distributions with the mean and median binned monthly averages is

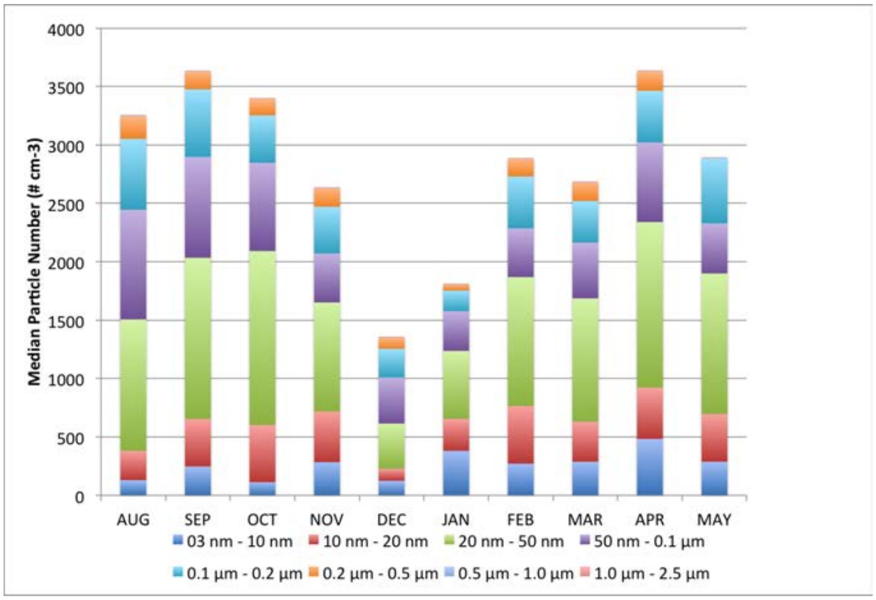

Figure 7.8: The monthly binned of median particle sizes broken down into size bins. The seasonality of the particle number is most pronounced in the 20 nm – 50 nm size bins.

provided for the month of September in Appendix G

7.2.3 Nucleation Events In September

September 2013 was a month with a high frequency of new particle formation activity (See Table 7.3). Evidence of strong or moderate new particle formation and growth was visible on eight and seven days, respectively. Figure 7.9 shows a sample time period of one week (9/20 - 9/26) where nucleation and growth were observed on five of seven days.

Comparing the diurnal median size distribution, binned by different ranges of particle number for the month of September vs. the entire study period reveals significantly higher particle number concentrations with higher values specifically in

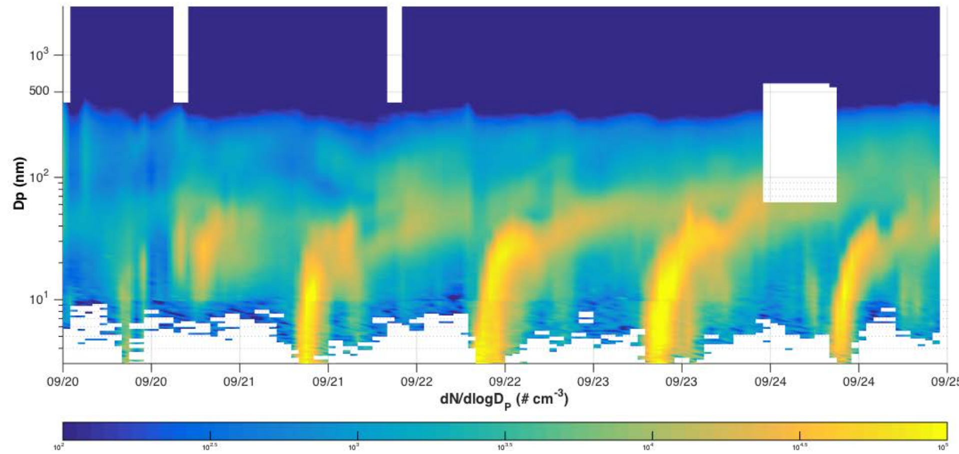

Figure 7.9: Seven days of particle size distribution measurements in September 2013. Nucleation occurs on five of seven days, with the other two days featuring bursts of new particle formation, but without sustained growth.

the ultra fine modes. A further comparison of only new particle formation days shows and even larger enhancement (See Figure 7.10).

The diurnal average for all months in the study shows the highest concentrations occurring in September, followed by April. The peaks occur at ∼11 AM CST on average for the whole period (See Figure 7.7). In August and May, the diurnal peak occurs before 10 AM CST and in January the peak occurs at roughly 3:00 PM CST.

7.3 Nucleation Event Frequency

Nucleation was seen at different magnitudes during all months of the study. Nucleation was more intense and more frequent during the Spring and Fall months. In some instances nucleation was accompanied by continuous growth, other times there

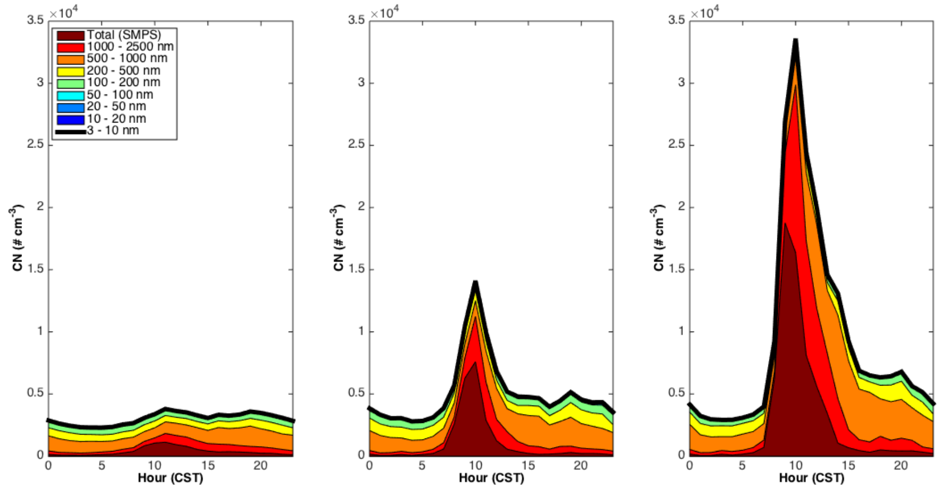

Figure 7.10: This figure shows the binned diurnal average for three separate conditions. The first panel shows the diurnal average for the entire study period. The middle panel shows the diurnal average for a nucleation intensive month (September). The third panel shows the diurnal average for regional nucleation days in September. The diurnal average peak occurs earlier in the day (10 AM) in September than on average (11 AM).

were only strong nucleation bursts with no growth. In other times growth seemed to occur, but would stop for periods of minutes to hours only to resume.

7.4 Conclusion

The average number, surface, and volume distributions have modes at 37 nm, 250 nm, and 310 nm, respectively. The surface and volume distributions are bimodal with additional modes at 2 μm and 2.5 μm, respectively. The binned monthly average particle number concentrations are dominated by particles from 20 - 50 nm, and show a seasonality in the fall and spring months. The diurnal average number concentration peaks near mid day (11 AM CST) on average and earlier or later in warmer or cooler months, respectively. Nucleation Frequency was very high in September, with

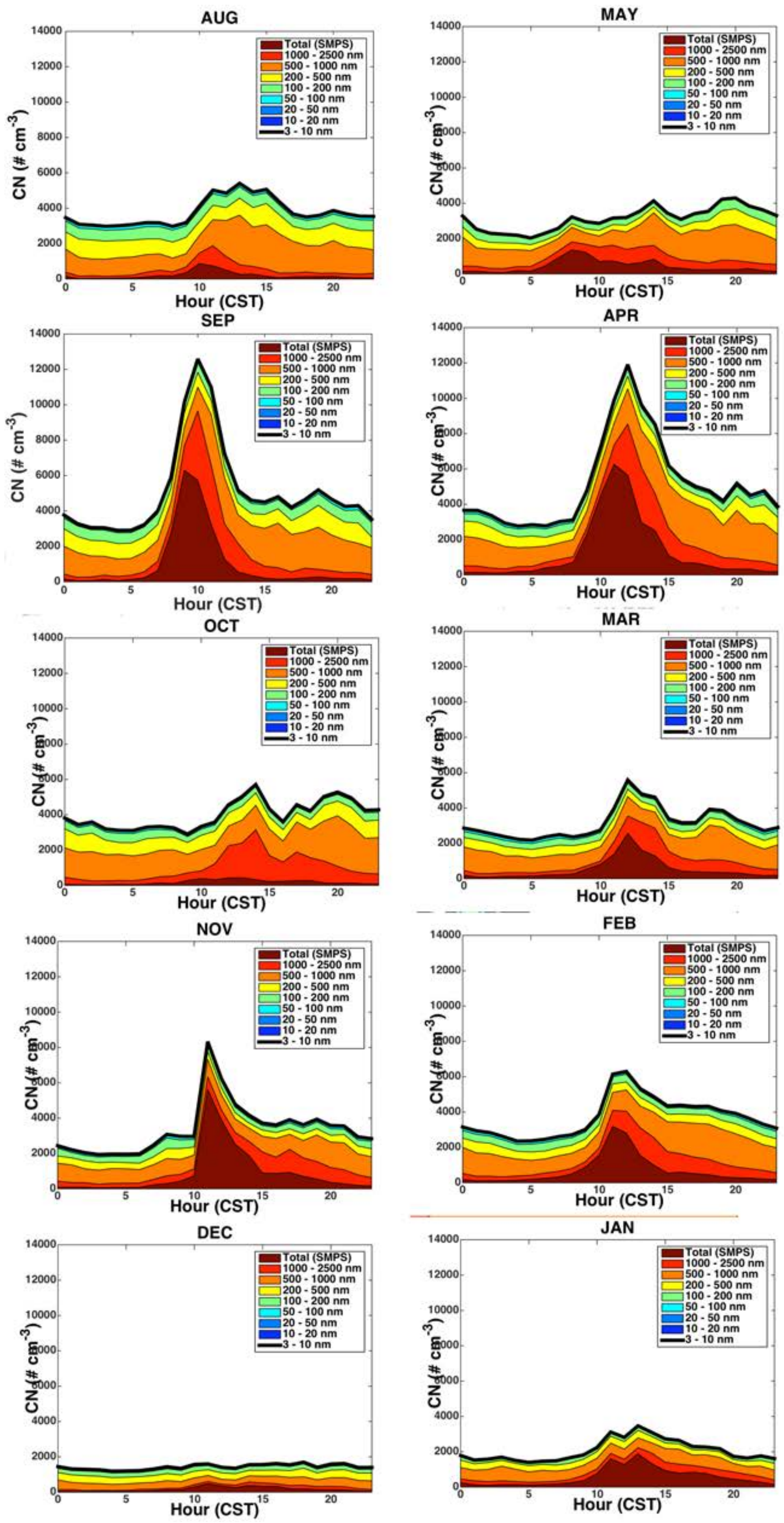

Figure 7.11: The diurnal medians for all months of the study period in Bondville, IL.

	# Days Valid Data	Strong Nucleation	Moderate Nucleation	Weak Nucleation	Bursts Nucleation	# Days Nucleation
JUL	15	3	2	2	2	9
AUG	31	1	5	4	9	19
SEP	30	6	7	3	5	21
OCT	31	4	8	4	3	19
NOV	30	1	7	6	4	18
DEC	31	0	3	3	1	7
JAN	29	0	5	4	1	10(3)
FEB	28	4	7	3	2	16
MAR	31	3	8	5	5	21
APR	30	5	11	1	4	21(1)
MAY	29	5	7	3	2	17(2)
JUN	4	0	2	0	2	4
Total	319	32	72	38	40	182(6)

Table 7.3: This table shows the number of Strong, Medium, and Weak nucleation and growth events for the duration of the Bondville field campaign. The last column gives the total number of nucleation event days, with the number in parenthesis denoting nucleation events determined by NOAA MCPC data alone

strong regional nucleation occurring on eight days, with moderate or weak nucleation occurring in another seven days.

CHAPTER 8
CONCLUSION

8.1 Instrumentation

Instruments have been constructed for the purpose of sizing and measuring the volatility of atmospheric aerosols. These instruments are capable of accurately controlling the voltage in a differential mobility analyzer over four orders of magnitude, accounting for time delay in unique plumbing configurations, and ultimately for examining the volatility of ultra-fine particulate matter under a number of different conditions. The components and software lend themselves easily to modification for ever-changing research interests. These instruments can be programmed to interface with a number of other scientific instruments to meet specific scientific objectives. The software also produces an intermediate file that produces an easily readable text file that can then be inverted via MATLAB to produce the aerosol size distribution from measurements of counts vs. applied voltage. Future work includes developing an inversion algorithm to be used in conjunction with the existing system to report particle number concentration as a function of size and time.

8.2 JoCAQS

The Johnson County Air Quality study examined periods where the sampling equipment was influenced by the power plant plume. During the study period, a high percentage of the winds coming from the direction of the power plant showed elevated levels of NO_x, SO_2, and PM. Data from a landfill fire plume impaction study showed emission ratios of 0.46 $PM_{2.5}$ to SO_2, which is higher than the ratio of EF's, but it is difficult to attribute the extent to which the concentration of SO_2 or NO_x is raised above background by the power plant, vs. other regional sources in so small a sample size. Samples taken on 07/31/2012 were above background, but actually decreased from the previous day (See Figure 4.6), showing the possible significance of other sources to $PM_{2.5}$ in Johnson County. The emission ratios of $PM_{2.5}$ to NO_x are higher than predicted but differences may be negligible with uncertainty considerations. Future work will include modeling to evaluate the impacts of the power plant on all of Johnson county.

8.3 Long-Term NOAA Measurements

Particle number concentration averages show peaks in the spring and fall months. From 1994 - 2012 the average monthly particle number is trending downward in all seasons except the spring according to our analysis and Asmi et. al. 2013 [4]. The decreasing levels of SO_2 from 1988 - 2012 is likely responsible for decreases in particle number. NTN wet deposition data suggests that total NH_3 concentrations are not trending up or down, while particulate NH_3 is trending downward. This indicates a probable increase in gas-phase NH_3. These results suggest that despite some gas-phase precursors (SO_2, NO_3^-) to nucleation decreasing with industry controls, other gas-phase precursors (NH_3) are still prevalent and are likely increasing. Diurnal averages show mid-day peaks in particle number that become earlier in warmer months and later in colder months further demonstrate the contribution of solar radiation and plant biogenic activity. The vertical profile shows an enhancement of particles in the boundary layer with a specific size enhancement in the smallest particles (15 - 30 nm). No evidence in this analysis leads to a strong conclusion that nucleation is occurring aloft and mixing down. Future enhancements to the understanding of this data set would be greatly aided by a long-term measurement of ammonia or improved methods for resolving the seasonal trends in atmospheric ammonia concentrations. Vertical profile measurements are rare and the conclusions drawn about the vertical nature of nucleation can be difficult due to the fast turbulent mixing mechanisms of the atmospheric boundary layer. An extensive analysis of the size distribution particle number in aircraft, balloon, or tall tower study could help answer more questions as to the vertical profile of new particle formation.

8.4 Long-Term CPC Comparison

We conclude that even when counting efficiencies and losses are taken into account, that the long-standing data records in Bondville, IL are reporting less particles than exist in the atmosphere. The sources of this error are unknown, but confirmation of low bias in this data record is important to the scientific community who routinely use these data for ground-truth of global climate models. In months with high new particle formation activity, the enhancement in the Stanier total particle number is even more pronounced than in the winter months. Cooler months that feature less nucleation activity have closer agreement. The errors are likely due to the size-dependent counting efficiency of the MCPC. In addition errors could be introduced by an inlet flow rate of the MCPC that is lower than assumed in the instruments internal particle number concentration calculations. This could result in lower concentrations due to lower flow rate into the instrument.

8.5 Bondville Nucleation Study

The full size distribution was sampled in a rural continental non-forested location for 10 months. Inlet transmission efficiencies were accounted for and extensive records were kept on periods where instruments were not sampling optimally. Care was taken to examine the overlap regions of the three particle sizing instruments and the correlation with existing $PM_{2.5}$ records. Nucleation is observed in Bondville in all seasons. The average size distribution for the whole period shows a peak number mode at 37 nm, a peak surface area mode at 250 nm, and a peak volume mode at 310 nm. The surface and volume distributions are bimodal with additional modes at 2 μm and 2.5 μm, respectively. The binned monthly average particle number concentrations are dominated by particles from 20 - 50 nm, and show a seasonality in the fall and spring months. The diurnal average number concentration peaks near mid day (11 AM CST) with high concentrations of aerosols persisting to the late afternoon consistent with nucleation and growth activity. The peaks in the diurnal average correspond with seasonal photochemical and biogenic activity. Nucleation Frequency was very high and well sampled in September, with strong regional nucleation occurring on eight days, and moderate or weak nucleation occurring in another seven days.

APPENDIX A
DETAILS ON CLASSIFIER ELECTRICAL CONNECTIONS

A.1 First Generation Classifier

The first generation classifier was finished in the Spring of 2013. This featured voltage control from a Bertan high voltage power supply. This supply necessitated the use of an additional low voltage power supply for accurate voltage control below 64 volts. The LabVIEW data acquisition card was built into the classifier, which produced a number of data acquisition ports that are not used by the classifier and unusable by other applications. The blowers used in the first generation classifier were not leak-free and therefore required a “once-through” operation configuration.

A.2 Second Generation Classifier

The second generation classifiers were build in late 2013 and included an improved high voltage power supply that didn’t require a back up power supply for low voltages. This classifier was also designed to be more modular with a LabVIEW data acquisition card that could run two classifiers simultaneously and interchangeably by the use of 25-pin connectors and cables. The blowers featured in these classifiers were an updated manufacturer design that included features for leak-free operation. In addition to the manufacturer’s modifications, encasements from the University of Iowa’s Engineering shop were used to ensure leak-free operation.

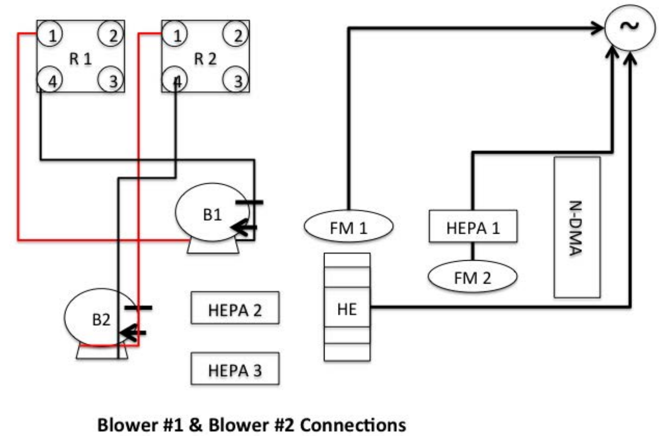

Figure A.1: Electrical Connections for Ametek Blowers

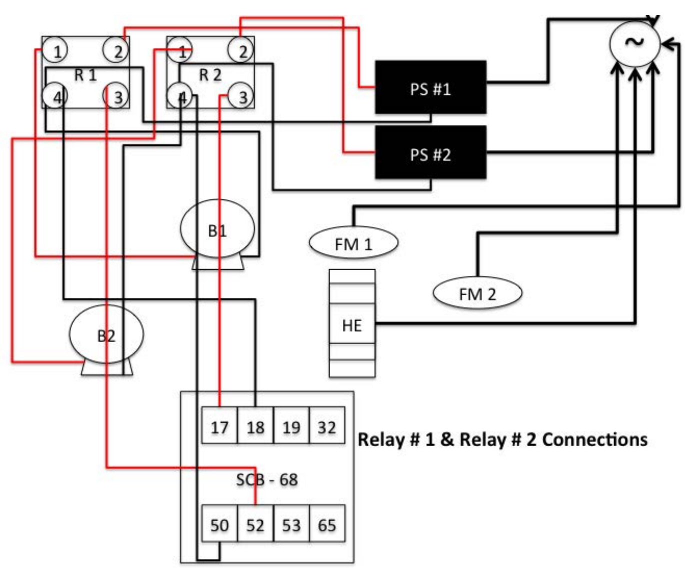

Figure A.2: Electrical Connections for Blower Relays

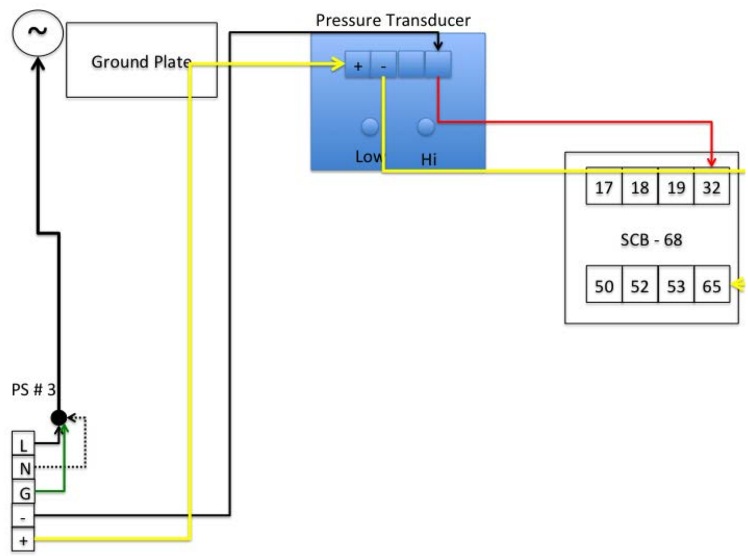

Figure A.3: Electrical Connections For LabVIEW SCB-68 Analog I/O Card

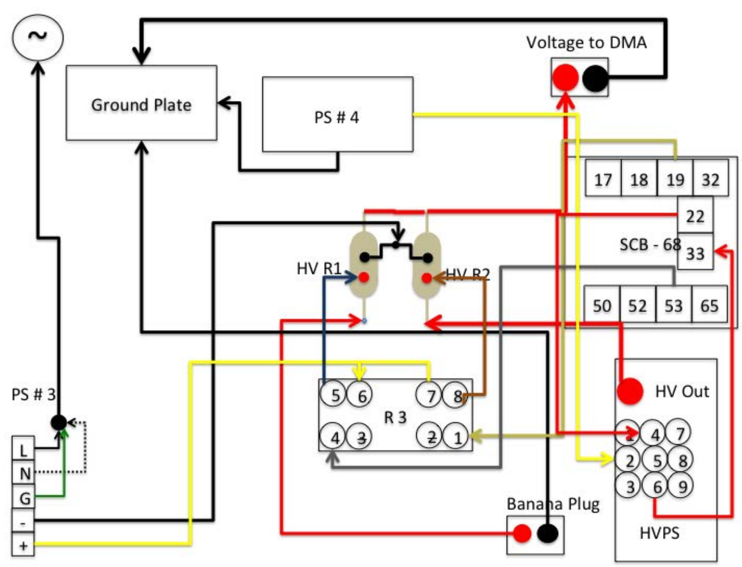

Figure A.4: Full Electrical Connection Diagram For First Generation Classifier

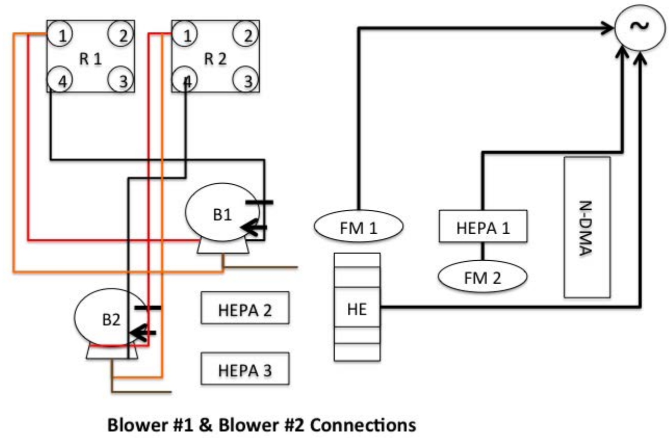

Figure A.5: Electrical Connections for Ametek Blowers

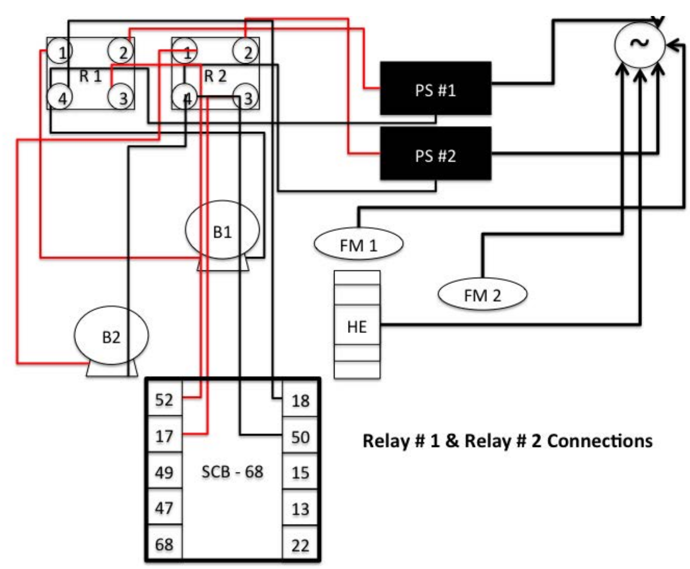

Figure A.6: Electrical Connections for Blower Relays

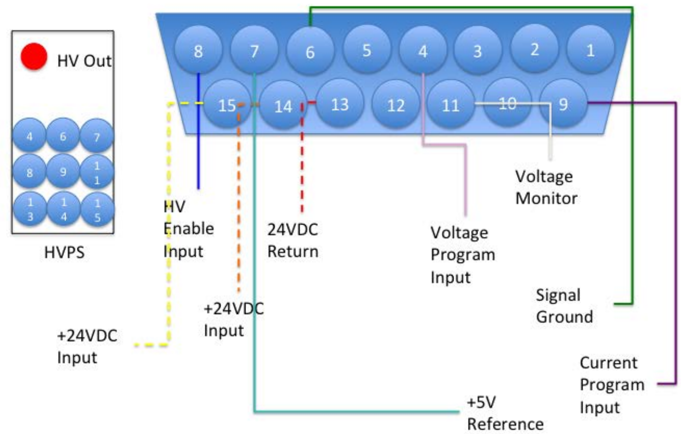

Figure A.7: Electrical Connections for the 15-pin connector on the new Spellman High Voltage Power Supply

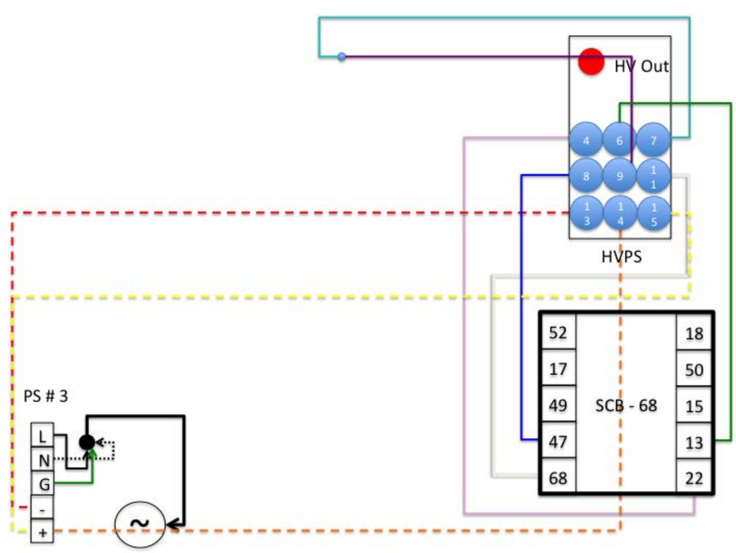

Figure A.8: Electrical Connections For LabVIEW SCB-68 Analog I/O Card, where two classifiers can be run from the same LabVIEW card.

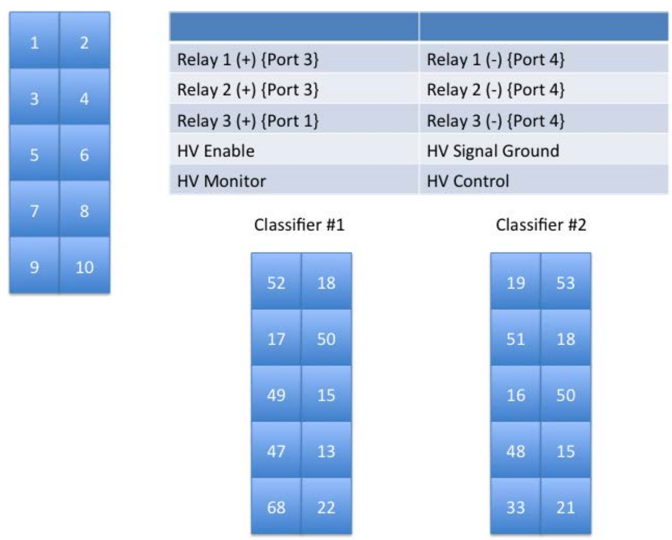

Figure A.9: This shows a template using 10 pins (left) on an SCB-68 card that can control an entire classifier. The diagrams below show which pins should feed into each classifier to make it run together with its components. These pin configurations are programmed into the LabVIEW software for operation of the instrument.

APPENDIX B
MAJOR COMPONENTS OF CONSTRUCTED CLASSIFIERS

B.1 First Generation Classifier

The first generation classifier was constructed using a high voltage power supply that was later discontinued. The voltage control was poor at low voltages, which provided the necessity of a low voltage power supply. The first generation classifiers also never obtained leak free operation in the sheath air system.

Symbol	Name	Manufacturer	Part No.
B1	Blower #1	Ametek	SE12RE21
B2	Blower #2	Ametek	SE12RE21
HEPA1	HEPA Filter #1	Pall	PN 12144
HEPA2	HEPA Filter #2	Pall	PN 12144
HEPA3	HEPA Filter #3	Pall	PN 12144
HE	Heat Exchanger	Lytron	6110G1SB
FM1	Flow Meter #1	TSI	4143
FM2	Flow Meter #2	TSI	4143
N-DMA	Nano DMA	TSI	3085
R1	Blower Relay #1	Digikey	CC1037-ND
R2	Blower Relay #2	Digikey	CC1037-ND
R3	Switching Relay	Digikey	255-2844-ND
HV #1 (#2)	HV Relay	Newark	34M7895
PS#1	12-VDC, 3-A Power Supply	Digikey	3A-502DN12
PS#2	12-VDC, 3-A Power Supply	Chemistry Dept.	3A-502DN12
PS#3	24-VDC, 1.1-A	Digikey	285-1886-ND
PS#4	28-VDC,	Chemistry Dept.	
HVPS	High Voltage Power Supply	Bertan	V6D10N30
SCB-68	SCB-68	National Instruments	182469E-01L

Table B.1: Major components of the Stanier - First Generation Particle Classifier

B.2 Second Generation Classifier

The second generation classifier used an updated high voltage power supply with good control at low voltages. Some updated blowers and engineered fittings were used on the blower sheath air system to provide leak free operation. The second generation classifiers in general are much easier to use whereas the first generation classifier was more of a proto type.

Symbol	Name	Manufacturer	Part No.
B1	Blower #1	Ametek	SE12RE21
B2	Blower #2	Ametek	SE12RE21
HEPA1	HEPA Filter #1	Pall	PN 12144
HEPA2	HEPA Filter #2	Pall	PN 12144
HEPA3	HEPA Filter #3	Pall	PN 12144
HE	Heat Exchanger	Lytron	6110G1SB
FM1	Flow Meter #1	TSI	4143
FM2	Flow Meter #2	TSI	4143
N-DMA	Nano DMA	TSI	3085
R1	Blower Relay #1	Digikey	CC1037-ND
R2	Blower Relay #2	Digikey	CC1037-ND
R3	Switching Relay	Digikey	255-2844-ND
HV #1/HV #2	HV Relay	Newark	34M7895
PS#1	12-VDC, 3-A Power Supply	Digikey	3A-502DN12
PS#2	12-VDC, 3-A Power Supply	Chemistry Dept.	3A-502DN12
PS#3	24-VDC, 1.1-A	Digikey	285-1886-ND
PS#4	28-VDC,	Chemistry Dept.	
HVPS	High Voltage Power Supply	Bertan	V6D10N30
SCB-68	SCB-68	National Instruments	182469E-01L

Table B.2: Major components of the Stanier - Second Generation Particle Classifier

APPENDIX C
DESCRIPTION AND PURPOSE OF MAJOR LABVIEW CODE

All LabVIEW code developed for operation of instruments in the Stanier lab has been placed in the Dropbox Folder entitled "LabVIEW Code". Many old versions of codes exist in other LabVIEW folders in the Dropbox folder "Bondville_Prep" that may not be functional. In addition there are codes developed by Don Collins at Texas A&M University that are not in use in any application in our lab. A Brief description of major virtual instruments (VIs) developed is listed below with associated subVIs.

C.1 Ametek Blowers

This VI controls the flow rate of two blowers simultaneously. The program sends a square wave with a specified duty cycle percentage to a relay that connects power to the Ametek blower motors. Increasing the percentage of the high to low on the square wave, increases the flow of the blower motor. The program also works under in a PI feedback control loop with a TSI flowmeter that is measuring the flow rate against a desired flow rate. The program changes the duty cycle according to the proportional and integrated error from the set point flow rate. There are options for manually controlling the blower by changing the duty cycle percentage directly

- **Name:** "Blowers.vi"
- **Location:** /Dropbox/LabVIEW Code/Operational/Blowers/
- **Uses:** Runs in conjunction with the Classifier and SMPS programs
- **List of Sub Vis:**

  - "Array Window Reducer.vi"
  - "Blower Communication Setup.vi"
  - "Blower DAQmax Setup 2 Sheath.vi"
  - "Blower DAQmax Setup 4 Blowers.vi"
  - "Blower DAQmax Setup.vi"
  - "Blower PID Control Example.vi"
  - "High Low Array.vi"
  - "Serial Flowmeter Sub v3.vi"
  - "Set Flow Rate Type.vi"

- **"Communications and Setup" Tab Features:**
  - Select "Sheath Air COM port" and "Excess Air COM port"
    - Locate port used on 8-port serial connector
    - Add 20 to the number on port label (e.g. Port 6 corresponds to COM 26)
  - Select "PC LabVIEW Slot In Use"
    - The National Instruments PCI 6229 card installed in the PC tower of the computer has two slots for connection to LabVIEW SCB-68 boxes.
    - Trace the 25-pin controller cable to the SCB-68 box and from the SCB-68 to the tower
      - Is your setup connected to the "Upper" or "Lower" slot
      - Note: Most testing done on "Upper" and this is the recommended

configuration

- Select "SCB Controller Configuration"
    - * The SCB-68 box that controls the classifier has two pre-configured 25-pin connectors labeled "Controller 1" and "Controller 2"
        - · Is the instrument you are trying to run connected to "Controller 1" or "Controller 2"?
- Flow Rate Type
    - * Flow balance needs to be achieved on a volumetric basis. The volumetric flow should be reported as an input parameter when classifying or scanning
    - * Choose "Standard" or "Volumetric"
- "Manual Sheath" or "Manual Excess"
    - * You can choose to make the control of the blower manual and adjust the duty cycle by hand in the run "Run Program" tab
    - * Select "T" if you want to control the blowers manual
    - * Select "F" if you want to use PI control to keep the blowers at a desired set-point flow rate

- **"Run Program" Tab Features**
    - **Controls**
        - * "Sheath" and "Excess" Duty Cycle Selection Dials
            - · Used to manually adjust blower flow in "Manual Mode"

        - ∗ "Sheath" and "Excess" Set Points
            - · PI control is used to adjust duty cycle so that these set point flow rates are maintained
    - **Readouts**
        - ∗ "Sheath" and "Excess" Duty Cycle
        - ∗ "Sheath" and "Excess" Flow
            - · In units of standard or volumetric flow (lpm) depending on user selection
        - ∗ "Sheath" and "Excess" Volumetric Flow
            - · Always in units of volumetric flow (lpm)
        - ∗ "Sheath" and "Excess" Pressure
        - ∗ "Sheath" and "Excess" Temperature

C.2 Stanier Particle Classifier

This program takes information on the "Sheath" flow rate from the "Blowers.vi" program and the geometry of the DMA column to provide the voltage necessary to achieve a user-defined particle size. The program is used as a Sub VI in the TDMA and SMPS program where the size of particles to be classified is constantly changing. This program can also be run in voltage mode, where the voltage can be changed directly, without regard to what size of particle is being classified or what geometry exists in the DMA system. This feature is useful for calibration of the high voltage power supply in the classifier.

- **Name:** "Particle Classifier.vi"
- **Location:** /Dropbox/LabVIEW Code/Operational/Particle Classifier/
- **Uses:** Runs in conjunction with the Blowers program to size particles. Also runs as a Sub VI in SMPS and VTDMA programs.
- **List of Sub VIs:**
  - "Voltage Calibration (USB)"
  - "Flow.vi"
  - "dma_settings.vi"
  - "Voltage_v3.vi"
  - "Classifier LabVIEW Card Settings v2(USB).vi"
  - "Dp.vi"
- **"Communications and Setup" Tab Features:**
  - Select "PC LabVIEW Slot In Use"
    - The National Instruments PCI 6229 card installed in the PC tower of the computer has two slots for connection to LabVIEW SCB-68 boxes.
    - Trace the 25-pin controller cable to the SCB-68 box and from the SCB-68 to the tower
      - Is your setup connected to the "Upper" or "Lower" slot
      - Note: Most testing done on "Upper" and this is the recommended configuration
  - Select "SCB Controller Configuration"

    * The SCB-68 box that controls the classifier has two pre-configured 25-pin connectors labeled "Controller 1" and "Controller 2"
        · Is the instrument you are trying to run connected to "Controller 1" or "Controller 2"?
- Select "Voltage Calibration Parameters"
    * A piecewise linear fit function is applied to different sections of the voltage range to ensure accurate voltage control throughout the whole voltage range.
        · If using Classifier 2, choose "VCP1"
        · If using Classifier 3, choose "VCP2"
        · If calibrating the instrument, choose "No Calibration"
- Select "Mode"
    * The classifier can calculate a voltage based on the desired size selection of particles, this is highly dependent on the geometry of the DMA and the sheath flow rate into the DMA. The desired voltage can also be selected directly from 10V - 10kV.
        · Select "Change Particle Size" if you want to size select a specific particle diameter and know the DMA and sheath flow rate
        · Select "Change Voltage" if you want a specific voltage or are calibrating the instrument
- Select "Sheath Flow Rate"

    * This is the volumetric flow rate from the "Blowers.vi" program that should be running in the background if you want to size select particles. If you are running in "Change Voltage" mode, this feature doesn't matter

- **"Run Program" Tab Features**
  - **Controls**
    * "Voltage" only functions in "Change Voltage" mode
    * "Dp" only functions in "Change Particle Size" mode
    * "Stop" button. For safety purposes, this button should be used and not the stop button in the menu bar.
  - **Readouts**
    * "Bertan Voltage"
      · This is the voltage read by the internal volt meter on the high voltage power supply

C.3 Stanier Scanning Mobility Particle Sizer

This program builds on the particle classifier program and uses the geometry and the sheath flow into the DMA to logarithmically scan through a range of voltages corresponding to a range of particle sizes. While scanning, the program communicates with a CPC to get the counts at each size. This program produces an output file of counts vs. time. The output file is read by an intermediate MATLAB script that inverts the particle size distribution and writes a new file in a format that can be read by the same data processing scripts that are used for TSI text output files.

- **Name:** "SMPS.vi"
- **Location:** /Dropbox/LabVIEW Code/Operational/Scanning Particle Sizer/
- **Uses:** Runs in conjunction with the Blowers program to scan through an array of particle sizes. Produces an output file that is read with packaged MATLAB data processing scripts.
- **List of Sub VIs:**
  - "Get Time Info String.vi"
  - "PI Controller.vi"
  - "Intermediate File.vi"
  - "Header File v2.vi"
  - "Voltage_v3_Array.vi"
  - "CPC 3786 COM Configuration.vi"
  - "CPC 3025 COM Configuration.vi"
  - "Voltage_v3.vi"
  - "Classifier Labview Card Settings v2.vi"
  - "Dp Array.vi"
  - "Flow.vi"
  - "dma_settings.vi"
  - "Classifier Sub v2.vi"
  - "Voltage Calibration.vi"

  - "Dp_Sizes.vi"
  - "Dp.vi"
  - "Dpi.vi"
  - "dlogDpUp.vi"
  - "dlogDpDown.vi"

- **"Hardware" Tab Features:**
  - Select "CPC"
    - This program has included functionality for three different types of CPC. Others may work with the system but have not been verified
      - "TSI 3786"
      - "TSI 3785"
      - "TSI 3025"
  - Select "Mode"
    - If the Type of CPC is "TSI 3025", select "High Flow" or "Low Flow"
    - Otherwise this function is not used

- **"Scheduling" Tab Features:**
  - Choose "Sample Start Number"
    - This can be any number and is designed as a way of book keeping if multi-day samples are taken
  - Choose "Number of Samples"

    - This tells the classifier how many scans to execute before stopping. For continuous scanning, select a large number
  - Choose "T_up"
    - This is the up-scan time. It is best to keep times within the ranges specified for TSI classifiers
  - Choose "T_down"
    - This is the down-scan time.
  - Choose "Save Path"
    - This gives a computer location for files to be deposited. The files have a predetermined naming conventions, so there is no need to specify a file name.
  - Select "Delimiter"
    - Choose the type of delimiter to be used in output text files. Comma delimited is recommended
- **"Physical Properties" Tab Features:**
  - Select "DMA"
    - 3085 or 3081
  - Select "Dp Units"
    - "nm" recommended
  - Select "Flow Units"

      * "lpm" recommended

  - Select "Sheath Flow" Rate

      * This is the number from the blowers program and should be set to roughly 10 times the aerosol inlet of the CPC you are using

  - Choose "Time Delay"

      * Best to look at same configuration with TSI software and look at their time delay.

- **"Communications" Tab Features:**

  - Select "PC LabVIEW Slot In Use"

      * The National Instruments PCI 6229 card installed in the PC tower of the computer has two slots for connection to LabVIEW SCB-68 boxes.

      * Trace the 25-pin controller cable to the SCB-68 box and from the SCB-68 to the tower

          · Is your setup connected to the "Upper" or "Lower" slot

          · Note: Most testing done on "Upper" and this is the recommended configuration

  - Select "SCB Controller Configuration"

      * The SCB-68 box that controls the classifier has two pre-configured 25-pin connectors labeled "Controller 1" and "Controller 2"

          · Is the instrument you are trying to run connected to "Controller

1" or "Controller 2"?

- Select "Voltage Calibration Parameters"
  * A piecewise linear fit function is applied to different sections of the voltage range to ensure accurate voltage control throughout the whole voltage range.
    · If using Classifier 2, choose "VCP1"
    · If using Classifier 3, choose "VCP2"
    · If calibrating the instrument, choose "No Calibration"

- **"Run Program" Tab Features**
  - **Controls**
    * "Stop" Button. For safety purposes, the program should always be stopped with this button and not the "Stop" Button in the menu bar
  - **Readouts**
    * "Sample Number"
    * "Number of Samples"
    * "Timer"
    * "Time"
    * "Raw Counts"
      · Raw Counts from CPC
    * "Dp Setting"

- · Shows the current particle size

* "Voltage Setting"

  - · Gives the current voltage to the DMA

* "Particle Minumum"

* "Particle Maximum"

* "CPC Status"

* "Graph"

  - · Visual display of counts vs. Size

APPENDIX D
TRANSMISSION EFFICIENCY CONFIGURATION TABLES

The transmission of particles through sample lines is dependent on a number of factors governing the residence time, including the flow rate, length of tubing. In addition bends and size changes in tubing can produce additional size dependent losses. The loss description files detail each length of tubing in the system and a date range for which that particular configuration was in use. The transmission efficiency configuration code corresponds to a MATLAB header file in "/nfs/hail/local/vol00/projects/cstanier/yara_hail/header_files/" that applies the losses to correcting the size poly size distribution

Begin Date	End Date	TE Config. Code
07/17/13 12:26	07/17/13 17:27	Loss_BND_nano1
07/17/13 17:31	07/21/13 22:56	Loss_BND_nano3
07/22/13 07:05	07/22/13 21:32	Loss_BND_nano1
07/22/13 21:39	07/28/13 06:56	Loss_BND_nano2
07/28/13 06:57	08/02/13 07:01	Loss_BND_nano1
08/02/13 07:02	08/02/13 09:48	Loss_BND_nano2
08/02/13 09:52	08/06/13 11:28	Loss_BND_nano1
08/06/13 11:29	04/21/14 10:19	Loss_BND_nano5
04/21/14 10:20	05/05/14 14:06	Loss_BND_nano6
05/05/14 14:22	05/22/14 19:00	Loss_BND_nano7
05/22/14 19:00	05/24/14 06:24	Loss_BND_nano8
05/24/14 06:25	05/24/14 07:27	Loss_BND_nano9
05/24/14 07:27	05/26/14 16:13	Loss_BND_nano8
05/26/14 16:13	06/04/14 11:05	Loss_BND_nano6
06/04/14 11:14	06/04/14 11:19	Loss_BND_nano7
06/04/14 11:20	06/04/14 13:44	Loss_BND_nano10
06/04/14 13:51	06/04/14 14:56	Loss_BND_nano6

Table D.1: Transmission efficiency files for Nano SMPS

Begin Date	**End Date**	**TE Code**
09/13/13 06:54	03/13/14 13:46	Loss_BND_long1
03/13/14 14:08	03/15/14 16:00	Loss_BND_long2
03/15/14 16:03	04/11/14 07:47	Loss_BND_long1
04/11/14 09:12	04/21/14 10:01	Loss_BND_long2
04/21/14 10:20	05/05/14 14:06	Loss_BND_long3
05/05/14 14:22	05/22/14 19:01	Loss_BND_long4
05/26/14 16:11	06/04/14 11:05	Loss_BND_long3
06/04/14 11:14	06/04/14 11:19	Loss_BND_long4
06/04/14 11:20	06/04/14 13:44	Loss_BND_long5
06/04/14 13:51	06/04/14 14:56	Loss_BND_long3

Table D.2: Transmission Efficiency Files for Long SMPS

APPENDIX E
MASS COMPARISON WITH EPA FILTER SAMPLES

The EPA federal reference method near Bondville Illinois, takes a 24-hour filter sample one day out of every six. This filter samples has no diurnal information, but is a 24-hour average of the mass of particles smaller than 2.5 μ m. We measured the size distribution continuously for 10 months. The three instruments covering the range of particles from 3 nm to 2.5 μ m were averaged hourly, corrected for efficiency line losses, and merged. Some extra treatment was necessary for the APS, due to its size dependent counting efficiency and time of flight operating principle. There was a small gap of sizes not sampled by the APS or long column DMA that was approximated by a logarithmic interpolation for the region between the extremes of the two samples. Hourly averages shown below are for days when there was at least 18 hours of valid data in both the long SMPS and the APS.

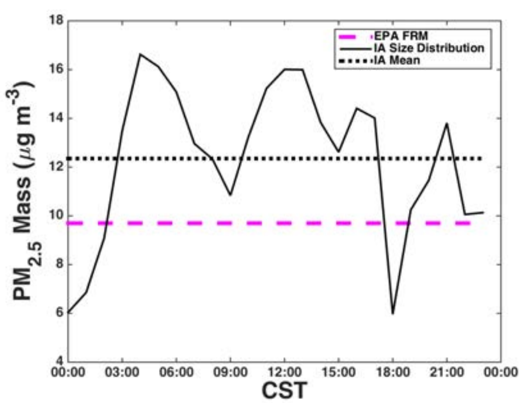

Figure E.1: Mass Comparison With EPA FRM For Aug-08-2013

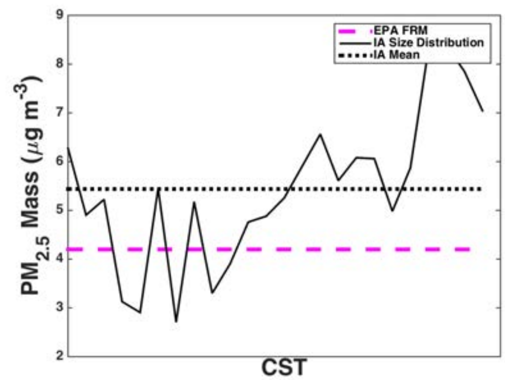

Figure E.2: Mass Comparison With EPA FRM For Aug-14-2013

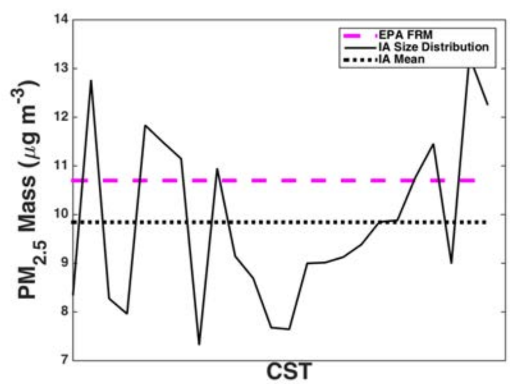

Figure E.3: Mass Comparison With EPA FRM For Aug-17-2013

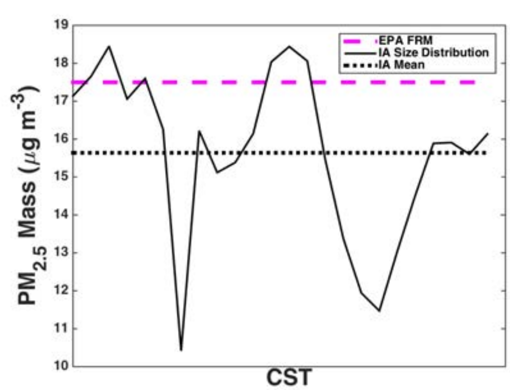

Figure E.4: Mass Comparison With EPA FRM For Aug-20-2013

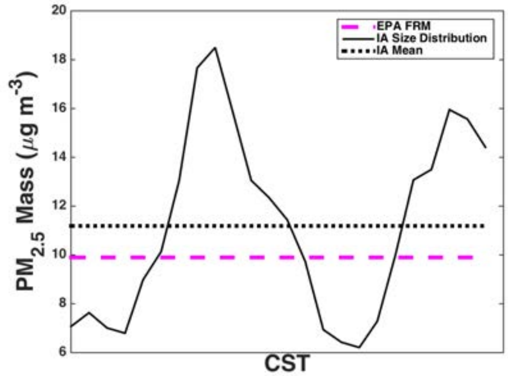

Figure E.5: Mass Comparison With EPA FRM For Aug-23-2013

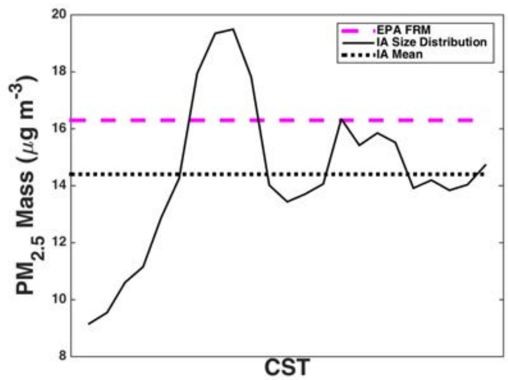

Figure E.6: Mass Comparison With EPA FRM For Aug-26-2013

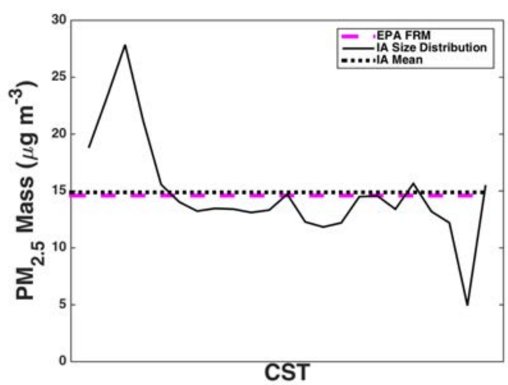

Figure E.7: Mass Comparison With EPA FRM For Aug-29-2013

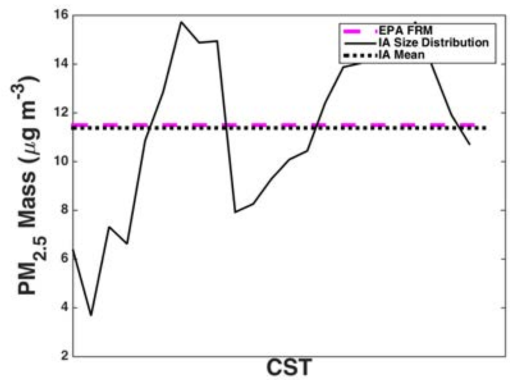

Figure E.8: Mass Comparison With EPA FRM For Sep-01-2013

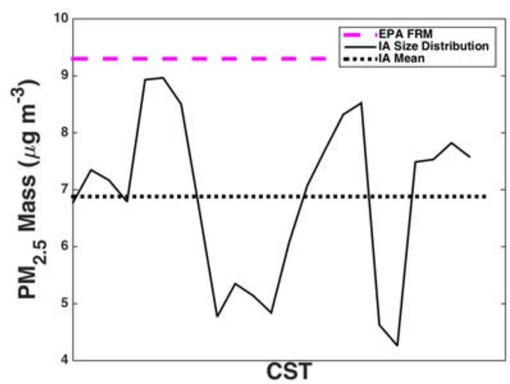

Figure E.9: Mass Comparison With EPA FRM For Sep-04-2013

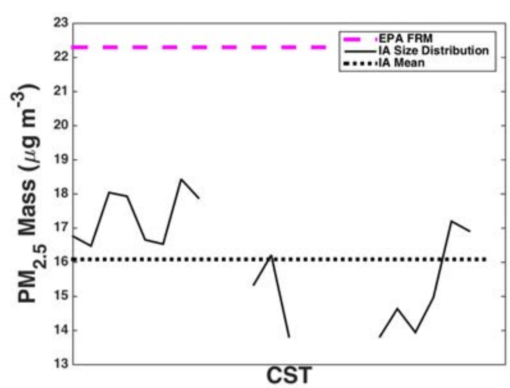

Figure E.10: Mass Comparison With EPA FRM For Sep-07-2013

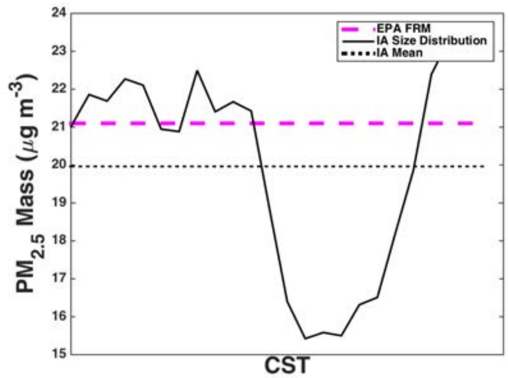

Figure E.11: Mass Comparison With EPA FRM For Sep-10-2013

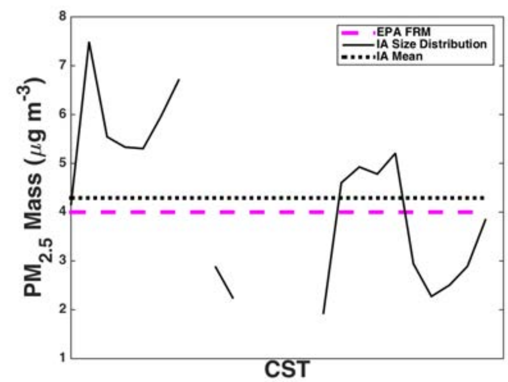

Figure E.12: Mass Comparison With EPA FRM For Sep-13-2013

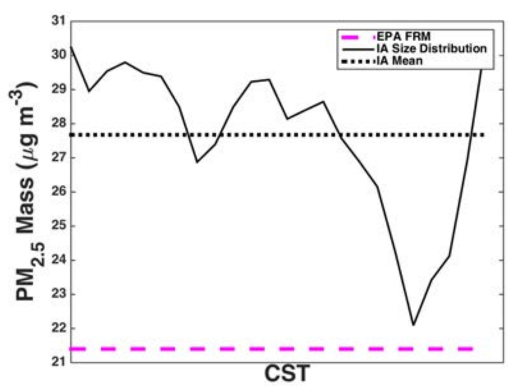

Figure E.13: Mass Comparison With EPA FRM For Sep-19-2013

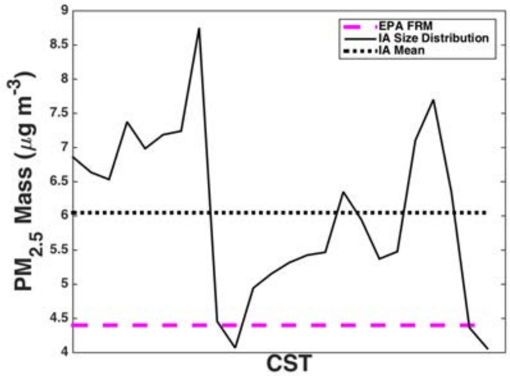

Figure E.14: Mass Comparison With EPA FRM For Sep-22-2013

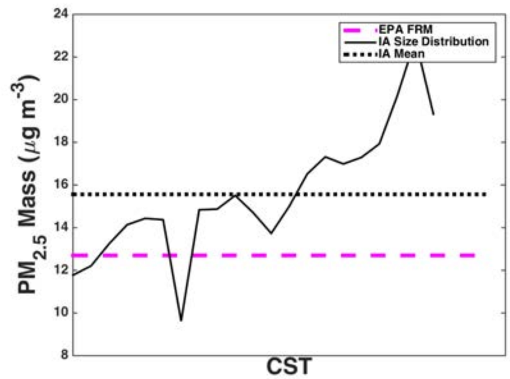

Figure E.15: Mass Comparison With EPA FRM For Sep-25-2013

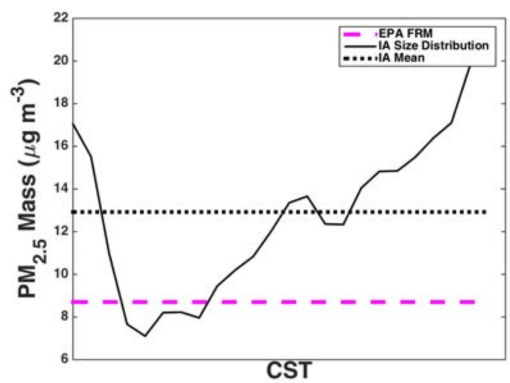

Figure E.16: Mass Comparison With EPA FRM For Oct-01-2013

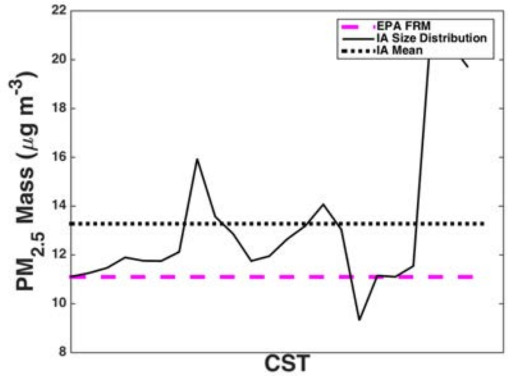

Figure E.17: Mass Comparison With EPA FRM For Oct-10-2013

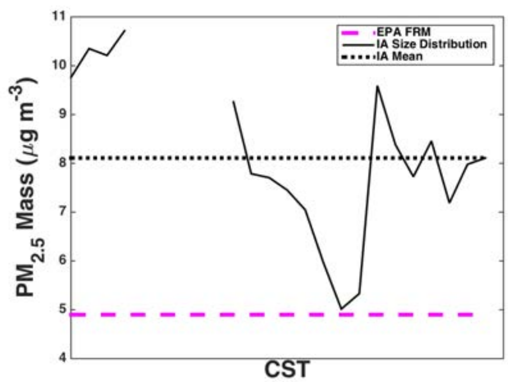

Figure E.18: Mass Comparison With EPA FRM For Oct-13-2013

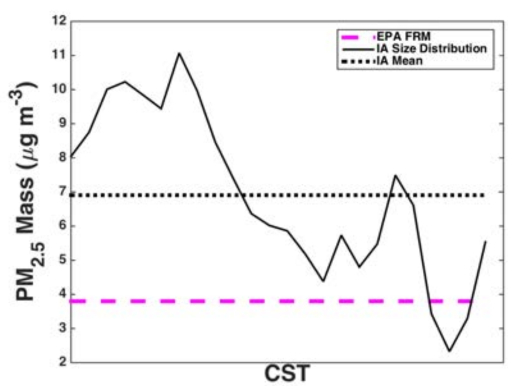

Figure E.19: Mass Comparison With EPA FRM For Oct-22-2013

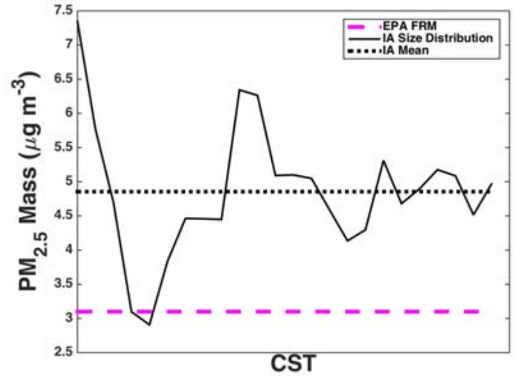

Figure E.20: Mass Comparison With EPA FRM For Oct-19-2013

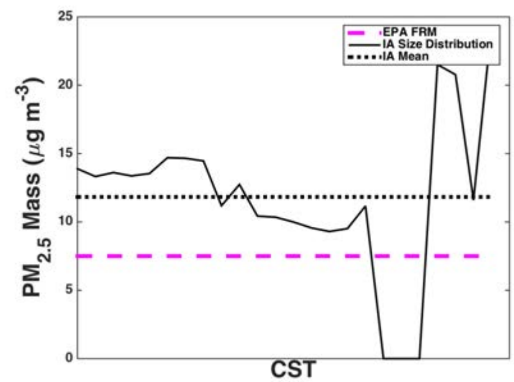

Figure E.21: Mass Comparison With EPA FRM For Oct-28-2013

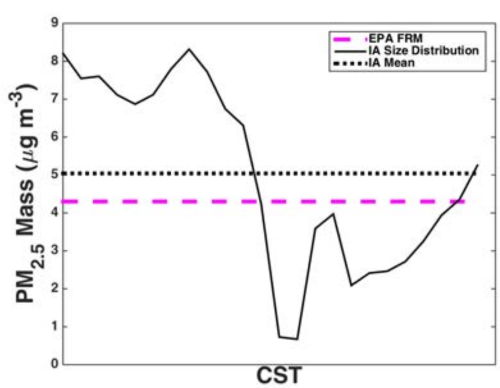

Figure E.22: Mass Comparison With EPA FRM For Nov-06-2013

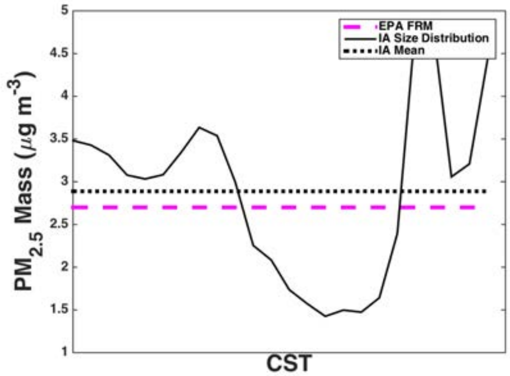

Figure E.23: Mass Comparison With EPA FRM For Nov-24-2013

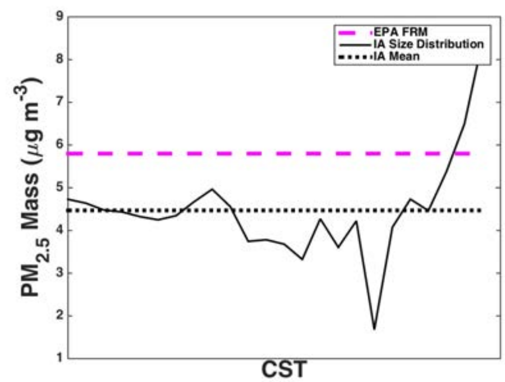

Figure E.24: Mass Comparison With EPA FRM For Nov-27-2013

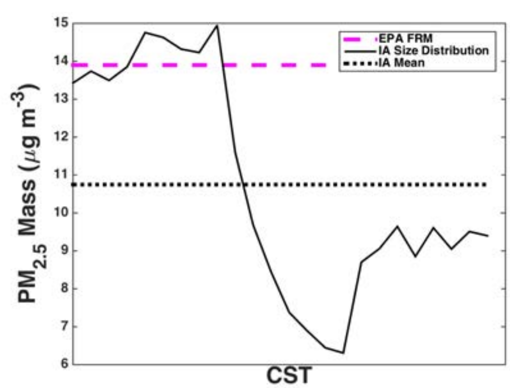

Figure E.25: Mass Comparison With EPA FRM For Nov-30-2013

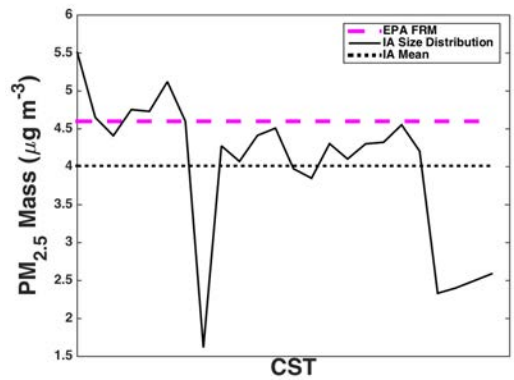

Figure E.26: Mass Comparison With EPA FRM For Dec-06-2013

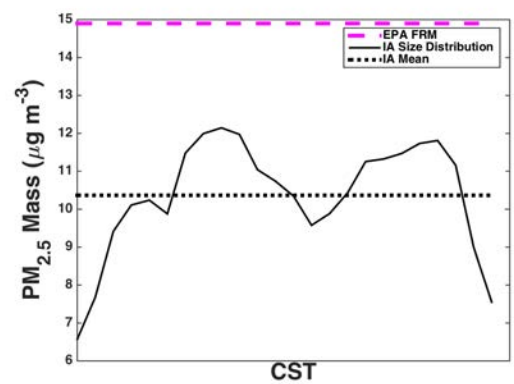

Figure E.27: Mass Comparison With EPA FRM For Dec-15-2013

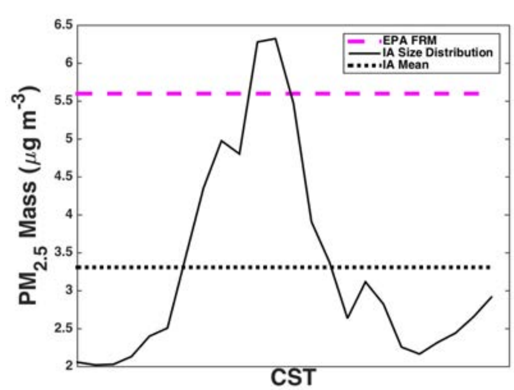

Figure E.28: Mass Comparison With EPA FRM For Dec-18-2013

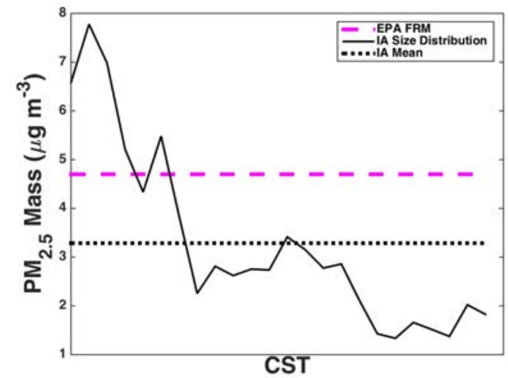

Figure E.29: Mass Comparison With EPA FRM For Dec-21-2013

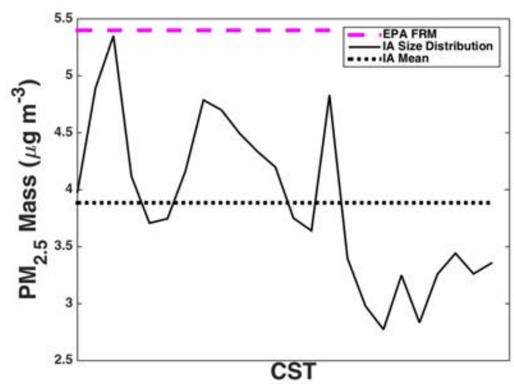

Figure E.30: Mass Comparison With EPA FRM For Dec-24-2013

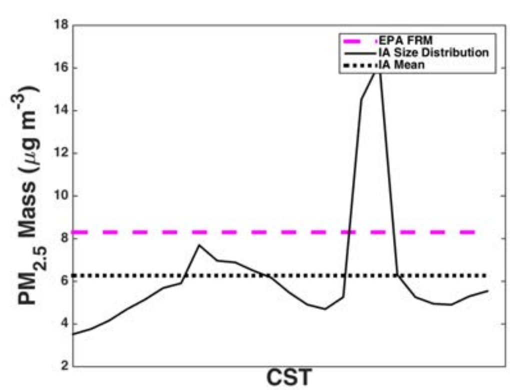

Figure E.31: Mass Comparison With EPA FRM For Dec-30-2013

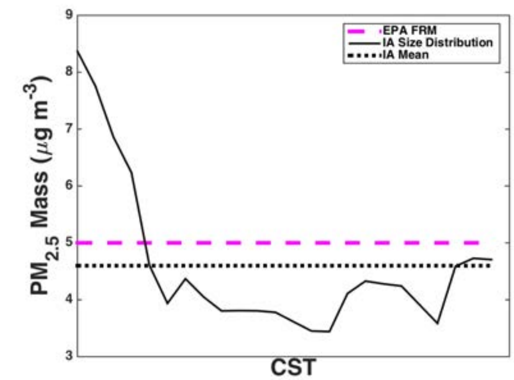

Figure E.32: Mass Comparison With EPA FRM For Jan-02-2014

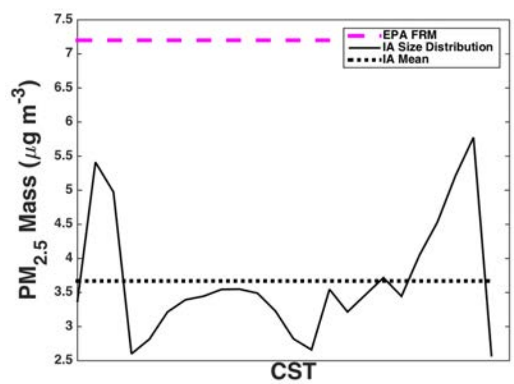

Figure E.33: Mass Comparison With EPA FRM For Jan-20-2014

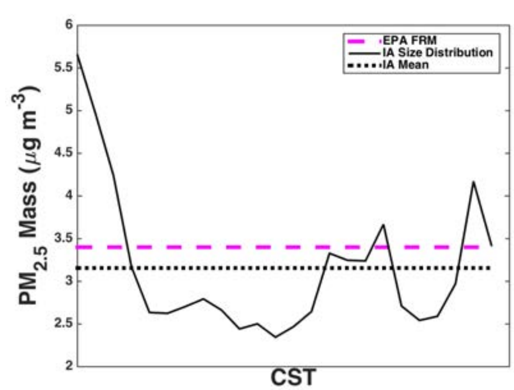

Figure E.34: Mass Comparison With EPA FRM For Jan-23-2014

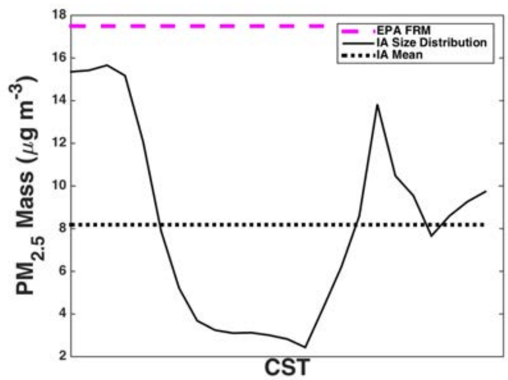

Figure E.35: Mass Comparison With EPA FRM For Feb-01-2014

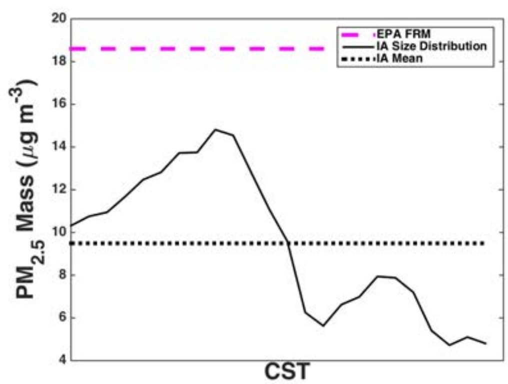

Figure E.36: Mass Comparison With EPA FRM For Feb-04-2014

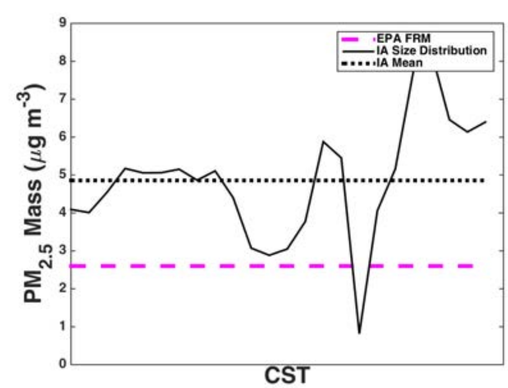

Figure E.37: Mass Comparison With EPA FRM For Mar-15-2014

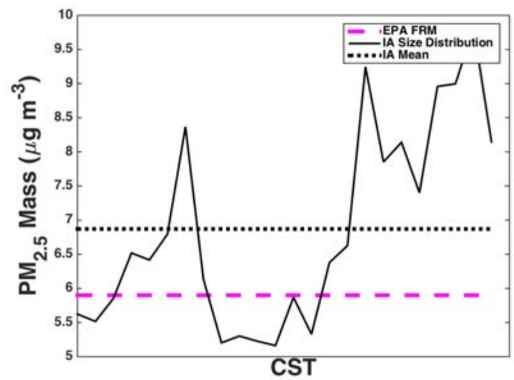

Figure E.38: Mass Comparison With EPA FRM For Mar-24-2014

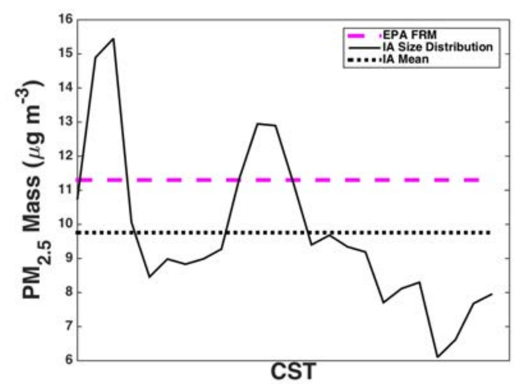

Figure E.39: Mass Comparison With EPA FRM For Mar-27-2014

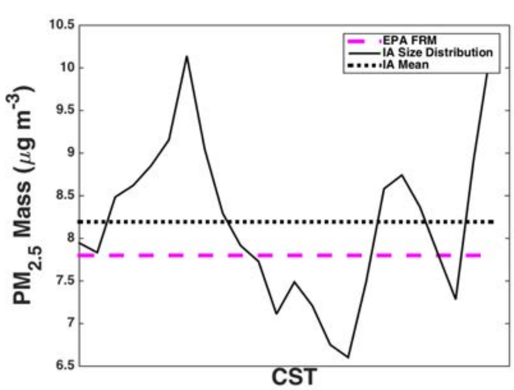

Figure E.40: Mass Comparison With EPA FRM For Apr-02-2014

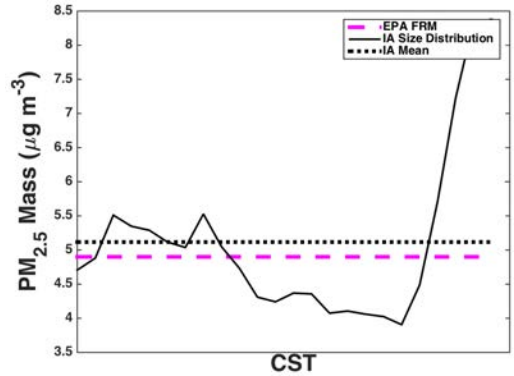

Figure E.41: Mass Comparison With EPA FRM For Apr-05-2014

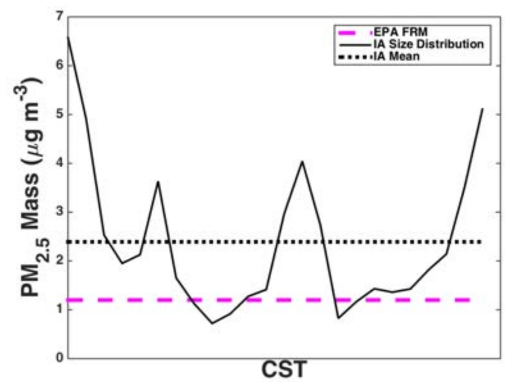

Figure E.42: Mass Comparison With EPA FRM For Apr-14-2014

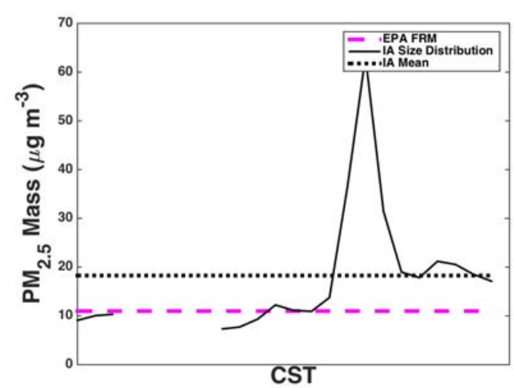

Figure E.43: Mass Comparison With EPA FRM For Apr-17-2014

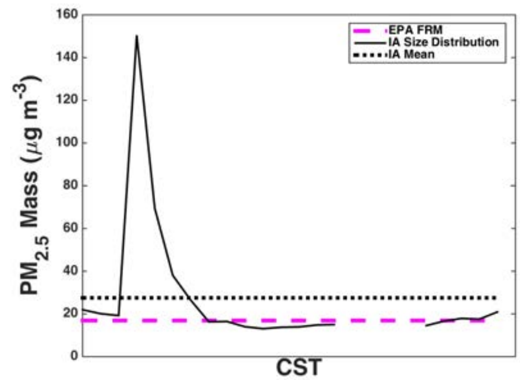

Figure E.44: Mass Comparison With EPA FRM For Apr-20-2014

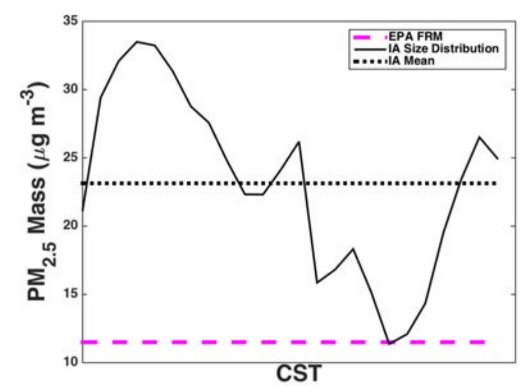

Figure E.45: Mass Comparison With EPA FRM For May-29-2014

APPENDIX F
DATA COVERAGE BY MONTH

Due to instrument availability and instrument malfunction, it was necessary to operate a number of different particle counters during this field campaign. The instruments were also run periodically in different configurations. The monthly data coverage plots capture the different configurations and instruments run throughout the campaign. The blue series are representative of instruments that use a nano DMA and measure sizes from $\sim 3\ nm$ to $65\ nm$. The green series represent instruments that use a long DMA for sizing and operate at $\sim 10\ nm$ to $400\ nm$. There is only one red instrument, the APS, which operates from $\sim 0.5\ \mu$ m to $20\ \mu$ m.

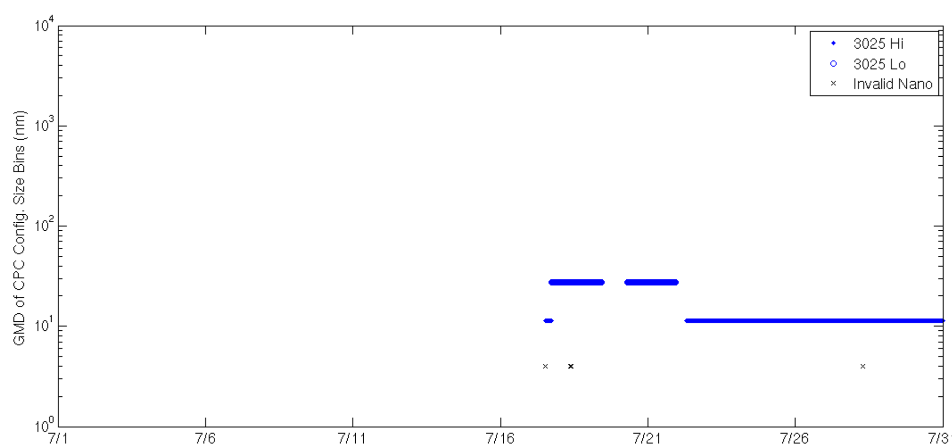

Figure F.1: Data Coverage For July 2013

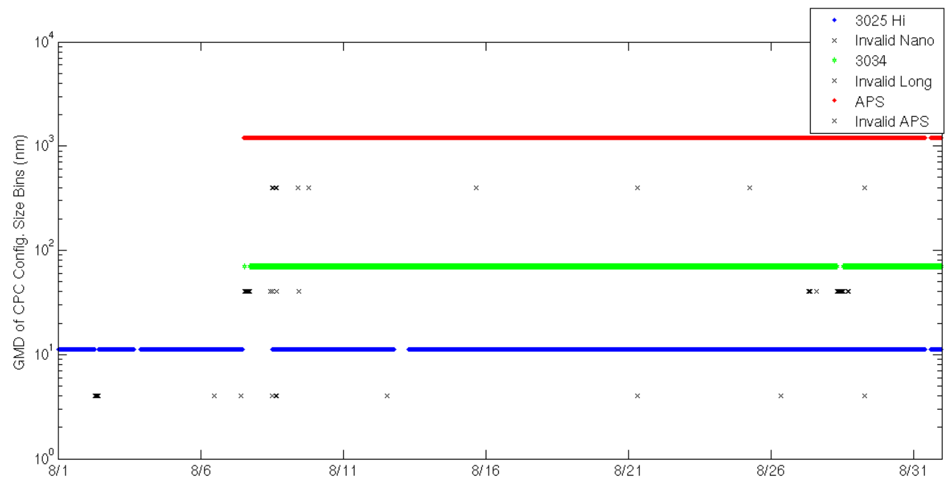

Figure F.2: Data Coverage For August 2013

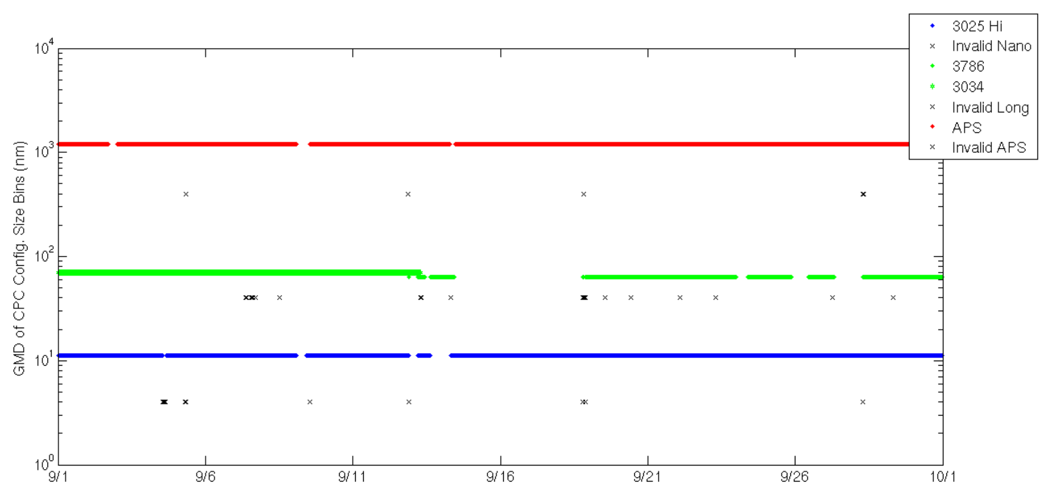

Figure F.3: Data Coverage For September 2013

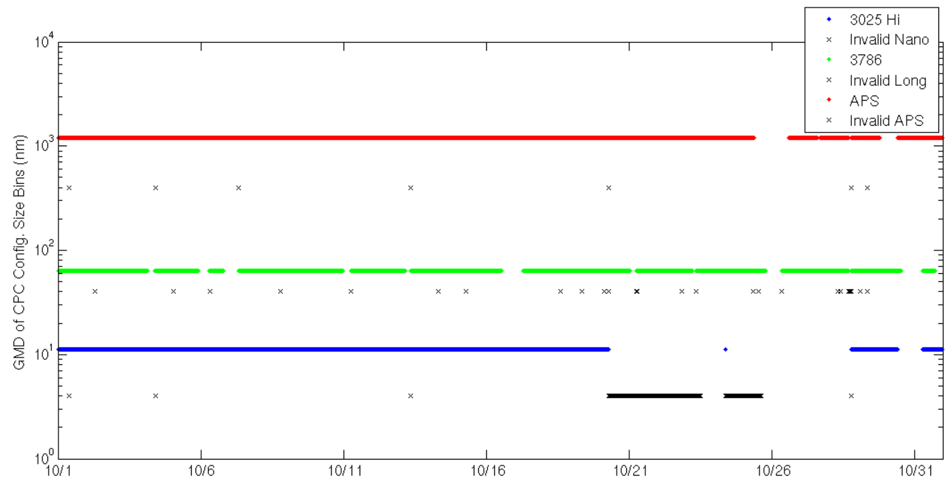

Figure F.4: Data Coverage For October 2013

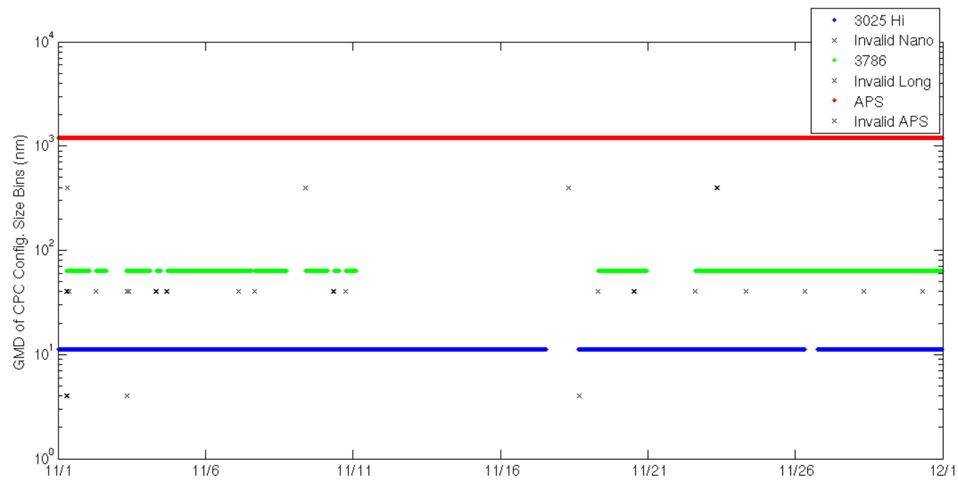

Figure F.5: Data Coverage For November 2013

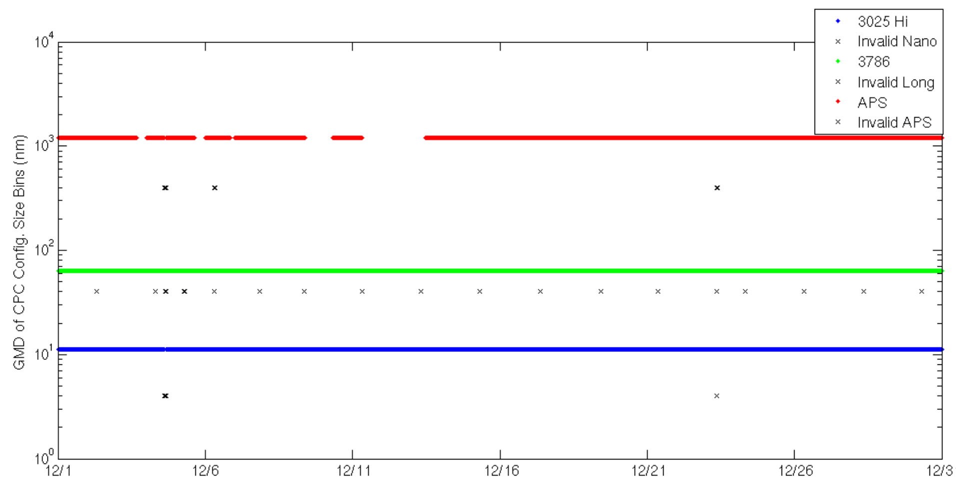

Figure F.6: Data Coverage For December 2013

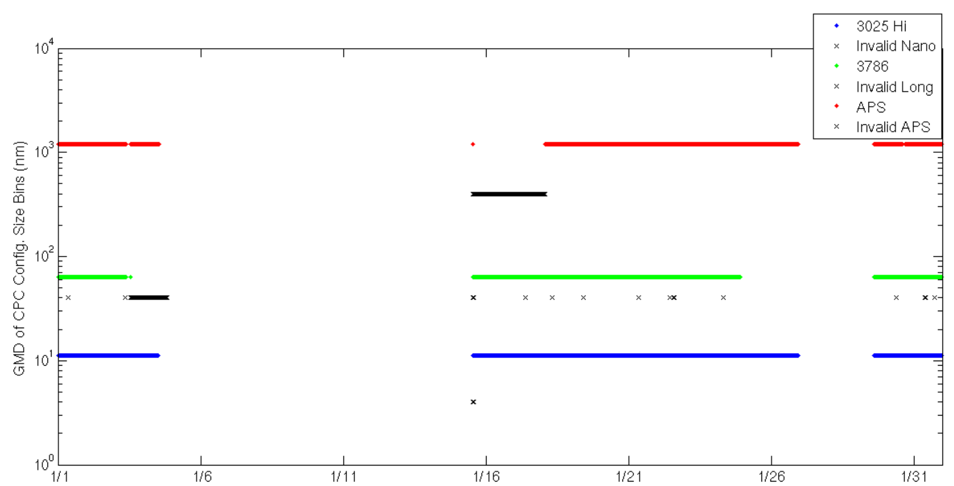

Figure F.7: Data Coverage For January 2014

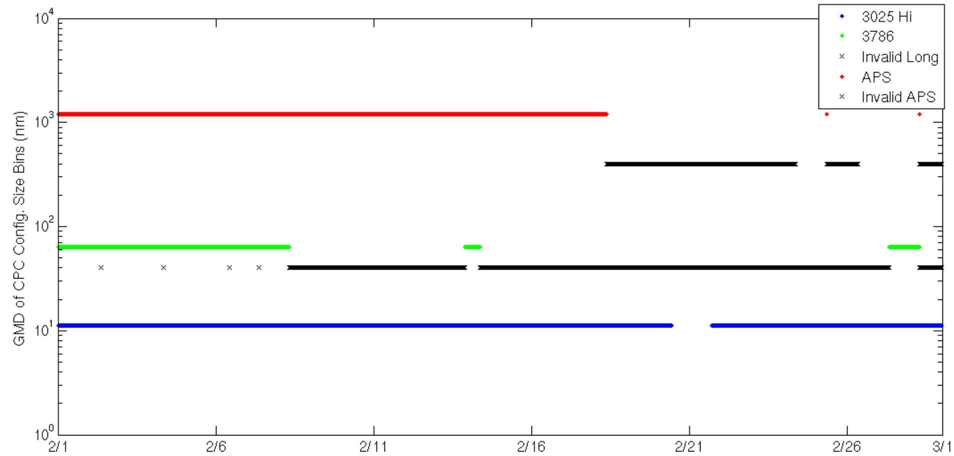

Figure F.8: Data Coverage For February 2014

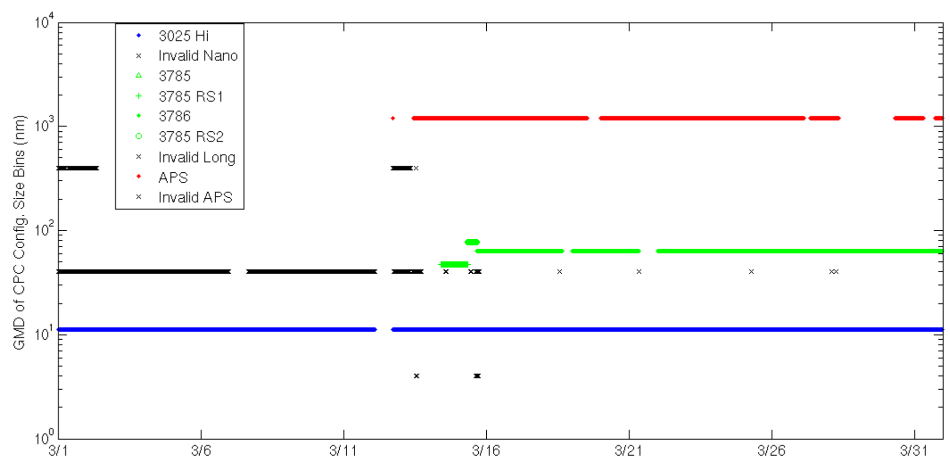

Figure F.9: Data Coverage For March 2014

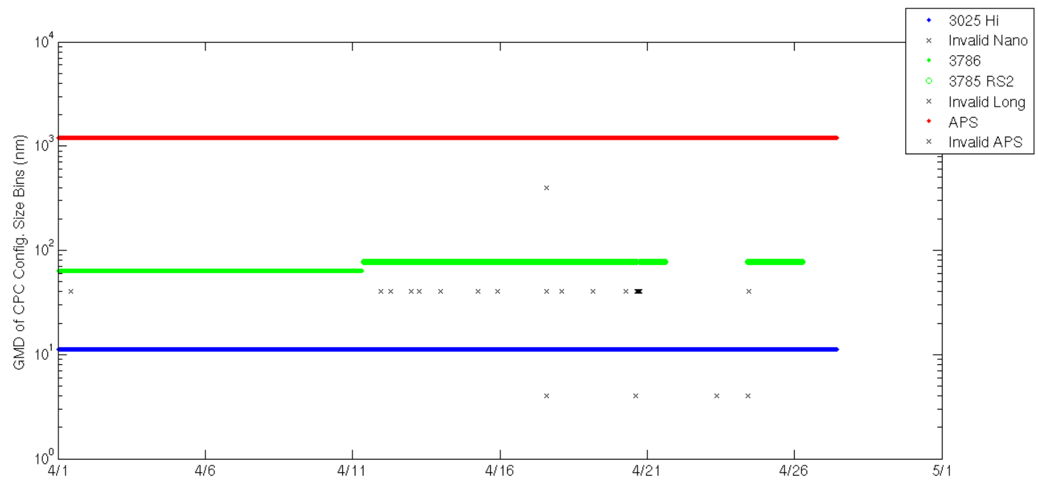

Figure F.10: Data Coverage For April 2014

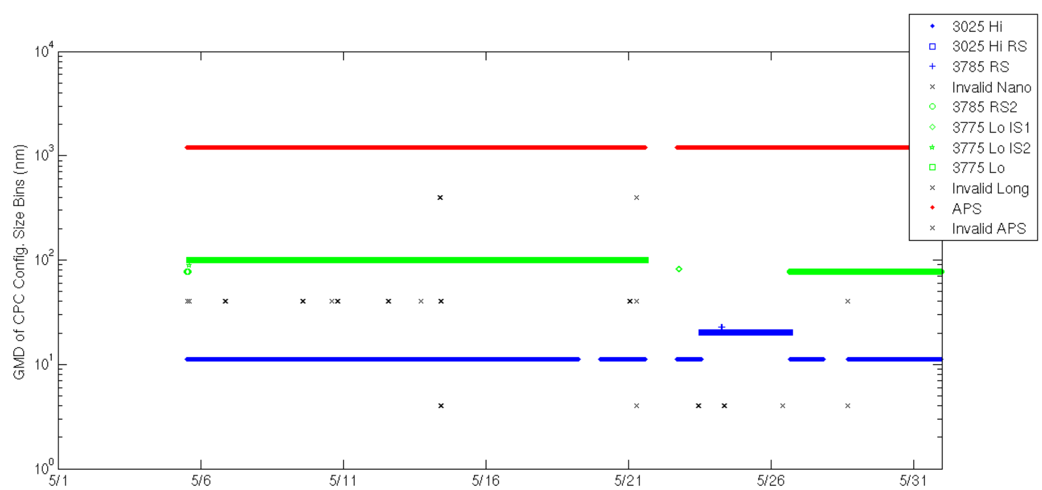

Figure F.11: Data Coverage For May 2014

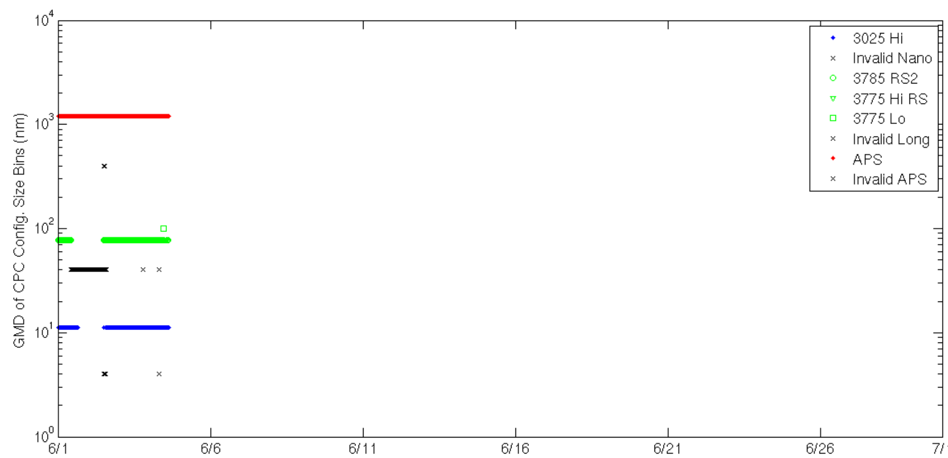

Figure F.12: Data Coverage For June 2014

APPENDIX G
MEAN VS. MEDIAN IN DIURNAL DISTRIBUTIONS

On first glance using Median values the monthly median does not seem to be consist with the diurnal mean. The mean values are more consistent, but are not used in most of Chapter 7 due to the episodic spikes that occur during months with smaller sample size.

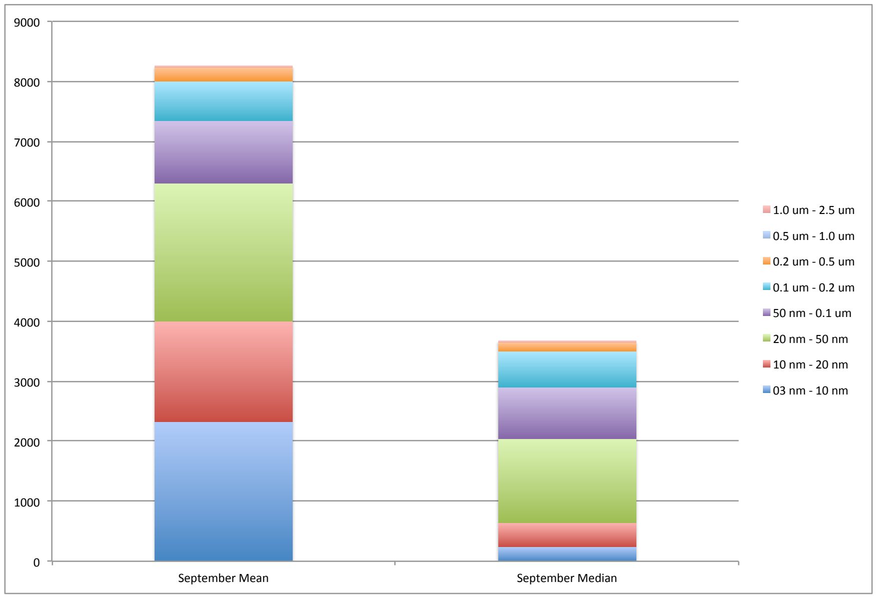

Figure G.1: The difference between binned monthly averages and binned monthly medians for September 2013.

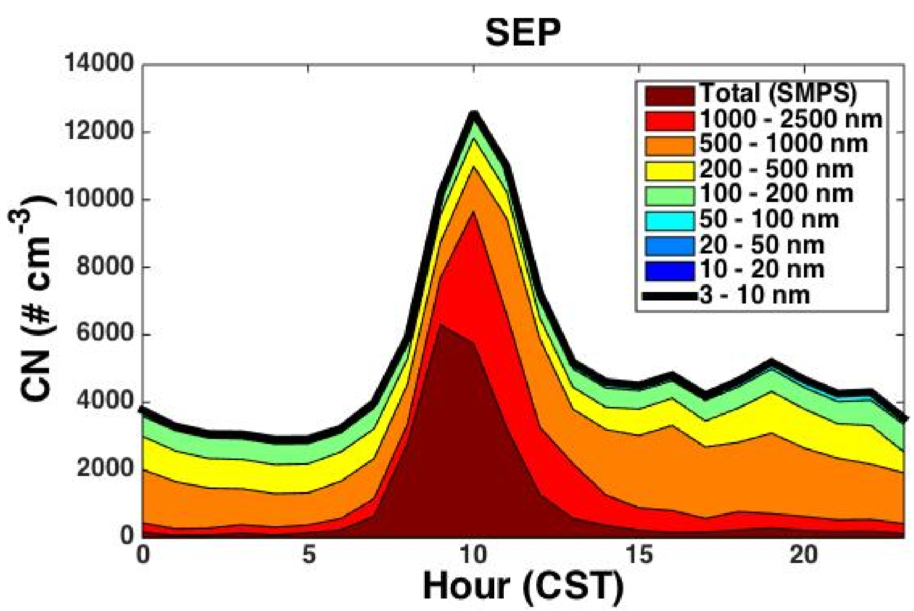

Figure G.2: The binned diurnal median for the month of September

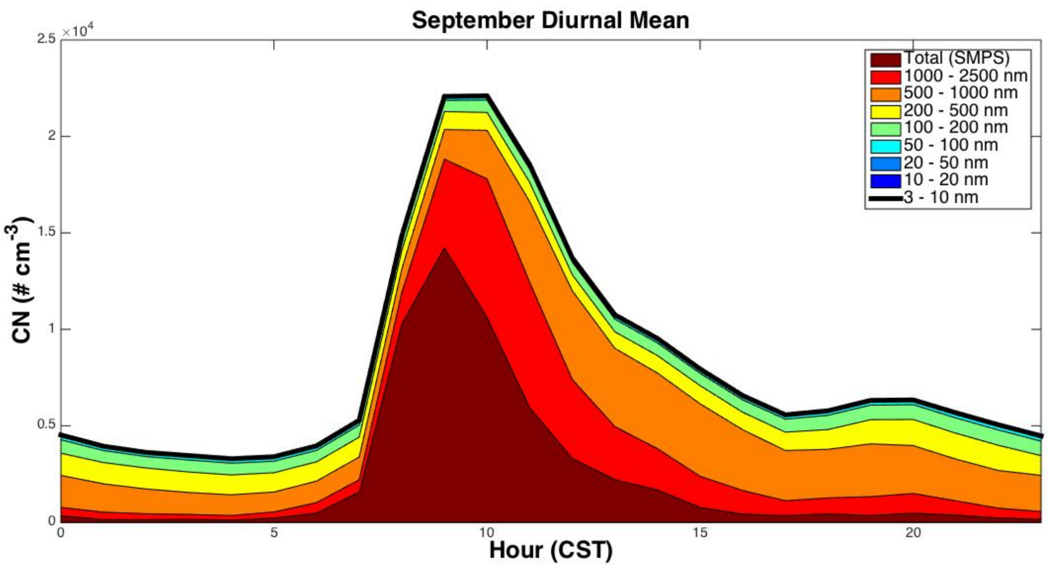

Figure G.3: The binned diurnal average for the month of September

APPENDIX H
OVERLAP OF NDMA AND LDMA AT 30 NM

This section includes a table describing the overlap conditions at 30 *nm* for the lDMA and the nDMA. For most of the campaign there seems to be good agreement. There are times when the overlap can be lower in the nDMA and vice versa.

Interval Start	Interval End	Agreement	Notes:
07/17/13	08/07/13	N/A	No Long DMA
08/08/13	09/12/13	Excellent	SMPS 3034 In Use
09/13/13	09/17/13	N/A	Long DMA Down
09/18/13	09/26/13	Good	Long DMA Slightly Enhanced
09/27/13	09/27/13	N/A	No Long DMA
09/28/13	10/03/13	Good	Long DMA Slightly Enhanced
10/04/13	10/12/13	Fair	More Long DMA Enhancement
10/13/13	10/20/13	Poor	Large Long DMA Enhancement
10/21/13	10/27/13	N/A	Long and Nano Down Time
10/28/13	11/04/13	Fair	More Long DMA Enhancement
11/05/13	11/11/13	Good	Long DMA Slightly Enhanced
11/12/13	11/18/13	N/A	No Long DMA
11/19/13	11/22/13	Fair	More Long DMA Enhancement
11/23/13	11/28/13	Good	Long DMA Slightly Enhanced
11/29/13	12/04/13	Good	Nano DMA Enhancement
12/05/13	01/03/14	Fair	More Nano DMA Enhancement
01/04/14	01/14/14	N/A	Polar Vortex Down Time
01/15/14	01/24/14	Fair	More Nano DMA Enhancement
01/25/14	01/28/14	N/A	More Polar Vortex Down Time
01/29/14	02/05/14	Fair	More Nano DMA Enhancement
02/06/14	02/07/14	Good	More Nano DMA Enhancement
02/08/14	03/13/14	N/A	Instrument Down Time
03/14/14	03/19/14	Good	Nano DMA Enhancement
03/20/14	04/08/14	Excellent	Running With 3785 CPC
04/09/14	04/10/14	N/A	Not Running
04/11/14	04/14/14	Good	Long DMA Slightly Enhanced
04/15/14	04/26/14	Fair	More Long DMA Enhancement
04/27/14	05/04/14	N/A	Instrument Down Time
05/05/14	05/09/14	Fair	More Nano DMA Enhancement
05/10/14	05/13/14	Good	Alternating Enhancement
05/14/14	05/21/14	Fair	More Nano DMA Enhancement
05/22/14	05/25/14	N/A	Instrument Down Time
05/26/14	06/04/14	Fair	More Long DMA Enhancement

Table H.1: Different time periods show different levels of agreement in the 30 nm overlap region. More analysis and verification with instrument logs is needed to determine causal factors in particle sizing discrepancies.

APPENDIX I
DATA QUALITY FLAGS

Data quality flags were applied for a number of different situations during the field campaign. The flags are stored as a configuration file for the data processing. Some flags invalidate a sample and some flags only alert the user of the conditions present at the time of sampling. The flags also have the option of being implemented or not. It may be useful for example to have a flag in place where an unusual event occurred, but after finding that it didn't affect the data, the implementation of the flags is not needed or can be changed to a flag that only alerts users but doesn't invalidate data.

Date	Time Start	Time End	Description	Instrument
07/16/2012	00:00:00	17:18:58	MISSING DATA	LONG
07/16/2012	22:18:56	23:59:59	MISSING DATA	LONG
07/17/2012	00:00:00	09:02:47	MISSING DATA	LONG
07/17/2012	00:00:00	13:59:25	MISSING DATA	APS
07/17/2012	11:22:19	23:59:59	MISSING DATA	LONG
07/17/2012	13:59:26	14:23:26	NOT SAMPLING THROUGH INLE	APS
07/17/2012	14:23:27	23:59:59	MISSING DATA	APS
07/18/2012	00:00:00	09:12:54	MISSING DATA	LONG
07/18/2012	11:46:43	12:53:18	MISSING DATA	LONG
07/19/2012	19:32:34	19:37:33	TEMPORARY GLITCH IN SAMPL	LONG
07/23/2012	06:22:55	23:59:59	MISSING DATA	LONG
07/24/2012	00:00:00	12:18:24	MISSING DATA	LONG
07/26/2012	07:47:49	08:18:27	MISSING DATA	LONG
07/27/2012	00:00:00	14:56:46	MISSING DATA	APS
07/27/2012	10:24:05	15:04:24	MISSING DATA	LONG
07/28/2012	12:36:48	12:52:44	MISSING DATA	APS
07/30/2012	11:12:46	12:29:29	MISSING DATA	APS
07/30/2012	12:13:02	12:32:15	MISSING DATA	LONG
08/01/2012	15:27:17	19:14:06	MISSING DATA	LONG
08/01/2012	15:28:31	19:11:47	MISSING DATA	APS
08/03/2012	08:53:57	23:59:59	VOLATILITY TDMA MODE	LONG
08/03/2012	16:29:40	16:41:30	HEPA FILTER ON INLET	LONG
08/03/2012	16:52:50	18:08:05	MISSING DATA	LONG
08/04/2012	00:00:00	23:59:59	VOLATILITY TDMA MODE	LONG
08/04/2012	11:45:24	15:14:41	MISSING DATA	APS
08/04/2012	16:29:43	23:59:59	MISSING DATA	APS
08/05/2012	00:00:00	23:59:59	VOLATILITY TDMA MODE	LONG
08/06/2012	00:00:00	23:59:59	VOLATILITY TDMA MODE	LONG
08/07/2012	00:00:00	08:27:12	VOLATILITY TDMA MODE	LONG
08/07/2012	08:27:12	23:59:59	MISSING DATA	LONG
07/17/2013	00:00:00	12:27:40	NOT CONNECTED THROUGH INL	NANO
07/17/2013	12:27:40	23:59:59	INVALID DATA AT SMALL SIZ	NANO
07/17/2013	13:37:11	17:41:38	MISSING DATA	NANO
07/18/2013	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	NANO
07/18/2013	06:38:00		FLOW TEST	NANO
07/18/2013	06:38:00		HEPA FILTER ON AEROSOL IN	NANO
07/18/2013	08:30:01	09:04:24	MISSING DATA	NANO
07/18/2013	08:47:40	09:30:49	NOT SAMPLING THROUGH INLE	NANO
07/18/2013	09:04:00	09:23:00	ZERO OF SO2 MONITOR	NANO
07/19/2013	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	NANO
07/19/2013	02:29:07	02:29:08	SHORT DURATION SPIKE	NANO
07/19/2013	10:41:37	23:59:59	MISSING DATA	NANO
07/20/2013	00:00:00	07:47:29	MISSING DATA	NANO
07/20/2013	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	NANO
07/20/2013	07:43:42	07:45:54	NOT SAMPLING THROUGH INLE	NANO
07/21/2013	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	NANO
07/21/2013	21:20:00	21:37:00	RAINFALL	NANO
07/21/2013	22:06:00	23:42:00	RAINFALL	NANO
07/21/2013	22:55:31	23:59:59	MISSING DATA	NANO
07/22/2013	00:00:00	01:32:00	RAINFALL	NANO

Table I.1: Table 1 of 53

Date	Time Start	Time End	Description	Instrument
07/22/2013	00:00:00	07:06:40	MISSING DATA	NANO
07/22/2013	21:32:19	21:32:58	DRYER CHANGE	NANO
07/22/2013	23:53:00	23:59:59	RAINFALL	NANO
07/23/2013	06:23:22	06:45:51	DISCONTINUOUS SIZE DISTRI	NANO
07/26/2013	04:56:01	05:16:15	POSSIBLE LOCAL SOURCE	NANO
07/26/2013	17:21:00	17:44:00	RAINFALL	NANO
07/27/2013	02:11:13	02:11:14	SHORT DURATION SPIKE	NANO
07/27/2013	06:18:36	06:18:37	SHORT DURATION SPIKE	NANO
07/28/2013	05:24:00	05:24:01	SHORT DURATION SPIKE	NANO
07/28/2013	06:56:09	06:57:19	DRYER CHANGE	NANO
07/29/2013	07:29:19	07:33:49	DISCONTINUOUS SIZE DISTRI	NANO
07/29/2013	12:28:26	12:29:26	DISCONTINUOUS SIZE DISTRI	NANO
07/29/2013	15:12:37	15:23:51	DISCONTINUOUS SIZE DISTRI	NANO
07/30/2013	09:32:00	12:13:00	RAINFALL	NANO
07/30/2013	14:53:59	14:54:00	SHORT DURATION SPIKE	NANO
07/30/2013	16:59:56	16:59:57	SHORT DURATION SPIKE	NANO
07/31/2013	13:12:00	13:29:00	RAINFALL	NANO
08/01/2013	07:16:11	07:38:40	POSSIBLE LOCAL SOURCE	NANO
08/01/2013	19:04:38	19:04:39	SHORT DURATION SPIKE	NANO
08/02/2013	07:01:02	07:03:00	DRYER CHANGE	NANO
08/02/2013	07:01:02	09:56:43	NOT SAMPLING THROUGH INLE	NANO
08/02/2013	18:10:27	18:10:28	SHORT DURATION SPIKE	NANO
08/03/2013	02:18:00	02:44:00	RAINFALL	NANO
08/03/2013	14:36:10	14:38:24	POSSIBLE LOCAL SOURCE	NANO
08/03/2013	14:47:24	14:49:39	POSSIBLE LOCAL SOURCE	NANO
08/03/2013	16:15:07	21:41:43	MISSING DATA	NANO
08/04/2013	19:37:27	19:39:42	POSSIBLE LOCAL SOURCE	NANO
08/04/2013	19:41:57	19:44:12	POSSIBLE LOCAL SOURCE	NANO
08/04/2013	19:53:12	19:57:42	POSSIBLE LOCAL SOURCE	NANO
08/05/2013	07:16:54	07:19:09	POSSIBLE LOCAL SOURCE	NANO
08/05/2013	07:39:23	07:40:23	POSSIBLE LOCAL SOURCE	NANO
08/05/2013	09:47:37	09:52:05	POSSIBLE LOCAL SOURCE	NANO
08/05/2013	10:21:19	10:22:19	POSSIBLE LOCAL SOURCE	NANO
08/05/2013	10:41:33	10:42:33	POSSIBLE LOCAL SOURCE	NANO
08/05/2013	14:42:12	14:48:57	POSSIBLE LOCAL SOURCE	NANO
08/06/2013	11:28:19	11:29:19	DRYER CHANGE	NANO
08/06/2013	15:42:18	15:51:18	POSSIBLE LOCAL SOURCE	NANO
08/07/2013	00:00:00	12:42:08	MISSING DATA	APS
08/07/2013	00:00:00	12:48:21	MISSING DATA	S34
08/07/2013	10:13:19	10:17:49	MISSING DATA	NANO
08/07/2013	10:13:19	10:28:00	HEPA FILTER TEST	NANO
08/07/2013	10:31:00	10:58:00	ZERO OF SO2 MONITOR	S34
08/07/2013	10:31:00	10:58:00	ZERO OF SO2 MONITOR	NANO
08/07/2013	11:18:32	23:59:59	MISSING DATA	NANO
08/07/2013	11:21:00	23:59:59	NOT SAMPLING THROUGH INLE	NANO
08/07/2013	12:48:21	17:57:21	NOT SAMPLING THROUGH INLE	S34
08/07/2013	15:09:21	15:18:21	MISSING DATA	S34
08/07/2013	17:53:08	23:59:59	PATTERN CHANGE	APS
08/07/2013	17:57:21	23:59:59	PATTERN CHANGE	S34
08/07/2013	18:29:08	18:31:09	INSUFFICENT WATER REMOVAL	APS

Table I.2: Table 2 of 53

Date	Time Start	Time End	Description	Instrument
08/07/2013	18:41:08	18:41:09	INSUFFICENT WATER REMOVAL	APS
08/07/2013	19:56:08	20:19:09	INSUFFICENT WATER REMOVAL	APS
08/07/2013	20:28:08	20:40:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	00:00:00	12:12:27	INSTRUMENT CALIBRATION AN	NANO
08/08/2013	00:00:00	12:19:15	MISSING DATA	NANO
08/08/2013	04:34:08	04:36:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	06:15:08	06:17:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	06:32:08	06:34:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	06:40:08	06:40:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	07:28:08	07:28:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	10:33:08	10:33:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	10:40:41	10:56:45	NOT SAMPLING THROUGH INLE	S34
08/08/2013	11:29:08	11:30:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	11:35:08	11:35:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	11:49:19	11:52:59	DRYER CHANGE	NANO
08/08/2013	12:12:27	12:14:44	FLOW TEST	NANO
08/08/2013	12:14:45	12:19:14	HEPA FILTER ON AEROSOL IN	NANO
08/08/2013	12:15:21	12:18:20	FLOW TEST	S34
08/08/2013	12:19:15	12:21:29	FLOW TEST	NANO
08/08/2013	12:24:21	12:39:20	HEPA FILTER ON AEROSOL IN	S34
08/08/2013	12:39:09	12:42:07	FLOW TEST	APS
08/08/2013	12:42:08	12:49:07	HEPA FILTER TEST	APS
08/08/2013	12:49:08	12:49:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	12:55:08	12:56:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	14:14:08	14:18:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	14:33:08	14:35:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	15:14:08	15:14:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	15:14:40	15:21:24	FLOW TEST	NANO
08/08/2013	15:34:55	15:39:24	FLOW TEST	NANO
08/08/2013	15:40:08	15:41:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	15:40:08	15:42:07	FLOW TEST	APS
08/08/2013	15:45:21	15:48:20	FLOW TEST	S34
08/08/2013	15:48:08	15:51:07	FLOW TEST	APS
08/08/2013	15:49:08	15:50:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	15:50:39	15:52:54	POSSIBLE LOCAL SOURCE	NANO
08/08/2013	15:52:54	15:52:55	SHORT DURATION SPIKE	NANO
08/08/2013	16:45:08	16:56:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	17:16:08	17:18:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	17:27:08	17:28:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	17:53:08	18:07:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	18:10:08	18:11:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	18:23:08	18:32:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	19:19:08	19:26:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	20:28:08	20:30:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	21:04:08	21:08:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	22:34:14	22:34:15	SHORT DURATION SPIKE	NANO
08/08/2013	23:27:08	23:31:09	INSUFFICENT WATER REMOVAL	APS
08/08/2013	23:35:08	23:37:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	00:51:08	01:16:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	06:36:08	06:38:09	INSUFFICENT WATER REMOVAL	APS

Table I.3: Table 3 of 53

Date	Time Start	Time End	Description	Instrument
08/09/2013	06:56:08	07:02:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	07:29:08	07:31:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	07:45:08	07:54:08	POSSIBLE LOCAL SOURCE	APS
08/09/2013	09:33:08	09:33:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	09:46:08	09:49:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	10:08:08	10:19:08	DRYER CHANGE	APS
08/09/2013	10:18:08	10:18:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	10:30:00	11:00:00	LOW FLYING CROP DUSTING A	S34
08/09/2013	10:30:00	11:00:00	LOW FLYING CROP DUSTING A	NANO
08/09/2013	10:30:00	11:00:00	LOW FLYING CROP DUSTING A	APS
08/09/2013	10:43:00	10:44:00	ACCIDENTALLY TURNED OFF P	S34
08/09/2013	13:55:08	13:58:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	14:13:08	14:20:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	15:03:08	15:03:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	15:05:08	15:07:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	15:19:08	15:19:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	15:44:08	15:47:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	16:20:08	16:20:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	16:24:08	16:49:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	17:04:08	17:14:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	17:47:08	18:02:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	18:06:08	18:24:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	18:26:08	18:26:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	18:48:08	18:48:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	18:54:08	18:56:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	18:59:08	19:00:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	19:08:08	19:11:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	19:19:08	19:25:08	POSSIBLE LOCAL SOURCE	APS
08/09/2013	19:19:08	19:27:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	19:30:08	20:43:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	20:52:08	22:10:09	INSUFFICENT WATER REMOVAL	APS
08/09/2013	22:35:08	22:50:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	00:22:08	00:22:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	07:45:08	07:45:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	09:55:08	09:55:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	11:42:08	11:42:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	12:30:08	12:31:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	15:14:08	15:14:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	15:26:08	15:28:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	15:36:08	15:36:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	15:45:08	15:45:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	16:26:08	16:30:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	17:19:08	17:20:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	17:30:08	17:35:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	18:43:08	18:53:08	POSSIBLE LOCAL SOURCE	APS
08/10/2013	18:44:08	18:53:09	INSUFFICENT WATER REMOVAL	APS
08/10/2013	19:19:08	19:50:08	POSSIBLE LOCAL SOURCE	APS
08/10/2013	19:19:08	21:32:09	INSUFFICENT WATER REMOVAL	APS
08/11/2013	07:52:08	07:53:09	INSUFFICENT WATER REMOVAL	APS
08/11/2013	08:48:08	08:48:09	INSUFFICENT WATER REMOVAL	APS

Table I.4: Table 4 of 53

Date	Time Start	Time End	Description	Instrument
08/11/2013	09:42:11	10:04:40	POSSIBLE LOCAL SOURCE	NANO
08/11/2013	09:45:21	10:03:21	POSSIBLE LOCAL SOURCE	S34
08/11/2013	10:11:08	10:11:09	INSUFFICENT WATER REMOVAL	APS
08/11/2013	10:52:08	10:52:09	INSUFFICENT WATER REMOVAL	APS
08/11/2013	12:51:09	12:51:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	13:41:09	13:41:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	15:40:09	15:41:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	17:06:09	17:09:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	17:15:09	17:16:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	17:59:09	18:00:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	18:27:09	19:12:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	19:16:09	19:16:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	19:23:09	19:33:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	19:36:09	19:50:10	INSUFFICENT WATER REMOVAL	APS
08/11/2013	20:02:09	20:02:10	INSUFFICENT WATER REMOVAL	APS
08/12/2013	12:50:08	12:50:09	INSUFFICENT WATER REMOVAL	APS
08/12/2013	12:50:28	12:54:58	DISCONTINUOUS SIZE DISTRI	NANO
08/12/2013	12:52:08	12:52:09	INSUFFICENT WATER REMOVAL	APS
08/12/2013	12:55:08	12:55:09	INSUFFICENT WATER REMOVAL	APS
08/12/2013	13:32:08	13:32:09	INSUFFICENT WATER REMOVAL	APS
08/12/2013	13:34:08	13:36:09	INSUFFICENT WATER REMOVAL	APS
08/12/2013	15:12:09	23:59:59	PATTERN CHANGE	S34
08/12/2013	19:03:48	23:59:59	MISSING DATA	NANO
08/13/2013	00:00:00	07:01:34	MISSING DATA	NANO
08/13/2013	04:35:08	04:42:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	04:49:08	04:53:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	06:20:08	06:21:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	06:35:08	06:36:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	06:43:08	06:50:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	06:54:08	07:15:08	MISSING DATA	APS
08/13/2013	07:52:52	08:02:07	DISCONTINUOUS SIZE DISTRI	NANO
08/13/2013	09:04:08	09:04:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	10:24:08	10:24:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	11:01:08	11:05:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	11:19:08	11:19:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	12:14:08	12:15:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	12:18:08	12:18:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	12:42:08	12:42:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	13:20:08	13:21:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	13:58:08	13:59:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	15:04:08	15:05:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	15:10:08	15:11:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	15:24:08	15:28:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	16:00:08	16:00:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	16:14:08	16:14:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	16:20:08	16:21:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	16:26:08	16:26:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	17:00:08	17:00:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	17:09:08	17:11:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	19:00:08	19:03:09	INSUFFICENT WATER REMOVAL	APS

Table I.5: Table 5 of 53

Date	Time Start	Time End	Description	Instrument
08/13/2013	21:17:08	21:23:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	22:33:08	22:39:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	22:43:08	22:45:09	INSUFFICENT WATER REMOVAL	APS
08/13/2013	22:49:08	23:37:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	03:34:08	03:50:07	POSSIBLE LOCAL SOURCE	APS
08/14/2013	03:34:08	03:51:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	04:39:08	05:07:07	POSSIBLE LOCAL SOURCE	APS
08/14/2013	04:40:08	05:05:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	06:21:34	06:21:35	SHORT DURATION SPIKE	NANO
08/14/2013	06:22:08	06:32:07	POSSIBLE LOCAL SOURCE	APS
08/14/2013	06:23:08	06:29:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	06:41:08	06:45:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	06:48:08	06:49:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	06:56:08	06:59:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	06:56:08	07:01:07	POSSIBLE LOCAL SOURCE	APS
08/14/2013	08:27:21	23:59:59	PATTERN CHANGE	S34
08/14/2013	08:27:34	23:59:59	PATTERN CHANGE	NANO
08/14/2013	09:57:08	09:57:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	09:57:08	09:58:07	POSSIBLE LOCAL SOURCE	APS
08/14/2013	10:05:08	10:06:07	POSSIBLE LOCAL SOURCE	APS
08/14/2013	11:54:08	11:58:07	POSSIBLE LOCAL SOURCE	APS
08/14/2013	11:55:08	11:56:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	12:35:08	12:36:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	13:24:08	13:24:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	15:02:08	15:02:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	16:27:08	16:29:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	16:39:08	16:39:09	INSUFFICENT WATER REMOVAL	APS
08/14/2013	16:53:08	16:54:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	04:37:08	05:34:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	05:45:08	06:02:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	06:18:08	07:01:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	07:03:08	07:13:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	07:15:08	07:17:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	07:21:08	07:34:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	10:21:08	10:21:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	16:05:19	16:16:19	DRYER CHANGE	APS
08/15/2013	16:11:08	16:12:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	21:46:08	21:46:09	INSUFFICENT WATER REMOVAL	APS
08/15/2013	22:16:08	22:54:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	04:34:08	04:50:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	05:57:08	06:09:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	06:17:08	06:34:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	06:38:08	06:45:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	06:59:08	07:13:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	07:15:08	07:29:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	08:44:08	08:44:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	08:57:08	08:57:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	16:04:08	16:04:09	SHORT DURATION SPIKE	NANO
08/16/2013	18:32:08	18:33:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	18:52:08	18:56:09	INSUFFICENT WATER REMOVAL	APS

Table I.6: Table 6 of 53

Date	Time Start	Time End	Description	Instrument
08/16/2013	21:08:08	21:15:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	21:19:08	21:37:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	21:39:08	22:33:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	22:35:08	22:35:09	INSUFFICENT WATER REMOVAL	APS
08/16/2013	23:21:08	00:12:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	00:33:08	00:35:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	00:38:08	00:38:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	00:42:08	00:42:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	00:45:08	00:45:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	00:55:08	01:12:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	02:28:08	02:28:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	02:30:08	02:45:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	03:35:08	04:04:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	06:51:08	06:51:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	06:53:08	07:07:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	07:10:08	07:10:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	07:12:08	07:13:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	07:15:08	07:20:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	08:00:08	08:00:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	19:39:08	19:48:08	POSSIBLE LOCAL SOURCE	APS
08/17/2013	19:39:21	19:48:21	POSSIBLE LOCAL SOURCE	S34
08/17/2013	19:53:08	20:02:09	INSUFFICENT WATER REMOVAL	APS
08/17/2013	21:11:08	22:06:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	00:23:08	00:46:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	04:08:08	04:18:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	04:23:08	04:23:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	04:25:08	04:33:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	18:40:08	19:02:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	19:29:08	19:29:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	20:57:08	21:14:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	21:17:08	21:18:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	21:23:08	21:26:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	22:00:08	22:00:09	INSUFFICENT WATER REMOVAL	APS
08/18/2013	22:03:08	22:32:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	00:41:08	00:50:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	00:54:08	00:59:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	04:44:08	04:55:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	05:48:08	06:22:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	06:26:08	06:31:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	06:38:08	07:13:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	07:15:08	07:55:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	08:27:08	08:38:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	09:29:08	09:29:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	12:33:21	14:30:21	POSSIBLE LOCAL SOURCE	S34
08/19/2013	18:29:08	18:34:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	18:37:08	18:37:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	18:39:08	18:41:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	19:09:08	19:23:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	19:26:08	19:33:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	19:35:08	19:36:09	INSUFFICENT WATER REMOVAL	APS

Table I.7: Table 7 of 53

Date	Time Start	Time End	Description	Instrument
08/19/2013	19:38:08	19:49:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	20:01:08	20:06:09	INSUFFICENT WATER REMOVAL	APS
08/19/2013	20:10:08	20:10:09	INSUFFICENT WATER REMOVAL	APS
08/20/2013	05:18:08	05:18:09	INSUFFICENT WATER REMOVAL	APS
08/20/2013	05:21:08	05:24:09	INSUFFICENT WATER REMOVAL	APS
08/20/2013	05:27:08	05:34:09	INSUFFICENT WATER REMOVAL	APS
08/20/2013	06:14:08	06:44:09	INSUFFICENT WATER REMOVAL	APS
08/20/2013	13:28:53	13:28:54	SHORT DURATION SPIKE	NANO
08/20/2013	14:30:21	14:33:21	DISCONTINUOUS SIZE DISTRI	S34
08/20/2013	14:48:21	14:54:21	DISCONTINUOUS SIZE DISTRI	S34
08/21/2013	07:30:29	07:37:39	DRYER CHANGE	APS
08/21/2013	07:35:08	07:36:09	INSUFFICENT WATER REMOVAL	APS
08/21/2013	07:35:08	23:59:59	PATTERN CHANGE	APS
08/21/2013	07:37:49	07:50:09	DRYER CHANGE	NANO
08/21/2013	14:39:21	14:45:21	DISCONTINUOUS SIZE DISTRI	S34
08/21/2013	19:06:08	19:10:09	INSUFFICENT WATER REMOVAL	APS
08/21/2013	19:12:08	19:20:09	INSUFFICENT WATER REMOVAL	APS
08/21/2013	19:23:08	19:24:09	INSUFFICENT WATER REMOVAL	APS
08/21/2013	19:26:08	19:26:09	INSUFFICENT WATER REMOVAL	APS
08/21/2013	19:30:08	19:30:09	INSUFFICENT WATER REMOVAL	APS
08/22/2013	04:00:00	04:17:00	RAINFALL	S34
08/22/2013	04:00:00	04:17:00	RAINFALL	NANO
08/22/2013	04:00:00	04:17:00	RAINFALL	APS
08/22/2013	11:00:00	12:00:00	POSSIBLE LOCAL SOURCE	S34
08/22/2013	13:22:08	13:22:09	INSUFFICENT WATER REMOVAL	APS
08/22/2013	13:30:08	13:44:09	INSUFFICENT WATER REMOVAL	APS
08/22/2013	13:49:08	13:53:09	INSUFFICENT WATER REMOVAL	APS
08/22/2013	13:50:00	14:12:00	RAINFALL	S34
08/22/2013	13:50:00	14:12:00	RAINFALL	NANO
08/22/2013	13:50:00	14:12:00	RAINFALL	APS
08/23/2013	04:09:08	23:59:59	PATTERN CHANGE	APS
08/23/2013	08:06:08	08:06:09	INSUFFICENT WATER REMOVAL	APS
08/23/2013	08:25:08	08:25:09	INSUFFICENT WATER REMOVAL	APS
08/23/2013	19:00:00	19:30:00	POSSIBLE LOCAL SOURCE	S34
08/23/2013	22:50:08	22:50:09	INSUFFICENT WATER REMOVAL	APS
08/23/2013	22:56:08	22:57:09	INSUFFICENT WATER REMOVAL	APS
08/23/2013	22:59:08	23:02:09	INSUFFICENT WATER REMOVAL	APS
08/24/2013	07:37:07	07:37:08	SHORT DURATION SPIKE	NANO
08/24/2013	17:34:08	17:35:09	INSUFFICENT WATER REMOVAL	APS
08/24/2013	17:39:08	17:39:09	INSUFFICENT WATER REMOVAL	APS
08/24/2013	19:08:07	19:41:46	MISSING DATA	NANO
08/24/2013	19:09:21	19:38:27	MISSING DATA	S34
08/24/2013	19:10:08	19:39:33	MISSING DATA	APS
08/25/2013	00:00:00	00:00:00	HEPA FILTER ON AEROSOL IN	NANO
08/25/2013	06:20:33	06:21:34	INSUFFICENT WATER REMOVAL	APS
08/25/2013	06:26:53	06:30:46	DRYER CHANGE	APS
08/25/2013	06:27:33	06:28:34	INSUFFICENT WATER REMOVAL	APS
08/25/2013	06:34:33	06:34:34	INSUFFICENT WATER REMOVAL	APS
08/25/2013	19:43:33	19:47:34	INSUFFICENT WATER REMOVAL	APS
08/26/2013	08:35:24	08:37:43	DRYER CHANGE	NANO

Table I.8: Table 8 of 53

Date	Time Start	Time End	Description	Instrument
08/26/2013	11:26:27	14:00:00	PATTERN CHANGE	S34
08/27/2013	07:41:27	07:44:27	PATTERN CHANGE	S34
08/27/2013	08:47:27	09:08:27	PATTERN CHANGE	S34
08/27/2013	14:32:27	14:35:27	PATTERN CHANGE	S34
08/28/2013	08:05:27	12:47:27	PATTERN CHANGE	S34
08/28/2013	08:50:27	09:26:27	POSSIBLE LOCAL SOURCE	S34
08/28/2013	11:23:27	11:32:27	POSSIBLE LOCAL SOURCE	S34
08/28/2013	16:12:33	16:15:34	INSUFFICENT WATER REMOVAL	APS
08/28/2013	17:08:27	17:44:27	PATTERN CHANGE	S34
08/28/2013	18:25:33	18:54:33	POSSIBLE LOCAL SOURCE	APS
08/28/2013	18:28:33	18:52:34	INSUFFICENT WATER REMOVAL	APS
08/28/2013	19:02:12	23:59:59	PATTERN CHANGE	NANO
08/28/2013	19:02:27	23:49:59	PATTERN CHANGE	S34
08/29/2013	06:46:33	06:47:34	INSUFFICENT WATER REMOVAL	APS
08/29/2013	06:53:49	06:59:19	DRYER CHANGE	NANO
08/29/2013	07:02:49	07:10:29	DRYER CHANGE	APS
08/29/2013	07:09:33	07:09:34	INSUFFICENT WATER REMOVAL	APS
08/29/2013	09:03:33	09:03:34	INSUFFICENT WATER REMOVAL	APS
08/29/2013	12:27:33	12:27:34	INSUFFICENT WATER REMOVAL	APS
08/29/2013	18:58:33	19:09:34	INSUFFICENT WATER REMOVAL	APS
08/29/2013	22:12:34	22:24:35	INSUFFICENT WATER REMOVAL	APS
08/29/2013	22:27:34	22:29:35	INSUFFICENT WATER REMOVAL	APS
08/30/2013	20:46:12	23:59:59	PATTERN CHANGE	NANO
08/30/2013	20:47:27	23:59:59	PATTERN CHANGE	S34
08/30/2013	20:47:34	23:59:59	PATTERN CHANGE	APS
08/31/2013	07:16:34	07:16:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	07:44:27	14:55:12	PATTERN CHANGE	S34
08/31/2013	08:20:34	08:20:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	08:27:34	08:27:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	08:37:34	08:37:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	08:44:34	08:44:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	08:48:34	08:48:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	08:50:34	08:55:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	08:58:34	09:00:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	09:03:34	09:21:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	09:23:34	09:34:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	09:36:34	09:50:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	09:54:34	10:05:35	INSUFFICENT WATER REMOVAL	APS
08/31/2013	10:02:27	14:25:12	MISSING DATA	S34
08/31/2013	10:03:57	14:30:16	MISSING DATA	NANO
08/31/2013	10:05:34	14:37:03	MISSING DATA	APS
08/31/2013	14:37:03	14:37:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	14:39:03	14:43:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	14:46:03	15:00:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	15:03:03	15:07:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	15:10:03	15:12:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	15:14:03	15:19:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	15:23:03	16:04:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	19:00:03	19:01:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	19:06:03	19:06:04	INSUFFICENT WATER REMOVAL	APS

Table I.9: Table 9 of 53

Date	Time Start	Time End	Description	Instrument
08/31/2013	21:13:03	21:25:04	INSUFFICENT WATER REMOVAL	APS
08/31/2013	22:53:03	23:00:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	01:22:03	01:22:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	01:29:03	01:29:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	01:31:03	01:32:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	01:34:03	01:40:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	01:42:03	01:44:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	01:47:03	01:59:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	05:51:03	09:07:03	PATTERN CHANGE	APS
09/01/2013	07:47:03	07:48:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	08:16:03	08:18:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	12:50:03	12:51:04	INSUFFICENT WATER REMOVAL	APS
09/01/2013	14:30:03	14:30:04	INSUFFICENT WATER REMOVAL	APS
09/02/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/02/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/02/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/02/2013	04:49:03	04:56:04	INSUFFICENT WATER REMOVAL	APS
09/02/2013	08:02:03	08:04:04	INSUFFICENT WATER REMOVAL	APS
09/02/2013	08:58:15	08:58:16	SHORT DURATION SPIKE	NANO
09/02/2013	12:00:00		POSSIBLE LOCAL SOURCE	APS
09/03/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/03/2013	11:04:00	11:04:01	SHORT DURATION SPIKE	NANO
09/03/2013	12:00:00		POSSIBLE LOCAL SOURCE	APS
09/03/2013	22:10:16	23:59:59	PATTERN CHANGE	S34
09/04/2013	12:00:00	00:00:00	POSSIBLE LOCAL SOURCE	APS
09/04/2013	12:00:00		POSSIBLE LOCAL SOURCE	APS
09/04/2013	12:29:03	23:59:59	PATTERN CHANGE DUE TO LOO	APS
09/04/2013	13:21:16	15:41:16	APPARENT LEAK	NANO
09/04/2013	14:24:03	14:24:04	INSUFFICENT WATER REMOVAL	APS
09/04/2013	15:07:16	15:08:16	LOW COUNTS	S34
09/04/2013	15:41:16	15:50:03	MISSING DATA	NANO
09/04/2013	15:57:03	15:59:04	INSUFFICENT WATER REMOVAL	APS
09/04/2013	17:02:03	18:28:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/05/2013	02:51:59	02:52:00	SHORT DURATION SPIKE	NANO
09/05/2013	07:44:39	07:52:49	DRYER CHANGE	NANO
09/05/2013	07:52:03	07:52:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	07:55:29	08:00:39	DRYER CHANGE	APS
09/05/2013	07:58:03	07:58:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	09:29:03	09:29:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	12:00:00		POSSIBLE LOCAL SOURCE	APS
09/05/2013	12:00:00		POSSIBLE LOCAL SOURCE	APS
09/05/2013	13:55:03	13:55:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	14:39:03	14:40:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	14:53:03	14:53:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	15:52:16	15:58:16	LOW COUNTS	S34
09/05/2013	15:53:03	15:53:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	15:59:03	15:59:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	16:42:03	16:42:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	16:57:03	16:57:04	INSUFFICENT WATER REMOVAL	APS

Table I.10: Table 10 of 53

Date	Time Start	Time End	Description	Instrument
09/05/2013	17:10:03	17:10:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	17:55:03	18:01:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	18:04:03	18:04:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	18:04:16	23:59:59	PATTERN CHANGE	S34
09/05/2013	18:08:03	18:10:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	18:14:03	18:14:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	18:18:03	18:23:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	18:28:03	18:47:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	18:50:03	18:50:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	18:55:03	18:58:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	19:02:03	19:18:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	19:20:03	19:20:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	19:25:03	19:25:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	19:29:03	19:29:04	INSUFFICENT WATER REMOVAL	APS
09/05/2013	19:35:03	19:35:04	INSUFFICENT WATER REMOVAL	APS
09/06/2013	06:34:03	06:34:04	INSUFFICENT WATER REMOVAL	APS
09/06/2013	11:51:57	11:51:58	SHORT DURATION SPIKE	NANO
09/06/2013	15:37:16	15:43:16	LOW COUNTS	S34
09/06/2013	16:36:03	16:36:04	INSUFFICENT WATER REMOVAL	APS
09/06/2013	18:27:03	18:29:04	INSUFFICENT WATER REMOVAL	APS
09/06/2013	18:34:03	18:36:04	INSUFFICENT WATER REMOVAL	APS
09/07/2013	08:34:16	09:28:16	PATTERN CHANGE	S34
09/07/2013	11:04:16	11:28:16	POSSIBLE LOCAL SOURCE	S34
09/07/2013	11:04:58	11:28:14	POSSIBLE LOCAL SOURCE	NANO
09/07/2013	13:13:16	13:19:16	LOW COUNTS	S34
09/07/2013	13:46:16	13:49:16	LOW COUNTS	S34
09/07/2013	13:58:16	14:04:16	LOW COUNTS	S34
09/07/2013	14:13:16	14:28:16	LOW COUNTS	S34
09/07/2013	16:58:16	17:01:16	LOW COUNTS	S34
09/08/2013	01:29:03	01:32:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	01:34:03	01:39:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	01:42:03	01:42:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	02:25:03	02:25:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	02:27:03	02:27:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	02:29:03	02:31:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	02:34:03	02:35:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	12:30:03	12:30:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	12:31:16	12:40:16	LOW COUNTS	S34
09/08/2013	17:37:03	17:37:04	INSUFFICENT WATER REMOVAL	APS
09/08/2013	18:32:29	18:32:30	SHORT DURATION SPIKE	NANO
09/09/2013	01:48:56	10:26:17	MISSING DATA	NANO
09/09/2013	01:50:03	13:20:59	MISSING DATA	APS
09/09/2013	12:43:29	12:48:09	DRYER CHANGE	APS
09/09/2013	12:50:29	12:54:49	DRYER CHANGE	NANO
09/09/2013	13:30:00	13:55:00	ZERO OF SO2 MONITOR	S34
09/09/2013	13:30:00	13:55:00	ZERO OF SO2 MONITOR	NANO
09/10/2013	07:21:18	12:13:03	PATTERN CHANGE	NANO
09/10/2013	07:22:16	12:13:16	PATTERN CHANGE	S34
09/10/2013	12:24:44	18:04:16	PATTERN CHANGE	NANO
09/10/2013	12:25:16	18:07:16	PATTERN CHANGE	S34

Table I.11: Table 11 of 53

Date	Time Start	Time End	Description	Instrument
09/10/2013	15:10:16	15:34:16	POSSIBLE LOCAL SOURCE	S34
09/10/2013	15:10:17	15:31:17	POSSIBLE LOCAL SOURCE	NANO
09/10/2013	15:45:18	15:54:45	POSSIBLE LOCAL SOURCE	NANO
09/10/2013	15:46:16	15:55:16	POSSIBLE LOCAL SOURCE	S34
09/11/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/11/2013	21:38:59	21:42:00	INSUFFICENT WATER REMOVAL	APS
09/11/2013	21:44:59	21:48:00	INSUFFICENT WATER REMOVAL	APS
09/11/2013	22:34:59	22:52:00	INSUFFICENT WATER REMOVAL	APS
09/11/2013	22:54:59	22:56:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	00:00:00	21:31:12	MISSING DATA	LONG
09/12/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/12/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/12/2013	01:21:59	02:08:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	02:10:59	02:11:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	10:15:59	10:16:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	10:38:59	10:40:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	10:42:59	10:43:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	13:52:59	13:54:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	14:45:59	14:46:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	15:32:59	15:35:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	15:39:59	15:41:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	15:49:59	15:50:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	16:07:59	16:09:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	16:39:59	16:40:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	17:01:59	17:02:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	17:39:59	17:40:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	20:39:59	20:48:09	DRYER CHANGE	APS
09/12/2013	20:45:59	20:46:00	INSUFFICENT WATER REMOVAL	APS
09/12/2013	21:14:49	21:24:19	DRYER CHANGE	NANO
09/12/2013	21:47:29	23:59:59	MISSING DATA	LONG
09/12/2013	21:53:18	23:59:59	MISSING DATA	NANO
09/13/2013	00:00:00	05:06:27	MISSING DATA	NANO
09/13/2013	00:00:00	05:06:53	MISSING DATA	LONG
09/13/2013	00:03:59	00:14:00	INSUFFICENT WATER REMOVAL	APS
09/13/2013	00:36:59	00:45:00	INSUFFICENT WATER REMOVAL	APS
09/13/2013	06:38:00	06:45:50	MISSING DATA	APS
09/13/2013	06:47:21	06:55:05	MISSING DATA	LONG
09/13/2013	06:54:51	23:59:59	PATTERN CHANGE	APS
09/13/2013	06:55:51	06:55:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	06:56:51	23:59:59	MISSING DATA	S34
09/13/2013	06:57:22	07:26:07	DRYER CHANGE	LONG
09/13/2013	06:59:39	07:02:05	NOT SAMPLING THROUGH INLE	LONG
09/13/2013	07:13:39	07:18:23	NOT SAMPLING THROUGH INLE	LONG
09/13/2013	07:39:24	07:41:38	NOT SAMPLING THROUGH INLE	LONG
09/13/2013	07:39:51	07:39:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	07:39:51	07:41:50	NOT SAMPLING THROUGH INLE	APS
09/13/2013	08:00:51	08:00:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	08:35:24	08:44:24	MISSING DATA	NANO
09/13/2013	08:53:29	08:58:01	MISSING DATA	NANO
09/13/2013	10:37:27	14:49:33	MISSING DATA	LONG

Table I.12: Table 12 of 53

Date	Time Start	Time End	Description	Instrument
09/13/2013	13:45:00		FLOW TEST	NANO
09/13/2013	13:45:00		HEPA FILTER ON AEROSOL IN	NANO
09/13/2013	13:45:00		FLOW TEST	LONG
09/13/2013	13:45:00		HEPA FILTER ON AEROSOL IN	LONG
09/13/2013	14:31:27	14:57:37	MISSING DATA	NANO
09/13/2013	14:34:51	14:34:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	15:16:12	23:59:59	MISSING DATA	NANO
09/13/2013	15:19:51	15:19:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	15:54:51	15:54:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	15:57:51	15:58:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	16:23:51	16:24:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	16:28:51	16:29:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	16:44:51	16:45:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	16:56:51	16:57:52	INSUFFICENT WATER REMOVAL	APS
09/13/2013	18:12:51	18:15:52	INSUFFICENT WATER REMOVAL	APS
09/14/2013	00:00:00	07:54:32	MISSING DATA	NANO
09/14/2013	00:45:51	01:20:52	INSUFFICENT WATER REMOVAL	APS
09/14/2013	05:39:51	05:44:52	INSUFFICENT WATER REMOVAL	APS
09/14/2013	05:48:51	05:51:52	INSUFFICENT WATER REMOVAL	APS
09/14/2013	06:43:52	11:41:14	MISSING DATA	APS
09/14/2013	07:45:00		FLOW TEST	S34
09/14/2013	07:54:01	07:58:37	MISSING DATA	LONG
09/14/2013	10:19:18	11:06:32	MISSING DATA	NANO
09/14/2013	10:51:16	23:59:59	MISSING DATA	LONG
09/15/2013	00:00:00	23:59:59	MISSING DATA	LONG
09/15/2013	04:14:15	04:15:16	INSUFFICENT WATER REMOVAL	APS
09/15/2013	07:20:00		CPC DRAINED	LONG
09/15/2013	17:29:15	17:30:16	INSUFFICENT WATER REMOVAL	APS
09/15/2013	19:51:00	20:22:00	RAINFALL	NANO
09/15/2013	19:51:00	20:22:00	RAINFALL	LONG
09/15/2013	19:51:00	20:22:00	RAINFALL	APS
09/16/2013	00:00:00	23:59:59	MISSING DATA	LONG
09/16/2013	00:00:00		POSSIBLE LOCAL SOURCE	APS
09/16/2013	20:52:15	20:52:16	INSUFFICENT WATER REMOVAL	APS
09/16/2013	21:38:05	21:38:06	SHORT DURATION SPIKE	NANO
09/16/2013	22:14:15	22:25:16	INSUFFICENT WATER REMOVAL	APS
09/17/2013	00:00:00	23:59:59	MISSING DATA	LONG
09/18/2013	00:00:00	18:59:09	MISSING DATA	LONG
09/18/2013	18:26:00	19:43:00	ZERO OF SO2 MONITOR	NANO
09/18/2013	18:26:00	19:43:00	ZERO OF SO2 MONITOR	LONG
09/18/2013	18:51:51	18:56:31	FLOW TEST	NANO
09/18/2013	18:51:51	18:56:31	HEPA FILTER ON AEROSOL IN	NANO
09/18/2013	19:29:28	19:41:09	FLOW TEST	LONG
09/18/2013	19:29:28	19:41:09	HEPA FILTER ON AEROSOL IN	LONG
09/18/2013	19:29:28	19:41:09	NOT SAMPLING THROUGH INLE	LONG
09/18/2013	19:45:43	21:09:42	NOT SAMPLING THROUGH INLE	LONG
09/18/2013	20:04:43	20:10:33	DRYER CHANGE	APS
09/18/2013	20:06:15	20:07:16	INSUFFICENT WATER REMOVAL	APS
09/18/2013	20:58:04	21:00:22	DRYER CHANGE	LONG
09/18/2013	20:59:01	21:06:21	DRYER CHANGE	NANO

Table I.13: Table 13 of 53

Date	Time Start	Time End	Description	Instrument
09/19/2013	05:10:15	05:10:16	INSUFFICENT WATER REMOVAL	APS
09/19/2013	06:15:15	06:15:16	INSUFFICENT WATER REMOVAL	APS
09/19/2013	06:29:15	06:29:16	INSUFFICENT WATER REMOVAL	APS
09/19/2013	06:35:15	06:35:16	INSUFFICENT WATER REMOVAL	APS
09/19/2013	06:50:15	06:50:16	INSUFFICENT WATER REMOVAL	APS
09/19/2013	07:09:28	07:09:29	SHORT DURATION SPIKE	LONG
09/19/2013	07:11:15	07:11:16	INSUFFICENT WATER REMOVAL	APS
09/19/2013	13:25:10	13:29:44	TEMPORARY GLITCH IN SAMPL	LONG
09/19/2013	22:29:16	22:29:17	INSUFFICENT WATER REMOVAL	APS
09/19/2013	22:46:16	22:46:17	INSUFFICENT WATER REMOVAL	APS
09/19/2013	23:16:16	23:16:17	INSUFFICENT WATER REMOVAL	APS
09/19/2013	23:36:16	23:36:17	INSUFFICENT WATER REMOVAL	APS
09/19/2013	23:56:16	23:56:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:00:00		PATTERN CHANGE	APS
09/20/2013	00:07:16	00:07:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:11:16	00:12:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:20:16	00:24:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:29:16	00:29:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:34:16	00:36:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:38:16	00:38:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:40:16	00:40:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:43:16	00:47:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	00:49:16	00:49:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	01:34:00	01:51:00	RAINFALL	NANO
09/20/2013	01:34:00	01:51:00	RAINFALL	LONG
09/20/2013	01:34:00	01:51:00	RAINFALL	APS
09/20/2013	04:35:00	05:54:00	RAINFALL	NANO
09/20/2013	04:35:00	05:54:00	RAINFALL	LONG
09/20/2013	04:35:00	05:54:00	RAINFALL	APS
09/20/2013	06:13:00	06:30:00	RAINFALL	NANO
09/20/2013	06:13:00	06:30:00	RAINFALL	LONG
09/20/2013	06:13:00	06:30:00	RAINFALL	APS
09/20/2013	07:27:16	07:27:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	07:38:16	07:39:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	08:55:16	08:55:17	INSUFFICENT WATER REMOVAL	APS
09/20/2013	10:15:43	10:20:27	CPC DRAIN	LONG
09/20/2013	16:06:15	16:08:16	INSUFFICENT WATER REMOVAL	APS
09/20/2013	16:12:15	16:12:16	INSUFFICENT WATER REMOVAL	APS
09/20/2013	16:18:15	16:18:16	INSUFFICENT WATER REMOVAL	APS
09/20/2013	16:22:15	16:22:16	INSUFFICENT WATER REMOVAL	APS
09/20/2013	16:24:15	16:26:16	INSUFFICENT WATER REMOVAL	APS
09/20/2013	16:30:15	17:00:16	INSUFFICENT WATER REMOVAL	APS
09/20/2013	17:07:15	17:07:16	INSUFFICENT WATER REMOVAL	APS
09/20/2013	17:11:15	17:11:16	INSUFFICENT WATER REMOVAL	APS
09/20/2013	17:21:15	17:21:16	INSUFFICENT WATER REMOVAL	APS
09/21/2013	17:54:16	18:02:17	INSUFFICENT WATER REMOVAL	APS
09/21/2013	21:20:16	21:21:17	INSUFFICENT WATER REMOVAL	APS
09/21/2013	21:30:16	21:39:17	INSUFFICENT WATER REMOVAL	APS
09/21/2013	21:43:16	21:43:17	INSUFFICENT WATER REMOVAL	APS
09/21/2013	21:51:16	21:53:17	INSUFFICENT WATER REMOVAL	APS

Table I.14: Table 14 of 53

Date	Time Start	Time End	Description	Instrument
09/21/2013	21:56:16	21:56:17	INSUFFICENT WATER REMOVAL	APS
09/22/2013	02:26:10	02:33:09	TEMPORARY GLITCH IN SAMPL	LONG
09/23/2013	07:33:43	07:36:09	CPC DRAIN	LONG
09/23/2013	13:49:13	13:49:14	SHORT DURATION SPIKE	NANO
09/24/2013	00:14:45	09:06:35	MISSING DATA	LONG
09/25/2013	06:28:15	06:51:16	INSUFFICENT WATER REMOVAL	APS
09/25/2013	06:53:15	06:53:16	INSUFFICENT WATER REMOVAL	APS
09/25/2013	12:43:13	12:43:14	SHORT DURATION SPIKE	NANO
09/25/2013	16:33:15	16:33:16	INSUFFICENT WATER REMOVAL	APS
09/25/2013	19:24:15	19:30:16	INSUFFICENT WATER REMOVAL	APS
09/25/2013	20:47:15	20:50:16	INSUFFICENT WATER REMOVAL	APS
09/25/2013	21:00:10	23:59:59	MISSING DATA	LONG
09/26/2013	00:00:00	10:41:08	MISSING DATA	LONG
09/26/2013	10:35:15	10:35:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	12:24:15	12:25:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	15:03:15	15:03:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	20:31:15	20:31:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	20:34:15	20:34:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	20:38:15	20:38:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	20:41:15	20:41:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	21:46:15	21:46:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	21:51:15	21:51:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	22:07:15	22:07:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	22:11:15	22:11:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	22:19:15	22:21:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	22:27:15	22:27:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	22:38:15	22:38:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	22:50:15	22:50:16	INSUFFICENT WATER REMOVAL	APS
09/26/2013	23:28:43	23:59:59	MISSING DATA	LONG
09/27/2013	00:00:00	06:21:41	MISSING DATA	LONG
09/27/2013	01:36:15	01:38:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	01:47:15	02:33:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	02:37:15	02:45:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	02:49:15	02:49:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	02:52:15	02:52:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	06:17:32	06:21:05	CPC DRAINED	LONG
09/27/2013	06:23:15	06:23:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	07:38:43	23:59:59	MISSING DATA	LONG
09/27/2013	12:00:00		OBVIOUS LOCAL SOURCE	NANO
09/27/2013	12:00:00		OBVIOUS LOCAL SOURCE	NANO
09/27/2013	13:41:15	13:41:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	13:53:15	13:53:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	14:08:15	14:08:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	14:27:15	14:27:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	14:30:15	14:30:16	INSUFFICENT WATER REMOVAL	APS
09/27/2013	14:33:15	14:34:16	INSUFFICENT WATER REMOVAL	APS
09/28/2013	00:00:00	06:56:11	MISSING DATA	LONG
09/28/2013	06:27:15	06:27:16	INSUFFICENT WATER REMOVAL	APS
09/28/2013	07:12:02	07:20:30	DRYER CHANGE	NANO
09/28/2013	07:20:55	07:28:49	DRYER CHANGE	APS

Table I.15: Table 15 of 53

Date	Time Start	Time End	Description	Instrument
09/28/2013	07:21:15	07:21:16	INSUFFICENT WATER REMOVAL	APS
09/28/2013	07:23:15	07:24:16	INSUFFICENT WATER REMOVAL	APS
09/28/2013	07:27:15	07:27:16	INSUFFICENT WATER REMOVAL	APS
09/29/2013	00:00:00	00:00:00	PATTERN CHANGE	APS
09/29/2013	01:37:00	01:54:00	RAINFALL	NANO
09/29/2013	01:37:00	01:54:00	RAINFALL	LONG
09/29/2013	01:37:00	01:54:00	RAINFALL	APS
09/29/2013	02:25:00	02:43:00	RAINFALL	NANO
09/29/2013	02:25:00	02:43:00	RAINFALL	LONG
09/29/2013	02:25:00	02:43:00	RAINFALL	APS
09/29/2013	07:35:30	07:37:44	CPC DRAIN	LONG
09/29/2013	13:42:36	13:42:37	SHORT DURATION SPIKE	NANO
09/29/2013	16:51:15	16:51:16	INSUFFICENT WATER REMOVAL	APS
09/29/2013	18:30:15	18:31:16	INSUFFICENT WATER REMOVAL	APS
09/29/2013	18:34:15	18:35:16	INSUFFICENT WATER REMOVAL	APS
09/29/2013	18:43:15	18:48:16	INSUFFICENT WATER REMOVAL	APS
09/29/2013	20:00:15	20:06:16	INSUFFICENT WATER REMOVAL	APS
09/29/2013	20:12:15	20:13:16	INSUFFICENT WATER REMOVAL	APS
09/29/2013	20:19:15	20:19:16	INSUFFICENT WATER REMOVAL	APS
10/01/2013	08:21:03	08:23:20	POSSIBLE PUMP TURN OFF OR	LONG
10/01/2013	09:06:43	09:12:38	DRYER CHANGE	NANO
10/01/2013	09:11:15	09:16:15	LOCAL SOURCE	APS
10/02/2013	07:22:46	07:25:11	CPC DRAIN	LONG
10/03/2013	00:00:00		PATTERN CHANGE	LONG
10/03/2013	06:31:00	08:34:00	RAINFALL	NANO
10/03/2013	06:31:00	08:34:00	RAINFALL	LONG
10/03/2013	06:31:00	08:34:00	RAINFALL	APS
10/03/2013	08:42:00	09:00:00	RAINFALL	NANO
10/03/2013	08:42:00	09:00:00	RAINFALL	LONG
10/03/2013	08:42:00	09:00:00	RAINFALL	APS
10/03/2013	12:00:00		PATTERN CHANGE	APS
10/03/2013	19:04:00	19:28:00	RAINFALL	NANO
10/03/2013	19:04:00	19:28:00	RAINFALL	LONG
10/03/2013	19:04:00	19:28:00	RAINFALL	APS
10/03/2013	19:49:00	21:12:00	RAINFALL	NANO
10/03/2013	19:49:00	21:12:00	RAINFALL	LONG
10/03/2013	19:49:00	21:12:00	RAINFALL	APS
10/04/2013	03:14:47	09:30:43	MISSING DATA	LONG
10/04/2013	09:56:55	10:02:06	DRYER CHANGE	NANO
10/04/2013	10:01:21	10:04:22	DRYER CHANGE	APS
10/05/2013	00:00:00	00:00:00	PATTERN CHANGE	APS
10/05/2013	01:22:44	01:29:43	TEMPORARY GLITCH IN SAMPL	LONG
10/05/2013	05:04:15	05:04:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:07:15	05:10:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:13:15	05:13:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:19:15	05:21:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:25:15	05:27:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:30:15	05:30:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:32:15	05:32:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:35:15	05:40:16	INSUFFICENT WATER REMOVAL	APS

Table I.16: Table 16 of 53

Date	Time Start	Time End	Description	Instrument
10/05/2013	05:42:15	05:43:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:45:15	05:53:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:56:15	05:56:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	05:59:15	06:07:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	06:10:15	06:13:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	06:17:15	06:40:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	06:42:15	06:47:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	06:50:15	06:51:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	06:53:15	06:53:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	07:03:15	07:03:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	07:21:15	07:21:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	07:46:15	07:46:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	08:34:15	08:34:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	08:42:15	08:42:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	08:53:15	08:53:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	09:04:15	09:04:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	09:07:15	09:07:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	10:07:15	10:07:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	11:27:15	11:32:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	11:42:15	11:51:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	11:43:00	12:29:00	RAINFALL	NANO
10/05/2013	11:43:00	12:29:00	RAINFALL	LONG
10/05/2013	11:43:00	12:29:00	RAINFALL	APS
10/05/2013	11:55:15	12:26:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	12:30:15	12:37:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	12:47:15	12:47:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	14:15:00	14:32:00	RAINFALL	NANO
10/05/2013	14:15:00	14:32:00	RAINFALL	LONG
10/05/2013	14:15:00	14:32:00	RAINFALL	APS
10/05/2013	16:44:15	16:44:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	17:24:15	17:25:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	17:28:15	17:28:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	17:50:15	17:52:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	18:01:15	18:01:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	18:10:15	18:10:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	18:27:15	18:28:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	18:32:15	18:32:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	18:45:15	18:49:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	18:52:15	18:54:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	18:57:15	19:03:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	19:06:15	19:17:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	19:20:15	19:28:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	19:36:15	19:38:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	19:42:15	19:42:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	19:48:15	19:52:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	19:58:15	19:58:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:01:15	20:02:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:15:15	20:15:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:18:15	20:18:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:24:15	20:24:16	INSUFFICENT WATER REMOVAL	APS

Table I.17: Table 17 of 53

Date	Time Start	Time End	Description	Instrument
10/05/2013	20:30:15	20:30:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:32:15	20:33:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:35:15	20:35:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:40:15	20:40:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:42:15	20:44:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:47:15	20:49:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:52:15	20:52:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	20:55:15	20:58:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	21:01:15	21:01:16	INSUFFICENT WATER REMOVAL	APS
10/05/2013	21:45:19	23:59:59	MISSING DATA	LONG
10/06/2013	00:00:00	07:27:27	MISSING DATA	LONG
10/06/2013	07:41:28	07:43:46	CPC DRAIN	LONG
10/06/2013	19:19:03	23:59:59	MISSING DATA	LONG
10/06/2013	23:15:00	23:39:00	RAINFALL	NANO
10/06/2013	23:15:00	23:39:00	RAINFALL	LONG
10/06/2013	23:15:00	23:39:00	RAINFALL	APS
10/07/2013	00:00:00	00:27:00	RAINFALL	NANO
10/07/2013	00:00:00	07:53:43	MISSING DATA	LONG
10/07/2013	00:00:00		LOCAL SOURCE	LONG
10/07/2013	00:00:00		LOCAL SOURCE	LONG
10/07/2013	00:00:00		LOCAL SOURCE	LONG
10/07/2013	08:02:51	08:07:56	DRYER CHANGE	APS
10/07/2013	08:05:16	08:05:17	INSUFFICENT WATER REMOVAL	APS
10/07/2013	12:00:00		LOCAL SOURCE	LONG
10/07/2013	15:00:44	15:07:43	SUDDEN TEMPORARY SHIFT IN	LONG
10/07/2013	16:40:15	16:53:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	16:41:03	16:48:02	SUDDEN TEMPORARY SHIFT IN	LONG
10/07/2013	17:06:44	17:09:01	SUDDEN TEMPORARY SHIFT IN	LONG
10/07/2013	17:12:15	17:14:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	17:30:15	17:43:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	17:45:15	17:51:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	17:54:15	17:54:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	17:59:15	18:01:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	18:04:15	18:04:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	19:47:15	19:47:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	19:49:15	19:58:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	20:00:15	20:06:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	20:09:15	20:09:16	INSUFFICENT WATER REMOVAL	APS
10/07/2013	23:54:00	23:59:59	RAINFALL	NANO
10/07/2013	23:54:00	23:59:59	RAINFALL	LONG
10/07/2013	23:54:00	23:59:59	RAINFALL	APS
10/08/2013	00:00:00	00:27:00	RAINFALL	LONG
10/08/2013	00:00:00	00:27:00	RAINFALL	APS
10/08/2013	06:57:18	07:14:27	MISSING DATA	LONG
10/08/2013	14:23:58	14:23:59	SHORT DURATION SPIKE	NANO
10/08/2013	18:14:15	19:01:16	INSUFFICENT WATER REMOVAL	APS
10/08/2013	18:47:28	18:48:22	CPC DRAINGED	LONG
10/08/2013	19:06:15	19:06:16	INSUFFICENT WATER REMOVAL	APS
10/08/2013	19:20:15	19:20:16	INSUFFICENT WATER REMOVAL	APS
10/08/2013	19:26:15	19:26:16	INSUFFICENT WATER REMOVAL	APS

Table I.18: Table 18 of 53

Date	Time Start	Time End	Description	Instrument
10/09/2013	16:56:16	17:01:17	INSUFFICENT WATER REMOVAL	APS
10/09/2013	17:22:16	17:24:17	INSUFFICENT WATER REMOVAL	APS
10/09/2013	17:39:16	17:48:17	INSUFFICENT WATER REMOVAL	APS
10/09/2013	17:57:16	17:58:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	01:37:58	01:37:59	SHORT DURATION SPIKE	NANO
10/10/2013	11:46:59	11:47:00	SHORT DURATION SPIKE	NANO
10/10/2013	12:03:16	12:04:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	12:26:16	12:27:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	12:33:16	12:33:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	13:20:16	13:20:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	13:28:16	13:29:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	14:13:16	14:14:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	14:28:16	14:29:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	14:35:16	14:37:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	14:45:16	14:45:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	14:56:16	14:56:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	15:47:16	15:47:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	15:53:16	15:53:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	16:01:16	16:03:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	16:09:16	16:10:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	16:19:16	16:22:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	16:27:16	16:28:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	16:48:16	16:48:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	16:55:16	17:08:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	17:11:16	17:12:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	17:15:16	17:17:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	17:21:16	17:21:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	17:24:16	17:42:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	17:46:16	17:47:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	18:40:16	19:15:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	19:18:16	19:20:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	19:22:16	19:22:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	19:55:16	19:55:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:08:16	20:08:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:15:16	20:15:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:20:16	20:20:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:24:16	20:25:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:28:16	20:28:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:31:16	20:31:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:37:16	20:38:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:49:16	20:49:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	20:57:16	20:57:17	INSUFFICENT WATER REMOVAL	APS
10/10/2013	23:43:02	23:59:59	MISSING DATA	LONG
10/11/2013	00:00:00	06:24:43	MISSING DATA	LONG
10/11/2013	01:02:36	01:02:37	SHORT DURATION SPIKE	NANO
10/11/2013	01:35:13	01:35:14	SHORT DURATION SPIKE	NANO
10/11/2013	05:54:13	05:54:14	SHORT DURATION SPIKE	NANO
10/11/2013	06:29:17	06:31:43	CPC DRAIN	LONG
10/11/2013	09:24:16	09:24:17	INSUFFICENT WATER REMOVAL	APS
10/11/2013	10:55:16	10:55:17	INSUFFICENT WATER REMOVAL	APS

Table I.19: Table 19 of 53

Date	Time Start	Time End	Description	Instrument
10/11/2013	11:26:16	11:26:17	INSUFFICENT WATER REMOVAL	APS
10/11/2013	11:31:16	11:31:17	INSUFFICENT WATER REMOVAL	APS
10/11/2013	11:51:15	11:51:16	INSUFFICENT WATER REMOVAL	APS
10/11/2013	13:21:15	13:21:16	INSUFFICENT WATER REMOVAL	APS
10/11/2013	13:30:15	13:31:16	INSUFFICENT WATER REMOVAL	APS
10/11/2013	16:28:15	16:29:16	INSUFFICENT WATER REMOVAL	APS
10/11/2013	17:08:15	17:13:16	INSUFFICENT WATER REMOVAL	APS
10/11/2013	17:23:15	17:36:16	INSUFFICENT WATER REMOVAL	APS
10/11/2013	18:57:15	19:54:16	INSUFFICENT WATER REMOVAL	APS
10/11/2013	19:57:15	19:57:16	INSUFFICENT WATER REMOVAL	APS
10/11/2013	20:05:15	20:26:16	INSUFFICENT WATER REMOVAL	APS
10/12/2013	00:00:00		PATTERN CHANGE	LONG
10/12/2013	16:57:28	17:12:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	17:14:28	17:14:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	17:22:28	17:25:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	17:49:28	17:55:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	17:59:28	18:03:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	18:33:28	18:33:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	19:01:28	19:15:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	19:28:14	19:28:15	SHORT DURATION SPIKE	NANO
10/12/2013	19:30:28	19:37:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	20:13:28	20:19:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	21:45:28	21:52:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	22:09:28	22:15:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	22:39:28	22:43:29	INSUFFICENT WATER REMOVAL	APS
10/12/2013	23:16:28	23:21:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	04:13:17	08:22:56	MISSING DATA	LONG
10/13/2013	06:47:28	06:50:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	07:52:28	07:52:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	08:29:30	08:34:10	DRYER CHANGE	NANO
10/13/2013	08:32:28	08:32:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	08:32:42	08:38:33	DRYER CHANGE	APS
10/13/2013	08:34:28	08:36:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	09:16:28	09:17:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	09:22:28	09:22:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	09:37:28	09:37:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	10:11:28	10:13:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	10:37:28	10:37:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	10:48:28	10:48:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	11:00:28	11:00:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	11:34:28	11:34:29	INSUFFICENT WATER REMOVAL	APS
10/13/2013	12:49:15	12:49:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	13:14:15	13:14:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	13:34:15	13:34:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	13:44:15	13:44:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	14:06:15	14:07:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	14:12:15	14:12:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	14:26:15	14:26:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	14:48:15	14:48:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	14:57:15	14:58:16	INSUFFICENT WATER REMOVAL	APS

Table I.20: Table 20 of 53

Date	Time Start	Time End	Description	Instrument
10/13/2013	15:39:15	15:40:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	16:01:15	16:01:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	17:10:15	17:10:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	17:43:15	17:43:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	17:53:15	18:12:16	INSUFFICENT WATER REMOVAL	APS
10/13/2013	20:47:15	20:55:16	INSUFFICENT WATER REMOVAL	APS
10/14/2013	05:21:15	05:38:16	INSUFFICENT WATER REMOVAL	APS
10/14/2013	05:47:15	05:52:16	INSUFFICENT WATER REMOVAL	APS
10/14/2013	05:54:15	05:55:16	INSUFFICENT WATER REMOVAL	APS
10/14/2013	05:58:15	06:19:16	INSUFFICENT WATER REMOVAL	APS
10/14/2013	06:22:15	06:22:16	INSUFFICENT WATER REMOVAL	APS
10/14/2013	06:34:15	06:49:16	INSUFFICENT WATER REMOVAL	APS
10/14/2013	08:10:56	08:13:13	CPC DRAIN	LONG
10/14/2013	18:54:16	18:54:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	18:57:16	19:01:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	19:03:16	20:20:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	20:22:16	20:28:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	20:30:16	20:51:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	20:53:16	20:53:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	20:55:16	20:55:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	20:58:16	21:01:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	21:03:16	21:03:17	INSUFFICENT WATER REMOVAL	APS
10/14/2013	21:06:16	21:06:17	INSUFFICENT WATER REMOVAL	APS
10/15/2013	06:26:16	06:29:17	INSUFFICENT WATER REMOVAL	APS
10/15/2013	07:00:30	07:02:55	CPC DRAIN	LONG
10/15/2013	09:59:00	10:16:00	RAINFALL	NANO
10/15/2013	09:59:00	10:16:00	RAINFALL	LONG
10/15/2013	09:59:00	10:16:00	RAINFALL	APS
10/15/2013	19:57:15	19:58:16	INSUFFICENT WATER REMOVAL	APS
10/15/2013	20:01:15	20:01:16	INSUFFICENT WATER REMOVAL	APS
10/15/2013	20:05:15	20:05:16	INSUFFICENT WATER REMOVAL	APS
10/15/2013	20:10:15	20:11:16	INSUFFICENT WATER REMOVAL	APS
10/15/2013	20:14:15	20:17:16	INSUFFICENT WATER REMOVAL	APS
10/15/2013	20:20:15	20:20:16	INSUFFICENT WATER REMOVAL	APS
10/15/2013	20:22:15	20:23:16	INSUFFICENT WATER REMOVAL	APS
10/15/2013	20:27:15	20:28:16	INSUFFICENT WATER REMOVAL	APS
10/15/2013	20:36:15	20:36:16	INSUFFICENT WATER REMOVAL	APS
10/16/2013	13:27:31	23:59:59	MISSING DATA	LONG
10/16/2013	16:33:28	16:34:29	INSUFFICENT WATER REMOVAL	APS
10/16/2013	22:33:36	22:33:37	SHORT DURATION SPIKE	NANO
10/17/2013	00:00:00	06:56:05	MISSING DATA	LONG
10/17/2013	06:52:21	06:55:01	CPC DRAINED	LONG
10/17/2013	13:59:40	13:59:41	INSUFFICENT WATER REMOVAL	APS
10/17/2013	14:03:40	14:03:41	INSUFFICENT WATER REMOVAL	APS
10/17/2013	15:33:40	15:33:41	INSUFFICENT WATER REMOVAL	APS
10/17/2013	18:02:40	18:02:41	INSUFFICENT WATER REMOVAL	APS
10/17/2013	18:04:40	18:04:41	INSUFFICENT WATER REMOVAL	APS
10/17/2013	18:12:40	18:17:41	INSUFFICENT WATER REMOVAL	APS
10/17/2013	18:43:40	19:54:41	INSUFFICENT WATER REMOVAL	APS
10/17/2013	19:59:40	20:27:41	INSUFFICENT WATER REMOVAL	APS

Table I.21: Table 21 of 53

Date	Time Start	Time End	Description	Instrument
10/18/2013	00:00:00		PATTERN CHANGE	APS
10/18/2013	07:50:40	07:50:41	INSUFFICENT WATER REMOVAL	APS
10/18/2013	10:51:40	10:52:41	INSUFFICENT WATER REMOVAL	APS
10/18/2013	14:47:06	14:48:03	TEMPORARY GLITCH IN SAMPL	LONG
10/18/2013	16:41:52	16:42:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	17:02:52	17:07:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	17:44:52	17:56:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	18:59:52	18:59:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	19:18:52	19:20:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	19:24:52	19:25:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	19:30:52	19:46:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	19:49:52	19:56:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	20:01:52	20:19:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	20:26:52	20:40:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	20:42:52	20:56:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	22:59:52	23:07:53	INSUFFICENT WATER REMOVAL	APS
10/18/2013	23:13:52	23:16:53	INSUFFICENT WATER REMOVAL	APS
10/19/2013	00:41:00	03:27:00	RAINFALL	NANO
10/19/2013	00:41:00	03:27:00	RAINFALL	LONG
10/19/2013	00:41:00	03:27:00	RAINFALL	APS
10/19/2013	03:43:00	05:22:00	RAINFALL	NANO
10/19/2013	03:43:00	05:22:00	RAINFALL	LONG
10/19/2013	03:43:00	05:22:00	RAINFALL	APS
10/19/2013	08:32:24	08:35:01	CPC DRAINED	LONG
10/20/2013	03:07:58	03:07:59	SHORT DURATION SPIKE	NANO
10/20/2013	03:39:06	03:40:03	TEMPORARY GLITCH IN SAMPL	LONG
10/20/2013	06:50:24	06:52:39	DRYER CHANGE	LONG
10/20/2013	06:55:22	07:01:25	DRYER CHANGE	NANO
10/20/2013	07:00:05	07:03:06	INSUFFICENT WATER REMOVAL	APS
10/20/2013	07:00:05	07:04:05	DRYER CHANGE	APS
10/20/2013	07:01:13	23:59:59	APPARENT LEAK	NANO
10/20/2013	17:29:41	23:59:59	MISSING DATA	LONG
10/21/2013	00:00:00	06:36:26	MISSING DATA	LONG
10/21/2013	00:00:00	23:59:59	APPARENT LEAK	NANO
10/21/2013	06:38:46	06:47:51	CPC DRAIN	LONG
10/21/2013	10:23:17	10:23:18	INSUFFICENT WATER REMOVAL	APS
10/21/2013	14:49:31	14:49:32	INSUFFICENT WATER REMOVAL	APS
10/21/2013	17:43:31	17:44:32	INSUFFICENT WATER REMOVAL	APS
10/21/2013	17:47:31	17:47:32	INSUFFICENT WATER REMOVAL	APS
10/21/2013	17:52:31	17:52:32	INSUFFICENT WATER REMOVAL	APS
10/21/2013	18:11:31	18:17:32	INSUFFICENT WATER REMOVAL	APS
10/22/2013	00:00:00	23:59:59	APPARENT LEAK	NANO
10/22/2013	06:46:31	06:49:32	INSUFFICENT WATER REMOVAL	APS
10/22/2013	13:15:00	15:21:00	RAINFALL	NANO
10/22/2013	13:15:00	15:21:00	RAINFALL	LONG
10/22/2013	13:15:00	15:21:00	RAINFALL	APS
10/22/2013	15:36:00	16:06:00	RAINFALL	NANO
10/22/2013	15:36:00	16:06:00	RAINFALL	LONG
10/22/2013	15:36:00	16:06:00	RAINFALL	APS
10/22/2013	17:16:00	17:34:00	RAINFALL	NANO

Table I.22: Table 22 of 53

Date	Time Start	Time End	Description	Instrument
10/22/2013	17:16:00	17:34:00	RAINFALL	LONG
10/22/2013	17:16:00	17:34:00	RAINFALL	APS
10/22/2013	18:29:00	19:16:00	RAINFALL	NANO
10/22/2013	18:29:00	19:16:00	RAINFALL	LONG
10/22/2013	18:29:00	19:16:00	RAINFALL	APS
10/22/2013	19:53:00	20:53:00	RAINFALL	NANO
10/22/2013	19:53:00	20:53:00	RAINFALL	LONG
10/22/2013	19:53:00	20:53:00	RAINFALL	APS
10/22/2013	20:56:52	20:57:49	TEMPORARY GLITCH IN SAMPL	LONG
10/23/2013	00:00:00	12:29:13	APPARENT LEAK	NANO
10/23/2013	05:53:26	08:21:02	MISSING DATA	LONG
10/23/2013	08:14:11	08:35:16	CPC DRAINED	LONG
10/23/2013	12:29:14	23:59:59	MISSING DATA	NANO
10/24/2013	00:00:00	09:39:32	MISSING DATA	NANO
10/24/2013	09:04:57	09:26:47	MISSING DATA	APS
10/24/2013	09:39:33	23:59:59	APPARENT LEAK	NANO
10/24/2013	16:54:48	16:54:49	INSUFFICENT WATER REMOVAL	APS
10/25/2013	00:00:00	15:05:51	APPARENT LEAK	NANO
10/25/2013	08:36:37	08:41:20	CPC DRAIN	LONG
10/25/2013	09:24:49	23:59:59	MISSING DATA	APS
10/25/2013	12:49:13	13:09:26	NOT SAMPLING THROUGH INLE	NANO
10/25/2013	12:49:13	13:09:26	POSSIBLE DISTURBANCE TO I	LONG
10/25/2013	15:05:52	23:59:59	MISSING DATA	NANO
10/25/2013	18:45:38	23:59:59	MISSING DATA	LONG
10/26/2013	00:00:00	08:21:51	MISSING DATA	LONG
10/26/2013	00:00:00	14:18:07	MISSING DATA	APS
10/26/2013	00:00:00	23:59:59	MISSING DATA	NANO
10/26/2013	08:16:54	08:30:03	CPC DRAINED	LONG
10/26/2013	15:56:08	15:56:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	16:15:08	16:15:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	16:34:08	16:34:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	16:39:08	16:40:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	16:43:08	16:43:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	16:55:08	16:55:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	17:44:08	17:49:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	17:53:08	18:05:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	18:13:08	18:26:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	21:13:08	21:22:09	INSUFFICENT WATER REMOVAL	APS
10/26/2013	21:31:08	21:32:09	INSUFFICENT WATER REMOVAL	APS
10/27/2013	00:00:00	23:59:59	MISSING DATA	NANO
10/27/2013	00:02:08	00:06:09	INSUFFICENT WATER REMOVAL	APS
10/27/2013	00:22:08	00:23:09	INSUFFICENT WATER REMOVAL	APS
10/27/2013	00:37:08	00:46:09	INSUFFICENT WATER REMOVAL	APS
10/27/2013	14:16:09	17:01:51	MISSING DATA	APS
10/28/2013	00:00:00	19:08:25	MISSING DATA	NANO
10/28/2013	06:50:43	06:50:44	INSUFFICENT WATER REMOVAL	APS
10/28/2013	07:20:26	07:32:19	CPC DRAIN	LONG
10/28/2013	09:57:02	10:04:01	TEMPORARY GLITCH IN SAMPL	LONG
10/28/2013	16:17:43	16:17:44	INSUFFICENT WATER REMOVAL	APS
10/28/2013	17:05:44	18:57:40	MISSING DATA	APS

Table I.23: Table 23 of 53

Date	Time Start	Time End	Description	Instrument
10/28/2013	17:09:09	19:24:56	NOT SAMPLING THROUGH INLE	LONG
10/28/2013	17:09:20	19:24:16	NOT SAMPLING THROUGH INLE	APS
10/28/2013	17:19:32	19:22:46	NOT SAMPLING THROUGH INLE	NANO
10/28/2013	17:38:00	18:19:00	HEPA FILTER ON AEROSOL IN	NANO
10/28/2013	18:20:00	18:26:00	HEPA FILTER ON AEROSOL IN	NANO
10/28/2013	18:27:00	18:38:00	HEPA FILTER ON AEROSOL IN	NANO
10/28/2013	18:32:35	18:48:30	MISSING DATA	LONG
10/28/2013	19:03:41	19:08:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	21:38:41	21:40:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	21:43:41	21:43:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	21:47:41	21:47:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	21:50:41	21:50:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	21:56:41	21:56:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	22:06:41	22:06:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	22:10:41	22:16:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	22:23:41	22:31:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	22:33:41	22:34:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	22:39:41	22:39:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	22:57:41	22:57:42	INSUFFICENT WATER REMOVAL	APS
10/28/2013	23:00:41	23:00:42	INSUFFICENT WATER REMOVAL	APS
10/29/2013	00:30:26	00:30:27	SHORT DURATION SPIKE	NANO
10/29/2013	02:30:31	02:37:30	TEMPORARY GLITCH IN SAMPL	LONG
10/29/2013	08:35:00	09:07:00	ZERO OF SO2 MONITOR	NANO
10/29/2013	08:35:00	09:07:00	ZERO OF SO2 MONITOR	LONG
10/29/2013	08:41:31	08:46:03	NOT SAMPLING THROUGH INLE	LONG
10/29/2013	08:56:41	08:58:40	NOT SAMPLING THROUGH INLE	APS
10/29/2013	08:59:41	08:59:42	INSUFFICENT WATER REMOVAL	APS
10/29/2013	18:55:42	23:59:59	MISSING DATA	APS
10/30/2013	00:00:00	10:00:46	MISSING DATA	APS
10/30/2013	09:56:58	23:59:59	MISSING DATA	NANO
10/30/2013	13:25:50	23:59:59	MISSING DATA	LONG
10/30/2013	19:03:00	19:20:00	RAINFALL	NANO
10/30/2013	19:03:00	19:20:00	RAINFALL	LONG
10/30/2013	19:03:00	19:20:00	RAINFALL	APS
10/31/2013	00:00:00	07:13:41	MISSING DATA	NANO
10/31/2013	00:00:00	07:25:56	MISSING DATA	LONG
10/31/2013	04:23:00	10:35:00	RAINFALL	NANO
10/31/2013	04:23:00	10:35:00	RAINFALL	LONG
10/31/2013	04:23:00	10:35:00	RAINFALL	APS
10/31/2013	07:18:38	07:20:38	NOT SAMPLING THROUGH INLE	LONG
10/31/2013	11:01:00	11:18:00	RAINFALL	NANO
10/31/2013	11:01:00	11:18:00	RAINFALL	LONG
10/31/2013	11:01:00	11:18:00	RAINFALL	APS
10/31/2013	11:32:00	11:49:00	RAINFALL	NANO
10/31/2013	11:32:00	11:49:00	RAINFALL	LONG
10/31/2013	11:32:00	11:49:00	RAINFALL	APS
10/31/2013	17:46:31	23:59:59	MISSING DATA	LONG
10/31/2013	18:29:00	18:46:00	RAINFALL	NANO
10/31/2013	18:29:00	18:46:00	RAINFALL	LONG
10/31/2013	18:29:00	18:46:00	RAINFALL	APS

Table I.24: Table 24 of 53

Date	Time Start	Time End	Description	Instrument
10/31/2013	20:06:00	20:30:00	RAINFALL	NANO
10/31/2013	20:06:00	20:30:00	RAINFALL	LONG
10/31/2013	20:06:00	20:30:00	RAINFALL	APS
10/31/2013	22:55:00	23:59:59	RAINFALL	NANO
10/31/2013	22:55:00	23:59:59	RAINFALL	LONG
10/31/2013	22:55:00	23:59:59	RAINFALL	APS
11/01/2013	00:00:00	03:47:00	RAINFALL	NANO
11/01/2013	00:00:00	03:47:00	RAINFALL	LONG
11/01/2013	00:00:00	03:47:00	RAINFALL	APS
11/01/2013	00:00:00	07:03:46	MISSING DATA	LONG
11/01/2013	06:44:36	06:54:33	CPC DRAINED	LONG
11/01/2013	07:10:47	07:20:05	DRYER CHANGE	NANO
11/01/2013	07:10:47	07:20:05	NOT SAMPLING THROUGH INLE	LONG
11/01/2013	07:18:08	07:24:52	DRYER CHANGE	APS
11/01/2013	09:02:47	09:09:46	TEMPORARY GLITCH IN SAMPL	LONG
11/01/2013	21:01:21	23:59:59	MISSING DATA	LONG
11/02/2013	00:00:00	06:50:40	MISSING DATA	LONG
11/02/2013	06:45:24	06:47:00	CPC DRAINED	LONG
11/02/2013	07:06:59	07:09:13	TEMPORARY GLITCH IN SAMPL	LONG
11/02/2013	15:54:15	23:59:59	MISSING DATA	LONG
11/03/2013	00:00:00	07:47:39	MISSING DATA	LONG
11/03/2013	07:54:40	07:56:57	DRYER CHANGE	NANO
11/03/2013	07:54:40	07:56:57	NOT SAMPLING THROUGH INLE	LONG
11/03/2013	09:39:40	09:41:58	CPC DRAIN	LONG
11/04/2013	03:14:15	07:30:36	MISSING DATA	LONG
11/04/2013	07:24:27	07:57:16	CPC DRAINED	LONG
11/04/2013	11:40:11	16:31:37	MISSING DATA	LONG
11/04/2013	16:20:17	16:58:12	NOT SAMPLING THROUGH INLE	LONG
11/06/2013	01:03:00	01:20:00	RAINFALL	NANO
11/06/2013	01:03:00	01:20:00	RAINFALL	LONG
11/06/2013	01:03:00	01:20:00	RAINFALL	APS
11/06/2013	02:01:00	02:59:00	RAINFALL	NANO
11/06/2013	02:01:00	02:59:00	RAINFALL	LONG
11/06/2013	02:01:00	02:59:00	RAINFALL	APS
11/06/2013	06:40:00	06:57:00	RAINFALL	NANO
11/06/2013	06:40:00	06:57:00	RAINFALL	LONG
11/06/2013	06:40:00	06:57:00	RAINFALL	APS
11/06/2013	07:06:00	08:13:00	RAINFALL	NANO
11/06/2013	07:06:00	08:13:00	RAINFALL	LONG
11/06/2013	07:06:00	08:13:00	RAINFALL	APS
11/06/2013	08:30:00		CPC DRAIN	LONG
11/06/2013	11:36:00	11:53:00	RAINFALL	NANO
11/06/2013	11:36:00	11:53:00	RAINFALL	LONG
11/06/2013	11:36:00	11:53:00	RAINFALL	APS
11/06/2013	12:00:00	00:00:00	PATTERN CHANGE	APS
11/07/2013	03:08:03	03:15:02	TEMPORARY GLITCH IN SAMPL	LONG
11/07/2013	13:56:37	15:50:46	MISSING DATA	LONG
11/07/2013	15:41:30	15:45:56	CPC DRAIN	LONG
11/07/2013	16:02:21	16:09:20	NOT SAMPLING THROUGH INLE	LONG
11/08/2013	18:03:22	23:59:59	MISSING DATA	LONG

Table I.25: Table 25 of 53

Date	Time Start	Time End	Description	Instrument
11/09/2013	00:00:00	09:05:00	MISSING DATA	LONG
11/09/2013	08:53:27	08:57:02	CPC DRAINED	LONG
11/09/2013	09:14:39	09:24:44	DRYER CHANGE	APS
11/09/2013	14:22:16	14:22:17	SHORT DURATION SPIKE	NANO
11/10/2013	03:42:35	08:00:44	MISSING DATA	LONG
11/10/2013	07:49:53	08:26:22	CPC DRAINED	LONG
11/10/2013	11:20:08	11:20:09	INSUFFICENT WATER REMOVAL	APS
11/10/2013	12:44:12	18:06:12	MISSING DATA	LONG
11/10/2013	14:15:08	14:15:09	INSUFFICENT WATER REMOVAL	APS
11/10/2013	14:22:08	14:24:09	INSUFFICENT WATER REMOVAL	APS
11/10/2013	16:32:08	16:32:09	INSUFFICENT WATER REMOVAL	APS
11/10/2013	17:37:08	17:39:09	INSUFFICENT WATER REMOVAL	APS
11/10/2013	17:56:39	18:11:01	NOT SAMPLING THROUGH INLE	LONG
11/11/2013	02:34:47	23:59:59	MISSING DATA	LONG
11/11/2013	11:41:08	11:42:09	INSUFFICENT WATER REMOVAL	APS
11/11/2013	11:51:08	11:51:09	INSUFFICENT WATER REMOVAL	APS
11/11/2013	11:57:01	11:58:01	SHORT DURATION SPIKE	NANO
11/11/2013	13:08:08	13:08:09	INSUFFICENT WATER REMOVAL	APS
11/11/2013	13:37:08	13:37:09	INSUFFICENT WATER REMOVAL	APS
11/11/2013	14:21:08	14:22:09	INSUFFICENT WATER REMOVAL	APS
11/12/2013	00:00:00	23:59:59	MISSING DATA	LONG
11/12/2013	02:41:15	02:42:15	SHORT DURATION SPIKE	NANO
11/13/2013	00:00:00	23:59:59	MISSING DATA	LONG
11/14/2013	00:00:00	23:59:59	MISSING DATA	LONG
11/14/2013	11:37:16	11:38:16	SHORT DURATION SPIKE	NANO
11/15/2013	00:00:00	23:59:59	MISSING DATA	LONG
11/16/2013	00:00:00	23:59:59	MISSING DATA	LONG
11/16/2013	02:26:01	02:27:01	SHORT DURATION SPIKE	NANO
11/16/2013	19:41:00	19:59:00	RAINFALL	NANO
11/16/2013	19:41:00	19:59:00	RAINFALL	LONG
11/16/2013	19:41:00	19:59:00	RAINFALL	APS
11/17/2013	00:00:00	23:59:59	MISSING DATA	LONG
11/17/2013	12:33:00	13:05:00	RAINFALL	NANO
11/17/2013	12:33:00	13:05:00	RAINFALL	LONG
11/17/2013	12:33:00	13:05:00	RAINFALL	APS
11/17/2013	13:06:17	23:59:59	MISSING DATA	NANO
11/17/2013	14:10:08	14:29:09	INSUFFICENT WATER REMOVAL	APS
11/17/2013	14:32:08	14:32:09	INSUFFICENT WATER REMOVAL	APS
11/17/2013	14:34:08	14:34:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	00:00:00	15:39:11	MISSING DATA	NANO
11/18/2013	00:00:00	23:59:59	MISSING DATA	LONG
11/18/2013	07:40:08	07:43:07	DRYER CHANGE	APS
11/18/2013	07:42:08	07:42:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	12:50:08	12:50:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	14:33:08	14:33:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	14:40:08	14:40:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	14:51:08	14:51:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	15:02:08	15:02:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	15:12:08	15:12:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	15:16:08	15:16:09	INSUFFICENT WATER REMOVAL	APS

Table I.26: Table 26 of 53

Date	Time Start	Time End	Description	Instrument
11/18/2013	15:23:08	15:23:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	15:47:08	15:47:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	16:16:30	16:18:44	DRYER CHANGE	NANO
11/18/2013	16:42:08	16:43:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	16:49:08	16:49:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	16:55:08	16:56:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	17:09:08	17:15:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	17:44:08	17:47:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	18:19:08	18:25:09	INSUFFICENT WATER REMOVAL	APS
11/18/2013	18:28:08	18:30:09	INSUFFICENT WATER REMOVAL	APS
11/19/2013	00:00:00	07:20:56	MISSING DATA	LONG
11/19/2013	00:00:00		LOCAL SOURCE	APS
11/19/2013	00:00:00		LOCAL SOURCE	APS
11/19/2013	00:00:00		LOCAL SOURCE	APS
11/19/2013	05:50:08	05:52:09	INSUFFICENT WATER REMOVAL	APS
11/19/2013	06:47:08	06:54:09	INSUFFICENT WATER REMOVAL	APS
11/19/2013	06:57:08	06:59:09	INSUFFICENT WATER REMOVAL	APS
11/19/2013	07:01:08	07:07:09	INSUFFICENT WATER REMOVAL	APS
11/19/2013	07:20:57	07:23:14	NOT SAMPLING THROUGH INLE	LONG
11/19/2013	07:41:09	07:54:10	INSUFFICENT WATER REMOVAL	APS
11/19/2013	07:58:09	08:00:10	INSUFFICENT WATER REMOVAL	APS
11/19/2013	08:07:09	08:09:10	INSUFFICENT WATER REMOVAL	APS
11/19/2013	09:21:09	09:21:10	INSUFFICENT WATER REMOVAL	APS
11/20/2013	01:02:31	07:54:37	MISSING DATA	LONG
11/20/2013	07:43:47	07:48:24	NOT SAMPLING THROUGH INLE	LONG
11/20/2013	12:48:37	12:53:09	CPC DRAIN	LONG
11/20/2013	19:45:00	20:34:00	RAINFALL	NANO
11/20/2013	19:45:00	20:34:00	RAINFALL	LONG
11/20/2013	19:45:00	20:34:00	RAINFALL	APS
11/20/2013	23:02:11	23:59:59	MISSING DATA	LONG
11/20/2013	23:24:09	23:59:59	MISSING DATA	APS
11/21/2013	00:00:00	23:59:59	MISSING DATA	LONG
11/21/2013	02:49:00	03:06:00	RAINFALL	NANO
11/21/2013	02:49:00	03:06:00	RAINFALL	LONG
11/21/2013	02:49:00	03:06:00	RAINFALL	APS
11/21/2013	12:04:00	15:37:00	RAINFALL	NANO
11/21/2013	12:04:00	15:37:00	RAINFALL	LONG
11/21/2013	12:04:00	15:37:00	RAINFALL	APS
11/21/2013	15:49:00	16:54:00	RAINFALL	NANO
11/21/2013	15:49:00	16:54:00	RAINFALL	LONG
11/21/2013	15:49:00	16:54:00	RAINFALL	APS
11/22/2013	00:00:00	14:33:55	MISSING DATA	LONG
11/22/2013	03:30:00	03:47:00	RAINFALL	NANO
11/22/2013	03:30:00	03:47:00	RAINFALL	LONG
11/22/2013	03:30:00	03:47:00	RAINFALL	APS
11/22/2013	14:24:18	14:42:28	NOT SAMPLING THROUGH INLE	LONG
11/22/2013	14:40:44	14:42:58	DRYER CHANGE	LONG
11/23/2013	05:33:12	05:34:12	SHORT DURATION SPIKE	NANO
11/23/2013	08:18:08	08:23:07	DRYER CHANGE	APS
11/24/2013	08:04:40	08:06:54	CPC DRAIN	LONG

Table I.27: Table 27 of 53

Date	Time Start	Time End	Description	Instrument
11/26/2013	07:02:08	07:24:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	07:33:31	18:18:28	MISSING DATA	NANO
11/26/2013	07:39:48	07:42:02	CPC DRAIN	LONG
11/26/2013	13:18:08	13:18:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	13:27:08	13:27:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	14:48:08	14:48:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	15:22:08	15:22:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	15:47:08	15:47:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	16:29:08	16:29:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	17:32:08	17:32:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	18:10:08	18:10:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	18:42:08	18:42:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	19:55:08	19:55:09	INSUFFICENT WATER REMOVAL	APS
11/26/2013	21:56:08	21:56:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	05:08:08	05:09:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	06:47:08	06:48:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	07:24:08	07:24:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	07:41:08	07:43:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	07:51:08	07:53:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	09:43:08	09:43:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	12:05:08	12:05:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	13:05:08	13:05:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	14:29:08	14:29:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	14:39:08	14:39:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	14:42:08	14:42:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	14:58:08	14:58:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	15:14:08	15:14:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	15:24:08	15:24:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	16:17:08	16:19:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	16:34:08	16:36:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	17:01:08	17:01:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	17:15:08	17:16:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	17:20:08	17:32:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	17:50:08	17:51:09	INSUFFICENT WATER REMOVAL	APS
11/27/2013	17:53:08	17:53:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	07:41:59	07:46:29	CPC DRAIN	LONG
11/28/2013	16:47:08	16:53:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	17:20:08	17:25:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	18:46:08	18:51:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	18:54:08	19:00:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	19:03:08	19:03:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	19:07:08	19:10:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	19:16:08	19:18:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	19:30:08	19:34:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	19:47:08	19:48:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	19:51:08	19:52:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	20:25:08	20:27:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	21:19:08	21:21:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	21:38:08	21:41:09	INSUFFICENT WATER REMOVAL	APS
11/28/2013	22:51:08	22:51:09	INSUFFICENT WATER REMOVAL	APS

Table I.28: Table 28 of 53

Date	Time Start	Time End	Description	Instrument
11/28/2013	23:58:08	00:01:09	INSUFFICENT WATER REMOVAL	APS
11/29/2013	07:23:08	07:27:09	INSUFFICENT WATER REMOVAL	APS
11/29/2013	07:23:08	07:28:07	LOCAL SOURCE	APS
11/29/2013	07:36:08	07:46:09	INSUFFICENT WATER REMOVAL	APS
11/30/2013	07:37:25	07:39:39	CPC DRAIN	LONG
12/01/2013	11:09:09	11:09:10	INSUFFICENT WATER REMOVAL	APS
12/01/2013	12:00:09	12:01:10	INSUFFICENT WATER REMOVAL	APS
12/01/2013	14:58:09	14:58:10	INSUFFICENT WATER REMOVAL	APS
12/01/2013	16:05:09	16:07:10	INSUFFICENT WATER REMOVAL	APS
12/01/2013	16:20:09	16:20:10	INSUFFICENT WATER REMOVAL	APS
12/01/2013	16:58:09	16:58:10	INSUFFICENT WATER REMOVAL	APS
12/01/2013	17:14:09	17:15:10	INSUFFICENT WATER REMOVAL	APS
12/01/2013	18:34:09	18:36:10	INSUFFICENT WATER REMOVAL	APS
12/01/2013	18:40:09	18:42:10	INSUFFICENT WATER REMOVAL	APS
12/02/2013	07:50:43	07:55:12	CPC DRAIN	LONG
12/03/2013	15:57:09	23:59:59	MISSING DATA	APS
12/04/2013	07:14:37	07:19:06	CPC DRAIN	LONG
12/04/2013	14:59:05	16:22:02	NOT SAMPLING THROUGH INLE	NANO
12/04/2013	14:59:38	15:52:13	NOT SAMPLING THROUGH INLE	APS
12/04/2013	15:15:00	15:36:00	ZERO OF SO2 MONITOR	NANO
12/04/2013	15:15:00	15:36:00	ZERO OF SO2 MONITOR	LONG
12/04/2013	15:23:08	15:24:08	NOT SAMPLING THROUGH INLE	APS
12/04/2013	15:34:06	15:40:30	NOT SAMPLING THROUGH INLE	LONG
12/04/2013	15:34:46	15:41:46	NOT SAMPLING THROUGH INLE	NANO
12/04/2013	16:09:22	16:21:08	NOT SAMPLING THROUGH INLE	LONG
12/04/2013	16:09:47	16:12:01	LOCAL SOURCE	NANO
12/05/2013	07:01:04	07:10:04	TEMPORARY GLITCH IN SAMPL	LONG
12/05/2013	07:43:01	07:45:27	DISCONTINUOUS SIZE DISTRI	NANO
12/05/2013	15:34:29	16:02:27	MISSING DATA	NANO
12/05/2013	15:36:10	23:59:59	MISSING DATA	APS
12/06/2013	02:51:02	02:52:02	SHORT DURATION SPIKE	NANO
12/06/2013	07:31:44	07:40:43	CPC DRAIN	LONG
12/06/2013	07:40:08	08:11:07	DRYER CHANGE	APS
12/06/2013	20:30:30	20:42:00	MISSING DATA	NANO
12/06/2013	20:32:09	23:59:59	MISSING DATA	APS
12/07/2013	08:43:08	08:43:09	INSUFFICENT WATER REMOVAL	APS
12/07/2013	13:49:43	19:47:25	MISSING DATA	LONG
12/07/2013	15:55:08	15:56:09	INSUFFICENT WATER REMOVAL	APS
12/07/2013	16:21:08	16:21:09	INSUFFICENT WATER REMOVAL	APS
12/07/2013	17:15:08	17:21:09	INSUFFICENT WATER REMOVAL	APS
12/07/2013	18:12:08	18:13:09	INSUFFICENT WATER REMOVAL	APS
12/07/2013	19:20:01	19:22:27	LOCAL SOURCE	NANO
12/07/2013	20:09:56	20:12:10	NOT SAMPLING THROUGH INLE	LONG
12/07/2013	22:48:08	22:50:09	INSUFFICENT WATER REMOVAL	APS
12/08/2013	00:00:00		LOCAL SOURCE	APS
12/08/2013	08:59:03	09:16:59	MISSING DATA	NANO
12/08/2013	09:02:09	09:39:16	MISSING DATA	APS
12/08/2013	13:12:32	13:13:32	SHORT DURATION SPIKE	NANO
12/09/2013	08:27:43	08:34:27	CPC DRAIN	LONG
12/09/2013	09:37:18	23:59:59	MISSING DATA	APS

Table I.29: Table 29 of 53

Date	Time Start	Time End	Description	Instrument
12/10/2013	00:00:00	07:53:25	MISSING DATA	APS
12/10/2013	07:40:33	07:58:43	MISSING DATA	NANO
12/10/2013	16:42:26	17:09:27	INSUFFICENT WATER REMOVAL	APS
12/10/2013	17:12:26	17:12:27	INSUFFICENT WATER REMOVAL	APS
12/10/2013	20:36:26	20:49:27	INSUFFICENT WATER REMOVAL	APS
12/11/2013	07:38:09	07:42:38	CPC DRAIN	LONG
12/11/2013	07:51:27	23:59:59	MISSING DATA	APS
12/13/2013	00:00:00	11:17:31	MISSING DATA	APS
12/13/2013	07:53:50	07:58:19	CPC DRAIN	LONG
12/14/2013	11:14:00	13:12:00	RAINFALL	NANO
12/14/2013	11:14:00	13:12:00	RAINFALL	LONG
12/14/2013	11:14:00	13:12:00	RAINFALL	APS
12/14/2013	14:29:03	14:33:44	DISCONTINUOUS SIZE DISTRI	NANO
12/15/2013	07:40:06	07:44:35	CPC DRAIN	LONG
12/17/2013	08:47:32	08:49:46	CPC DRAIN	LONG
12/17/2013	10:32:18	10:33:18	SHORT DURATION SPIKE	NANO
12/19/2013	04:25:00	05:12:00	RAINFALL	NANO
12/19/2013	04:25:00	05:12:00	RAINFALL	LONG
12/19/2013	04:25:00	05:12:00	RAINFALL	APS
12/19/2013	10:33:12	10:37:41	CPC DRAIN	LONG
12/20/2013	06:08:00	06:40:00	RAINFALL	NANO
12/20/2013	06:08:00	06:40:00	RAINFALL	LONG
12/20/2013	06:08:00	06:40:00	RAINFALL	APS
12/20/2013	15:02:00	15:37:00	RAINFALL	NANO
12/20/2013	15:02:00	15:37:00	RAINFALL	LONG
12/20/2013	15:02:00	15:37:00	RAINFALL	APS
12/21/2013	04:28:00	04:56:00	RAINFALL	NANO
12/21/2013	04:28:00	04:56:00	RAINFALL	LONG
12/21/2013	04:28:00	04:56:00	RAINFALL	APS
12/21/2013	05:33:00	06:14:00	RAINFALL	NANO
12/21/2013	05:33:00	06:14:00	RAINFALL	LONG
12/21/2013	05:33:00	06:14:00	RAINFALL	APS
12/21/2013	06:32:00	07:03:00	RAINFALL	NANO
12/21/2013	06:32:00	07:03:00	RAINFALL	LONG
12/21/2013	06:32:00	07:03:00	RAINFALL	APS
12/21/2013	08:44:44	08:58:37	CPC DRAIN	LONG
12/21/2013	10:01:00	12:07:00	RAINFALL	NANO
12/21/2013	10:01:00	12:07:00	RAINFALL	LONG
12/21/2013	10:01:00	12:07:00	RAINFALL	APS
12/21/2013	12:20:00	14:06:00	RAINFALL	NANO
12/21/2013	12:20:00	14:06:00	RAINFALL	LONG
12/21/2013	12:20:00	14:06:00	RAINFALL	APS
12/21/2013	14:53:00	20:03:00	RAINFALL	NANO
12/21/2013	14:53:00	20:03:00	RAINFALL	LONG
12/21/2013	14:53:00	20:03:00	RAINFALL	APS
12/23/2013	08:50:48	08:57:32	CPC DRAIN	LONG
12/23/2013	09:02:45	09:08:44	DRYER	APS
12/23/2013	09:03:50	09:05:22	DRYER CHANGE	NANO
12/24/2013	07:47:46	07:54:30	CPC DRAIN	LONG
12/26/2013	04:12:46	04:16:47	INSUFFICENT WATER REMOVAL	APS

Table I.30: Table 30 of 53

Date	Time Start	Time End	Description	Instrument
12/26/2013	04:12:46	04:20:45	LOCAL SOURCE	APS
12/26/2013	06:17:18	06:18:18	SHORT DURATION SPIKE	NANO
12/26/2013	07:45:27	07:52:11	CPC DRAIN	LONG
12/27/2013	21:55:03	21:56:03	SHORT DURATION SPIKE	NANO
12/28/2013	08:12:22	08:14:36	CPC DRAIN	LONG
12/28/2013	18:17:45	18:18:45	SHORT DURATION SPIKE	NANO
12/30/2013	02:20:19	02:21:19	SHORT DURATION SPIKE	NANO
12/30/2013	07:22:48	07:27:17	CPC DRAIN	LONG
01/01/2014	05:45:03	05:46:03	SHORT DURATION SPIKE	NANO
01/01/2014	08:18:58	08:25:42	CPC DRAIN	LONG
01/03/2014	08:37:39	08:42:08	CPC DRAIN	LONG
01/03/2014	09:15:55	13:25:48	MISSING DATA	LONG
01/03/2014	09:17:46	13:19:03	MISSING DATA	APS
01/03/2014	13:25:49	23:59:59	APPARENT LEAK	LONG
01/03/2014	13:28:45	13:29:45	SHORT DURATION SPIKE	NANO
01/04/2014	00:00:00	19:30:16	APPARENT LEAK	LONG
01/04/2014	12:32:20	23:59:59	MISSING DATA	NANO
01/04/2014	13:17:08	23:59:59	MISSING DATA	APS
01/04/2014	19:30:17	23:59:59	MISSING DATA	LONG
01/05/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/05/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/05/2014	00:00:00	23:59:59	MISSING DATA	APS
01/06/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/06/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/06/2014	00:00:00	23:59:59	MISSING DATA	APS
01/07/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/07/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/07/2014	00:00:00	23:59:59	MISSING DATA	APS
01/08/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/08/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/08/2014	00:00:00	23:59:59	MISSING DATA	APS
01/09/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/09/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/09/2014	00:00:00	23:59:59	MISSING DATA	APS
01/10/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/10/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/10/2014	00:00:00	23:59:59	MISSING DATA	APS
01/11/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/11/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/11/2014	00:00:00	23:59:59	MISSING DATA	APS
01/12/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/12/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/12/2014	00:00:00	23:59:59	MISSING DATA	APS
01/13/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/13/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/13/2014	00:00:00	23:59:59	MISSING DATA	APS
01/14/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/14/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/14/2014	00:00:00	23:59:59	MISSING DATA	APS
01/15/2014	00:00:00	12:59:41	MISSING DATA	APS

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Date	Time Start	Time End	Description	Instrument
01/15/2014	00:00:00	13:03:01	MISSING DATA	LONG
01/15/2014	00:00:00	13:04:39	MISSING DATA	NANO
01/15/2014	12:35:00		FLOW TEST	NANO
01/15/2014	12:35:00		HEPA FILTER ON AEROSOL IN	NANO
01/15/2014	12:35:00		FLOW TEST	LONG
01/15/2014	12:35:00		HEPA FILTER ON AEROSOL IN	LONG
01/15/2014	12:35:00		FLOW TEST	APS
01/15/2014	12:59:42	13:40:41	NOT SAMPLING THROUGH INLE	APS
01/15/2014	13:27:50	13:39:04	NOT SAMPLING THROUGH INLE	LONG
01/15/2014	13:27:59	13:39:39	NOT SAMPLING THROUGH INLE	NANO
01/15/2014	13:28:00		HEPA FILTER ON AEROSOL IN	APS
01/15/2014	13:40:00	14:44:00	ZERO OF SO2 MONITOR	NANO
01/15/2014	13:40:00	14:44:00	ZERO OF SO2 MONITOR	LONG
01/15/2014	13:40:42	23:59:59	OBSTRUCTION	APS
01/15/2014	22:52:40	22:53:40	SHORT DURATION SPIKE	NANO
01/16/2014	00:00:00	23:59:59	OBSTRUCTION	APS
01/17/2014	00:00:00	23:59:59	OBSTRUCTION	APS
01/17/2014	09:06:46	09:13:30	CPC DRAIN	LONG
01/17/2014	17:08:16	17:23:46	MISSING DATA	LONG
01/18/2014	00:00:00	01:50:41	OBSTRUCTION	APS
01/18/2014	07:36:49	08:03:33	CPC DRAIN	LONG
01/19/2014	09:44:46	09:58:15	CPC DRAIN	LONG
01/19/2014	15:58:14	15:59:14	SHORT DURATION SPIKE	NANO
01/21/2014	08:46:15	08:52:59	CPC DRAIN	LONG
01/22/2014	03:16:40	03:17:40	SHORT DURATION SPIKE	NANO
01/22/2014	10:58:57	11:07:56	CPC DRAIN	LONG
01/22/2014	13:58:57	14:01:11	CPC DRAIN	LONG
01/22/2014	14:16:57	14:19:11	CPC DRAIN	LONG
01/23/2014	07:48:42	07:48:43	INSUFFICENT WATER REMOVAL	APS
01/23/2014	08:50:42	08:50:43	INSUFFICENT WATER REMOVAL	APS
01/23/2014	17:00:42	17:00:43	INSUFFICENT WATER REMOVAL	APS
01/23/2014	17:23:42	17:23:43	INSUFFICENT WATER REMOVAL	APS
01/23/2014	17:43:42	17:43:43	INSUFFICENT WATER REMOVAL	APS
01/23/2014	17:46:42	17:46:43	INSUFFICENT WATER REMOVAL	APS
01/23/2014	21:15:42	21:17:43	INSUFFICENT WATER REMOVAL	APS
01/23/2014	21:26:42	21:27:43	INSUFFICENT WATER REMOVAL	APS
01/23/2014	22:00:42	22:00:43	INSUFFICENT WATER REMOVAL	APS
01/24/2014	07:45:23	07:49:52	CPC DRAIN	LONG
01/24/2014	22:04:49	23:59:59	MISSING DATA	LONG
01/25/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/25/2014	10:25:42	10:25:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	11:17:42	11:17:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	11:46:42	11:49:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	11:54:42	11:59:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	13:23:42	13:23:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	15:13:42	15:13:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	16:07:42	16:07:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	16:20:42	16:20:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	17:10:42	17:10:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	17:49:42	17:49:43	INSUFFICENT WATER REMOVAL	APS

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Date	Time Start	Time End	Description	Instrument
01/25/2014	18:30:42	18:30:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	18:39:42	18:39:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	19:59:42	19:59:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	20:26:42	20:27:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	21:16:42	21:18:43	INSUFFICENT WATER REMOVAL	APS
01/25/2014	22:44:40	22:45:40	SHORT DURATION SPIKE	NANO
01/26/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/26/2014	22:41:59	23:59:59	MISSING DATA	NANO
01/26/2014	22:46:59	23:59:59	MISSING DATA	APS
01/27/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/27/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/27/2014	00:00:00	23:59:59	MISSING DATA	APS
01/28/2014	00:00:00	23:59:59	MISSING DATA	NANO
01/28/2014	00:00:00	23:59:59	MISSING DATA	LONG
01/28/2014	00:00:00	23:59:59	MISSING DATA	APS
01/29/2014	00:00:00	14:23:27	MISSING DATA	NANO
01/29/2014	00:00:00	14:43:55	MISSING DATA	APS
01/29/2014	00:00:00	14:54:52	MISSING DATA	LONG
01/29/2014	14:49:02	14:50:02	SHORT DURATION SPIKE	NANO
01/30/2014	09:18:09	09:20:23	CPC DRAIN	LONG
01/30/2014	14:41:57	17:00:44	MISSING DATA	APS
01/30/2014	16:05:20	17:06:16	MISSING DATA	LONG
01/30/2014	20:58:58	20:59:58	SHORT DURATION SPIKE	NANO
01/31/2014	09:43:04	09:49:48	CPC DRAIN	LONG
01/31/2014	09:46:10	09:47:10	SHORT DURATION SPIKE	NANO
01/31/2014	16:58:46	17:28:08	MISSING DATA	APS
01/31/2014	17:31:03	17:35:32	TEMPORARY GLITCH IN SAMPL	LONG
02/01/2014	06:21:00	08:25:00	RAINFALL	NANO
02/01/2014	06:21:00	08:25:00	RAINFALL	LONG
02/01/2014	06:21:00	08:25:00	RAINFALL	APS
02/01/2014	09:37:00	12:33:00	RAINFALL	NANO
02/01/2014	09:37:00	12:33:00	RAINFALL	LONG
02/01/2014	09:37:00	12:33:00	RAINFALL	APS
02/01/2014	13:21:00	13:38:00	RAINFALL	NANO
02/01/2014	13:21:00	13:38:00	RAINFALL	LONG
02/01/2014	13:21:00	13:38:00	RAINFALL	APS
02/01/2014	13:59:00	14:30:00	RAINFALL	NANO
02/01/2014	13:59:00	14:30:00	RAINFALL	LONG
02/01/2014	13:59:00	14:30:00	RAINFALL	APS
02/01/2014	14:49:00	15:06:00	RAINFALL	NANO
02/01/2014	14:49:00	15:06:00	RAINFALL	LONG
02/01/2014	14:49:00	15:06:00	RAINFALL	APS
02/02/2014	08:42:18	08:49:02	CPC DRAIN	LONG
02/04/2014	08:17:29	08:21:47	CPC DRAIN	LONG
02/05/2014	01:39:10	01:40:10	SHORT DURATION SPIKE	NANO
02/06/2014	09:51:44	10:35:51	MISSING DATA	LONG
02/06/2014	15:13:10	15:14:10	SHORT DURATION SPIKE	NANO
02/07/2014	08:38:50	08:41:04	CPC DRAIN	LONG
02/07/2014	13:22:21	23:59:59	MISSING DATA	LONG
02/07/2014	15:43:10	15:44:10	SHORT DURATION SPIKE	NANO

Table I.33: Table 33 of 53

Date	Time Start	Time End	Description	Instrument
02/08/2014	00:00:00	08:00:32	MISSING DATA	LONG
02/08/2014	08:00:33	23:59:59	APPARENT LEAK	LONG
02/08/2014	10:20:44	10:21:44	SHORT DURATION SPIKE	NANO
02/08/2014	20:01:43	20:02:43	SHORT DURATION SPIKE	NANO
02/09/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/10/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/10/2014	08:40:00		CPC DRAINED	LONG
02/10/2014	16:56:09	16:57:10	INSUFFICENT WATER REMOVAL	APS
02/11/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/11/2014	07:28:09	07:29:10	INSUFFICENT WATER REMOVAL	APS
02/11/2014	07:39:09	07:40:10	INSUFFICENT WATER REMOVAL	APS
02/11/2014	08:07:09	08:07:10	INSUFFICENT WATER REMOVAL	APS
02/11/2014	19:38:09	19:38:10	INSUFFICENT WATER REMOVAL	APS
02/12/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/13/2014	00:00:00	21:25:42	APPARENT LEAK	LONG
02/13/2014	21:25:43	23:59:59	MISSING DATA	LONG
02/14/2014	00:00:00	09:00:55	MISSING DATA	LONG
02/14/2014	09:00:56	23:59:59	APPARENT LEAK	LONG
02/15/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/16/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/17/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/18/2014	00:00:00	09:15:09	PATTERN CHANGE	APS
02/18/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/18/2014	08:30:00		CPC DRAINED	LONG
02/18/2014	09:15:10	23:59:59	OBSTRUCTION	APS
02/18/2014	10:54:00	11:25:00	RAINFALL	NANO
02/18/2014	10:54:00	11:25:00	RAINFALL	LONG
02/18/2014	10:54:00	11:25:00	RAINFALL	APS
02/19/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/19/2014	00:00:00	23:59:59	OBSTRUCTION	APS
02/20/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/20/2014	00:00:00	23:59:59	OBSTRUCTION	APS
02/20/2014	02:08:00	02:48:00	RAINFALL	NANO
02/20/2014	02:08:00	02:48:00	RAINFALL	LONG
02/20/2014	02:08:00	02:48:00	RAINFALL	APS
02/20/2014	04:28:00	04:46:00	RAINFALL	NANO
02/20/2014	04:28:00	04:46:00	RAINFALL	LONG
02/20/2014	04:28:00	04:46:00	RAINFALL	APS
02/20/2014	07:27:00	08:15:00	RAINFALL	NANO
02/20/2014	07:27:00	08:15:00	RAINFALL	LONG
02/20/2014	07:27:00	08:15:00	RAINFALL	APS
02/20/2014	08:27:00	08:51:00	RAINFALL	NANO
02/20/2014	08:27:00	08:51:00	RAINFALL	LONG
02/20/2014	08:27:00	08:51:00	RAINFALL	APS
02/20/2014	10:23:44	23:59:59	MISSING DATA	NANO
02/20/2014	17:02:00	17:32:00	RAINFALL	NANO
02/20/2014	17:02:00	17:32:00	RAINFALL	LONG
02/20/2014	17:02:00	17:32:00	RAINFALL	APS
02/21/2014	00:00:00	16:40:25	MISSING DATA	NANO
02/21/2014	00:00:00	23:59:59	APPARENT LEAK	LONG

Table I.34: Table 34 of 53

Date	Time Start	Time End	Description	Instrument
02/21/2014	00:00:00	23:59:59	OBSTRUCTION	APS
02/21/2014	08:40:00		CPC DRAINED	LONG
02/22/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/22/2014	00:00:00	23:59:59	OBSTRUCTION	APS
02/22/2014	17:22:00	19:20:00	RAINFALL	NANO
02/22/2014	17:22:00	19:20:00	RAINFALL	LONG
02/22/2014	17:22:00	19:20:00	RAINFALL	APS
02/23/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/23/2014	00:00:00	23:59:59	OBSTRUCTION	APS
02/23/2014	08:20:00		CPC DRAINED	LONG
02/24/2014	00:00:00	08:29:00	OBSTRUCTION	APS
02/24/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/24/2014	08:29:01	23:59:59	MISSING DATA	APS
02/25/2014	00:00:00	07:59:36	MISSING DATA	APS
02/25/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/25/2014	07:50:00		CPC DRAINED	LONG
02/25/2014	07:59:37	23:59:59	OBSTRUCTION	APS
02/26/2014	00:00:00	07:57:37	OBSTRUCTION	APS
02/26/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
02/26/2014	07:57:38	23:59:59	MISSING DATA	APS
02/26/2014	10:06:45	10:07:45	SHORT DURATION SPIKE	NANO
02/27/2014	00:00:00	07:27:25	APPARENT LEAK	LONG
02/27/2014	00:00:00	23:59:59	MISSING DATA	APS
02/27/2014	07:27:26	23:59:59	MISSING DATA	LONG
02/27/2014	07:30:00		CPC DRAINED	LONG
02/28/2014	00:00:00	06:42:22	MISSING DATA	LONG
02/28/2014	00:00:00	06:44:07	MISSING DATA	APS
02/28/2014	02:49:44	02:50:44	SHORT DURATION SPIKE	NANO
02/28/2014	06:44:08	23:59:59	APPARENT LEAK	LONG
02/28/2014	06:44:08	23:59:59	OBSTRUCTION	APS
03/01/2014	00:00:00	06:42:08	OBSTRUCTION	APS
03/01/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/01/2014	00:00:00	23:59:59	OBSTRUCTION	APS
03/01/2014	06:42:09	08:19:39	MISSING DATA	APS
03/01/2014	08:19:40	23:59:59	OBSTRUCTION	APS
03/02/2014	00:00:00	08:17:40	OBSTRUCTION	APS
03/02/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/02/2014	08:17:41	23:59:59	MISSING DATA	APS
03/02/2014	08:50:00		CPC DRAINED	LONG
03/03/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/03/2014	00:00:00	23:59:59	MISSING DATA	APS
03/04/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/04/2014	00:00:00	23:59:59	MISSING DATA	APS
03/04/2014	07:50:00		CPC DRAINED	LONG
03/04/2014	16:36:44	16:37:44	SHORT DURATION SPIKE	NANO
03/05/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/05/2014	00:00:00	23:59:59	MISSING DATA	APS
03/06/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/06/2014	00:00:00	23:59:59	MISSING DATA	APS
03/06/2014	06:45:44	06:46:44	SHORT DURATION SPIKE	NANO

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Date	Time Start	Time End	Description	Instrument
03/06/2014	07:10:00		CPC DRAINED	LONG
03/07/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/07/2014	00:00:00	23:59:59	MISSING DATA	APS
03/08/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/08/2014	00:00:00	23:59:59	MISSING DATA	APS
03/08/2014	12:00:00		CPC DRAINED	LONG
03/09/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/09/2014	00:00:00	23:59:59	MISSING DATA	APS
03/10/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/10/2014	00:00:00	23:59:59	MISSING DATA	APS
03/10/2014	13:02:27	13:03:27	SHORT DURATION SPIKE	NANO
03/11/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/11/2014	00:00:00	23:59:59	MISSING DATA	APS
03/12/2014	00:00:00	17:46:16	MISSING DATA	APS
03/12/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/12/2014	00:56:00	02:33:00	RAINFALL	NANO
03/12/2014	00:56:00	02:33:00	RAINFALL	LONG
03/12/2014	00:56:00	02:33:00	RAINFALL	APS
03/12/2014	02:53:59	18:28:54	MISSING DATA	LONG
03/12/2014	02:55:00	17:48:56	MISSING DATA	NANO
03/12/2014	03:09:00	04:04:00	RAINFALL	NANO
03/12/2014	03:09:00	04:04:00	RAINFALL	LONG
03/12/2014	03:09:00	04:04:00	RAINFALL	APS
03/12/2014	06:50:00		CPC DRAINED	LONG
03/12/2014	17:46:17	23:59:59	OBSTRUCTION	APS
03/12/2014	18:28:55	23:59:59	APPARENT LEAK	LONG
03/12/2014	21:42:16	21:43:16	SHORT DURATION SPIKE	NANO
03/12/2014	22:40:00	23:59:59	RAINFALL	NANO
03/12/2014	22:40:00	23:59:59	RAINFALL	LONG
03/12/2014	22:40:00	23:59:59	RAINFALL	APS
03/13/2014	00:00:00	00:34:00	RAINFALL	NANO
03/13/2014	00:00:00	00:34:00	RAINFALL	LONG
03/13/2014	00:00:00	00:34:00	RAINFALL	APS
03/13/2014	00:00:00	08:30:17	OBSTRUCTION	APS
03/13/2014	00:00:00	23:59:59	APPARENT LEAK	LONG
03/13/2014	08:30:18	10:47:08	MISSING DATA	APS
03/13/2014	13:17:57	13:34:15	HEPA FILTER ON AEROSOL IN	NANO
03/13/2014	13:18:09	13:28:08	HEPA FILTER ON AEROSOL IN	APS
03/13/2014	13:25:00		HEPA FILTER ON AEROSOL IN	LONG
03/13/2014	14:40:42	15:56:25	MISSING DATA	LONG
03/13/2014	17:33:44	23:59:59	MISSING DATA	LONG
03/14/2014	00:00:00	09:49:19	MISSING DATA	LONG
03/14/2014	14:00:02	14:18:35	APPARENT LEAK	LONG
03/15/2014	08:17:50	08:26:38	MISSING DATA	LONG
03/15/2014	10:08:00		DRYER CHANGE	NANO
03/15/2014	10:08:00		DRYER CHANGE	LONG
03/15/2014	11:13:13	11:15:27	NOT SAMPLING THROUGH INLE	LONG
03/15/2014	15:04:31	15:06:56	NOT SAMPLING THROUGH INLE	NANO
03/15/2014	15:05:01	15:07:15	NOT SAMPLING THROUGH INLE	LONG
03/15/2014	15:09:15	15:11:29	NOT SAMPLING THROUGH INLE	NANO

Table I.36: Table 36 of 53

Date	Time Start	Time End	Description	Instrument
03/15/2014	15:09:31	15:11:45	NOT SAMPLING THROUGH INLE	LONG
03/15/2014	15:18:30	15:23:15	NOT SAMPLING THROUGH INLE	NANO
03/15/2014	15:30:16	15:32:30	NOT SAMPLING THROUGH INLE	NANO
03/15/2014	15:38:46	15:43:15	NOT SAMPLING THROUGH INLE	LONG
03/15/2014	15:39:30	15:46:30	NOT SAMPLING THROUGH INLE	NANO
03/15/2014	15:59:01	16:04:42	MISSING DATA	LONG
03/15/2014	16:04:43	16:11:31	NOT SAMPLING THROUGH INLE	LONG
03/15/2014	16:27:17	16:34:01	MISSING DATA	LONG
03/15/2014	16:30:57	16:33:15	NOT SAMPLING THROUGH INLE	NANO
03/15/2014	16:40:46	16:49:46	NOT SAMPLING THROUGH INLE	LONG
03/15/2014	16:42:30	16:56:29	NOT SAMPLING THROUGH INLE	NANO
03/15/2014	16:56:32	16:58:45	NOT SAMPLING THROUGH INLE	LONG
03/15/2014	17:01:16	17:15:14	NOT SAMPLING THROUGH INLE	NANO
03/15/2014	17:05:31	17:16:46	NOT SAMPLING THROUGH INLE	LONG
03/15/2014	17:19:58	17:24:30	NOT SAMPLING THROUGH INLE	NANO
03/15/2014	18:06:16	18:08:30	NOT SAMPLING THROUGH INLE	LONG
03/16/2014	16:18:58	16:19:58	SHORT DURATION SPIKE	NANO
03/17/2014	07:05:30	07:26:29	MISSING DATA	NANO
03/17/2014	14:52:35	15:28:53	MISSING DATA	LONG
03/17/2014	17:29:09	17:37:10	INSUFFICENT WATER REMOVAL	APS
03/18/2014	13:29:39	13:31:52	TEMPORARY GLITCH IN SAMPL	LONG
03/18/2014	16:07:09	23:59:59	MISSING DATA	LONG
03/19/2014	00:23:00	00:40:00	RAINFALL	NANO
03/19/2014	00:23:00	00:40:00	RAINFALL	LONG
03/19/2014	00:23:00	00:40:00	RAINFALL	APS
03/19/2014	01:23:00	01:40:00	RAINFALL	NANO
03/19/2014	01:23:00	01:40:00	RAINFALL	LONG
03/19/2014	01:23:00	01:40:00	RAINFALL	APS
03/19/2014	01:50:00	02:13:00	RAINFALL	NANO
03/19/2014	01:50:00	02:13:00	RAINFALL	LONG
03/19/2014	01:50:00	02:13:00	RAINFALL	APS
03/19/2014	13:14:10	23:59:59	MISSING DATA	APS
03/21/2014	08:32:26	08:34:40	NOT SAMPLING THROUGH INLE	LONG
03/21/2014	08:34:42	23:59:59	MISSING DATA	LONG
03/21/2014	13:56:09	13:56:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	13:58:09	14:04:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:06:09	14:06:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:09:09	14:10:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:13:09	14:15:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:17:09	14:19:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:23:09	14:23:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:27:09	14:27:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:30:09	14:31:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:34:09	14:42:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	14:45:09	14:50:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	15:01:09	15:01:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	15:04:09	15:05:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	15:09:09	15:13:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	15:16:09	15:17:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	15:23:09	15:27:10	INSUFFICENT WATER REMOVAL	APS

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Date	Time Start	Time End	Description	Instrument
03/21/2014	15:30:09	15:30:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	15:40:09	15:40:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	15:43:09	15:45:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	15:56:09	16:08:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:10:09	16:12:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:14:09	16:18:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:21:09	16:22:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:24:09	16:24:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:27:09	16:33:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:35:09	16:36:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:41:09	16:43:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:48:09	16:48:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	16:55:09	16:56:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:02:09	17:04:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:06:09	17:08:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:11:09	17:11:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:15:09	17:15:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:17:09	17:18:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:21:09	17:23:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:28:09	17:28:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:36:09	17:36:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:40:09	17:40:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	17:51:09	17:51:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	19:51:09	19:51:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	19:54:09	19:54:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	19:56:09	19:56:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	19:59:09	19:59:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	20:02:09	20:02:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	20:05:09	20:05:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	20:09:09	20:09:10	INSUFFICENT WATER REMOVAL	APS
03/21/2014	20:29:09	20:29:10	INSUFFICENT WATER REMOVAL	APS
03/22/2014	08:56:09	08:56:10	INSUFFICENT WATER REMOVAL	APS
03/22/2014	14:49:09	14:49:10	INSUFFICENT WATER REMOVAL	APS
03/22/2014	15:14:09	15:14:10	INSUFFICENT WATER REMOVAL	APS
03/22/2014	15:24:09	15:24:10	INSUFFICENT WATER REMOVAL	APS
03/22/2014	17:12:09	17:12:10	INSUFFICENT WATER REMOVAL	APS
03/22/2014	18:21:09	18:21:10	INSUFFICENT WATER REMOVAL	APS
03/22/2014	22:02:09	22:03:10	INSUFFICENT WATER REMOVAL	APS
03/23/2014	06:44:09	06:44:10	INSUFFICENT WATER REMOVAL	APS
03/23/2014	07:34:09	07:34:10	INSUFFICENT WATER REMOVAL	APS
03/23/2014	10:27:09	10:27:10	INSUFFICENT WATER REMOVAL	APS
03/23/2014	15:38:09	15:38:10	INSUFFICENT WATER REMOVAL	APS
03/23/2014	17:04:09	17:04:10	INSUFFICENT WATER REMOVAL	APS
03/23/2014	17:26:09	17:26:10	INSUFFICENT WATER REMOVAL	APS
03/23/2014	17:59:09	17:59:10	INSUFFICENT WATER REMOVAL	APS
03/24/2014	00:00:00		LOCAL SOURCE	APS
03/24/2014	12:53:16	12:54:16	SHORT DURATION SPIKE	NANO
03/24/2014	16:04:09	16:05:10	INSUFFICENT WATER REMOVAL	APS
03/24/2014	16:24:09	16:24:10	INSUFFICENT WATER REMOVAL	APS
03/24/2014	17:04:09	17:04:10	INSUFFICENT WATER REMOVAL	APS

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Date	Time Start	Time End	Description	Instrument
03/24/2014	17:58:09	18:06:10	INSUFFICENT WATER REMOVAL	APS
03/25/2014	00:00:00		PATTERN CHANGE	APS
03/25/2014	06:46:23	06:48:37	CPC DRAIN	LONG
03/25/2014	15:50:09	15:50:10	INSUFFICENT WATER REMOVAL	APS
03/25/2014	16:14:09	16:14:10	INSUFFICENT WATER REMOVAL	APS
03/25/2014	16:41:09	16:41:10	INSUFFICENT WATER REMOVAL	APS
03/25/2014	17:33:09	17:33:10	INSUFFICENT WATER REMOVAL	APS
03/25/2014	17:36:09	17:36:10	INSUFFICENT WATER REMOVAL	APS
03/26/2014	00:00:00		LOCAL SOURCE	APS
03/26/2014	00:00:00		LOCAL SOURCE	APS
03/26/2014	00:00:00		LOCAL SOURCE	APS
03/26/2014	03:03:09	03:15:10	INSUFFICENT WATER REMOVAL	APS
03/26/2014	12:52:30	12:53:30	SHORT DURATION SPIKE	NANO
03/27/2014	01:00:30	01:01:30	SHORT DURATION SPIKE	NANO
03/27/2014	03:02:10	08:38:43	MISSING DATA	APS
03/27/2014	03:48:00	06:25:00	RAINFALL	NANO
03/27/2014	03:48:00	06:25:00	RAINFALL	LONG
03/27/2014	03:48:00	06:25:00	RAINFALL	APS
03/27/2014	09:16:00	10:08:00	RAINFALL	NANO
03/27/2014	09:16:00	10:08:00	RAINFALL	LONG
03/27/2014	09:16:00	10:08:00	RAINFALL	APS
03/27/2014	11:43:00	12:00:00	RAINFALL	NANO
03/27/2014	11:43:00	12:00:00	RAINFALL	LONG
03/27/2014	11:43:00	12:00:00	RAINFALL	APS
03/27/2014	19:00:57	19:01:57	SHORT DURATION SPIKE	NANO
03/27/2014	21:08:00	22:00:00	RAINFALL	NANO
03/27/2014	21:08:00	22:00:00	RAINFALL	LONG
03/27/2014	21:08:00	22:00:00	RAINFALL	APS
03/28/2014	02:25:10	02:27:24	TEMPORARY GLITCH IN SAMPL	LONG
03/28/2014	06:39:25	06:41:39	TEMPORARY GLITCH IN SAMPL	LONG
03/28/2014	08:36:45	23:59:59	MISSING DATA	APS
03/29/2014	00:00:00	23:59:59	MISSING DATA	APS
03/29/2014	09:28:30	09:29:30	SHORT DURATION SPIKE	NANO
03/30/2014	00:00:00	08:08:44	MISSING DATA	APS
03/30/2014	00:00:00	23:59:59	MISSING DATA	APS
03/30/2014	01:41:31	01:42:31	SHORT DURATION SPIKE	NANO
03/31/2014	08:06:46	17:32:17	MISSING DATA	APS
04/01/2014	00:00:00		LOCAL SOURCE	APS
04/01/2014	00:00:00		LOCAL SOURCE	APS
04/01/2014	00:00:00		LOCAL SOURCE	APS
04/01/2014	09:50:21	10:33:39	MISSING DATA	LONG
04/01/2014	15:15:18	15:15:19	INSUFFICENT WATER REMOVAL	APS
04/01/2014	16:00:18	16:01:19	INSUFFICENT WATER REMOVAL	APS
04/01/2014	16:50:18	16:50:19	INSUFFICENT WATER REMOVAL	APS
04/01/2014	19:22:18	19:23:19	INSUFFICENT WATER REMOVAL	APS
04/01/2014	20:16:18	20:16:19	INSUFFICENT WATER REMOVAL	APS
04/01/2014	21:41:18	21:41:19	INSUFFICENT WATER REMOVAL	APS
04/01/2014	23:10:00	23:27:00	RAINFALL	NANO
04/01/2014	23:10:00	23:27:00	RAINFALL	LONG
04/01/2014	23:10:00	23:27:00	RAINFALL	APS

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Date	Time Start	Time End	Description	Instrument
04/02/2014	00:09:00	01:17:00	RAINFALL	NANO
04/02/2014	00:09:00	01:17:00	RAINFALL	LONG
04/02/2014	00:09:00	01:17:00	RAINFALL	APS
04/02/2014	02:02:00	02:19:00	RAINFALL	NANO
04/02/2014	02:02:00	02:19:00	RAINFALL	LONG
04/02/2014	02:02:00	02:19:00	RAINFALL	APS
04/02/2014	12:05:00	13:53:00	RAINFALL	NANO
04/02/2014	12:05:00	13:53:00	RAINFALL	LONG
04/02/2014	12:05:00	13:53:00	RAINFALL	APS
04/02/2014	22:06:00	22:23:00	RAINFALL	NANO
04/02/2014	22:06:00	22:23:00	RAINFALL	LONG
04/02/2014	22:06:00	22:23:00	RAINFALL	APS
04/03/2014	03:43:00	04:00:00	RAINFALL	NANO
04/03/2014	03:43:00	04:00:00	RAINFALL	LONG
04/03/2014	03:43:00	04:00:00	RAINFALL	APS
04/03/2014	04:49:00	05:07:00	RAINFALL	NANO
04/03/2014	04:49:00	05:07:00	RAINFALL	LONG
04/03/2014	04:49:00	05:07:00	RAINFALL	APS
04/03/2014	05:29:00	05:54:00	RAINFALL	NANO
04/03/2014	05:29:00	05:54:00	RAINFALL	LONG
04/03/2014	05:29:00	05:54:00	RAINFALL	APS
04/03/2014	06:11:00	08:29:00	RAINFALL	NANO
04/03/2014	06:11:00	08:29:00	RAINFALL	LONG
04/03/2014	06:11:00	08:29:00	RAINFALL	APS
04/03/2014	06:25:17	06:30:18	INSUFFICENT WATER REMOVAL	APS
04/03/2014	07:25:31	07:26:31	SHORT DURATION SPIKE	NANO
04/03/2014	21:27:00	22:18:00	RAINFALL	NANO
04/03/2014	21:27:00	22:18:00	RAINFALL	LONG
04/03/2014	21:27:00	22:18:00	RAINFALL	APS
04/03/2014	22:33:00	22:50:00	RAINFALL	NANO
04/03/2014	22:33:00	22:50:00	RAINFALL	LONG
04/03/2014	22:33:00	22:50:00	RAINFALL	APS
04/03/2014	23:02:00	23:50:00	RAINFALL	NANO
04/03/2014	23:02:00	23:50:00	RAINFALL	LONG
04/03/2014	23:02:00	23:50:00	RAINFALL	APS
04/04/2014	00:00:00		PATTERN CHANGE	APS
04/07/2014	04:22:17	04:24:18	INSUFFICENT WATER REMOVAL	APS
04/07/2014	06:54:17	06:54:18	INSUFFICENT WATER REMOVAL	APS
04/07/2014	12:40:00	13:16:00	RAINFALL	NANO
04/07/2014	12:40:00	13:16:00	RAINFALL	LONG
04/07/2014	12:40:00	13:16:00	RAINFALL	APS
04/07/2014	13:41:00	16:04:00	RAINFALL	NANO
04/07/2014	13:41:00	16:04:00	RAINFALL	LONG
04/07/2014	13:41:00	16:04:00	RAINFALL	APS
04/08/2014	00:00:00		LOCAL SOURCE	APS
04/08/2014	00:00:00		LOCAL SOURCE	APS
04/08/2014	00:26:00	01:10:00	RAINFALL	NANO
04/08/2014	00:26:00	01:10:00	RAINFALL	LONG
04/08/2014	00:26:00	01:10:00	RAINFALL	APS
04/08/2014	09:59:26	23:59:59	MISSING DATA	LONG

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Date	Time Start	Time End	Description	Instrument
04/09/2014	00:00:00	23:59:59	MISSING DATA	LONG
04/09/2014	00:00:00		LOCAL SOURCE	APS
04/09/2014	17:13:57	17:14:57	SHORT DURATION SPIKE	NANO
04/10/2014	00:00:00	09:46:17	MISSING DATA	LONG
04/10/2014	00:00:00		LOCAL SOURCE	APS
04/10/2014	10:35:48	23:59:59	MISSING DATA	LONG
04/11/2014	00:00:00	09:13:32	MISSING DATA	LONG
04/11/2014	00:00:00		LOCAL SOURCE	APS
04/11/2014	12:30:57	12:31:57	SHORT DURATION SPIKE	NANO
04/11/2014	22:45:50	22:48:04	TEMPORARY GLITCH IN SAMPL	LONG
04/12/2014	00:00:00		LOCAL SOURCE	APS
04/12/2014	00:00:00		LOCAL SOURCE	APS
04/12/2014	07:18:49	07:23:17	TEMPORARY GLITCH IN SAMPL	LONG
04/12/2014	12:00:00		LOCAL SOURCE	APS
04/12/2014	23:26:16	23:28:30	TEMPORARY GLITCH IN SAMPL	LONG
04/13/2014	00:00:00		LOCAL SOURCE	APS
04/13/2014	06:20:15	06:22:29	TEMPORARY GLITCH IN SAMPL	LONG
04/13/2014	20:41:00	22:21:00	RAINFALL	NANO
04/13/2014	20:41:00	22:21:00	RAINFALL	LONG
04/13/2014	20:41:00	22:21:00	RAINFALL	APS
04/13/2014	23:26:13	23:28:27	TEMPORARY GLITCH IN SAMPL	LONG
04/14/2014	15:49:00	16:06:00	RAINFALL	NANO
04/14/2014	15:49:00	16:06:00	RAINFALL	LONG
04/14/2014	15:49:00	16:06:00	RAINFALL	APS
04/14/2014	17:19:00	17:36:00	RAINFALL	NANO
04/14/2014	17:19:00	17:36:00	RAINFALL	LONG
04/14/2014	17:19:00	17:36:00	RAINFALL	APS
04/15/2014	06:26:54	06:29:08	TEMPORARY GLITCH IN SAMPL	LONG
04/15/2014	17:00:16	17:01:16	SHORT DURATION SPIKE	NANO
04/15/2014	22:09:28	22:11:42	TEMPORARY GLITCH IN SAMPL	LONG
04/17/2014	00:00:00	00:00:00	LOCAL SOURCE	APS
04/17/2014	02:17:30	02:18:30	SHORT DURATION SPIKE	NANO
04/17/2014	02:57:24	07:22:53	MISSING DATA	LONG
04/17/2014	13:49:53	13:56:37	NOT SAMPLING THROUGH INLE	LONG
04/17/2014	13:50:31	14:09:14	MISSING DATA	NANO
04/17/2014	13:52:31	13:52:32	INSUFFICENT WATER REMOVAL	APS
04/17/2014	13:52:31	14:14:30	NOT SAMPLING THROUGH INLE	APS
04/17/2014	13:56:38	14:07:52	MISSING DATA	LONG
04/17/2014	14:00:31	14:14:30	MISSING DATA	APS
04/17/2014	14:19:08	14:23:37	TEMPORARY GLITCH IN SAMPL	LONG
04/17/2014	14:20:57	14:23:15	NOT SAMPLING THROUGH INLE	NANO
04/17/2014	14:23:16	14:24:16	SHORT DURATION SPIKE	NANO
04/17/2014	19:01:17	19:03:18	INSUFFICENT WATER REMOVAL	APS
04/17/2014	19:08:17	19:11:18	INSUFFICENT WATER REMOVAL	APS
04/17/2014	19:21:17	19:22:18	INSUFFICENT WATER REMOVAL	APS
04/17/2014	19:48:17	19:50:18	INSUFFICENT WATER REMOVAL	APS
04/17/2014	19:59:17	20:02:18	INSUFFICENT WATER REMOVAL	APS
04/17/2014	21:00:17	21:02:18	INSUFFICENT WATER REMOVAL	APS
04/17/2014	21:56:17	22:00:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	02:43:51	02:46:05	TEMPORARY GLITCH IN SAMPL	LONG

Table I.41: Table 41 of 53

Date	Time Start	Time End	Description	Instrument
04/18/2014	05:17:17	05:18:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	06:10:17	06:11:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	06:23:17	06:26:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	06:30:17	06:31:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	06:58:17	06:58:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	08:33:17	08:33:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	11:16:17	11:16:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	18:03:17	18:05:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	18:23:17	18:25:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	18:33:17	18:36:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	18:55:17	18:57:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	18:59:17	19:06:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	19:10:17	19:10:18	INSUFFICENT WATER REMOVAL	APS
04/18/2014	19:29:17	19:30:18	INSUFFICENT WATER REMOVAL	APS
04/19/2014	00:00:00	12:00:00	LOCAL SOURCE	APS
04/19/2014	03:51:18	03:53:32	TEMPORARY GLITCH IN SAMPL	LONG
04/19/2014	04:43:03	06:46:46	MISSING DATA	LONG
04/20/2014	00:00:00	00:00:00	LOCAL SOURCE	APS
04/20/2014	06:21:59	06:24:13	TEMPORARY GLITCH IN SAMPL	LONG
04/20/2014	06:31:17	06:35:16	LOCAL SOURCE	APS
04/20/2014	06:39:59	06:42:13	TEMPORARY GLITCH IN SAMPL	LONG
04/20/2014	14:24:31	14:59:30	PATTERN CHANGE	NANO
04/20/2014	15:30:58	18:28:41	PATTERN CHANGE	LONG
04/21/2014	00:00:00		DRYER CHANGE	NANO
04/21/2014	00:00:00		DRYER CHANGE	LONG
04/21/2014	00:00:00		DRYER CHANGE	APS
04/21/2014	10:00:11	10:20:27	MISSING DATA	LONG
04/21/2014	14:32:32	23:59:59	MISSING DATA	LONG
04/22/2014	00:00:00	23:59:59	MISSING DATA	LONG
04/22/2014	05:10:18	05:10:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	05:38:18	05:38:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	06:18:18	06:18:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	06:28:18	06:28:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	06:31:18	06:33:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	06:54:18	06:54:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	07:00:18	07:00:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	07:16:18	07:16:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	07:56:18	07:56:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	08:46:18	08:46:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	08:51:18	08:51:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	09:33:18	09:33:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	09:39:18	09:39:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	10:17:18	10:17:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	11:27:18	11:27:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	12:15:18	12:15:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	12:24:18	12:25:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	13:29:18	13:29:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	13:31:18	13:31:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	15:22:18	15:22:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	15:39:18	15:40:19	INSUFFICENT WATER REMOVAL	APS

Table I.42: Table 42 of 53

Date	Time Start	Time End	Description	Instrument
04/22/2014	15:48:18	15:51:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	16:01:18	16:01:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	16:12:18	16:12:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	16:29:18	16:29:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	16:37:18	16:38:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	16:46:18	16:46:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	16:54:18	16:55:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	17:16:18	17:16:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	19:05:18	19:06:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	19:40:18	19:44:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	19:56:18	20:02:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	20:09:18	20:11:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	20:21:18	20:25:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	20:56:18	20:57:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	21:00:18	21:02:19	INSUFFICENT WATER REMOVAL	APS
04/22/2014	21:04:18	21:06:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	00:00:00	23:59:59	MISSING DATA	LONG
04/23/2014	03:09:18	03:13:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	04:47:18	04:56:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	05:10:18	05:13:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	05:17:18	05:23:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	05:30:18	05:35:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	05:41:18	05:45:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	06:46:18	06:46:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	07:05:18	07:05:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	07:10:18	07:10:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	07:32:18	07:32:19	INSUFFICENT WATER REMOVAL	APS
04/23/2014	09:01:30	09:03:57	NOT SAMPLING THROUGH INLE	NANO
04/23/2014	09:50:18	09:50:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	00:00:00	10:18:56	MISSING DATA	LONG
04/24/2014	07:04:30	07:05:30	SHORT DURATION SPIKE	NANO
04/24/2014	08:19:16	08:20:16	SHORT DURATION SPIKE	NANO
04/24/2014	09:49:05	10:11:20	NOT SAMPLING THROUGH INLE	NANO
04/24/2014	11:10:45	11:12:59	TEMPORARY GLITCH IN SAMPL	LONG
04/24/2014	13:47:18	13:48:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	14:07:18	14:07:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	14:38:18	14:39:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	14:44:18	14:45:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	14:48:18	14:48:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	14:54:18	14:54:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:01:18	15:01:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:06:18	15:08:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:17:18	15:17:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:21:18	15:21:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:28:18	15:30:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:33:18	15:33:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:38:18	15:40:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:49:18	15:49:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:54:18	15:54:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	15:58:18	15:58:19	INSUFFICENT WATER REMOVAL	APS

Table I.43: Table 43 of 53

Date	Time Start	Time End	Description	Instrument
04/24/2014	16:11:18	16:11:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	16:28:18	16:29:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	16:33:18	16:33:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	16:38:18	16:38:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	16:43:18	16:44:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	17:20:18	17:20:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	17:44:18	17:44:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	18:04:18	18:05:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	18:13:18	18:13:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	18:26:18	18:26:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	18:31:18	18:31:19	INSUFFICENT WATER REMOVAL	APS
04/24/2014	21:19:00	21:36:00	RAINFALL	NANO
04/24/2014	21:19:00	21:36:00	RAINFALL	LONG
04/24/2014	21:19:00	21:36:00	RAINFALL	APS
04/24/2014	21:51:00	23:01:00	RAINFALL	NANO
04/24/2014	21:51:00	23:01:00	RAINFALL	LONG
04/24/2014	21:51:00	23:01:00	RAINFALL	APS
04/25/2014	01:35:00	03:51:00	RAINFALL	NANO
04/25/2014	01:35:00	03:51:00	RAINFALL	LONG
04/25/2014	01:35:00	03:51:00	RAINFALL	APS
04/25/2014	11:14:18	11:14:19	INSUFFICENT WATER REMOVAL	APS
04/25/2014	13:18:18	13:18:19	INSUFFICENT WATER REMOVAL	APS
04/25/2014	16:49:18	16:50:19	INSUFFICENT WATER REMOVAL	APS
04/25/2014	18:07:17	18:08:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	18:11:17	18:12:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	18:27:17	18:27:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	18:51:17	18:53:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:00:17	19:04:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:08:17	19:09:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:13:17	19:14:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:18:17	19:18:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:27:17	19:27:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:33:17	19:33:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:36:17	19:37:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:42:17	19:43:18	INSUFFICENT WATER REMOVAL	APS
04/25/2014	19:45:17	19:46:18	INSUFFICENT WATER REMOVAL	APS
04/26/2014	03:04:39	23:59:59	MISSING DATA	LONG
04/26/2014	08:25:17	08:25:18	INSUFFICENT WATER REMOVAL	APS
04/26/2014	09:21:17	09:22:18	INSUFFICENT WATER REMOVAL	APS
04/26/2014	09:57:17	09:58:18	INSUFFICENT WATER REMOVAL	APS
04/26/2014	11:26:17	11:26:18	INSUFFICENT WATER REMOVAL	APS
04/26/2014	18:20:17	18:20:18	INSUFFICENT WATER REMOVAL	APS
04/27/2014	00:00:00	23:59:59	MISSING DATA	LONG
04/27/2014	10:26:31	23:59:59	MISSING DATA	NANO
04/27/2014	10:28:18	23:59:59	MISSING DATA	APS
04/27/2014	14:41:00	15:37:00	RAINFALL	NANO
04/27/2014	14:41:00	15:37:00	RAINFALL	LONG
04/27/2014	14:41:00	15:37:00	RAINFALL	APS
04/27/2014	16:14:00	17:18:00	RAINFALL	NANO
04/27/2014	16:14:00	17:18:00	RAINFALL	LONG

Table I.44: Table 44 of 53

Date	Time Start	Time End	Description	Instrument
04/27/2014	16:14:00	17:18:00	RAINFALL	APS
04/27/2014	17:56:00	18:28:00	RAINFALL	NANO
04/27/2014	17:56:00	18:28:00	RAINFALL	LONG
04/27/2014	17:56:00	18:28:00	RAINFALL	APS
04/27/2014	18:42:00	19:15:00	RAINFALL	NANO
04/27/2014	18:42:00	19:15:00	RAINFALL	LONG
04/27/2014	18:42:00	19:15:00	RAINFALL	APS
04/27/2014	19:29:00	19:46:00	RAINFALL	NANO
04/27/2014	19:29:00	19:46:00	RAINFALL	LONG
04/27/2014	19:29:00	19:46:00	RAINFALL	APS
04/28/2014	00:00:00	23:59:59	MISSING DATA	NANO
04/28/2014	00:00:00	23:59:59	MISSING DATA	LONG
04/28/2014	00:00:00	23:59:59	MISSING DATA	APS
04/29/2014	00:00:00	23:59:59	MISSING DATA	NANO
04/29/2014	00:00:00	23:59:59	MISSING DATA	LONG
04/29/2014	00:00:00	23:59:59	MISSING DATA	APS
04/30/2014	00:00:00	23:59:59	MISSING DATA	NANO
04/30/2014	00:00:00	23:59:59	MISSING DATA	LONG
04/30/2014	00:00:00	23:59:59	MISSING DATA	APS
05/01/2014	00:00:00	23:59:59	MISSING DATA	NANO
05/01/2014	00:00:00	23:59:59	MISSING DATA	LONG
05/01/2014	00:00:00	23:59:59	MISSING DATA	APS
05/02/2014	00:00:00	23:59:59	MISSING DATA	NANO
05/02/2014	00:00:00	23:59:59	MISSING DATA	LONG
05/02/2014	00:00:00	23:59:59	MISSING DATA	APS
05/03/2014	00:00:00	23:59:59	MISSING DATA	NANO
05/03/2014	00:00:00	23:59:59	MISSING DATA	LONG
05/03/2014	00:00:00	23:59:59	MISSING DATA	APS
05/04/2014	00:00:00	23:59:59	MISSING DATA	NANO
05/04/2014	00:00:00	23:59:59	MISSING DATA	LONG
05/04/2014	00:00:00	23:59:59	MISSING DATA	APS
05/05/2014	00:00:00	12:30:22	MISSING DATA	NANO
05/05/2014	00:00:00	12:33:54	MISSING DATA	APS
05/05/2014	00:00:00	12:41:51	MISSING DATA	LONG
05/05/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/05/2014	12:55:25	13:08:54	NOT SAMPLING THROUGH INLE	LONG
05/05/2014	12:55:55	12:55:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	13:06:55	13:06:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	13:25:55	13:26:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	13:41:55	13:41:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	14:05:11	14:23:03	MISSING DATA	LONG
05/05/2014	14:23:04	14:29:52	NOT SAMPLING THROUGH INLE	LONG
05/05/2014	14:29:53	14:43:33	MISSING DATA	LONG
05/05/2014	14:43:34	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/05/2014	15:37:55	15:38:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	16:09:55	16:10:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	16:13:55	16:13:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	16:16:55	16:16:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	16:25:55	16:25:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	16:30:55	16:31:56	INSUFFICENT WATER REMOVAL	APS

Table I.45: Table 45 of 53

Date	Time Start	Time End	Description	Instrument
05/05/2014	17:10:55	17:14:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	17:19:55	17:19:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	17:39:55	17:39:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	17:45:55	17:45:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	17:50:55	17:50:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	17:58:55	17:59:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	18:01:55	18:02:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	18:10:55	18:10:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	18:12:55	18:12:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	18:20:55	18:21:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	18:29:55	18:29:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	18:39:55	18:40:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	18:48:55	18:48:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	19:48:55	19:48:56	INSUFFICENT WATER REMOVAL	APS
05/05/2014	23:14:00	23:59:59	RAINFALL	NANO
05/05/2014	23:14:00	23:59:59	RAINFALL	LONG
05/05/2014	23:14:00	23:59:59	RAINFALL	APS
05/06/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/06/2014	03:33:24	03:34:24	SHORT DURATION SPIKE	NANO
05/06/2014	08:30:00		CPC DRAINED	CPC
05/06/2014	15:57:55	15:57:56	INSUFFICENT WATER REMOVAL	APS
05/06/2014	19:00:55	19:00:56	INSUFFICENT WATER REMOVAL	APS
05/06/2014	19:09:55	19:12:56	INSUFFICENT WATER REMOVAL	APS
05/06/2014	20:54:59	21:08:28	LOCAL SOURCE	LONG
05/07/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/07/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/07/2014	19:07:56	19:07:57	INSUFFICENT WATER REMOVAL	APS
05/07/2014	19:21:56	19:21:57	INSUFFICENT WATER REMOVAL	APS
05/07/2014	20:12:56	20:12:57	INSUFFICENT WATER REMOVAL	APS
05/07/2014	20:16:56	20:18:57	INSUFFICENT WATER REMOVAL	APS
05/07/2014	20:35:56	20:35:57	INSUFFICENT WATER REMOVAL	APS
05/07/2014	20:38:56	20:38:57	INSUFFICENT WATER REMOVAL	APS
05/07/2014	20:40:56	20:40:57	INSUFFICENT WATER REMOVAL	APS
05/07/2014	20:43:56	20:52:57	INSUFFICENT WATER REMOVAL	APS
05/08/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/08/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/08/2014	06:10:52	06:15:15	CPC DRAINED	CPC
05/08/2014	22:38:39	23:59:59	MISSING DATA	LONG
05/09/2014	00:00:00	13:48:02	MISSING DATA	LONG
05/09/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/09/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/09/2014	02:36:00	02:53:00	RAINFALL	NANO
05/09/2014	02:36:00	02:53:00	RAINFALL	LONG
05/09/2014	02:36:00	02:53:00	RAINFALL	APS
05/09/2014	03:30:00	05:49:00	RAINFALL	NANO
05/09/2014	03:30:00	05:49:00	RAINFALL	LONG
05/09/2014	03:30:00	05:49:00	RAINFALL	APS
05/09/2014	07:06:00	07:23:00	RAINFALL	NANO
05/09/2014	07:06:00	07:23:00	RAINFALL	LONG
05/09/2014	07:06:00	07:23:00	RAINFALL	APS

Table I.46: Table 46 of 53

Date	Time Start	Time End	Description	Instrument
05/09/2014	07:27:00	07:53:00	RAINFALL	NANO
05/09/2014	07:27:00	07:53:00	RAINFALL	LONG
05/09/2014	07:27:00	07:53:00	RAINFALL	APS
05/09/2014	13:48:03	14:19:32	NOT SAMPLING THROUGH INLE	LONG
05/09/2014	17:52:56	17:52:57	INSUFFICENT WATER REMOVAL	APS
05/09/2014	20:11:56	20:12:57	INSUFFICENT WATER REMOVAL	APS
05/09/2014	20:24:56	20:24:57	INSUFFICENT WATER REMOVAL	APS
05/09/2014	20:36:56	20:39:57	INSUFFICENT WATER REMOVAL	APS
05/09/2014	23:36:56	23:42:57	INSUFFICENT WATER REMOVAL	APS
05/10/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/10/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/10/2014	06:41:14	06:44:24	CPC DRAINED	CPC
05/10/2014	14:37:38	14:44:22	LOCAL SOURCE	LONG
05/10/2014	14:38:55	14:38:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	15:25:55	15:25:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	15:36:55	15:36:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	15:41:55	15:42:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	15:53:55	15:54:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	18:15:55	18:18:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	18:21:55	18:23:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	18:28:55	18:45:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	18:49:55	18:50:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	19:00:55	19:00:56	INSUFFICENT WATER REMOVAL	APS
05/10/2014	19:25:39	19:39:08	LOCAL SOURCE	LONG
05/11/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/11/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/11/2014	00:03:55	00:05:56	INSUFFICENT WATER REMOVAL	APS
05/11/2014	00:08:55	00:20:56	INSUFFICENT WATER REMOVAL	APS
05/11/2014	05:50:33	07:17:39	CPC DRAINED	CPC
05/11/2014	10:05:57	10:06:57	SHORT DURATION SPIKE	NANO
05/11/2014	23:52:00	23:59:59	RAINFALL	NANO
05/11/2014	23:52:00	23:59:59	RAINFALL	LONG
05/11/2014	23:52:00	23:59:59	RAINFALL	APS
05/12/2014	00:00:00	02:22:00	RAINFALL	NANO
05/12/2014	00:00:00	02:22:00	RAINFALL	LONG
05/12/2014	00:00:00	02:22:00	RAINFALL	APS
05/12/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/12/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/12/2014	09:18:00	09:35:00	RAINFALL	NANO
05/12/2014	09:18:00	09:35:00	RAINFALL	LONG
05/12/2014	09:18:00	09:35:00	RAINFALL	APS
05/12/2014	13:30:00	14:30:00	HEPA FILTER ON AEROSOL IN	NANO
05/12/2014	13:57:48	14:24:31	NOT SAMPLING THROUGH INLE	NANO
05/12/2014	13:59:32	14:22:01	HEPA FILTER ON AEROSOL IN	LONG
05/12/2014	13:59:32	14:22:01	MISSING DATA	LONG
05/12/2014	22:49:00	23:21:00	RAINFALL	NANO
05/12/2014	22:49:00	23:21:00	RAINFALL	LONG
05/12/2014	22:49:00	23:21:00	RAINFALL	APS
05/12/2014	22:49:00	23:59:59	PATTERN CHANGE	APS
05/12/2014	23:06:55	23:09:56	INSUFFICENT WATER REMOVAL	APS

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Date	Time Start	Time End	Description	Instrument
05/12/2014	23:33:00	23:54:00	RAINFALL	NANO
05/12/2014	23:33:00	23:54:00	RAINFALL	LONG
05/12/2014	23:33:00	23:54:00	RAINFALL	APS
05/12/2014	23:35:55	23:35:56	INSUFFICENT WATER REMOVAL	APS
05/12/2014	23:52:00	23:59:59	PATTERN CHANGE	LONG
05/13/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/13/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/13/2014	00:20:00	00:39:00	RAINFALL	NANO
05/13/2014	00:20:00	00:39:00	RAINFALL	LONG
05/13/2014	00:20:00	00:39:00	RAINFALL	APS
05/13/2014	00:24:55	00:28:56	INSUFFICENT WATER REMOVAL	APS
05/13/2014	01:21:00	01:47:00	RAINFALL	NANO
05/13/2014	01:21:00	01:47:00	RAINFALL	LONG
05/13/2014	01:21:00	01:47:00	RAINFALL	APS
05/13/2014	01:27:55	01:35:56	INSUFFICENT WATER REMOVAL	APS
05/13/2014	04:00:00	04:34:00	RAINFALL	NANO
05/13/2014	04:00:00	04:34:00	RAINFALL	LONG
05/13/2014	04:00:00	04:34:00	RAINFALL	APS
05/13/2014	09:09:10	09:13:51	CPC DRAINED	CPC
05/13/2014	17:45:48	17:59:47	NOT SAMPLING THROUGH INLE	LONG
05/14/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/14/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/14/2014	09:26:00	12:05:00	RAINFALL	NANO
05/14/2014	09:26:00	12:05:00	RAINFALL	LONG
05/14/2014	09:26:00	12:05:00	RAINFALL	APS
05/14/2014	09:36:55	09:36:56	INSUFFICENT WATER REMOVAL	APS
05/14/2014	09:36:55	10:17:54	DRYER CHANGE	APS
05/14/2014	09:49:06	10:38:20	DRYER CHANGE	NANO
05/14/2014	09:49:06	10:38:20	DRYER CHANGE	LONG
05/14/2014	10:16:55	10:16:56	INSUFFICENT WATER REMOVAL	APS
05/14/2014	12:24:00	13:15:00	RAINFALL	NANO
05/14/2014	12:24:00	13:15:00	RAINFALL	LONG
05/14/2014	12:24:00	13:15:00	RAINFALL	APS
05/14/2014	13:48:00	14:14:00	RAINFALL	NANO
05/14/2014	13:48:00	14:14:00	RAINFALL	LONG
05/14/2014	13:48:00	14:14:00	RAINFALL	APS
05/14/2014	14:30:00	16:11:00	RAINFALL	NANO
05/14/2014	14:30:00	16:11:00	RAINFALL	LONG
05/14/2014	14:30:00	16:11:00	RAINFALL	APS
05/14/2014	16:22:00	17:52:00	RAINFALL	NANO
05/14/2014	16:22:00	17:52:00	RAINFALL	LONG
05/14/2014	16:22:00	17:52:00	RAINFALL	APS
05/14/2014	20:34:00	21:03:00	RAINFALL	NANO
05/14/2014	20:34:00	21:03:00	RAINFALL	LONG
05/14/2014	20:34:00	21:03:00	RAINFALL	APS
05/15/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/15/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/15/2014	06:27:51	06:43:10	CPC DRAIN	CPC
05/16/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/16/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG

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Date	Time Start	Time End	Description	Instrument
05/16/2014	02:52:00	03:09:00	RAINFALL	NANO
05/16/2014	02:52:00	03:09:00	RAINFALL	LONG
05/16/2014	02:52:00	03:09:00	RAINFALL	APS
05/16/2014	06:41:21	07:03:26	CPC DRAINED	CPC
05/16/2014	12:04:00	12:22:00	RAINFALL	NANO
05/16/2014	12:04:00	12:22:00	RAINFALL	LONG
05/16/2014	12:04:00	12:22:00	RAINFALL	APS
05/16/2014	14:47:00	15:24:00	RAINFALL	NANO
05/16/2014	14:47:00	15:24:00	RAINFALL	LONG
05/16/2014	14:47:00	15:24:00	RAINFALL	APS
05/17/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/17/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/17/2014	07:08:21	07:23:33	CPC DRAINED	CPC
05/17/2014	18:25:55	18:30:56	INSUFFICENT WATER REMOVAL	APS
05/17/2014	18:40:55	18:43:56	INSUFFICENT WATER REMOVAL	APS
05/18/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/18/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/18/2014	07:14:50	07:29:06	CPC DRAINED	CPC
05/19/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/19/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/19/2014	06:26:24	23:59:59	MISSING DATA	NANO
05/19/2014	06:30:00		CPC DRAINED	CPC
05/20/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/20/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/20/2014	03:51:56	03:52:56	SHORT DURATION SPIKE	NANO
05/20/2014	06:50:00		CPC DRAINED	CPC
05/20/2014	20:53:55	20:56:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	20:59:55	20:59:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:01:55	21:02:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:06:55	21:12:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:14:55	21:14:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:21:55	21:21:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:27:55	21:29:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:34:55	21:34:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:40:55	21:40:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:48:55	21:48:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	21:53:55	21:53:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	22:22:55	22:22:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	22:26:55	22:26:56	INSUFFICENT WATER REMOVAL	APS
05/20/2014	23:54:55	23:54:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/21/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/21/2014	00:36:55	00:36:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	01:23:06	01:37:05	LOCAL SOURCE	LONG
05/21/2014	02:51:55	02:51:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	02:55:55	02:55:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	02:58:55	02:59:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	03:01:55	03:03:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	03:06:55	03:09:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	03:12:55	03:12:56	INSUFFICENT WATER REMOVAL	APS

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Date	Time Start	Time End	Description	Instrument
05/21/2014	03:17:55	03:17:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	03:39:55	03:41:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	03:44:55	03:44:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	03:48:55	03:48:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	04:16:55	04:16:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	06:40:00		CPC DRAINED	CPC
05/21/2014	06:55:55	06:58:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	06:55:55	07:05:54	DRYER CHANGE	APS
05/21/2014	06:56:24	07:04:25	DRYER CHANGE	NANO
05/21/2014	06:56:24	07:04:25	DRYER CHANGE	LONG
05/21/2014	07:02:55	07:02:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	08:00:55	08:00:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	08:06:55	08:06:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	08:32:55	08:32:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	09:21:55	09:33:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	09:37:55	09:37:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	09:41:55	09:43:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	09:45:55	09:47:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	09:49:55	10:21:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	10:23:55	10:38:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	10:41:55	10:44:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	10:47:55	10:54:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	10:56:55	11:13:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	11:15:55	11:26:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	11:30:55	11:30:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	11:35:55	11:50:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	11:53:55	12:06:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	12:10:55	12:10:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	12:12:55	12:12:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	12:14:55	12:23:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	12:27:55	12:49:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	12:54:55	12:59:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	13:02:55	13:02:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	13:08:55	13:18:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	13:20:55	13:30:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	13:37:55	13:40:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	13:43:55	13:44:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	13:52:55	13:52:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	13:58:55	14:00:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	14:03:55	14:08:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	14:25:55	14:25:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	14:28:55	14:36:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	14:38:55	14:44:56	INSUFFICENT WATER REMOVAL	APS
05/21/2014	14:41:00	17:16:00	RAINFALL	NANO
05/21/2014	14:41:00	17:16:00	RAINFALL	LONG
05/21/2014	14:41:00	17:16:00	RAINFALL	APS
05/21/2014	14:42:43	23:59:59	MISSING DATA	NANO
05/21/2014	14:45:49	23:59:59	MISSING DATA	LONG
05/21/2014	14:48:56	23:59:59	MISSING DATA	APS
05/21/2014	17:57:00	18:19:00	RAINFALL	NANO

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Date	Time Start	Time End	Description	Instrument
05/21/2014	17:57:00	18:19:00	RAINFALL	LONG
05/21/2014	17:57:00	18:19:00	RAINFALL	APS
05/22/2014	00:00:00	16:59:28	MISSING DATA	APS
05/22/2014	00:00:00	17:06:57	MISSING DATA	NANO
05/22/2014	00:00:00	18:53:34	MISSING DATA	LONG
05/22/2014	00:00:00	23:59:59	INVALID DATA AT SMALL SIZ	LONG
05/22/2014	00:00:00	23:59:59	INCORRECT AEROSOL SHEATH	LONG
05/22/2014	17:16:29	17:16:30	INSUFFICENT WATER REMOVAL	APS
05/22/2014	17:19:29	17:19:30	INSUFFICENT WATER REMOVAL	APS
05/22/2014	17:41:29	17:41:30	INSUFFICENT WATER REMOVAL	APS
05/22/2014	18:50:29	18:51:30	INSUFFICENT WATER REMOVAL	APS
05/22/2014	19:00:24	23:59:59	MISSING DATA	LONG
05/22/2014	23:11:22	23:12:22	SHORT DURATION SPIKE	NANO
05/23/2014	00:00:00	23:59:59	MISSING DATA	LONG
05/23/2014	10:55:17	11:35:15	DRYER CHANGE	NANO
05/24/2014	00:00:00	23:59:59	MISSING DATA	LONG
05/24/2014	08:56:12	09:08:26	DRYER CHANGE	NANO
05/24/2014	11:43:34	11:44:34	SHORT DURATION SPIKE	NANO
05/24/2014	14:50:20	14:51:20	SHORT DURATION SPIKE	NANO
05/24/2014	16:37:29	16:37:30	INSUFFICENT WATER REMOVAL	APS
05/25/2014	00:00:00	23:59:59	MISSING DATA	LONG
05/25/2014	00:50:01	00:51:01	SHORT DURATION SPIKE	NANO
05/25/2014	08:15:35	08:16:35	SHORT DURATION SPIKE	NANO
05/25/2014	12:34:34	12:35:34	SHORT DURATION SPIKE	NANO
05/25/2014	23:07:01	23:08:01	SHORT DURATION SPIKE	NANO
05/26/2014	00:00:00	16:26:51	MISSING DATA	LONG
05/26/2014	09:52:31	10:00:04	DRYER CHANGE	NANO
05/27/2014	13:09:29	13:09:30	INSUFFICENT WATER REMOVAL	APS
05/27/2014	13:56:29	13:57:30	INSUFFICENT WATER REMOVAL	APS
05/27/2014	14:47:29	14:48:30	INSUFFICENT WATER REMOVAL	APS
05/27/2014	14:59:29	15:00:30	INSUFFICENT WATER REMOVAL	APS
05/27/2014	20:16:30	20:17:31	INSUFFICENT WATER REMOVAL	APS
05/27/2014	20:38:15	23:59:59	MISSING DATA	NANO
05/28/2014	00:00:00	16:46:41	MISSING DATA	NANO
05/28/2014	06:03:31	07:49:15	MISSING DATA	LONG
05/28/2014	06:15:30	06:15:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	10:26:00	10:52:00	RAINFALL	NANO
05/28/2014	10:26:00	10:52:00	RAINFALL	LONG
05/28/2014	10:26:00	10:52:00	RAINFALL	APS
05/28/2014	12:37:30	12:37:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	15:19:30	15:19:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	15:31:30	15:31:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	15:55:30	15:59:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	16:16:30	16:16:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	16:21:30	16:22:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	16:24:30	16:25:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	16:51:20	17:00:54	DRYER CHANGE	NANO
05/28/2014	16:51:20	17:00:54	DRYER CHANGE	LONG
05/28/2014	16:54:30	16:54:31	INSUFFICENT WATER REMOVAL	APS
05/28/2014	17:23:29	17:24:30	INSUFFICENT WATER REMOVAL	APS

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Date	Time Start	Time End	Description	Instrument
05/29/2014	13:06:29	13:06:30	INSUFFICENT WATER REMOVAL	APS
05/29/2014	13:17:00	14:10:00	RAINFALL	NANO
05/29/2014	13:17:00	14:10:00	RAINFALL	LONG
05/29/2014	13:17:00	14:10:00	RAINFALL	APS
05/29/2014	13:23:29	13:25:30	INSUFFICENT WATER REMOVAL	APS
05/29/2014	13:27:29	13:36:30	INSUFFICENT WATER REMOVAL	APS
05/30/2014	18:31:08	18:32:08	SHORT DURATION SPIKE	NANO
05/31/2014	00:28:44	00:29:44	SHORT DURATION SPIKE	NANO
06/01/2014	00:00:00	00:00:00	LOCAL SOURCE	APS
06/01/2014	00:43:29	00:43:30	INSUFFICENT WATER REMOVAL	APS
06/01/2014	01:59:29	01:59:30	INSUFFICENT WATER REMOVAL	APS
06/01/2014	10:26:32	23:59:59	DEPLETED BUTANOL RESERVOI	LONG
06/01/2014	15:29:29	15:31:30	INSUFFICENT WATER REMOVAL	APS
06/01/2014	15:30:00	15:58:00	RAINFALL	NANO
06/01/2014	15:30:00	15:58:00	RAINFALL	LONG
06/01/2014	15:30:00	15:58:00	RAINFALL	APS
06/01/2014	15:40:29	15:40:30	INSUFFICENT WATER REMOVAL	APS
06/01/2014	15:41:13	23:59:59	MISSING DATA	NANO
06/01/2014	15:42:29	15:42:30	INSUFFICENT WATER REMOVAL	APS
06/02/2014	00:00:00	11:56:28	DEPLETED BUTANOL RESERVOI	LONG
06/02/2014	00:00:00	12:03:55	MISSING DATA	NANO
06/02/2014	00:00:00		DRYER CHANGE	NANO
06/02/2014	00:00:00		DRYER CHANGE	LONG
06/02/2014	11:53:00	12:54:00	ZERO OF SO2 MONITOR	NANO
06/02/2014	11:53:00	12:54:00	ZERO OF SO2 MONITOR	LONG
06/02/2014	12:10:57	12:49:28	MISSING DATA	NANO
06/02/2014	12:13:29	12:48:14	FLOW TEST	APS
06/02/2014	12:13:29	12:48:14	HEPA FILTER ON AEROSOL IN	APS
06/02/2014	12:13:29	12:48:14	MISSING DATA	APS
06/02/2014	12:14:29	12:48:13	DEPLETED BUTANOL RESERVOI	LONG
06/02/2014	12:16:00	13:35:00	HEPA FILTER ON AEROSOL IN	NANO
06/02/2014	12:16:00	13:35:00	HEPA FILTER ON AEROSOL IN	LONG
06/02/2014	12:27:00		FLOW TEST	NANO
06/02/2014	12:27:00		FLOW TEST	LONG
06/02/2014	12:29:00	13:05:00	RAINFALL	NANO
06/02/2014	12:29:00	13:05:00	RAINFALL	LONG
06/02/2014	12:29:00	13:05:00	RAINFALL	APS
06/02/2014	12:50:29	13:01:43	NOT SAMPLING THROUGH INLE	LONG
06/02/2014	13:09:15	13:16:14	NOT SAMPLING THROUGH INLE	NANO
06/02/2014	13:12:59	13:21:58	NOT SAMPLING THROUGH INLE	LONG
06/02/2014	14:05:29	14:05:30	INSUFFICENT WATER REMOVAL	APS
06/02/2014	14:22:44	14:28:56	NOT SAMPLING THROUGH INLE	LONG
06/03/2014	07:12:29	07:12:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	09:47:29	09:47:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	14:54:29	14:54:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	15:17:15	15:18:15	SHORT DURATION SPIKE	NANO
06/03/2014	16:10:29	16:10:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	16:57:29	16:57:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	17:20:29	17:20:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	17:22:29	17:22:30	INSUFFICENT WATER REMOVAL	APS

Table I.52: Table 52 of 53

Date	Time Start	Time End	Description	Instrument
06/03/2014	17:55:29	17:57:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	18:35:29	18:39:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	18:52:11	18:54:25	CPC DRAIN	LONG
06/03/2014	18:52:29	18:52:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	18:55:29	18:56:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	18:59:29	19:00:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	19:14:29	19:16:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	19:41:29	19:58:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	20:21:29	20:28:30	INSUFFICENT WATER REMOVAL	APS
06/03/2014	20:31:29	20:35:30	INSUFFICENT WATER REMOVAL	APS
06/04/2014	01:28:00	03:24:00	RAINFALL	NANO
06/04/2014	01:28:00	03:24:00	RAINFALL	LONG
06/04/2014	01:28:00	03:24:00	RAINFALL	APS
06/04/2014	01:38:29	01:38:30	INSUFFICENT WATER REMOVAL	APS
06/04/2014	03:55:00	04:47:00	RAINFALL	NANO
06/04/2014	03:55:00	04:47:00	RAINFALL	LONG
06/04/2014	03:55:00	04:47:00	RAINFALL	APS
06/04/2014	05:11:00	06:57:00	RAINFALL	NANO
06/04/2014	05:11:00	06:57:00	RAINFALL	LONG
06/04/2014	05:11:00	06:57:00	RAINFALL	APS
06/04/2014	07:42:57	07:55:07	DRYER CHANGE	NANO
06/04/2014	07:42:57	07:55:07	DRYER CHANGE	LONG
06/04/2014	11:04:10	12:42:24	MISSING DATA	LONG
06/04/2014	14:55:57	23:59:59	MISSING DATA	LONG
06/04/2014	15:02:57	23:59:59	MISSING DATA	NANO
06/04/2014	15:04:30	23:59:59	MISSING DATA	APS

Table I.53: Table 53 of 53

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