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Evaluation of a low-cost aerosol sensor to assess occupational exposures

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EVALUATION OF A LOW-COST AEROSOL SENSOR TO
ASSESS OCCUPATIONAL EXPOSURES

by

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Thesis Supervisor: Associate Professor Thomas M. Peters

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MASTER'S THESIS

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has been approved by the Examining Committee for
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ABSTRACT

A Dylos DC1100 was evaluated to: 1. Establish relationship between low-cost DC1100 and higher-cost pDR 1200; 2. Develop a method to convert DC1100 particle number into mass concentration to compare with respirable and inhalable mass references.

A Dylos DC1100 was deployed in a swine CAFO, along with a pDR-1200 and filter set to collect respirable and inhalable particles. Deployment was conducted from December 2013 through February 2014 in 24 hour intervals. The pDR-1200 and respirable mass concentration was used to convert the DC1100 particle count to mass concentration. Two methods of conversion were used, physical property method (Method 1) and regression method (Method 2).

Direct measurements from the DC1100 and pDR-1200 had a coefficient of determination (R^2) of 0.85. DC1100 particle number were converted to mass concentration using Method 1 and Method 2, the coefficient of determination (R^2) was 0.72 and 0.73, respectively compared to pDR-1200. The slope of the best-fit line was 1.01 for Method 1 and 0.70 for Method 2. When the DC1100 daily averages were compared to respirable mass, the physical property method had an R^2 of 0.64 and a slope of 1.10. Regression method had an R^2 of 0.62 and a slope of 0.80. Both methods underestimated inhalable mass concentrations with slopes < 0.13.

The Dylos DC1100 can be used to estimate respirable mass concentrations within a CAFO. Using expensive dust monitors to correct the number of particles into a mass concentration is needed to establish a correction factor for the DC1100. Using these methods, correction factors can be determine for many occupational environment, with the physical property method being preferred over the regression method.

PUBLIC ABSTRACT

A low-cost dust monitor (Dylos DC1100, $200) was tested to determine if it can be a suitable replacement for dust sampling in a swine concentrated animal feeding operation (CAFO). The DC1100 was sampled in the swine CAFO during the winter along with a higher-cost sensor ($5,800) and filters to collect the dust. Two methods for converting DC1100 information into mass concentrations were developed. Statistical tests were run on the comparison of devices using both methods for converting the DC1100. The first method was a good estimation of mass concentrations, while the second method underestimated mass concentrations when comparing to both the higher-cost sensor and the filters. The DC1100 and higher-cost sensor responded to changes in dust concentrations similarly, both in scale of the response and response time. It was concluded that using the DC1100 low-cost dust monitor could be used in a swine CAFO.

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CHAPTER I: LITERATURE REVIEW

Overview

The U.S. swine industry has rapidly shifted from small farms to large industrial facilities. Since the 1960s, this industrialization has resulted in an increased herd size and fewer facilities. These facilities are often called concentrated animal feeding operations (CAFOs) because 1,000-2,400 swine are densely packed with each confined to pens usually slightly larger than the animal. Swine workers are exposed dust from byproducts from the swine as well as dust from typical operations (feeding and cleaning), as well as gaseous ammonia, hydrogen sulfide, carbon dioxide, carbon monoxide, and trace gases. These workers have an increased prevalence of adverse respiratory symptoms such as bronchial inflammation, allergic alveolitis, and occupational asthma. Although typical airborne dust concentrations have been studied in swine CAFOs, dust monitors that can provide real-time concentrations in these buildings are needed to identify when concentrations exceed levels associated with the development of adverse health effects. Dust monitors are, however, rarely used in agriculture primarily because they are expensive (>$5,000). This thesis investigates the performance of a low-cost dust monitor to identify dust concentrations within a CAFO.

CAFO Exposure

Roughly 5-10% of the 5 million US agricultural workers engage in CAFO work with ~250,000 working specifically within swine (Kirkhorn & Garry, 2000). In 2012, there were 63,246 swine CAFOs with 12% of these operations considered large operations (2,000 or more swine), which accounted for 90% of the total number of swine (USDA, 2012). Large CAFOs require full-time workers to maintain optimal production. The increase in the number of hours

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worked each day has resulted in a net increase in daily exposure to airborne contaminants (Wenger, 1999).

The dust in swine CAFOs is generated from a variety of sources. The swine generate dust composed of waste (urine and fecal material), dander, and hair. Other sources include animal feed, mold pollen, insect parts, and mineral ash (Donham, Haglind, Peterson, Rylander, & Belin, 1989; Pedersen et al., 2000; Wenger, 1999). Swine dust consists of carbon (dry matter and ash), nitrogen, phosphorus, potassium, chlorine, and sodium (Pedersen et al., 2000).

Particle sizes are defined by American Conference of Governmental Industrial Hygienists (ACGIH) for occupational exposures. Inhalable dust is defined as particles anticipated to penetrate into the human respiratory tract with a 50% collection efficiency for 100 µm and increasing efficiency with decreasing particle size (ACGIH, 2014). Respirable dust is a fraction of inhalable dust and is defined as particles anticipated to penetrate the pulmonary region of the human respiratory tract. Respirable sampling has a 50% collection efficiency at 4 µm and includes particles as large as 10 µm (ACGIH, 2014). Filter sampling is conducted to identify worker exposure to airborne dust. Traditional sampling techniques use a pre-weighed filter attached to a pump with a known flow rate (e.g., 2 L min^{-1}). After a specific time, the filter is weighed again to determine the accumulated mass on the filter. With the known duration and sampling flow rate, a mass concentration of airborne contaminates can be determined.

Adverse health effects from exposure to airborne particles can be size dependent. Particles larger than 100 µm are generally not aspirated into the respiratory system (Wenger, 1999). Due to specific bacteria present in swine dust, workers have increased prevalence to adverse health effects compared to other occupational settings. Particles in the upper airways can cause nasal epithelia, mucal discharge and direct irritation (Kirkhorn & Garry, 2000), while

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particles that penetrate the pulmonary region have shown to cause bronchial inflammation, allergic alveolitis, toxin fever, occupational asthma (Whyte, 1993), chest tightness, shortness of breath, dry cough, fever, chills, myalgias, and fatigue (Kirkhorn & Garry, 2000). Clinically these symptoms have been diagnosed as farmer's hypersensitivity pneumonitis (FHP) or Organic Dust Toxic Syndrome (ODTS).

Typical airborne concentrations of dust in a swine CAFO depend on multiple factors. These factors include the distribution and quantity of fresh air delivered to the CAFO, the relative location to dust sources, the amount of animal and human activity, the presence of air cleaning technologies, and seasonality (O'Shaughnessy et al., 2010; Wang, Zhang, & Riskowski, 1999). A study by Anthony et al. (2015) looked at effectiveness of air cleaning technologies in a Midwest farrowing room during the winter. They found respirable dust was reduced by 40% when air cleaning technologies were present. For changes in seasons, building ventilation and heating or cooling is altered to maintain indoor temperatures optimal for swine growth. Typically northern states close the CAFOs for longer periods of time to reduce the price of heating the rooms. O'Shaughnessy et al. (2010) measured the personal inhalable dust concentration over summer, spring, and winter in the Midwest. Their findings show that workers experience the highest concentrations in winter with a geometric mean of 3.8 mg/m^3, and lowest in summer with a geometric mean of 0.83 mg/m^3.

Airborne dust concentrations have been measured. Donham, Popendorf, Plamgren, and Larsson (1986) measured total dust in a swine CAFO in Iowa and found that the median diameter, mean total mass, and mean respirable mass of collected particles were 2.2 µm, 6.3 mg/m^3, and 0.5 mg/m^3, respectively. Maghirang, Puma, Liu, and Clark (1997) measured the mean respirable fraction to be 11% of total mass (range of 2 – 30%) and a mass concentration of

0.72 mg/m^3 (range of 0.12 – 2.14 mg/m^3), in a closed fan-ventilated swine nursery building. Peters et al. (2012) observed mass concentrations to range from 0.13 mg/m^3 to 0.50 mg/m^3 in a Midwestern USA gestation building throughout the year.

In the United States, worker exposure standards for CAFOs are defined by the Occupational Safety and Health Administration (OSHA). These standards are enforceable by OSHA for CAFOs that have more than 10 employees (29 CFR 1928). OSHA establishes permissible exposure limits (PELs) as maximum amount or concentration of substance in the air (OSHA, 2006), which are designed to protect worker health. The eight-hour, time-weighted average (TWA) PEL for particulates not otherwise regulated (PNOR) is 15 mg/m^3 for total dust and 5 mg/m^3 for respirable dust (OSHA, 2006). The American Council of Government Industrial Hygienists (ACGIH) sets threshold limit values (TLVs) that are concentrations below which adverse health effects are not expected. The TLV particulates not otherwise specified (PNOS) is 10 mg/m^3 for inhalable and 3 mg/m^3 for respirable dusts(ACGIH, 2014). PNOR and PNOS are the only exposure limits to dusts in swine barns because there are no specific PELs or TLVs for swine barn dust. Occupational recommendations are to keep personal exposures inside a swine CAFO below 2.8 mg/m^3 total dust averaged over an 8-h shift (Donham et al., 1995).

Direct-Reading Instruments (DRIs)

Direct-reading instruments (DRIs) are available to provide rapid measurement of aerosol concentrations. DRIs offer advantages over traditional filter methods, including real-time data, easy use, and elimination of the time and costs associated with handling and weighing filters (Lehocky & Williams, 1996). They can be operated with a particle size separator (e.g., cyclone or impactor) attached to the inlet to enable the measurement of particle concentration within a specific size range. Typical separators include respirable cyclones or impactors with a 50% cut-

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off diameters of 1 µm, 2.5 µm, and 10 µm. Measurements made with DRIs can be set to log at different intervals, which typically range from 1 second to 1 hour. However, DRIs are factory calibrated to a specific aerosol, and the calibration aerosol may not represent the particles found in the field (Benton-Vitz & Volckens, 2008), introducing measurement uncertainty.

Photometers are a class of DRIs that are commonly used to measure workplace aerosol concentrations. As shown in Table I - 1, examples of photometers are the DustTrak (TSI, Inc., St. Paul, MN), Sidepak AM510 (TSI, Inc., St. Paul, MN), pDR (Thermo Fisher Scientific, Waltham, MA), Shinyei PPD42NS (Shinyei Corp, New York, NY), Sharp GP2Y1010AU0F (Sharp Corporation, Osaka, OSK). Photometers use a laser source to illuminate a sensing zone, which contains many particles at one time. The light scattered by the assembly of particles is measured by a photodector at an angle specific to the photometer model, often 90° from the incident light. Photometers typically use a pump to pull air through the device, allowing aerosols to move through the sensing zone. The intensity of scattered light is directly proportional to gravimetrically measured mass concentration, although the relationship is dependent on particle light scattering characteristics, density, and size distribution.

Depending on the photometer, different options for sampling can be established. There are two personal DataRams models available: a pDR-1200 and a relatively new pDR-1500. The pDR-1200 has no internal pump, so an external pump must be used to pull particulates into the sensing zone. A 37-mm filter in a sampling cassette can be attached directly to the exhaust end of the device to allow filter collection of particles that have passed through the sensing zone for further analysis. Cyclones can be attached to the pDR-1200 inlet to meet desired particle size selection criteria. The newer pDR-1500 contains an internal pump and filter cassette. The pDR-1500 comes with the option of three inlets, a total dust inlet with cut points 1, 2.5, and 10 µm,

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and two cyclone accessories. The pump flow rate is adjusted based on the different particle cut points that are factory calibrated. Other photometers offered by TSI are a DustTrak II Model 8530 (desktop monitor), the DustTrak II Model 8532 (handheld monitor), and Sidepak AM510 (portable monitor). The Sidepak AM510 is similar to the pDRs, and contains built-in 1,2.5, and 10 µm impactors. These photometers can cost upwards of $4000.

Lost-cost photometer sensors, with the same operating technology but without enclosures or external logging devices, are available, including the Shinyei PPD42NS (~$16) and Sharp GP2Y1010AU0F (~$12) sensors. The Shinyei uses a single LED, a plastic lens, and an optical receiver oriented at a 45° angle to the LED. The Shinyei consists a partially closed chamber with a removable cap for easy cleaning of the lens. Air flow is driven by a 0.25 W resistor that creates a convection current when heated. The Sharp sensor uses an infrared emitting diode set up diagonally from a phototransistor. The amount of reflected light is an analog signal that is converted to mg/m^3 using a manufacture calibration curve.

As summarized in Table I - 2, there are other technologies available to measure real-time airborne particle concentrations, including optical particles counters (OPCs), beta ray attenuation monitors, and tapered element oscillating microbalances (TEOMs). In an OPC, a sensing volume is illuminated typically with a laser similar to a photometer. However, unlike photometers that measure an aggregate concentration of particles in the sensing zone, airborne particles in an OPC are counted and processed one at a time. OPCs function best at low particle concentrations (e.g., < 10,000 p/cc), ensuring that the optics are only viewing a single particle at a time. For high particle concentration locations, a diluter is often used to reduce the number of particles by a specific factor. Most OPCs, such as the PDM 1.108 (Grimm Technologies), use the intensity and angle of scattered light to classify particles into size channels.

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Recently, several models of low-cost OPCs produced by Dylos Corporation (DC1100 ~$200; and DC1700 ~$400, Riverside, CA) have become commercially available, primarily marketed for in-home use. These instruments use a small fan to pull particles into a sensing zone. A red laser is used to illuminate particles moving through the sensing zone with scattered light captured by a photodiode. The instrument uses signal processing to divide particles into two size bins: particles larger than 0.5 µm; and particles larger than 2.5 µm. Both the Dylos DC1100 and DC1700 report number concentration in particles per 100 ft^3 measurements every minute, but only the Dylos DC1700 can store the values to an accessible internal memory. The upper concentration limit is 65,536 particles per 100 ft^3 because of the use of a 16-bit storage register. While the DC1100 requires AC power, the DC1700 has an internal battery that can run up to 6 hours.

Beta ray attenuation monitors (BAMs) work by emitting high-energy electrons (beta rays) at filter tape that are detected by a scintillation detector. Clean filter tape is measured to achieve zero calibration. Air is pulled into the device and collected onto the filter tape. After sampling is complete over one logging interval, the tape moves the collected dust to a position between the beta source and detector, where the change in signal is recorded, allowing the determination of mass concentration. The BAM-1020 (Met One Instruments, Grants Pass, OR) beta ray attenuation monitors holds U.S. EPA Federal Equivalent Method (FEM) standards for both PM$_{2.5}$ and PM$_{10}$ continuous monitoring. The European Union has also certified the BAM-1020 for PM$_{2.5}$ and PM$_{10}$.

Tapered Element Oscillating Microbalance (TEOM) work by using a filter attached to an oscillating balance. As the mass accumulates on the filter and the frequency of oscillation changes, average PM concentrations are calculated as the final output. The TEOM is within FEM

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Standards for PM_{10} for US EPA (EPA, 1990) and have been shown to meet TSP regulatory performance requirements in Germany (RWTÜG_V, 1994).

Photometer Response

Comparison studies have been conducted to identify relationships between photometers and gravimetric measurements. Comparison criteria for equitant device have been established for $PM_{2.5}$ and PM_{10} by the Environmental Protection Agency (EPA). Criteria for $PM_{2.5}$ states the slope of the regression line must be 1 ± 0.05, and intercept 0 ± 1, with a Pearson correlation coefficient ≥ 0.97. PM_{10} is less strict, with a slope of 1 ± 0.10, intercept 1 ± 5, and Pearson correlation coefficient ≥ 0.97 (EPA, 2006b). Average bias for both $PM_{2.5}$ and PM_{10} must be within 10% (EPA, 2006a). Criteria is also established for DRIs for gases and vapors by NIOSH. It states that the device must have a bias no more than 10%, and accuracy should be $\leq 25\%$ with 95% confidence (NIOSH, 2012). Studies have shown that there is a linear relationship between traditional gravimetric sampling and photometers. These studies have been conducted in urban environments, indoor environments, and occupational locations.

There have been many urban environmental studies comparing photometer concentrations with gravimetric sample concentrations. Kingham et al. (2006) compared the DustTrak 8520 and PM_{10} gravimetric sampler (HiVol) in a wood smoke environment. The DustTrak compared to gravimetric sampler had a coefficient of determination (R^2) of 0.79 and slope of 2.7. Holstius, Pillarisetti, Smith, and Seto (2014) compared hourly paired values from a FRM BAM-1020 with the DustTrak II 8530, and a GRIMM OPC. The resulting in an R^2 of 0.49 – 0.59 for the DustTrak II, GRIMM $PM_{2.0}$, and GRIMM $PM_{3.0}$ compared to BAM-1020. Chakrabarti, Fine, Delfino, and Sioutas (2004) conducted a precision and accuracy study of three pDR-1200 devices compared a BAM-1020. The R^2, mean relative difference, and slopes of the

three pDRs were 0.99, less than 0.1 µg/m^3, and 1 ± 0.10, respectively. The R^2 between the 2 hr average real-time pDR measurements and the BAM-1020 was 0.86.

Similar results have been observed for DRIs when used indoors. Yanosky, Williams, and MacIntosh (2002) used a DustTrak model 8520 collect PM$_{2.5}$ along with gravimetric samplers. The comparison of gravimetric to DustTrak had an R^2 of 0.86. The best fit line shows that the DustTrak overestimated mass with a slope of 2.57. Zhou et al. (2014) used a pDR-1500 at New York City hookah bars. The gravimetric results had a range of 109 to 1270 µg/m^3 with an average value of 691 µg/m^3. The pDR-1500 recorded an average value of 1180 µg/m^3 and a range of 481 to 2986 µg/m^3. No pairwise comparisons were conducted.

Occupational locations have been tested, with DRIs having similar treads to gravimetric samplers. Lehocky and Williams (1996) compared the measurements from a DustTrak and a respirable sampler for coal dust. Daily values between the respirable sampler and the DustTrak has an R^2 of 0.94, with an underestimated slope of 0.73. Flanagan, Seixas, Majar, Camp, and Morgan (2003) compared a pDR-1200 with a respirable cyclone to a respirable filter for silica dust exposure at a construction site. The R^2 between the respirable mass and pDR was 0.67.

Studies Evaluating Low-Cost DRIs

Studies have shown that low-cost (<$500) DRIs detect similar airborne particles concentrations as more expensive DRIs. An urban air study by Holstius et al. (2014) compared hourly paired values from a DustTrak II 8530, GRIMM OPC, Dylos DC1700, and three Shinyei PPD42NS sensors. An accuracy test between the three Shinyei devices resulted in R^2 values between 0.91-0.92 The DC1700 had slightly lower R^2 (0.87 – 0.92) to the Shineyi sensors. Compared to the DustTrak, the Shinyei sensors were less robust, with R^2 ranging from 0.64 –

0.70 and the DC1700 had an R^2 of 0.78. The OPCs were highly correlated with the Dylos ($R^2 >$ 0.98) when compared to the GRIMM for $PM_{2.0}$ and $PM_{3.0}$.

Semple, Apsley, and Maccalman (2012) compared the Dylos DC1700 to a Sidepak AM510 Personal Aerosol Monitor (TSI Inc) for identification of secondhand smoke particulate levels in a chamber. The concentration of secondhand smoke varied by allowing a cigarette to burn at different durations in the chamber. Both instruments were set for a logging interval of one minute. The chamber concentrations ranged from 27 to 630 $\mu g/m^3$ (measured by the Sidepak) or 0 to 65,536 particles per 100 ft^3 (measured by the DC1700). Using a second order polynomial to fit the DC1700 data to the Sidepak, a best-fit curve established an R^2 of 0.90. A follow-up study by Semple, Ibrahim, Apsley, Steiner, and Turner (2013) looked at secondhand smoke levels in homes, using the same devices. A similar quadratic relationship between the DC1700 and the Sidepak established an R^2 of 0.86. The mean difference of the corrected DC1700 to the Sidepak concentrations was 0.09 mg/m^3.

Budde, Busse, and Beigl (2012) used a DustTrak as a reference device and attached a Sharp GP2Y1010AU0F sensor in line with the DustTrak inlet to measure the same particles. The experiment was conducted indoors, with no aerosol generation present. To compare the devices, the mean absolute error was computed for different time intervals (10 seconds to 30 minutes). Over the longer averaging periods, the mean absolute error was reduced and had a smaller standard deviation. These results show that the Sharp preforms better over a longer log interval and doesn't perform as well in environments that are rapidly changing.

Synthesis of Literature

There are many work environments where optical sensors can help to evaluate exposure and toxic levels present. Lehocky and Williams (1996) stated reliability testing of DRIs should

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be tested with medium and high-cost instruments to measure specific aerosols. The Dylos DC1100 is a relatively new sensor that has shown promise for detecting aerosol concentrations in urban environments and areas where secondhand smoking is an issue. No comparison studies have been conducted in occupational settings and, more specifically, within agriculture environments such as in a CAFO. However, if favorable performance is observed, the agricultural industry may benefit from having such a low-cost way to assess dust concentrations. This type of device could be integrated to allow control of ventilation to maintain dust concentrations below exposure limits and to identify specific hazards in the workplace. Ultimately, improved air quality could lead to healthier workers and animals.

Aims

The overall goal of this study was to evaluate the Dylos DC1100 for use in a swine farrowing barn. This goal was accomplished by measuring dust concentrations with the DC1100, a photometer (pDR-1200), and filter-based samplers (respirable and inhalable). The specific aims were to:

1. Establish the relationship between concentrations measured with the low-cost DC1100 compared to the higher-cost pDR-1200.

2. Develop a method to convert the DC1100 particle number into mass concentration

3. Determine the accuracy, bias, and precision of mass concentration estimates from the DC1100, using respirable and inhalable mass concentrations as a reference.

Table I - 1: Photometer specifications

Device	Manufacture	Price	Concentration Range	Particle Size Range (μm)	Resolution (mg/m^3)	Log Interval	Weight (kg)
Personal DataRAM pDR-1200	Thermo Scientific	$5829	0.001 - 400 mg/m^3	0.1 to 10	0.001 mg/m^3 or 0.1% *	1 second to 4 hours	0.68
Personal DataRAM pdr 1500	Thermo Scientific	$4880 + $1099**	0.001 - 400 mg/m^3	0.1 to 10	0.001 mg/m^3 or 0.1% *	1 second to 1 hours	1.2
DustTrak II – Model 8530 (Desktop)	TSI	$5420	0.001 - 400 mg/m^3	0.1 to 10	0.001 mg/m^3 or 0.1% *	1 second to 1 hour	1.5
DustTrak II – Model 8532 (Handheld)	TSI	$4995	0.001 - 150 mg/m^3	0.1 to 10	0.001 mg/m^3 or 0.1% *	1 second to 1 hour	2.2
Sidepak AM510	TSI	$3975	0.001 - 20 mg/m^3	0.1 to 10	0.001 mg/m^3	1 second to 60 seconds	0.46
Shinyei PPD42NS	Shinyei Corp	$16.00	0 - 28,000 pcs/L	Approximately 1 (minimum)	-	None (Needs external Datalogger)	0.024
Sharp GP2Y1010AU0F	Sharp	$12.00	0 - 0.5 mg/m^3	-	0.1 mg/m3	None (Needs external Datalogger)	-

*whichever is greater
** for accessory cyclones

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Table I - 2: Other DRI devices and specifications

Device	Manufacture	Price	Sensor Type	Concentration Range	Particle Size Range (μm)	Log Interval	Weight (kg)
Dylos DC 1100	Dylos Corporation	$200	Optical Particle Counter	0 - 65,536 particles/100ft^3	Small: >0.5 Large: >2.5	1 minute	1.13
Dylos DC 1700	Dylos Corporation	$425	Optical Particle Counter	0 - 65,536 particles/100ft^3	Small: >0.5 Large: >2.5	1 minute	1.13
GRIMM Environmental Dust Monitor	GRIMM Aerosol Technik	$19,370	Optical Particle Counter	-	0.25 - 32	5 seconds – 1 hour	20
BAM-1020	MetOne	$23,750	Beta Ray Attenuation	-	-	1 min to 1 hour	24.5
TEOM 1405 Ambient Particulate Monitor	Thermo Scientific	$23,092	Tapered Element Oscillating Microbalance	0.001 - 1,000 mg/m^3	-	Real-time: 10 to 3600 seconds Long-Term Averaging: 30 min, 1, 8 and 24 hour	18

CHAPTER II: EVALUATION OF A LOW-COST AEROSOL SENSOR TO ASSESS OCCUPATIONAL EXPOSURES

Introduction

For the past two decades, high-density, large (>2,000 head) enclosed livestock operations, also known as concentrated animal feeding operations (CAFOs), have proliferated across the US to address a growing demand for animal products. Full-time employees are necessary to maintain a CAFO, resulting in worker exposure to airborne dust of higher intensity and longer duration than what is found in smaller operations (Wenger, 1999). This dust is a complex mixture of waste, dander, feed, mold, pollen, insect parts, and mineral ash (Donham et al., 1989; Pedersen et al., 2000; Wenger, 1999). Adverse health effects associated with exposure to dust in a swine CAFO include bronchial inflammation, allergic alveolitis, and occupational asthma (Whyte, 1993). Many factors influence the magnitude of exposure to dust, including building ventilation, distance from source, and amount of animal and human activity (Wang et al., 1999). Building ventilation is a major driver of fluctuations in dust concentrations, with higher concentrations when a CAFO is sealed to maintain optimal temperatures (winters in upper Midwest, and summers in the South) (O'Shaughnessy et al., 2010).

Limits for worker exposure to dust are defined by the Occupational Safety and Health Administration (OSHA). Swine dust is categorized as particulates not otherwise regulated (PNOR), and the eight-hour time-weighted average (TWA) permissible exposure limits (PEL) is 15 mg/m^3 total dust and 5 mg/m^3 respirable dust (OSHA, 2006). However, industry recommendations for swine CAFOs suggest an 8-hr TWA limit of 2.8 mg/m^3 measured as total dust based on synergistic effects of dust and ammonia (Donham et al., 1995). Traditional filter-based sampling (e.g., NIOSH NMAM 0500) is conducted to determine compliance with

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exposure limits. Filter-based sampling requires workers to wear lapel-mounted samplers with belt-mounted air pumps. Such sampling is done infrequently because it is intrusive, requires trained personnel, and is expensive. Moreover, results of exposure measurements are typically not available for days or weeks after sampling because samples must be analyzed in a laboratory (e.g., weighed in a relative humidity and temperature controlled environment).

Aerosol photometers are direct-reading instruments (DRIs) that enable rapid measurement of particle dust concentrations. Photometers illuminate particles in a sensing zone with a light source, typically a laser. The light scattered by the particles is detected at an angle ~90 degrees from the incident light; this light intensity is linearly related to gravimetrically measured mass concentrations (Chakrabarti et al., 2004). Examples of commonly used field photometers include the personal Data Ram (pDR-1200 and pDR-1500, Thermo Fisher Scientific, Waltham, MA), the DustTrak (TSI, Inc., St. Paul, MN), and the Sidepak (AM510, TSI, Inc., St. Paul, MN). Compared to compliance sampling with subsequent gravimetric analysis, photometers offer real-time measurements, ease of use, time savings and cost effectiveness (Lehocky & Williams, 1996). Photometers can be operated with a particle size separator attached to the inlet, allowing measurement of particles within a specific size range. However, photometers are factory calibrated to an aerosol that may not scatter light the same way that the field aerosol does, resulting in inaccurate measurements (Benton-Vitz & Volckens, 2008). Photometers are also expensive ($5,000 to $10,000), limiting their adoption in agricultural settings.

Recently, a low-cost ($200) optical particle counter, the DC1100 (Dylos Corporation, Riverside, CA), has become commercially available. The DC1100 uses a laser to detect the number concentration of particles in two size bins: a small bin reports particle count

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concentration for particles > 0.5 µm to and a large bin reports particles > 2.5 µm. The number concentration measured with the DC1100 has been shown to correlate well to mass concentrations measured by photometers in ambient and indoor environments. Semple et al. (2013) used a collocated Dylos DC1700 and a photometer to quantify secondhand smoke concentrations in homes. The coefficient of determination (R^2) between the two devices was 0.86. Holstius et al. (2014) compared a DC1700 counter to a high-cost OPC, and a photometer DustTrak II in an urban setting. The DC1700 had the highest coefficient of determination with the OPC (0.99), with the coefficient of determination for the DustTrak II at 0.78. The DC1700 has not been tested in occupational environments where typical particle concentrations are substantially higher.

In this study, we evaluated the DC1100 in the occupational setting of a swine CAFO. We first established the relationship between the low-cost DC1100 and an aerosol photometer pDR 1200. Secondly, we developed a method to convert particle number into mass concentration for comparison with gravimetric respirable and inhalable mass concentrations. The DC1100 was converted to mass concentration using two methods, one accounting for the physical properties of particles (density and diameter of aerosol) and another using regression modeling, to determine the optimal method to convert DC1100 output to relevant occupational exposure units.

Methods

Site Description

Measurements were made at the Mansfield Swine Education Center of Kirkwood Community College (Cedar Rapids, IA) from December 2013 to February 2014 for 18 evenly spaced days. This study was conducted in conjunction with a study by Anthony et al. (2015), which investigated the effect of engineering controls on dust and gas concentrations. The

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building consisted of four rooms, one nursery, two farrowing with a hallway between the two farrowing rooms. All measurements in the study were conducted in the larger farrowing room depicted in Figure II - 1. The room contained three rows of five pens and one row of four, for a total of 19 pens. Each pen had its own feeding trough and water system, and two 0.91-m-deep pull-plug manure pits that were each vented by a $0.41 m^3/s$ exhaust fan. The farrowing room contained general ventilation to the hallway and outside, where outside vents were closed to reduce heating costs during this study period. It also had one open flame heater (Guardian 60 Model AW060, L.B. White, Onalaska, WI) that exhausted combustion gasses internally. An air pollution control device, Shaker-Dust Collector (SDC, Model 140, United Air Specialists Inc., Cincinnati, OH) was located outside, with the ducts arranged along the back wall of the CAFO. Two intakes at 0.5-m height located at the feeding isles, and exhausted duct through two fabric socks at a height of 2-m. The SDC was tested for use in a swine CAFO to reduce the airborne dust (Peters, Sawvel, Park, & Anthony, 2015).

Dust Measurement

Dust concentrations were measured with multiple instruments (Table II - 1) at two locations in the farrowing room (Location I and Location II, Figure II - 1). At each location, a low-cost DC1100 (Dylos Corporation, Riverside, CA), a photometer (pDR-1200, Thermo, Franklin, MA) with a respirable dust sampler (BGI GK2.69 cyclone with 5 µm PVC filters), and an inhalable dust sampler (IOM – plastic internal cassette with 5 µm PVC filters) were placed in an open crate with the sampler inlets positioned next to each other at 1.5 m above the floor. The crate at Location II contained two DC1100s, which allowed for measurement of instrument precision. The serial output from the DC1100s were captured with a microcontroller (Ardunio

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Mega, Ivrea, Italy), which then logged small and large bin number concentrations to an SD card every two minutes using a data logging shield (Adafruit, New York, NY).

The pDR-1200s were operated with a respirable cyclone on the inlet, a pre-weighed filter (37-mm polyvinyl chloride (PVC) filter, 225-5-37, Lot No. T306221, SKC, Eighty Four, PA) on the outlet, and a sampling pump (PCXR4, SKC, Eighty Four, PA) to pull air at 4.2 Lpm through the system. They were set to log mass concentrations every 60 seconds. Inhalable mass concentrations were measured with a separate sampler (IOM, SKC, Eighty Four, PA) and a second air sampling pump (PCXR4, SKC, Eighty Four, PA) operated at 2 Lpm. A micro-balance (MT5, Mettler-Toledo, Columbus, OH) was used to measure the weight of filters before and after sampling. Filters were pre and post-weighed in triplicate to ensure precision of measurements and were conditioned in a relative humidity and temperature controlled room for 7 days prior to weighing. Before each deployment, the pDR-1200s were calibrated to zero with a HEPA filter according to manufacturer specifications, and the airflows of pumps were pre-calibrated and post-checked with a Bios DryCal (Mesa Labs, Butler, NJ).

The equipment was deployed between 7:00-8:00 a.m. and collected 24 hours later for 18 days during the three-month span of the larger study (11 days with the SDC on and 7 days with SDC off). Each day, approximately 1440 measurements from the pDR-1200 (1 measurement per 60 seconds for 24-hr) and 720 measurements from the DC1100 (1 measurement per 120 seconds for 24-hr) were recorded at each location. Each gravimetric dust sample (respirable and inhalable) had only one 24-hr average concentration for each location per sampling event. Once back in the laboratory, filters were post-weighed.

Data Analysis

Inhalable and respirable mass concentrations were calculated as:

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$$C_m = \frac{\Delta m_f}{Q * t} \qquad \text{(Equation 1)}$$

where C_m is mass concentration, Δm_f is mass collected on the filter (difference of post-weighed filter and pre-weighed filter), Q is flow rate (Lpm, mean of pre- and post-sampling calibration), and t is sample time in minutes.

The raw concentrations measured from the DC1100 and pDR-1200 were averaged over ten minutes, resulting in raw number concentrations for the DC1100 (DC1100$_{allsmall,RAW}$, DC1100$_{large,RAW}$) and uncorrected mass concentration from the pDR-1200 (pDR$_{RAW}$). The DC1100$_{large,RAW}$ (>2.5 µm size bin) was subtracted from the DC1100$_{allsmall,RAW}$ (>0.5 µm size bin) to obtain a DC1100$_{small,RAW}$ which had a bin size of 0.5µm to 2.5µm. The pDR$_{RAW}$ measurements were corrected to the respirable filter mass (pDR$_{MC}$) by multiplying by the 24-hr filter concentration and dividing by 24 hour average of pDR$_{RAW}$.

Two methods were used to convert particle count from the DC1100 to mass concentration: Method 1 – physical property method; Method 2 – regression method. The physical property method (Method 1) was used to convert both DC1100$_{small,RAW}$ and DC1100$_{large,RAW}$ from particle count to mass concentration using Equation 2

$$PM\ Concentration\ \left(\frac{\mu g}{m^3}\right) = N * \left[\left(\frac{1}{6}\pi d^3\right) * \rho\right] * 3531.5\left(\frac{ft^3}{m^3}\right) \qquad \text{(Equation 2)}$$

where N is the number concentration of particles #/100ft^3 from the DC1100, d is the average diameter of the particles in meters, and ρ is the average density of particles in µg/m^3. The density of swine CAFO dust was assumed to be 1,450 kg/m^3 (Jerez, 2007). Since the DC1100 provides particles/0.01ft^3, the constant 3531.5 in Equation 2 converts the units to particles/m^3. The average diameters for the small particles and large particles were determined by testing multiple

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particle diameters and calculating percent bias using 40 CFR Part 58, Appendix A, 4.3.2, Equation 12. The diameter that was chosen had the smallest average percent bias reported for all three DC1100s when compared to pDR$_{MC}$.

The second method used linear regression to convert particle count to mass conversion, using 20% of the data (calibration data) to build a regression model, which was then applied to the other 80% of the data (validation data). The calibration data was chosen at random from the entire data set. A regression analysis was used on to find a slope and y-intercept using the calibration subset data. This equation was then applied to the validation data set, as well as the entire set of time sequence data, that was then averaged to compare to respirable and inhalable mass concentrations.

To compare concentration estimates between test device and reference samplers, metrics were computed. Average bias was calculated using 40 CFR Part 58, Appendix A, 4.3.2, Equation 12. The 95% confidence limits were calculated using Equation 3

$$95\% \ Confidence \ Limit = B \ \pm t_{0.975,df} se \qquad \text{(Equation 3)}$$

where B is the average bias, df is the number of data pairs minus one, $t_{0.975,df}$ is the 0.975 percentile of the Student's t distribution, and se is the standard error of the bias measurements. Slope, y-intercept and coefficient of determination (R^2) were determined using linear regression with X-sampler as independent variable and Y-sampler as dependent variable. The Pearson correlation coefficient (r) was determined. An "average ratio" was calculated by taking the mean of the Y-sampler divided by the X-sampler at each data point (Y/X). The mean difference was calculated by taking the mean of the Y-sampler minus the X-sampler for each data point (Y – X).

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Results

Pairwise comparisons of dust concentrations measured with various collocated instruments are summarized in Table II - 2 for 10-minute data and Table II - 3 for 24-hour data. A primary (X) sampler and duplicate (Y) sampler were designated for each pairwise comparison, and measurements made with the primary sampler were used to represent the true concentration to compute bias. EPA test procedures to establish comparability between a test device and a reference method are useful for interpreting the values in these tables. For PM_{10} a linear regression relationship between test device and reference method must have a slope of 1 ± 0.1, a y-intercept of 0 ± 5 $\mu g/m^3$, a Pearson correlation coefficient (r) ≥ 0.97 (40 CFR Part 53, Subpart C, Table C-4), and percent bias should be within $\pm 10\%$ (40 CFR Part 58). NIOSH has less stringent criteria for evaluation of direct-reading gases and vapor monitors. They require a linear slope of 1 ± 0.1, percent bias $\pm 10\%$, with no criteria for y-intercept. The criteria also states that 95% of test device recordings must be within 25% of the reference device (NIOSH, 2012).

10-Minute Averaged Data

The paired Dylos $DC1100_{small,RAW}$ measurements obtained at Location II over the entire study were used to assess instrument precision. This resulted in an average percent bias of -1.9%, a Pearson correlation coefficient (r) of 0.95, coefficient of determination (R^2) of 0.91, and coefficient of variation of 8.2%.

A scatterplot of $DC1100_{small,RAW}$ compared to pDR_{RAW} is shown in Figure II - 2. The Pearson correlation coefficient (r) was 0.92 and the coefficient of determination (R^2) was 0.85 (refer to Table 2-2). Comparisons between $DC1100_{small,RAW}$ and $DC1100_{large,RAW}$ were closely related with both r and R^2 being > 0.95, therefore only the DC1100 small particles will be discussed for the rest of this paper due to similar response from both small and large bins.

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Time paired, 10-min averaged data were used to determine the parameters for the two methods used to convert DC1100 number to mass concentration. A summary of bias minimization efforts to determine the particle diameter using the physical property method (Method 1) is shown in Table II - 4. For DC1100$_{small,RAW}$, when the SDC was on, the diameter that had the lowest average percent bias for the three DC1100s was 3.36 µm, and when the SDC was off the diameter was 3.28 µm. As these diameters were similar, the analysis was run with all data (including both SDC-on and SDC-off) to obtain a combined particle diameter of 3.32 µm.

Application of the regression method (Method 2) required finding the slope and intercepts of a best-fit line between the DC1100 and pDR$_{MC}$. The regression method was conducted on five trials to find a robust slope and intercept, as shown in Table II - 5. The average of five trials resulted in the equations

$$Small\ particles: y = 0.055x + 46.5 \left(\frac{\mu g}{m^3}\right) \qquad \text{(Equation 4)}$$

$$Large\ particles: y = 0.25x + 51.0 \left(\frac{\mu g}{m^3}\right) \qquad \text{(Equation 5)}$$

where y equals mass concentration and x equals number of particles recorded by the DC1100. For both slope and intercept the standard deviation of the five trials were smaller than 5% of the mean.

Scatter-plots of the DC1100$_{small,MC}$ compared to the pDR$_{MC}$ measurements using the both mass conversion methods are shown in Figure II - 3, and pairwise comparisons are shown in Table II - 2. For the physical property method (Method 1, Figure II-3a), the bias was -1.68%, R^2 = 0.72, and a Pearson correlation coefficient (r) was 0.85. The best-fit line had a slope (1.01 ± 0.01) and intercept (-3 ± 2 µg/m^3) with 53% of the DC1100$_{small,MC}$ recordings falling within ± 25% of pDR$_{MC}$ recordings. The regression method (Method 2, Figure II – 3b) had a similar correlation to the physical property method with R^2 = 0.73, r = 0.86, and a higher bias (7.37%),

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and had 63% of the $DC1100_{small,MC}$ recordings were within $\pm 25\%$ of the pDR_{MC}. The important difference between the two methods was the slope of the best fit line. The physical property method had a slope near the 1:1 line, while the regression method's slope (0.70 ± 0.01) underestimated pDR_{MC} by 30%.

A time-series plot of $DC1100_{small,MC}$ (physical property method) and pDR_{MC} on the same y-axis for a representative 24-hr period is shown in Figure II - 4. All daily time-series plots are provided in Appendix C. It is important to note that the concentrations measured with the different devices were synced temporally, and while the magnitudes of the mass concentrations between devices varied over the time period, the magnitude of response was similar for the peaks and valleys.

Daily Averaged Data

Scatter-plots of the 24-hour DC1100 measurements, adjusted by a: Physical property method; b: Regression method with validation data; and c: Regression method with all data, compared to the 24-hr gravimetric respirable mass concentrations are shown in Figure II - 5, with pairwise results in Table II - 3. The one-to-one comparison of DC1100 to respirable mass concentrations for the physical property method (Figure II - 5a) had a bias of -3.06%, a R^2 of 0.64, r of 0.80, slope (1.10 ± 0.16) and y-intercept $(-20.92 \pm 25.27 \ \mu g/m^3)$ of the best-fit line, with 60% of the $DC1100_{small,MC}$ within $\pm 25\%$ of respirable mass concentration. The regression method with only the validation data (Figure II - 5b) had poor correlation (r = -0.20 and R^2 = 0.04) between the $DC1100_{small,MC}$ and respirable mass. Because of this poor fit, the regression equations established in Table II - 5 were used to compute 24-hr DC1100 concentrations using all data (validation and calibration data) plotted in Figure II - 5c. The regression method established relationships similar to those seen with the 10-minute data. $DC1100_{small,MC}$ had an

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average bias of 3.6%, R^2 of 0.62, r of 0.78, slope (0.78 ± 0.12), y-intercept (33 ± 19), when compared to respirable mass concentration and 73% of the $DC1100_{small,MC}$ recordings were within ± 25% of respirable mass concentration.

All comparison criteria for both mass conversion methods for the DC1100 compared to pDR-1200 (10-min data) and respirable mass concentrations (24-hr data) are shown in Table II-6. This table restates the EPA criteria for PM_{10} and the criteria for the NIOSH DRI for gases and vapors criteria. The NIOSH 95% accuracy interval was calculated using methods in Appendix A and Appendix B in *Components for Evaluation of Direct-Reading Monitors for Gases and Vapors* (NIOSH, 2012).

Discussion

The Dylos DC1100 records airborne particle concentrations similarly to a high-cost photometer. With a Pearson correlation coefficient (r) of 0.92, the DC1100 is highly linear compared to the pDR-1200, and there is a small amount of variance ($R^2 = 0.85$). Therefore, both devices must be detecting similar airborne concentrations. Both devices read low variance at high and at low concentrations throughout the entire study, showing the low-cost DC1100 detection range is suitable for use in the swine CAFO. This indicates that the user can obtain similar information whether they use the $200 instrument or the $5,830 instrument. Unlike the pDR-1200 however, the DC1100 does not have the ability to collect particulates for later analysis, but in terms of applicability, farmers would not spend money on filter processing as a measure for determining dust concentrations at their facilities.

There has been no direct comparison of a pDR-1200 and DC1100 (or DC1700) in the literature; however, there have been comparisons of the DC1100 (and DC1700) with other commercially available photometers. Holstius et al. (2014) has compared the DC1700 with a

DustTrak II for PM2.5 and found a coefficient of determination ($R^2 = 0.78$), which is very similar to comparisons found in the swine CAFO. A chamber study by Semple et al. (2012) compared a DC1700 to a TSI Sidepak AM510. The data was fit with a second-order polynomial shape of the scatterplot between DC1700 and AM510. The best-fit regression curve gave a coefficient of determination (R^2) of 0.90. In a follow-up study using field data, the best-fit regression curve resulted in an $R^2 = 0.86$ (Semple et al., 2013).

Using the physical property method to convert particle counts to mass concentrations provides the best results, but if the physical properties of the aerosol are unknown, the regression method provides reasonable results. When using physical property method (Method 1) for mass correction to compare to the pDR-1200, the slope, intercept, and percent bias met the EPA acceptance criteria for PM_{10} (EPA, 2006a, 2006b); however, the Pearson correlation coefficient ($r = 0.85$) did not satisfy the EPA criteria (≥ 0.97). Having a slope near 1.0 showed that using physical property method to estimate mass concentration was an excellent representation for pDR_{MC}. The regression method (Method 2) only satisfied percent bias criteria when compared to pDR_{MC}, but did provide a similar Pearson correlation coefficient to the physical property method. These results may be specific to the size distribution of particles at the field test site and need further testing, but the swine CAFO regression method provides an underestimate of the mass concentration. In an ideal study, sampling should be conducted to determine the density and mean particle diameter of the aerosol in question, which will give a more robust conversion equation for estimating mass concentration. Even though neither method entirely satisfies EPA criteria for comparability between a test device and reference method, they are both sufficient for detecting airborne concentrations and relative changes in these concentrations (seen in time series plots Appendix C, Figure C - 1 through C - 52).

In a study by Northcross et al. (2013), mass converted Dylos DC1700 data was compared to data from a DustTrak model 8520. They used the same method as the physical properties method, as the density and particle diameter of their aerosol were both known. The DustTrak data was mass corrected daily using a beta attenuation monitor, similar to the daily correction of the pDR-1200 based on respirable samplers. They found that mass conversions of the DC1700 could predict mass concentration, with linear regression models having a coefficient of determination of ($R^2 = 0.81 - 0.99$). In the CAFO, the R^2 for $DC1100_{small,MC}$ and pDR_{MC} was 0.72. This relationship may be lower due to the unknown aerosol diameters for this study in the swine CAFO with field data, while the study by Northcross et al. (2013) was using generated aerosols in a chamber with known physical properties.

Daily respirable mass concentration can be estimated using the physical property method on a DC1100, while the regression method underestimated the airborne concentrations. Method 1 (physical property method) satisfies EPA slope criteria (1 ± 0.10) with a slope of 1.10, and average percent bias criteria ($\leq 10\%$) with a bias of 3.63, but does not satisfy the y-intercept and Pearson correlation. Method 2 (regression method) only satisfies percent bias (3.32) and is an underestimate (slope = 0.70) when comparing to respirable mass. Neither methods satisfied NIOSH's 95% accuracy interval criteria ($\pm 25\%$) with physical property having an accuracy of 55% and regression method having an accuracy of 41%. When using regression method for converting the DC1100 to mass concentrations, careful selection of training data should be conducted. In this study, a random 20% of pairwise DC1100 and pDR-1200 data was selected for the training data. The correction was made and applied to the validation data (80%) and daily averages were calculated to compare with respirable mass (Figure II -5b). This resulted in a poor correlation between the DC1100 and respirable sampler due to missing 20% of the information

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each day during the study. If careful selection of the test data was conducted, perhaps selecting 20% of the sample days for the training data so each run day had no missing information when comparing to respirable samplers, the regression method may provide better results.

For this study, the regression method used 20% (training data) of the total data sets to establish a correction factor when initially applied to the validation data set (remaining 80%). The selection of training data was random. This method is similar to the study by (Semple et al., 2013), in which they randomly selected 50% of their pairwise data as the training observations. There are other ways to select the training data. Selecting the training data by randomly picking 20% of run days would allow the validation data to be compared to respirable mass without losing information, unlike the method conducted in this study where regression equations were applied to both the validation method and calibration method. There are more extensive methods to cross-validate data to determine how well a linear regression model predicts values, such as the exhaustive cross-validation (Browne, 2000), and may be looked into in future studies to determine if using better selection criteria for training data will yield more reliable results.

Using methods provided in this study, relationships between inhalable mass concentrations and Dylos DC1100 were not established. For both the physical property method and the regression method, the DC1100 had very low slopes (< 0.14) and the average percent bias was greater than 78%. Further testing should be conducted to determine a way to convert $DC1100_{large,RAW}$ to compare with inhalable mass. One possible idea that has not be tested is to use the relationship between $DC1100_{small,RAW}$ and $DC1100_{large,RAW}$ to assess the relationship between respirable and inhalable mass concentration. In reality, getting the large particles from the DC1100 to meet comparison criteria is unlikely.

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There are many ways a low-cost DRI can be used in industry. Having a way to determine respirable mass can be a valuable tool for agricultural workers to visibly identify areas of concern. Using a DC1100 can allow for real-time understanding of high exposures to warn workers to take precautions such as personal protective equipment (respirator) or to open ventilation systems. Many CAFOs use technologies that control heating and ventilation to create optimal living conditions for the animals. A DRI could be integrated into the system, along with an engineering control for dust, to regulate the amount of airborne contaminates present. Another potential use for DRIs is tracking dust levels over time, which can give the farmer more information about the status of the barn and the activity inside, such as whether cleaning is necessary. The DC1100 provides the ability to test for airborne particle concentrations with minimal equipment costs ($200).

The big question is how precise does a low-cost monitor need to be to make informed decisions based on its output. The tradeoff of cost for low-cost instruments is performance, however for use in occupational settings will the performance be enough to make sound judgements based on real-time information. This argument is aimed at the user of the low-cost instruments. If they feel that the device will give them enough information to make a sound decision, and this decision would not be different if they were to use an higher-cost instrument, in can be concluded that the low-cost device is sufficient for use in that setting.

Limitations

There are several limitations to using the DC1100 counter for determining mass concentration. Both the DC1100 and the reference pDR-1200 required mass conversion methods. More testing is needed to see if the corrections are robust, therefore eliminating the need occupationally to sample with a pDR 1200 and respirable sampler.

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The DC1100 has some inherent limitations: the log interval, bin sizes, and particle size selector. The device only has a 1 minute logging interval. For application in a swine barn, the resolution may not be an issue because the environment did not change rapidly. However this could be an issue in other occupational settings where the environment does change rapidly (e.g., welding operations, construction). With set bins of small particles (0.5 – 2.5 µm) and large particles (0.5 – 10 µm), important occupational exposure cut points (respirable = $PM_{4.0}$) cannot be evaluated from the device. Having no control of the airflow or the inlet of the device does not allow for attachment of a size selector like the pDR-1200. Having an attached size selector could allow comparison, with better confidence, between many devices.

Conclusions

The Dylos DC1100 can be used in a Swine CAFO to estimate respirable mass concentrations present in farrowing barns. The DC1100 can detect airborne particles with similar accuracy to the higher-cost DRIs. Using the physical properties method provides a more reliable mass conversion than using regression method for mass conversion. Once the DC1100 particle count is converted to mass, it is a valid estimate for respirable mass present in swine CAFOs. This technology can be used in tandem with engineering controls to make smarter barn systems while providing farmers the ability to detect airborne concentrations to protect worker and swine health.

Table II - 1: Summary of Air Quality Monitoring Equipment

Contaminant	Device	Operation	Calibration
Dust, direct reading, # particles/100ft^3	Dylos 1100 (Dylos Corporation, Riverside, CA)	120-sec logging interval	-
Respirable Dust, direct-reading mg/m^3	pDR-1200 (Thermo-Electron Corp, Waltham, MA)	4.2 Lpm, 60-sec logging interval, connected to respirable dust gravimetric train, below	Bio DryCal
Respirable Dust, mg/m^3	BGI GK2.69 Cyclone with 5 µm PVC filters PVC filters	4.2 Lpm, PCXR4 pump on AC power (SKC, Eighty Four, PA)	Bios DryCal
Inhalable Dust, mg/m^3	IOM – plastic internal cassette with 5 µm PVC filters	2 Lpm, PCXR4 pump on AC power	Bios DryCal

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Table II - 2: Pairwise Comparisons for 10-minute Averaged Data

X-Sampler	Y-Sampler	Data Pairs	Average Bias %	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Slope ± Std. Error ($\mu g/m^3$)	Y Intercept ± Std. Error ($\mu g/m^3$)	r	R^2
Unadjusted Data									
pDR_{RAW}	$DC1100_{small,RAW}$	5085	--	--	--	--	--	0.92	0.85
pDR_{RAW}	$DC1100_{large,RAW}$	5085	--	--	--	--	--	0.90	0.81
$DC1100_{small,RAW}$	$DC1100_{large,RAW}$	6033	--	--	--	--	--	0.98	0.96
Method 1 – Physical Property Method									
pDR_{MC}	$DC1100_{small,MC}$	5085	-1.68	-1.72	-1.64	1.01 ± 0.01	-3.2 ± 1.8	0.85	0.72
pDR_{MC}	$DC1100_{large,MC}$	5085	-1.28	-1.31	-1.25	1.04 ± 0.01	-4.9 ± 2.0	0.83	0.68
Method 2 – Regression Method									
pDR_{MC}	$DC1100_{small,MC}$	4956	7.41	7.24	7.58	0.70 ± 0.01	45 ± 1.3	0.86	0.73
pDR_{MC}	$DC1100_{large,MC}$	4587	6.68	6.52	6.84	0.68 ± 0.01	46 ± 1.4	0.84	0.70

Table II - 3: Pairwise Comparison Table for Daily Averaged Data

X-Sampler	Y-Sampler	Data Pairs	Average Bias %	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Slope ± Std. Error ($\mu g/m^3$)	Y Intercept ± Std. Error Units ($\mu g/m^3$)	r	R^2
Method 1 – Physical Property Method									
Respirable	DC1100$_{small,MC}$	43	-3.1	-3.9	-2.3	1.1 ± 0.16	-21 ± 25	0.80	0.64
Inhalable	DC1100$_{small,MC}$	43	-81	-100	-61	0.13 ± 0.18	40 ± 18	0.75	0.57
Respirable	DC1100$_{large,MC}$	43	-1.2	-1.5	-0.85	1.1 ± 0.19	-18 ± 30	0.75	0.56
Inhalable	DC1100$_{large,MC}$	43	-81	-102	-60	0.14 ± 0.02	37 ± 19	0.75	0.57
Method 2 – Regression Method (all data)									
Respirable	DC1100$_{small,MC}$	44	3.6	2.7	4.6	0.8 ± 0.12	33 ± 19	0.78	0.62
Inhalable	DC1100$_{small,MC}$	44	-78	-98	-58	0.1 ± 0.01	75 ± 13	0.73	0.54
Respirable	DC1100$_{large,MC}$	44	3.3	2.5	4.2	0.3 ± 0.13	41 ± 20	0.74	0.54
Inhalable	DC1100$_{large,MC}$	44	-78	-98	-58	0.1 ± 0.01	77 ± 13	0.72	0.52

Table II - 4: Percent Bias in Mass Concentration Estimated with the DC1100 Using Physical proprety method (Method 1) for Different Particle Diameter Assumptions

Particle Diameter (µm)	Percent Bias			
	Dylos 1	Dylos 2	Dylos 3	Average
SDC ON				
3	-38.2	-28.4	-16.2	-27.6
4	46.5	69.6	98.5	71.6
3.6	6.8	23.7	44.7	25.1
3.4	-10.0	4.2	21.9	12.0
3.2	-25.0	-13.2	1.6	13.3
3.3	-17.7	-4.8	11.5	11.3
3.32	-16.2	-3.0	13.5	10.9
3.34	-14.7	-1.3	15.6	**10.5**
3.36	-13.2	0.5	17.7	**10.5**
3.38	-11.3	2.3	19.8	11.1
SDC OFF				
3	-34.4	-22.9	-23.2	26.9
4	55.4	82.7	82.0	73.4
3.6	13.3	33.2	32.7	26.4
3.4	-4.6	12.2	11.8	9.5
3.2	-20.4	-6.5	-6.8	11.2
3.3	-12.7	2.6	2.2	5.8
3.32	-11.1	4.5	4.1	6.6
3.28	-14.3	0.7	0.4	**5.1**
3.26	-15.9	-1.1	-1.5	6.1
All (SDC ON and SDC OFF)				
3	-37.0	-26.3	-19.0	27.4
4	49.4	74.7	91.9	72.0
3.2	-23.5	-10.6	-1.7	11.9
3.4	-8.3	7.3	17.9	11.1
3.3	-16.1	-1.9	7.8	8.6
3.32	-14.6	-0.1	9.7	**8.2**
3.34	-13.0	1.7	11.7	8.8

Bold indicates the optimized (smallest) percent bias

Table II - 5: Slope and Intercept Analysis for Regression Method (Method 2) to Find Relationship between Size and Mass Concentraions

Trials	Small Particles		Large Particles	
	Slope ($\mu g/m^3$)	Intercept ($\mu g/m^3$)	Slope ($\mu g/m^3$)	Intercept ($\mu g/m^3$)
1	0.053	48.1	0.25	50.6
2	0.055	46.9	0.25	52.5
3	0.055	44.8	0.26	49.7
4	0.054	49.1	0.25	52.6
5	0.057	43.5	0.26	49.6
Average	0.055	46.5	0.25	51.0
Standard Deviation	0.001	2.3	0.005	1.5
% Ratio (std/avg)	2.6	4.9	2.1	2.9

Table II - 6: Summary of Criteria for Equivalent Devices

	EPA PM$_{10}$ Criteria	NIOSH Criteria	DC1100 Physical Property Method		DC1100 Regression Method	
			10-min	24-hr	10-min	24-hr
Slope	1 ± 0.10	1 ± 0.10	**1.00**	**1.08**	0.70	0.70
Intercept ($\mu g/m^3$)	0 ± 5	-	-6.2	-15	42	45
r	≥ 0.97	-	0.85	0.80	0.86	0.78
% Bias	± 10	± 10	**-1.7**	**-3.1**	**7.2**	**3.6**
95% Accuracy Interval (%)	-	± 25	-	55	-	41
% of samples within ±25%	-	-	53	60	63	73

Bold values indicate criteria were met.
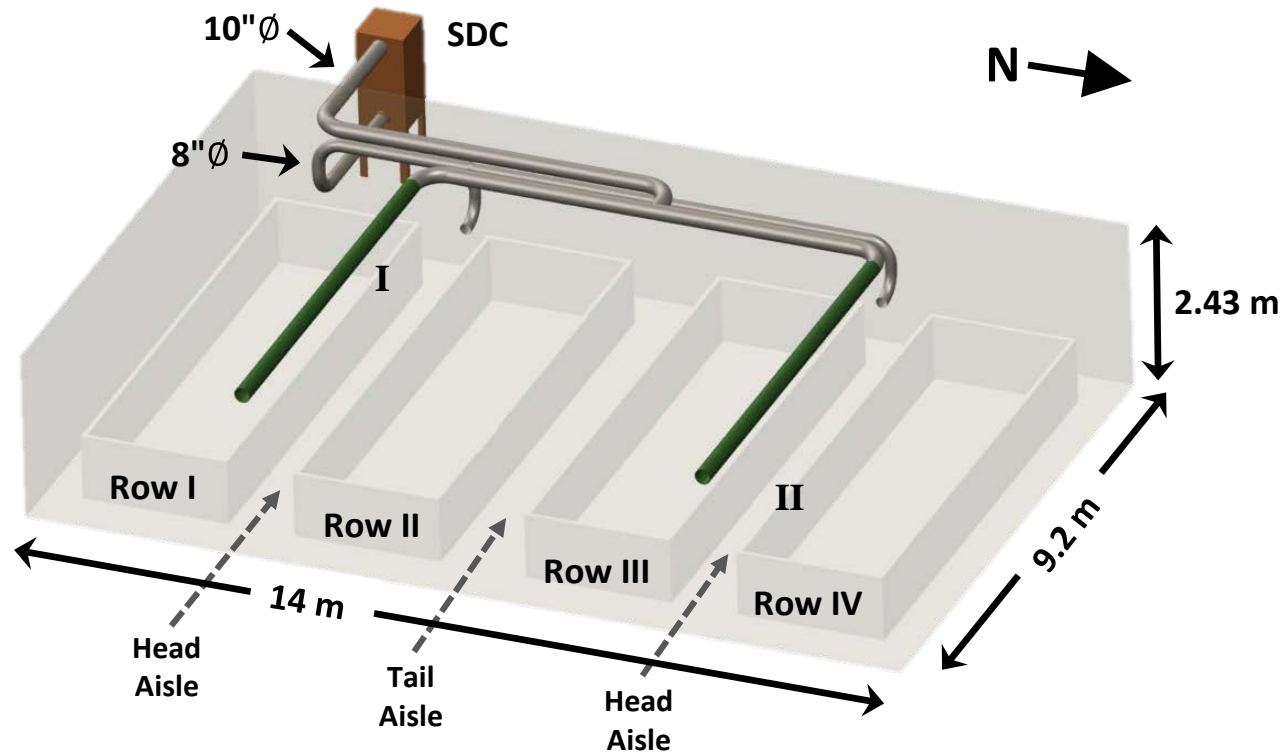
Figure II - 1: Map of farrowing room with locations of sampling. Roman numerals indicate sampling locations. Shaker Dust Collector (SDC) located outside the CAFO, with 8" duct for intake, and 10" duct for exhaust exiting fabric socks (green pipe)
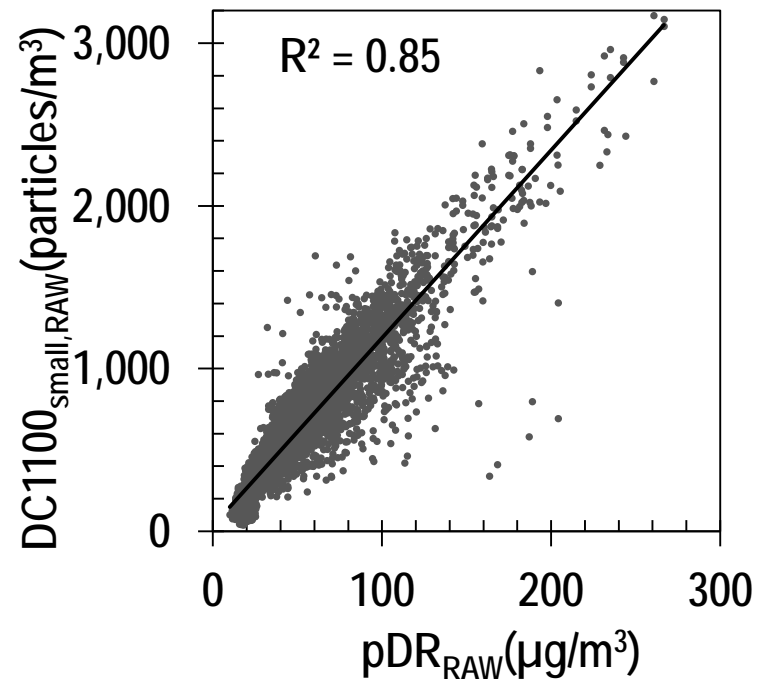
Figure II - 2: Particle number concentration measured with the DC1100 compared to uncorrected mass concentration measured with the pDR for 10-minute averaged data
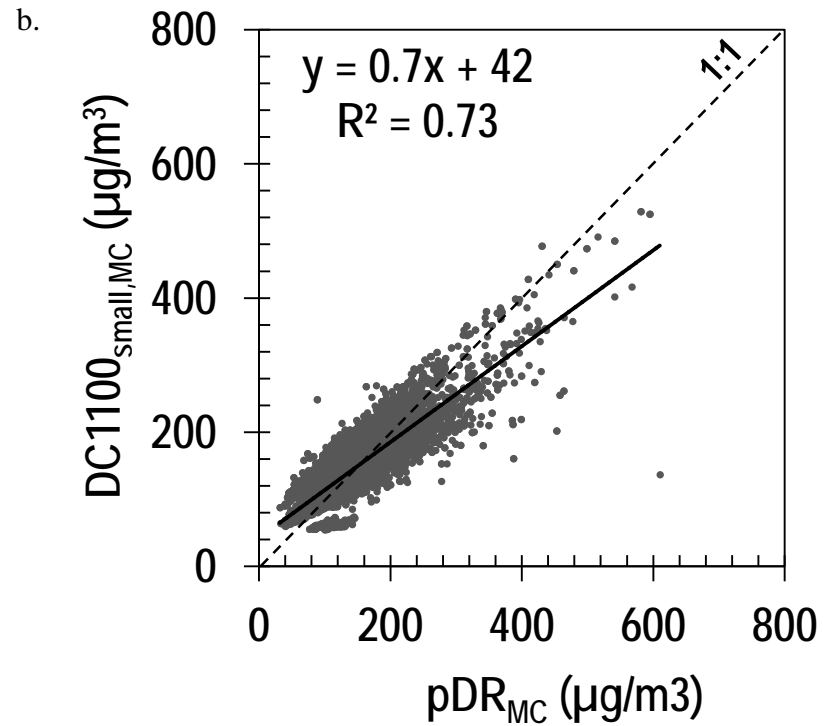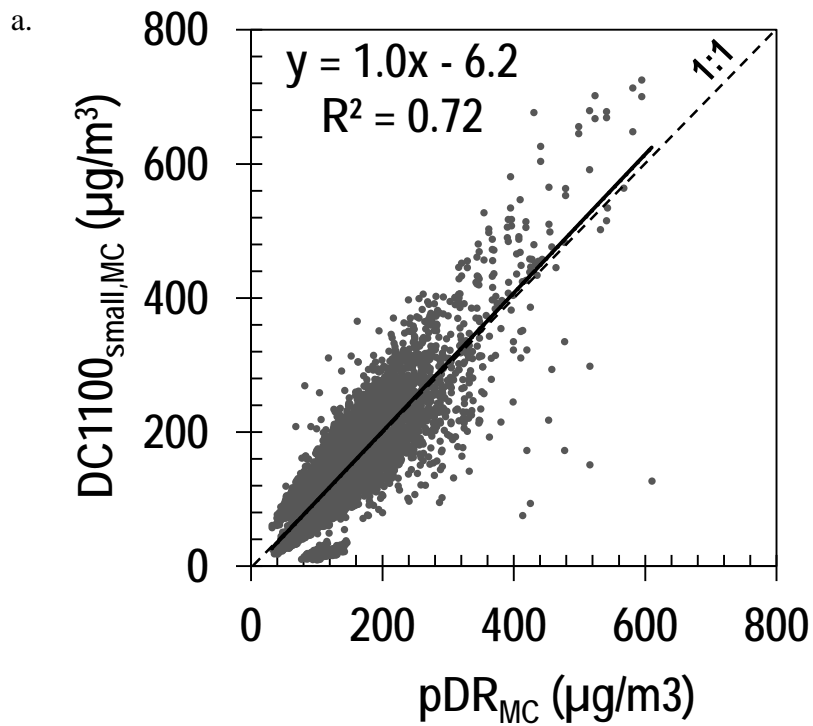
Figure II - 3: DC1100 small particle mass concentration using (a) Method 1 (Physical property method) and (b) Method 2 (Regression method) compared to respirable mass corrected pDR for 10-minute averaged data

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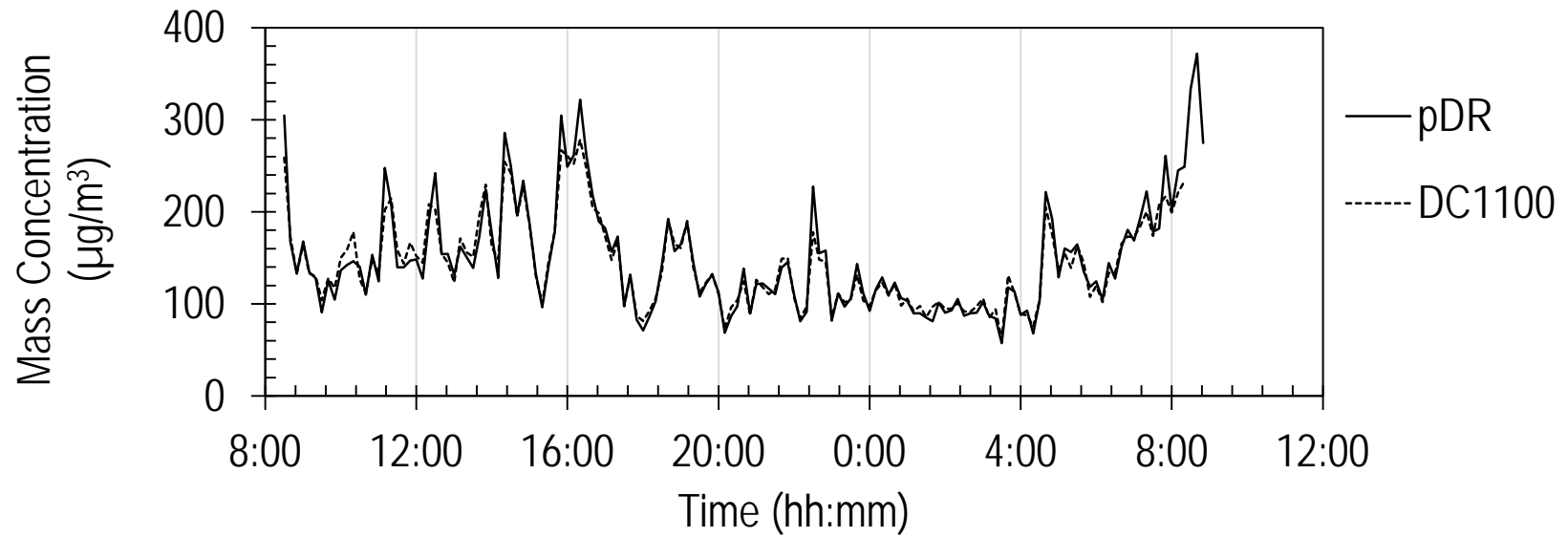
Figure II - 4 Time series plot of mass concentration DC1100 small particles using Method 1 (Physical properties method) and respirable mass corrected pDR
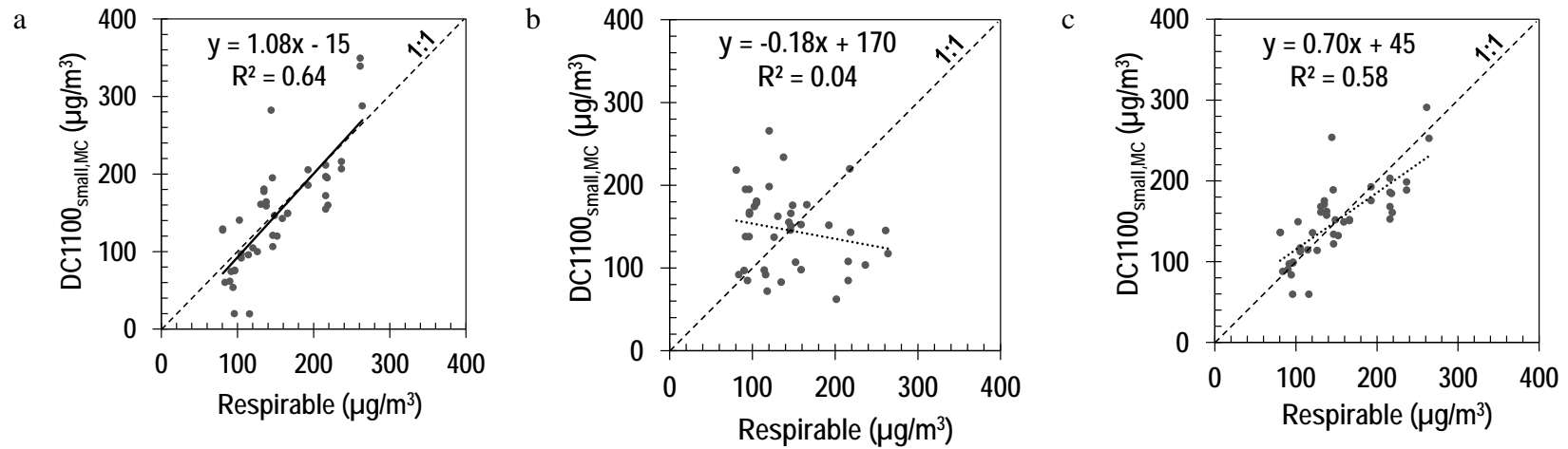
Figure II - 5: DC1100 small particle mass concentration for (a) Method 1 (Physical property method, full data), (b) Method 2 (Regression method, validation data) and (c) Method 2 (Regression method, full data) compared to respirable mass for 24-hour averaged data

CHAPTER III: CONCLUSIONS

This study evaluated the relationship between a low-cost optical particle counter (Dylos DC1100) to a higher-cost photometer (pDR-1200), and reference respirable and inhalable filters for use in a swine farrowing CAFO during winter. Two methods were used to convert particle number concentrations from the DC1100 to mass concentration: Method 1, the physical property method; Method 2, the regression method. Mass concentration estimates from the DC1100 were then compared to those measured by the respirable and inhalable samplers.

Evidence from Chapter II supports the conclusion that the number concentration of particles measured with the DC1100 scale closely with unadjusted mass concentration measured with the pDR. $DC1100_{small,RAW}$ and pDR_{RAW} had a coefficient of determination (R^2) of 0.85. This relationship between the two devices is amazing considering the DC1100 only costs $200, a fraction of the cost of a pDR ($5830). A consumer could purchase one DC1100 to obtain exposure information similar to what they would receive with a higher-cost DRI. They could also purchase many DC1100s and obtain a more information about the dust distributions in an area while still saving money when compared to purchasing one pDR-1200.

Method 1 (Physical property method) converted DC1100 number to mass concentration and provided the closest agreement to filter-based respirable samplers, although Method 2 (regression method) provided reasonable estimates. The linear regression of $DC1100_{small,MC}$ using the physical property method with respirable mass concentrations had a slope of 1.10, an intercept of -21 µg/m³ and a Pearson correlation (r) of 0.78, and an average bias of 3.63. Similar results were obtained for the regression method, except that the slope was 0.70, indicating an underestimation of respirable mass concentration. EPA's PM10 criteria for establishing an equivalent device states the best-fit line needs to have a slope of 1 ± 0.1, y-intercept of 0 ± 5,

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Pearson correlation (r) ≥ 0.97, and average bias ≤ 10%. The physical property method for mass conversion on the DC1100 satisfies the slope and average bias between the respirable filter, and the regression method only satisfies the average bias. Although the EPA cannot consider the DC1100 an equivalent device, it matches respirable mass collected on the filters very well. The physical property method is preferred over the regression method, but testing for airborne particle density and diameter should be conducted. This testing is associated with more costs, while the regression method only needs one higher-cost device to be collocated for a period of time. Occupationally, this can be used as an estimate for identifying areas where regulatory limits may be exceeded. Although the DC1100 cannot determine with confidence that employees are safe in a certain area, it will give a reasonable estimate as to the airborne respirable mass present.

This project was a good learning experience for me. The research was out of my field of expertise so there was sharp learning curve of knowledge that was necessary to learn about occupational exposures and agricultural health. I was able to apply my engineering knowledge to many facets of this project. I designed the ventilation system that was installed, both conceptually and using 3D modeling techniques. I 3D-printed a cover to prevent moisture from accumulating over the heaters that were present in the swine CAFO. I also helped design a way to mount the instruments at the sampling locations to ensure that there would be no risk of them falling inside the swine's pens.

Future studies need to be conducted to validate the DC1100 for use in other occupational settings. Testing correction factors that were established in this study to see if once applied to new DC1100 measurements, similar values could be recorded on a pDR and respirable filter in a farrowing room. Testing for physical properties (density and particle diameter) of the aerosol can

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be beneficial to creating new correction factors in any environment. Due to its simplicity and cost, the DC1100 has significant potential for many occupational settings. Methods for mass converting DC1100 large particles relationally to inhalable mass should be explored. With the availability of even lower cost instruments (<$50), understanding ways to convert raw measurements into mass concentrations can help sites stay below regulatory limits with minimal costs for testing.

APPENDIX A: MATLAB CODE

Matlab code for processing raw data from all devices into an organized form is presented. To get paired information and pairwise graphs use the following files in order; Read Raw Data, Identify Date Range, Time Averaging, and Plot Data. This will give both EPA stats for all comparisons shown in the graphs that are presented. At beginning of Plot Data file there is options to change method and what graphs are shown, by simply changing from a 1 (show info) to a 0 (do not show info). To get time series plots use following files in order; Read Raw Data, Identify Date Range, Time Series Plot. To change day, the first seven lines must be changed to be the same day (example: a = dtDylos_A_APC2, b = dtDylos_APC2), and lines 45 and 46 must be changed to read in the correct respirable mass (rA(#,1)).

Read Raw Data

```matlab
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%  Title:  Read Raw Data                       %%%%%
%%%%%  Author: Sam Jones & Sinan Sousan            %%%%%
%%%%%  Date:  December 30, 2014 - February 4, 2015     %%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clc
clear all

%USER INPUT
%Input Directory
%Location of Dylos A Raw Data
inDirDylosA = 'M:\General Research
Directory\102Peters\People\Sam\MatLab\Dylos\A';
%Location of Dylos F1 Raw Data
inDirDylosF1 = 'M:\General Research
Directory\102Peters\People\Sam\MatLab\Dylos\F1';
%Location of Dylos F2 Raw Data
inDirDylosF2 = 'M:\General Research
Directory\102Peters\People\Sam\MatLab\Dylos\F2';
%Location of pDR A Raw Data
inDirPDRA = 'M:\General Research
Directory\102Peters\People\Sam\MatLab\pDR\pDR_A';
%Location of pDR F Raw Data
inDirPDRF = 'M:\General Research
Directory\102Peters\People\Sam\MatLab\pDR\pDR_F';
%Location of Gravemetric Respriable Raw Data
inDir1 = 'M:\General Research
Directory\102Peters\People\Sam\MatLab\Gravemetric\Respriable';
%Location of Gravemetric Inhailable Raw Data
inDir2 = 'M:\General Research
Directory\102Peters\People\Sam\MatLab\Gravemetric\Inhailable';
%Location of Collocation pDR data
inDir3 = 'M:\General Research Directory\102Peters\People\Sam\MatLab\pDR';


%%%%%%%%%%%%%%%%%%%%%% Start Dylos Data Gathering %%%%%%%%%%%%%%%%%%%%%%%%%
dirList = getAllFiles(inDirDylosA);

onlyCSVName = dirList(~cellfun(@isempty,(regexp(dirList,'\.CSV$'))));
DateTime_dylosA   = [];
Temperature_dylosA  = [];
Pressure_dylosA   = [];
DylosSmall_dylosA  = [];
DylosLarge_dylosA  = [];
SharpV_dylosA    = [];

for i = 1: size(onlyCSVName)

  newDataCheck = importdata(char(onlyCSVName(i)), ',');
  if(~isempty(newDataCheck) )
```

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```matlab
        fid = fopen(char(onlyCSVName(i)));
        newData = textscan(fid,'%s %f %f %f %f %f',...
'delimiter',',','headerLines', 1);
        k = strfind(onlyCSVName(i), '\');
        strtemp = char(onlyCSVName(i));
        strSite = strtemp(k{1,1}(length(k{1:1})-1)+1:k{1,1}(length(k{1:1}))-1);
        DateTime_dylosA     = vertcat(DateTime_dylosA,(newData{:,7}));
        Temperature_dylosA  = vertcat(Temperature_dylosA,newData{:,2});
        Pressure_dylosA     = vertcat(Pressure_dylosA,newData{:,3});
        DylosSmall_dylosA   = vertcat(DylosSmall_dylosA,newData{:,4});
        DylosLarge_dylosA   = vertcat(DylosLarge_dylosA,newData{:,5});
        SharpV_dylosA       = vertcat(SharpV_dylosA,newData{:,6});
         fclose(fid);
    end
end


Date1= '01/01/2000 00:00:00';
Date2= '01/01/2000 00:02:00';
Dateadj= datenum(Date2)-datenum(Date1);
DateTime_dylosA = DateTime_dylosA - Dateadj;
clear x y
x = find(DylosSmall_dylosA <= 0);
DylosSmall_dylosA(x)= NaN;
y = find(DylosLarge_dylosA <= 0);
DylosLarge_dylosA(x)= NaN;
%End Dylos A Data Gathering



dirList = getAllFiles(inDirDylosF1);

onlyCSVName = dirList(~cellfun(@isempty,(regexp(dirList,'\.CSV$'))));
DateTime_dylosF1   = [];
Temperature_dylosF1  = [];
Pressure_dylosF1   = [];
DylosSmall_dylosF1  = [];
DylosLarge_dylosF1  = [];
SharpV_dylosF1    = [];

for i = 1: size(onlyCSVName)

  newDataCheck = importdata(char(onlyCSVName(i)), ',');
  if(~isempty(newDataCheck) )

        fid = fopen(char(onlyCSVName(i)));
        newData = textscan(fid,'%s %f %f %f %f %f',...
'delimiter',',','headerLines', 1);
        k = strfind(onlyCSVName(i), '\');
        strtemp = char(onlyCSVName(i));
        strSite = strtemp(k{1,1}(length(k{1:1})-1)+1:k{1,1}(length(k{1:1}))-1);
        DateTime_dylosF1     = vertcat(DateTime_dylosF1,(newData{:,7}));
        Temperature_dylosF1   = vertcat(Temperature_dylosF1,newData{:,2});
        Pressure_dylosF1     = vertcat(Pressure_dylosF1,newData{:,3});
        DylosSmall_dylosF1   = vertcat(DylosSmall_dylosF1,newData{:,4});
        DylosLarge_dylosF1   = vertcat(DylosLarge_dylosF1,newData{:,5});
```

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```matlab
        SharpV_dylosF1          = vertcat(SharpV_dylosF1,newData{:,6});
        fclose(fid);
    end
end


clear x y
x = find(DylosSmall_dylosF1 <= 0);
DylosSmall_dylosF1(x)= NaN;
y = find(DylosLarge_dylosF1 <= 0);
DylosLarge_dylosF1(x)= NaN;

%End Dylos F1 Data Gathering

dirList = getAllFiles(inDirDylosF2);

onlyCSVName = dirList(~cellfun(@isempty,(regexp(dirList,'\.CSV$'))));
DateTime_dylosF2   = [];
Temperature_dylosF2  = [];
Pressure_dylosF2   = [];
DylosSmall_dylosF2  = [];
DylosLarge_dylosF2  = [];
SharpV_dylosF2    = [];

for i = 1: size(onlyCSVName)

  newDataCheck = importdata(char(onlyCSVName(i)), ',');
  if(~isempty(newDataCheck) )

      fid = fopen(char(onlyCSVName(i)));
      newData = textscan(fid,'%s %f %f %f %f %f %f',
'delimiter',',','headerLines', 1);
      k = strfind(onlyCSVName(i), '\');
      strtemp = char(onlyCSVName(i));
      strSite = strtemp(k{1,1}(length(k{1:1})-1)+1:k{1,1}(length(k{1:1}))-1);
      DateTime_dylosF2     = vertcat(DateTime_dylosF2,(newData{:,7}));
      Temperature_dylosF2    = vertcat(Temperature_dylosF2,newData{:,2});
      Pressure_dylosF2     = vertcat(Pressure_dylosF2,newData{:,3});
      DylosSmall_dylosF2    = vertcat(DylosSmall_dylosF2,newData{:,4});
      DylosLarge_dylosF2    = vertcat(DylosLarge_dylosF2,newData{:,5});
      SharpV_dylosF2       = vertcat(SharpV_dylosF2,newData{:,6});
       fclose(fid);
  end
end


clear x y
x = find(DylosSmall_dylosF2 <= 0);
DylosSmall_dylosF2(x)= NaN;
y = find(DylosLarge_dylosF2 <= 0);
DylosLarge_dylosF2(x)= NaN;

%End Dylos F2 Data Gathering

%%%%%%%%%%%%%%%%%%%%%%%%Start pDR Data Gathering%%%%%%%%%%%%%%%%%%%%%%%%%%%%

dirList = getAllFiles(inDirPDRA);
```

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```matlab
onlyCSVName = dirList(~cellfun(@isempty,(regexp(dirList,'\.CSV$'))));
Point_pDRA     = [];
pDate_pDRA     = [];
pTime_pDRA     = [];
pDRconc_pDRA   = [];
DateTime_pDRA  = [];

for i = 1: size(onlyCSVName)

  newDataCheck = importdata(char(onlyCSVName(i)), ',');
  if(~isempty(newDataCheck) )

      fid = fopen(char(onlyCSVName(i)));
      newData = textscan(fid,'%d %s %s %f %f', 'delimiter',',','headerLines',
16);
      k = strfind(onlyCSVName(i), '\');
      strtemp = char(onlyCSVName(i));
      strSite = strtemp(k{1,1}(length(k{1:1})-1)+1:k{1,1}(length(k{1:1}))-1);
      Point_pDRA    = vertcat(Point_pDRA,newData{:,1});
      pDate_pDRA    = vertcat(pDate_pDRA,newData{:,2});
      pTime_pDRA    = vertcat(pTime_pDRA,newData{:,3});
      pDRconc_pDRA  = vertcat(pDRconc_pDRA,newData{:,4});
      DateTime_pDRA  = vertcat(DateTime_pDRA,newData{:,5});
       fclose(fid);
  end
end

%DateTime_pDRA = datenum(strcat(pDate_pDRA,', ',pTime_pDRA));

%End pDR A Data Gathering

dirList = getAllFiles(inDirPDRF);

onlyCSVName = dirList(~cellfun(@isempty,(regexp(dirList,'\.CSV$'))));
Point_pDRF     = [];
pDate_pDRF     = [];
pTime_pDRF     = [];
pDRconc_pDRF   = [];
DateTime_pDRF  = [];

for i = 1: size(onlyCSVName)

  newDataCheck = importdata(char(onlyCSVName(i)), ',');
  if(~isempty(newDataCheck) )

      fid = fopen(char(onlyCSVName(i)));
      newData = textscan(fid,'%d %s %s %f %f', 'delimiter',',','headerLines',
16);
      k = strfind(onlyCSVName(i), '\');
      strtemp = char(onlyCSVName(i));
      strSite = strtemp(k{1,1}(length(k{1:1})-1)+1:k{1,1}(length(k{1:1}))-1);
      Point_pDRF    = vertcat(Point_pDRF,newData{:,1});
      pDate_pDRF    = vertcat(pDate_pDRF,newData{:,2});
      pTime_pDRF    = vertcat(pTime_pDRF,newData{:,3});
```

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```matlab
        pDRconc_pDRF    = vertcat(pDRconc_pDRF,newData{:,4});
        DateTime_pDRF   = vertcat(DateTime_pDRF,newData{:,5});
         fclose(fid);
    end
end

%DateTime_pDRF = datenum(strcat(pDate_pDRF,', ',pTime_pDRF));

%End pDR F Data Gathering

%%%%%%%%%%%%%%Start Gravemetric Respirable Data Gathering%%%%%%%%%%%%%%%%%

dirList = getAllFiles(inDir1);

onlyCSVName = dirList(~cellfun(@isempty,(regexp(dirList,'\.csv$'))));
rDate    = [];
rA       = [];
rB       = [];
rC       = [];
rD       = [];
rE       = [];
rF       = [];


for i = 1: size(onlyCSVName)

  newDataCheck = importdata(char(onlyCSVName(i)), ',');
  if(~isempty(newDataCheck) )

      fid = fopen(char(onlyCSVName(i)));
      newData = textscan(fid,'%s %f %f %f %f %f %f',
'delimiter',',','headerLines', 1);
      k = strfind(onlyCSVName(i), '\');
      strtemp = char(onlyCSVName(i));
      strSite = strtemp(k{1,1}(length(k{1:1})-1)+1:k{1,1}(length(k{1:1}))-1);
      rDate   = vertcat(rDate,newData{:,1});
      rA      = vertcat(rA,newData{:,2})*1000; %convert mg to ug
      rB      = vertcat(rB,newData{:,3})*1000;
      rC      = vertcat(rC,newData{:,4})*1000;
      rD      = vertcat(rD,newData{:,5})*1000;
      rE      = vertcat(rE,newData{:,6})*1000;
      rF      = vertcat(rF,newData{:,7})*1000;
       fclose(fid);
  end
end %End Respirable Data Gathering

%%%%%%%%%%%%%%Start Gravemetric Inhaiable Raw Data Gathering%%%%%%%%%%%%%%%%

dirList = getAllFiles(inDir2);

onlyCSVName = dirList(~cellfun(@isempty,(regexp(dirList,'\.csv$'))));
iDate    = [];
iA       = [];
iB       = [];
```

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```matlab
iC      = [];
iD      = [];
iE      = [];
iF      = [];


for i = 1: size(onlyCSVName)

  newDataCheck = importdata(char(onlyCSVName(i)), ',');
  if(~isempty(newDataCheck) )

      fid = fopen(char(onlyCSVName(i)));
      newData = textscan(fid,'%s %f %f %f %f %f %f',
'delimiter',',','headerLines', 1);
      k = strfind(onlyCSVName(i), '\');
      strtemp = char(onlyCSVName(i));
      strSite = strtemp(k{1,1}(length(k{1:1})-1)+1:k{1,1}(length(k{1:1}))-1);
      iDate   = vertcat(iDate,newData{:,1});
      iA      = vertcat(iA,newData{:,2})*1000; %convert mg to ug
      iB      = vertcat(iB,newData{:,3})*1000;
      iC      = vertcat(iC,newData{:,4})*1000;
      iD      = vertcat(iD,newData{:,5})*1000;
      iE      = vertcat(iE,newData{:,6})*1000;
      iF      = vertcat(iF,newData{:,7})*1000;
       fclose(fid);
  end
end

%%%%%%%%%%%% Start Raw pDR Collocation Data %%%%%%%%%%%%%%%%%

dirList = getAllFiles(inDir3);

onlyCSVName = dirList(~cellfun(@isempty,(regexp(dirList,'\.csv$'))));
cA      = [];
cB      = [];
cC      = [];
cD      = [];
cE      = [];
cF      = [];


for i = 1: size(onlyCSVName)

  newDataCheck = importdata(char(onlyCSVName(i)), ',');
  if(~isempty(newDataCheck) )

      fid = fopen(char(onlyCSVName(i)));
      newData = textscan(fid,'%f %f %f %f %f %f',
'delimiter',',','headerLines', 1);
      k = strfind(onlyCSVName(i), '\');
      strtemp = char(onlyCSVName(i));
      strSite = strtemp(k{1,1}(length(k{1:1})-1)+1:k{1,1}(length(k{1:1}))-1);
      cA      = vertcat(cA,newData{:,1});
      cB      = vertcat(cB,newData{:,2});
      cC      = vertcat(cC,newData{:,3});
```

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```matlab
        cD      = vertcat(cD,newData{:,4});
        cE      = vertcat(cE,newData{:,5});
        cF      = vertcat(cF,newData{:,6});
         fclose(fid);
    end
end

%Converts Time numbers in Excel to Matlab time
DateTime_dylosA = DateTime_dylosA + 693960;
DateTime_dylosF1 = DateTime_dylosF1 + 693960;
DateTime_dylosF2 = DateTime_dylosF2 + 693960;
DateTime_pDRA = DateTime_pDRA + 693960;
DateTime_pDRF = DateTime_pDRF + 693960;
```

Identify Date Range

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%  Title:  Identify Date Range                  %%%%%
%%%%%  Author: Sam Jones & Sinan Sousan             %%%%%
%%%%%  Date:  December 30, 2014 - February 4, 2015        %%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


%%% APC 1 %%%
clear Date1 Date2 date1num date2num
Date1 = '12/21/2013 8:30:00';
Date2 = '12/22/2013 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/02/2000 08:56:00');
APC1_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC1_F1_adjust;
date4num = date2num - APC1_F1_adjust;

dtDylos_A_APC1 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC1 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC1 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC1 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC1 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC1 = Date1;
finaltime_APC1 = Date2;


%%% APC 2 %%%
clear Date1 Date2 date1num date2num
Date1 = '12/26/2013 8:30:00';
Date2 = '12/27/2013 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/02/2000 00:00:00');
APC2_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC2_F1_adjust;
date4num = date2num - APC2_F1_adjust;

dtDylos_A_APC2 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC2 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC2 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC2 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC2 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC2 = Date1;
finaltime_APC2 = Date2;
```

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```matlab
%%% APC 3 %%%
clear Date1 Date2 date1num date2num
Date1 = '12/31/2013 8:30:00';
Date2 = '01/01/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/02/2000 11:50:00');
APC3_F1_adjust = APCF1_2 - APCF1_1;
date3num = date1num - APC3_F1_adjust;
date4num = date2num - APC3_F1_adjust;

dtDylos_A_APC3 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC3 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC3 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC3 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC3 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC3 = Date1;
finaltime_APC3 = Date2;

%%% APC 4 %%%
clear Date1 Date2 date1num date2num
Date1 = '01/10/2014 8:30:00';
Date2 = '01/11/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/03/2000 07:00:00');
APC4_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC4_F1_adjust;
date4num = date2num - APC4_F1_adjust;

dtDylos_A_APC4 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC4 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC4 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC4 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC4 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC4 = Date1;
finaltime_APC4 = Date2;

%%% APC 5 %%%
clear Date1 Date2 date1num date2num
Date1 = '01/17/2014 8:30:00';
Date2 = '01/18/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/03/2000 08:36:00');
APC5_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC5_F1_adjust;
```

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```matlab
date4num = date2num - APC5_F1_adjust;

dtDylos_A_APC5 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC5 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC5 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC5 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC5 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC5 = Date1;
finaltime_APC5 = Date2;


%%% APC 6 %%%
clear Date1 Date2 date1num date2num
Date1 = '01/20/2014 8:30:00';
Date2 = '01/21/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/03/2000 08:55:00');
APC6_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC6_F1_adjust;
date4num = date2num - APC6_F1_adjust;

dtDylos_A_APC6 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC6 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC6 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC6 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC6 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC6 = Date1;
finaltime_APC6 = Date2;


%%% APC 7 %%%
clear Date1 Date2 date1num date2num
Date1 = '01/28/2014 8:30:00';
Date2 = '01/29/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/03/2000 01:36:00');
APC7_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC7_F1_adjust;
date4num = date2num - APC7_F1_adjust;

dtDylos_A_APC7 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC7 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC7 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC7 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC7 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
```

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```matlab
initialtime_APC7 = Date1;
finaltime_APC7 = Date2;


%%% APC 8 %%%
clear Date1 Date2 date1num date2num
Date1 = '02/03/2014 8:30:00';
Date2 = '02/04/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/05/2000 00:50:00');
APC8_F1_adjust = APCF1_2 - APCF1_1;
date3num = date1num - APC8_F1_adjust;
date4num = date2num - APC8_F1_adjust;

dtDylos_A_APC8 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC8 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC8 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC8 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC8 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC8 = Date1;
finaltime_APC8 = Date2;


%%% APC 9 %%%
clear Date1 Date2 date1num date2num
Date1 = '02/10/2014 8:30:00';
Date2 = '02/11/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/05/2000 03:07:00');
APC9_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC9_F1_adjust;
date4num = date2num - APC9_F1_adjust;

dtDylos_A_APC9 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC9 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC9 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC9 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC9 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC9 = Date1;
finaltime_APC9 = Date2;


%%% APC 10 %%%
clear Date1 Date2 date1num date2num
Date1 = '02/17/2014 8:30:00';
Date2 = '02/18/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
```

```matlab
APCF1_2 = datenum('01/06/2000 00:45:00');
APC10_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC10_F1_adjust;
date4num = date2num - APC10_F1_adjust;

dtDylos_A_APC10 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC10 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC10 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC10 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC10 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC10 = Date1;
finaltime_APC10 = Date2;


%%% APC 11 %%%
clear Date1 Date2 date1num date2num
Date1 = '02/24/2014 8:30:00';
Date2 = '02/25/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/06/2000 01:06:00');
APC11_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - APC11_F1_adjust;
date4num = date2num - APC11_F1_adjust;

dtDylos_A_APC11 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_APC11 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_APC11 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_APC11 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_APC11 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_APC11 = Date1;
finaltime_APC11 = Date2;


%%% B1 %%%
clear Date1 Date2 date1num date2num
Date1 = '12/13/2013 8:30:00';
Date2 = '12/14/2013 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
Date5 = '01/01/2000 12:00:00';
Date6 = '01/01/2000 01:00:00';
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/02/2000 09:06:00');
B1_F1_adjust = APCF1_2 - APCF1_1;
date3num = date1num - B1_F1_adjust;
date4num = date2num - B1_F1_adjust;

dtDylos_A_B1 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
```

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```matlab
dtDylos_F1_B1 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_B1 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_B1 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_B1 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_B1 = Date1;
finaltime_B1 = Date2;


%%% B2 %%%
clear Date1 Date2 date1num date2num
Date1 = '12/16/2013 8:30:00';
Date2 = '12/17/2013 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/02/2000 08:40:00');
B2_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - B2_F1_adjust;
date4num = date2num - B2_F1_adjust;

dtDylos_A_B2 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_B2 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_B2 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_B2 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_B2 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_B2 = Date1;
finaltime_B2 = Date2;


%%% B3 %%%
clear Date1 Date2 date1num date2num
Date1 = '12/18/2013 8:30:00';
Date2 = '12/19/2013 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/02/2000 08:44:00');
B3_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - B3_F1_adjust;
date4num = date2num - B3_F1_adjust;

dtDylos_A_B3 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_B3 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_B3 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_B3 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_B3 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_B3 = Date1;
finaltime_B3 = Date2;


%%% P1 %%%
```

```matlab
clear Date1 Date2 date1num date2num
Date1 = '01/22/2014 8:30:00';
Date2 = '01/23/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/03/2000 09:10:00');
P1_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - P1_F1_adjust;
date4num = date2num - P1_F1_adjust;

dtDylos_A_P1 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_P1 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_P1 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_P1 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_P1 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_P1 = Date1;
finaltime_P1 = Date2;

%%% P2 %%%
clear Date1 Date2 date1num date2num
Date1 = '01/24/2014 8:30:00';
Date2 = '01/25/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/03/2000 09:46:00');
P2_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - P2_F1_adjust;
date4num = date2num - P2_F1_adjust;

dtDylos_A_P2 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_P2 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_P2 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_P2 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_P2 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_P2 = Date1;
finaltime_P2 = Date2;

%%% P3 %%%
clear Date1 Date2 date1num date2num
Date1 = '01/26/2014 8:30:00';
Date2 = '01/27/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/03/2000 09:49:00');
P3_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - P3_F1_adjust;
date4num = date2num - P3_F1_adjust;
```

```matlab
dtDylos_A_P3 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_P3 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_P3 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_P3 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_P3 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_P3 = Date1;
finaltime_P3 = Date2;

%%% P4 %%%
clear Date1 Date2 date1num date2num
Date1 = '02/26/2014 8:30:00';
Date2 = '02/27/2014 9:00:00';
date1num = datenum(Date1);
date2num = datenum(Date2);
APCF1_1 = datenum('01/01/2000 00:00:00');
APCF1_2 = datenum('01/06/2000 01:14:00');
P4_F1_adjust = APCF1_2 - APCF1_1;
date3num =date1num - P4_F1_adjust;
date4num = date2num - P4_F1_adjust;

dtDylos_A_P4 = find(DateTime_dylosA >= date1num & DateTime_dylosA <=
date2num);
dtDylos_F1_P4 = find(DateTime_dylosF1 >= date3num & DateTime_dylosF1 <=
date4num);
dtDylos_F2_P4 = find(DateTime_dylosF2 >= date1num & DateTime_dylosF2 <=
date2num);
dtpDR_A_P4 = find(DateTime_pDRA >= date1num & DateTime_pDRA <= date2num);
dtpDR_F_P4 = find(DateTime_pDRF >= date1num & DateTime_pDRF <= date2num);
initialtime_P4 = Date1;
finaltime_P4 = Date2;
```

Time Averaging

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%  Title:  Time Averaging                      %%%%%
%%%%%  Author: Sam Jones & Sinan Sousan             %%%%%
%%%%%  Date:  December 30, 2014 - February 4, 2015        %%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


APC_ON = 1;
APC_OFF = 1;



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%       Call Varaibles     %%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


clear pDRtimeAvg_A DylosSmalltimeAvg_A DylosLargetimeAvg_A DateTimeAll Date1
Date2
clear pDRtimeAvg_F DylosSmalltimeAvg_F1 DylosLargetimeAvg_F1
clear pDRtimeAvg_F DylosSmalltimeAvg_F2 DylosLargetimeAvg_F2


j=1;


Date1 = '01/01/2000 00:00:00';
Date2 = '01/01/2000 00:10:00'; %Change interval to change size of average
TimeAdj = datenum(Date2)-datenum(Date1);


pDRtimeAvg_A          = [];
pDRtimeAvg_A_MassC      = [];
DylosSmalltimeAvg_A     = [];
DylosLargetimeAvg_A     = [];
pDRtimeAvg_F          = [];
pDRtimeAvg_F_MassC      = [];
DylosSmalltimeAvg_F1     = [];
DylosLargetimeAvg_F1     = [];
DylosSmalltimeAvg_F2     = [];
DylosLargetimeAvg_F2     = [];


DailyAvg_pDR_A        = [];
DailyAvg_pDR_A_MassC     = [];
DailyAvg_DylosSmall_A    = [];
DailyAvg_DylosLarge_A    = [];
DailyAvg_pDR_F        = [];
DailyAvg_pDR_F_MassC     = [];
DailyAvg_DylosSmall_F1    = [];
DailyAvg_DylosLarge_F1    = [];
DailyAvg_DylosSmall_F2    = [];
DailyAvg_DylosLarge_F2    = [];


if(APC_ON)

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%       APC1          %%%%%%%%%%%%%%%%%%%%
```

```matlab
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

 a = dtDylos_A_APC1;
 b = dtpDR_A_APC1;
 c = dtDylos_F1_APC1;
 d = dtDylos_F2_APC1;
 e = dtpDR_F_APC1;

 initialtime = datenum(initialtime_APC1);
 finaltime  = datenum(finaltime_APC1);
 Time_adjust = APC1_F1_adjust;

 DateTimedylos_A_new   = DateTime_dylosA(a);
 DylosSmall_A_new      = DylosSmall_dylosA(a);
 DylosLarge_A_new      = DylosLarge_dylosA(a);
 DateTimepDR_A_new      = DateTime_pDRA(b);
 pDRconc_A_new          = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3

 DateTimedylos_F1_new   = DateTime_dylosF1(c);
 DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
 DylosSmall_F1_new      = DylosSmall_dylosF1(c);
 DylosLarge_F1_new      = DylosLarge_dylosF1(c);
 DateTimepDR_F_new      = DateTime_pDRF(e);
 pDRconc_F_new          = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3

 DateTimedylos_F2_new   = DateTime_dylosF2(d);
 DylosSmall_F2_new      = DylosSmall_dylosF2(d);
 DylosLarge_F2_new      = DylosLarge_dylosF2(d);

 pDR_A_conversion = rA(4,1)/(nanmean(pDRconc_A_new)); % Respirable Mass/Mean
raw pDR
 pDR_F_conversion = rF(4,1)/(nanmean(pDRconc_F_new));
 Resp_A(4) = rA(4,1);
 Resp_F(4) = rF(4,1);
 Inh_A(4) = iA(4,1);
 Inh_F(4) = iF(4,1);

 DailyAvg_pDR_A_MassC(4)  = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
 DailyAvg_pDR_A(4)        = nanmean(pDRconc_A_new);
 DailyAvg_DylosSmall_A(4)   = nanmean(DylosSmall_A_new);
 DailyAvg_DylosLarge_A(4)   = nanmean(DylosLarge_A_new);
 DailyAvg_pDR_F_MassC(4)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
 DailyAvg_pDR_F(4)        = nanmean(pDRconc_F_new);
 DailyAvg_DylosSmall_F1(4)  = nanmean(DylosSmall_F1_new);
 DailyAvg_DylosLarge_F1(4)  = nanmean(DylosLarge_F1_new);
 DailyAvg_DylosSmall_F2(4)  = nanmean(DylosSmall_F2_new);
```

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```matlab
    DailyAvg_DylosLarge_F2(4)  = nanmean(DylosLarge_F2_new);

%%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  for i=initialtime:TimeAdj:finaltime
    x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
    y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);

    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%        APC2         %%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_APC2;
  b = dtpDR_A_APC2;
  c = dtDylos_F1_APC2;
  d = dtDylos_F2_APC2;
  e = dtpDR_F_APC2;

  initialtime = datenum(initialtime_APC2);
  finaltime  = datenum(finaltime_APC2);
  Time_adjust = APC2_F1_adjust;

  DateTimedylos_A_new  = DateTime_dylosA(a);
  DylosSmall_A_new    = DylosSmall_dylosA(a);
  DylosLarge_A_new    = DylosLarge_dylosA(a);
  DateTimepDR_A_new    = DateTime_pDRA(b);
  pDRconc_A_new        = pDRconc_pDRA(b)*1000; %convert from mg to ug
```

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```matlab
    DateTimedylos_F1_new   = DateTime_dylosF1(c);
    DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
    DylosSmall_F1_new      = DylosSmall_dylosF1(c);
    DylosLarge_F1_new      = DylosLarge_dylosF1(c);
    DateTimepDR_F_new      = DateTime_pDRF(e);
    pDRconc_F_new          = pDRconc_pDRF(e)*1000; %convert from mg to ug


    DateTimedylos_F2_new   = DateTime_dylosF2(d);
    DylosSmall_F2_new      = DylosSmall_dylosF2(d);
    DylosLarge_F2_new      = DylosLarge_dylosF2(d);

  pDR_A_conversion = rA(5,1)/(nanmean(pDRconc_A_new));
  pDR_F_conversion = rF(5,1)/(nanmean(pDRconc_F_new));
  Resp_A(5) = rA(5,1);
  Resp_F(5) = rF(5,1);
  Inh_A(5) = iA(5,1);
  Inh_F(5) = iF(5,1);

  DailyAvg_pDR_A_MassC(5)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
  DailyAvg_pDR_A(5)         = nanmean(pDRconc_A_new);
  DailyAvg_DylosSmall_A(5)  = nanmean(DylosSmall_A_new);
  DailyAvg_DylosLarge_A(5)  = nanmean(DylosLarge_A_new);
  DailyAvg_pDR_F_MassC(5)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
  DailyAvg_pDR_F(5)         = nanmean(pDRconc_F_new);
  DailyAvg_DylosSmall_F1(5) = nanmean(DylosSmall_F1_new);
  DailyAvg_DylosLarge_F1(5) = nanmean(DylosLarge_F1_new);
  DailyAvg_DylosSmall_F2(5) = nanmean(DylosSmall_F2_new);
  DailyAvg_DylosLarge_F2(5) = nanmean(DylosLarge_F2_new);



  %%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  for i=initialtime:TimeAdj:finaltime
    x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
    y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);

    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;
```

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```matlab
    clear x_A y_A x_F y_F1 y_F2
  end


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%         APC3         %%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_APC3;
  b = dtpDR_A_APC3;
  c = dtDylos_F1_APC3;
  d = dtDylos_F2_APC3;
  e = dtpDR_F_APC3;

  initialtime = datenum(initialtime_APC3);
  finaltime  = datenum(finaltime_APC3);
  Time_adjust = APC3_F1_adjust;

  DateTimedylos_A_new   = DateTime_dylosA(a);
  DylosSmall_A_new      = DylosSmall_dylosA(a);
  DylosLarge_A_new      = DylosLarge_dylosA(a);
  DateTimepDR_A_new     = DateTime_pDRA(b);
  pDRconc_A_new         = pDRconc_pDRA(b)*1000; %convert from mg to ug

  DateTimedylos_F1_new  = DateTime_dylosF1(c);
  DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
  DylosSmall_F1_new     = DylosSmall_dylosF1(c);
  DylosLarge_F1_new     = DylosLarge_dylosF1(c);
  DateTimepDR_F_new     = DateTime_pDRF(e);
  pDRconc_F_new         = pDRconc_pDRF(e)*1000; %convert from mg to ug

  DateTimedylos_F2_new  = DateTime_dylosF2(d);
  DylosSmall_F2_new     = DylosSmall_dylosF2(d);
  DylosLarge_F2_new     = DylosLarge_dylosF2(d);

  pDR_A_conversion = rA(6,1)/(nanmean(pDRconc_A_new));
  pDR_F_conversion = rF(6,1)/(nanmean(pDRconc_F_new));
  Resp_A(6) = rA(6,1);
  Resp_F(6) = rF(6,1);
  Inh_A(6) = iA(6,1);
  Inh_F(6) = iF(6,1);

  DailyAvg_pDR_A_MassC(6)  = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
  DailyAvg_pDR_A(6)        = nanmean(pDRconc_A_new);
  DailyAvg_DylosSmall_A(6)  = nanmean(DylosSmall_A_new);
  DailyAvg_DylosLarge_A(6)  = nanmean(DylosLarge_A_new);
```

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```matlab
DailyAvg_pDR_F_MassC(6)    = nanmean(pDRconc_F_new)*pDR_F_conversion;
DailyAvg_pDR_F(6)          = nanmean(pDRconc_F_new);
DailyAvg_DylosSmall_F1(6)  = nanmean(DylosSmall_F1_new);
DailyAvg_DylosLarge_F1(6)  = nanmean(DylosLarge_F1_new);
DailyAvg_DylosSmall_F2(6)  = nanmean(DylosSmall_F2_new);
DailyAvg_DylosLarge_F2(6)  = nanmean(DylosLarge_F2_new);




%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

for i=initialtime:TimeAdj:finaltime
  x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
  y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
  x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
  y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
  y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);

  pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
  pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
  DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
  DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
  pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
  pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
  DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
  DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
  DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
  DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

  DateTimeAll(j)=i;
  j=j+1;

  clear x_A y_A x_F y_F1 y_F2
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%          APC4          %%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

a = dtDylos_A_APC4;
b = dtpDR_A_APC4;
c = dtDylos_F1_APC4;
d = dtDylos_F2_APC4;
e = dtpDR_F_APC4;

initialtime = datenum(initialtime_APC4);
```

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```matlab
finaltime  = datenum(finaltime_APC4);
Time_adjust = APC4_F1_adjust;

DateTimedylos_A_new   = DateTime_dylosA(a);
DylosSmall_A_new      = DylosSmall_dylosA(a);
DylosLarge_A_new      = DylosLarge_dylosA(a);
DateTimepDR_A_new     = DateTime_pDRA(b);
pDRconc_A_new         = pDRconc_pDRA(b)*1000; %convert from mg to ug

DateTimedylos_F1_new  = DateTime_dylosF1(c);
DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
DylosSmall_F1_new     = DylosSmall_dylosF1(c);
DylosLarge_F1_new     = DylosLarge_dylosF1(c);
DateTimepDR_F_new     = DateTime_pDRF(e);
pDRconc_F_new         = pDRconc_pDRF(e)*1000; %convert from mg to ug

DateTimedylos_F2_new  = DateTime_dylosF2(d);
DylosSmall_F2_new     = DylosSmall_dylosF2(d);
DylosLarge_F2_new     = DylosLarge_dylosF2(d);

pDR_A_conversion = rA(7,1)/(nanmean(pDRconc_A_new));
pDR_F_conversion = rF(7,1)/(nanmean(pDRconc_F_new));
Resp_A(7) = rA(7,1);
Resp_F(7) = rF(7,1);
Inh_A(7) = iA(7,1);
Inh_F(7) = iF(7,1);

DailyAvg_pDR_A_MassC(7)  = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
DailyAvg_pDR_A(7)        = nanmean(pDRconc_A_new);
DailyAvg_DylosSmall_A(7)  = nanmean(DylosSmall_A_new);
DailyAvg_DylosLarge_A(7)  = nanmean(DylosLarge_A_new);
DailyAvg_pDR_F_MassC(7)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
DailyAvg_pDR_F(7)        = nanmean(pDRconc_F_new);
DailyAvg_DylosSmall_F1(7)  = nanmean(DylosSmall_F1_new);
DailyAvg_DylosLarge_F1(7)  = nanmean(DylosLarge_F1_new);
DailyAvg_DylosSmall_F2(7)  = nanmean(DylosSmall_F2_new);
DailyAvg_DylosLarge_F2(7)  = nanmean(DylosLarge_F2_new);



%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

for i=initialtime:TimeAdj:finaltime
  x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
  y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
  x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
  y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
  y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);

  pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
  pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
  DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
  DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
  pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
```

```matlab
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%          APC5          %%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_APC5;
  b = dtpDR_A_APC5;
  c = dtDylos_F1_APC5;
  d = dtDylos_F2_APC5;
  e = dtpDR_F_APC5;

  initialtime = datenum(initialtime_APC5);
  finaltime  = datenum(finaltime_APC5);
  Time_adjust = APC5_F1_adjust;

  DateTimedylos_A_new   = DateTime_dylosA(a);
  DylosSmall_A_new     = DylosSmall_dylosA(a);
  DylosLarge_A_new     = DylosLarge_dylosA(a);
  DateTimepDR_A_new     = DateTime_pDRA(b);
  pDRconc_A_new         = pDRconc_pDRA(b)*1000; %convert from mg to ug

  DateTimedylos_F1_new  = DateTime_dylosF1(c);
  DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
  DylosSmall_F1_new     = DylosSmall_dylosF1(c);
  DylosLarge_F1_new     = DylosLarge_dylosF1(c);
  DateTimepDR_F_new     = DateTime_pDRF(e);
  pDRconc_F_new         = pDRconc_pDRF(e)*1000; %convert from mg to ug

  DateTimedylos_F2_new  = DateTime_dylosF2(d);
  DylosSmall_F2_new     = DylosSmall_dylosF2(d);
  DylosLarge_F2_new     = DylosLarge_dylosF2(d);

  pDR_A_conversion = rA(8,1)/(nanmean(pDRconc_A_new));
  pDR_F_conversion = rF(8,1)/(nanmean(pDRconc_F_new));
  Resp_A(8) = rA(8,1);
  Resp_F(8) = rF(8,1);
```

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```matlab
    Inh_A(8) = iA(8,1);
    Inh_F(8) = iF(8,1);

    DailyAvg_pDR_A_MassC(8)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
    DailyAvg_pDR_A(8)        = nanmean(pDRconc_A_new);
    DailyAvg_DylosSmall_A(8)   = nanmean(DylosSmall_A_new);
    DailyAvg_DylosLarge_A(8)   = nanmean(DylosLarge_A_new);
    DailyAvg_pDR_F_MassC(8)    = nanmean(pDRconc_F_new)*pDR_F_conversion;
    DailyAvg_pDR_F(8)        = nanmean(pDRconc_F_new);
    DailyAvg_DylosSmall_F1(8)  = nanmean(DylosSmall_F1_new);
    DailyAvg_DylosLarge_F1(8)  = nanmean(DylosLarge_F1_new);
    DailyAvg_DylosSmall_F2(8)  = nanmean(DylosSmall_F2_new);
    DailyAvg_DylosLarge_F2(8)  = nanmean(DylosLarge_F2_new);


    %%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    for i=initialtime:TimeAdj:finaltime
      x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
      y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
      x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
      y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
      y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);

      pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
      pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
      DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
      DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
      pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
      pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
      DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
      DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
      DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
      DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

      DateTimeAll(j)=i;
      j=j+1;

      clear x_A y_A x_F y_F1 y_F2
    end

    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    %%%%%%%%%%%%%%%%%%%%%        APC6          %%%%%%%%%%%%%%%%%%%%
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


    clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
    clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
    clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

    a = dtDylos_A_APC6;
```

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```
    b = dtpDR_A_APC6;
    c = dtDylos_F1_APC6;
    d = dtDylos_F2_APC6;
    e = dtpDR_F_APC6;

    initialtime = datenum(initialtime_APC6);
    finaltime   = datenum(finaltime_APC6);
    Time_adjust = APC6_F1_adjust;

    DateTimedylos_A_new    = DateTime_dylosA(a);
    DylosSmall_A_new     = DylosSmall_dylosA(a);
    DylosLarge_A_new     = DylosLarge_dylosA(a);
    DateTimpDR_A_new      = DateTime_pDRA(b);
    pDRconc_A_new        = pDRconc_pDRA(b)*1000; %convert from mg to ug

    DateTimedylos_F1_new   = DateTime_dylosF1(c);
    DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
    DylosSmall_F1_new      = DylosSmall_dylosF1(c);
    DylosLarge_F1_new      = DylosLarge_dylosF1(c);
    DateTimpDR_F_new       = DateTime_pDRF(e);
    pDRconc_F_new          = pDRconc_pDRF(e)*1000; %convert from mg to ug

    DateTimedylos_F2_new   = DateTime_dylosF2(d);
    DylosSmall_F2_new      = DylosSmall_dylosF2(d);
    DylosLarge_F2_new      = DylosLarge_dylosF2(d);

    pDR_A_conversion = rA(9,1)/(nanmean(pDRconc_A_new));
    pDR_F_conversion = rF(9,1)/(nanmean(pDRconc_F_new));
    Resp_A(9) = rA(9,1);
    Resp_F(9) = rF(9,1);
    Inh_A(9) = iA(9,1);
    Inh_F(9) = iF(9,1);

    DailyAvg_pDR_A_MassC(9)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
    DailyAvg_pDR_A(9)         = nanmean(pDRconc_A_new);
    DailyAvg_DylosSmall_A(9)  = nanmean(DylosSmall_A_new);
    DailyAvg_DylosLarge_A(9)  = nanmean(DylosLarge_A_new);
    DailyAvg_pDR_F_MassC(9)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
    DailyAvg_pDR_F(9)         = nanmean(pDRconc_F_new);
    DailyAvg_DylosSmall_F1(9) = nanmean(DylosSmall_F1_new);
    DailyAvg_DylosLarge_F1(9) = nanmean(DylosLarge_F1_new);
    DailyAvg_DylosSmall_F2(9) = nanmean(DylosSmall_F2_new);
    DailyAvg_DylosLarge_F2(9) = nanmean(DylosLarge_F2_new);


    %%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    for i=initialtime:TimeAdj:finaltime
      x_A  = find(DateTimpDR_A_new    >=i & DateTimpDR_A_new    <i+TimeAdj);
      y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
      x_F  = find(DateTimpDR_F_new    >=i & DateTimpDR_F_new    <i+TimeAdj);
      y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
      y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);
```

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```matlab
    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%             APC7            %%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_APC7;
  b = dtpDR_A_APC7;
  c = dtDylos_F1_APC7;
  d = dtDylos_F2_APC7;
  e = dtpDR_F_APC7;

  initialtime = datenum(initialtime_APC7);
  finaltime  = datenum(finaltime_APC7);
  Time_adjust = APC7_F1_adjust;

  DateTimedylos_A_new   = DateTime_dylosA(a);
  DylosSmall_A_new      = DylosSmall_dylosA(a);
  DylosLarge_A_new      = DylosLarge_dylosA(a);
  DateTimepDR_A_new     = DateTime_pDRA(b);
  pDRconc_A_new         = pDRconc_pDRA(b)*1000; %convert from mg to ug

  DateTimedylos_F1_new  = DateTime_dylosF1(c);
  DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
  DylosSmall_F1_new     = DylosSmall_dylosF1(c);
  DylosLarge_F1_new     = DylosLarge_dylosF1(c);
  DateTimepDR_F_new     = DateTime_pDRF(e);
  pDRconc_F_new         = pDRconc_pDRF(e)*1000; %convert from mg to ug

  DateTimedylos_F2_new  = DateTime_dylosF2(d);
  DylosSmall_F2_new     = DylosSmall_dylosF2(d);
  DylosLarge_F2_new     = DylosLarge_dylosF2(d);
```

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```matlab
    pDR_A_conversion = rA(13,1)/(nanmean(pDRconc_A_new));
    pDR_F_conversion = rF(13,1)/(nanmean(pDRconc_F_new));
    Resp_A(13) = rA(13,1);
    Resp_F(13) = rF(13,1);
    Inh_A(13) = iA(13,1);
    Inh_F(13) = iF(13,1);


    DailyAvg_pDR_A_MassC(13)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
    DailyAvg_pDR_A(13)         = nanmean(pDRconc_A_new);
    DailyAvg_DylosSmall_A(13)  = nanmean(DylosSmall_A_new);
    DailyAvg_DylosLarge_A(13)  = nanmean(DylosLarge_A_new);
    DailyAvg_pDR_F_MassC(13)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
    DailyAvg_pDR_F(13)         = nanmean(pDRconc_F_new);
    DailyAvg_DylosSmall_F1(13) = nanmean(DylosSmall_F1_new);
    DailyAvg_DylosLarge_F1(13) = nanmean(DylosLarge_F1_new);
    DailyAvg_DylosSmall_F2(13) = nanmean(DylosSmall_F2_new);
    DailyAvg_DylosLarge_F2(13) = nanmean(DylosLarge_F2_new);




    %%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    for i=initialtime:TimeAdj:finaltime
      x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
      y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
      x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
      y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
      y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);

      pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
      pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
      DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
      DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
      pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
      pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
      DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
      DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
      DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
      DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

      DateTimeAll(j)=i;
      j=j+1;

      clear x_A y_A x_F y_F1 y_F2
    end

    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    %%%%%%%%%%%%%%%%%%%%%%%          APC8          %%%%%%%%%%%%%%%%%%%%%%
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

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```matlab
    clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
    clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
    clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

    a = dtDylos_A_APC8;
    b = dtpDR_A_APC8;
    c = dtDylos_F1_APC8;
    d = dtDylos_F2_APC8;
    e = dtpDR_F_APC8;

    initialtime = datenum(initialtime_APC8);
    finaltime   = datenum(finaltime_APC8);
    Time_adjust = APC8_F1_adjust;

    DateTimedylos_A_new   = DateTime_dylosA(a);
    DylosSmall_A_new     = DylosSmall_dylosA(a);
    DylosLarge_A_new     = DylosLarge_dylosA(a);
    DateTimepDR_A_new    = DateTime_pDRA(b);
    pDRconc_A_new        = pDRconc_pDRA(b)*1000; %convert from mg to ug

    DateTimedylos_F1_new  = DateTime_dylosF1(c);
    DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
    DylosSmall_F1_new    = DylosSmall_dylosF1(c);
    DylosLarge_F1_new    = DylosLarge_dylosF1(c);
    DateTimepDR_F_new    = DateTime_pDRF(e);
    pDRconc_F_new        = pDRconc_pDRF(e)*1000; %convert from mg to ug

    DateTimedylos_F2_new  = DateTime_dylosF2(d);
    DylosSmall_F2_new    = DylosSmall_dylosF2(d);
    DylosLarge_F2_new    = DylosLarge_dylosF2(d);

    pDR_A_conversion = rA(14,1)/(nanmean(pDRconc_A_new));
    pDR_F_conversion = rF(14,1)/(nanmean(pDRconc_F_new));
    Resp_A(14) = rA(14,1);
    Resp_F(14) = rF(14,1);
    Inh_A(14) = iA(14,1);
    Inh_F(14) = iF(14,1);

    DailyAvg_pDR_A_MassC(14)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
    DailyAvg_pDR_A(14)       = nanmean(pDRconc_A_new);
    DailyAvg_DylosSmall_A(14)   = nanmean(DylosSmall_A_new);
    DailyAvg_DylosLarge_A(14)   = nanmean(DylosLarge_A_new);
    DailyAvg_pDR_F_MassC(14)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
    DailyAvg_pDR_F(14)       = nanmean(pDRconc_F_new);
    DailyAvg_DylosSmall_F1(14)  = nanmean(DylosSmall_F1_new);
    DailyAvg_DylosLarge_F1(14)  = nanmean(DylosLarge_F1_new);
    DailyAvg_DylosSmall_F2(14)  = nanmean(DylosSmall_F2_new);
    DailyAvg_DylosLarge_F2(14)  = nanmean(DylosLarge_F2_new);
```

```matlab
%%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  for i=initialtime:TimeAdj:finaltime
    x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
    y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);

    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%         APC9         %%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

 a = dtDylos_A_APC9;
 b = dtpDR_A_APC9;
 c = dtDylos_F1_APC9;
 d = dtDylos_F2_APC9;
 e = dtpDR_F_APC9;

 initialtime = datenum(initialtime_APC9);
 finaltime  = datenum(finaltime_APC9);
 Time_adjust = APC9_F1_adjust;

 DateTimedylos_A_new   = DateTime_dylosA(a);
 DylosSmall_A_new     = DylosSmall_dylosA(a);
 DylosLarge_A_new     = DylosLarge_dylosA(a);
 DateTimepDR_A_new    = DateTime_pDRA(b);
 pDRconc_A_new        = pDRconc_pDRA(b)*1000; %convert from mg to ug

 DateTimedylos_F1_new  = DateTime_dylosF1(c);
```

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```matlab
    DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
    DylosSmall_F1_new      = DylosSmall_dylosF1(c);
    DylosLarge_F1_new      = DylosLarge_dylosF1(c);
    DateTimepDR_F_new      = DateTime_pDRF(e);
    pDRconc_F_new          = pDRconc_pDRF(e)*1000; %convert from mg to ug

    DateTimedylos_F2_new   = DateTime_dylosF2(d);
    DylosSmall_F2_new      = DylosSmall_dylosF2(d);
    DylosLarge_F2_new      = DylosLarge_dylosF2(d);

    pDR_A_conversion = rA(15,1)/(nanmean(pDRconc_A_new));
    pDR_F_conversion = rF(15,1)/(nanmean(pDRconc_F_new));
    Resp_A(15) = rA(15,1);
    Resp_F(15) = rF(15,1);
    Inh_A(15) = iA(15,1);
    Inh_F(15) = iF(15,1);

    DailyAvg_pDR_A_MassC(15)  = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
    DailyAvg_pDR_A(15)       = nanmean(pDRconc_A_new);
    DailyAvg_DylosSmall_A(15)  = nanmean(DylosSmall_A_new);
    DailyAvg_DylosLarge_A(15)  = nanmean(DylosLarge_A_new);
    DailyAvg_pDR_F_MassC(15)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
    DailyAvg_pDR_F(15)       = nanmean(pDRconc_F_new);
    DailyAvg_DylosSmall_F1(15) = nanmean(DylosSmall_F1_new);
    DailyAvg_DylosLarge_F1(15) = nanmean(DylosLarge_F1_new);
    DailyAvg_DylosSmall_F2(15) = nanmean(DylosSmall_F2_new);
    DailyAvg_DylosLarge_F2(15) = nanmean(DylosLarge_F2_new);



    %%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    for i=initialtime:TimeAdj:finaltime
      x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
      y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
      x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
      y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
      y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);

      pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
      pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
      DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
      DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
      pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
      pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
      DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
      DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
      DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
      DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

      DateTimeAll(j)=i;
      j=j+1;

      clear x_A y_A x_F y_F1 y_F2
```

74

```matlab
    end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%              APC10              %%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_APC10;
  b = dtpDR_A_APC10;
  c = dtDylos_F1_APC10;
  d = dtDylos_F2_APC10;
  e = dtpDR_F_APC10;

  initialtime = datenum(initialtime_APC10);
  finaltime  = datenum(finaltime_APC10);
  Time_adjust = APC10_F1_adjust;

  DateTimedylos_A_new    = DateTime_dylosA(a);
  DylosSmall_A_new     = DylosSmall_dylosA(a);
  DylosLarge_A_new     = DylosLarge_dylosA(a);
  DateTimepDR_A_new     = DateTime_pDRA(b);
  pDRconc_A_new        = pDRconc_pDRA(b)*1000; %convert from mg to ug

  DateTimedylos_F1_new  = DateTime_dylosF1(c);
  DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
  DylosSmall_F1_new     = DylosSmall_dylosF1(c);
  DylosLarge_F1_new     = DylosLarge_dylosF1(c);
  DateTimepDR_F_new     = DateTime_pDRF(e);
  pDRconc_F_new        = pDRconc_pDRF(e)*1000; %convert from mg to ug

  DateTimedylos_F2_new  = DateTime_dylosF2(d);
  DylosSmall_F2_new     = DylosSmall_dylosF2(d);
  DylosLarge_F2_new     = DylosLarge_dylosF2(d);

  pDR_A_conversion = rA(16,1)/(nanmean(pDRconc_A_new));
  pDR_F_conversion = rF(16,1)/(nanmean(pDRconc_F_new));
  Resp_A(16) = rA(16,1);
  Resp_F(16) = rF(16,1);
  Inh_A(16) = iA(16,1);
  Inh_F(16) = iF(16,1);

  DailyAvg_pDR_A_MassC(16)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
  DailyAvg_pDR_A(16)       = nanmean(pDRconc_A_new);
  DailyAvg_DylosSmall_A(16)   = nanmean(DylosSmall_A_new);
  DailyAvg_DylosLarge_A(16)   = nanmean(DylosLarge_A_new);
  DailyAvg_pDR_F_MassC(16)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
  DailyAvg_pDR_F(16)       = nanmean(pDRconc_F_new);
```

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```matlab
DailyAvg_DylosSmall_F1(16)  = nanmean(DylosSmall_F1_new);
DailyAvg_DylosLarge_F1(16)  = nanmean(DylosLarge_F1_new);
DailyAvg_DylosSmall_F2(16)  = nanmean(DylosSmall_F2_new);
DailyAvg_DylosLarge_F2(16)  = nanmean(DylosLarge_F2_new);




%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

for i=initialtime:TimeAdj:finaltime
  x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
  y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
  x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
  y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
  y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);

  pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
  pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
  DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
  DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
  pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
  pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
  DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
  DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
  DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
  DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

  DateTimeAll(j)=i;
  j=j+1;

  clear x_A y_A x_F y_F1 y_F2
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%          APC11        %%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%



clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

a = dtDylos_A_APC11;
b = dtpDR_A_APC11;
c = dtDylos_F1_APC11;
d = dtDylos_F2_APC11;
e = dtpDR_F_APC11;

initialtime = datenum(initialtime_APC11);
finaltime  = datenum(finaltime_APC11);
Time_adjust = APC11_F1_adjust;
```

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```matlab
    DateTimedylos_A_new    = DateTime_dylosA(a);
    DylosSmall_A_new       = DylosSmall_dylosA(a);
    DylosLarge_A_new       = DylosLarge_dylosA(a);
    DateTimepDR_A_new      = DateTime_pDRA(b);
    pDRconc_A_new          = pDRconc_pDRA(b)*1000; %convert from mg to ug


    DateTimedylos_F1_new   = DateTime_dylosF1(c);
    DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
    DylosSmall_F1_new      = DylosSmall_dylosF1(c);
    DylosLarge_F1_new      = DylosLarge_dylosF1(c);
    DateTimepDR_F_new      = DateTime_pDRF(e);
    pDRconc_F_new          = pDRconc_pDRF(e)*1000; %convert from mg to ug


    DateTimedylos_F2_new   = DateTime_dylosF2(d);
    DylosSmall_F2_new      = DylosSmall_dylosF2(d);
    DylosLarge_F2_new      = DylosLarge_dylosF2(d);


    pDR_A_conversion = rA(17,1)/(nanmean(pDRconc_A_new));
    pDR_F_conversion = rF(17,1)/(nanmean(pDRconc_F_new));
    Resp_A(17) = rA(17,1);
    Resp_F(17) = rF(17,1);
    Inh_A(17) = iA(17,1);
    Inh_F(17) = iF(17,1);


    DailyAvg_pDR_A_MassC(17)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
    DailyAvg_pDR_A(17)         = nanmean(pDRconc_A_new);
    DailyAvg_DylosSmall_A(17)  = nanmean(DylosSmall_A_new);
    DailyAvg_DylosLarge_A(17)  = nanmean(DylosLarge_A_new);
    DailyAvg_pDR_F_MassC(17)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
    DailyAvg_pDR_F(17)         = nanmean(pDRconc_F_new);
    DailyAvg_DylosSmall_F1(17) = nanmean(DylosSmall_F1_new);
    DailyAvg_DylosLarge_F1(17) = nanmean(DylosLarge_F1_new);
    DailyAvg_DylosSmall_F2(17) = nanmean(DylosSmall_F2_new);
    DailyAvg_DylosLarge_F2(17) = nanmean(DylosLarge_F2_new);



    %%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    for i=initialtime:TimeAdj:finaltime
      x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
      y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
      x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
      y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
      y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);

      pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
      pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
      DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
      DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
      pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
      pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
      DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
```

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```matlab
        DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
        DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
        DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

        DateTimeAll(j)=i;
        j=j+1;

        clear x_A y_A x_F y_F1 y_F2
    end
end

%%%%%%%%%%%%%%%%%%%%%%%%%%% APC OFF %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

if(APC_OFF)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%         B1          %%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
    clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
    clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

    a = dtDylos_A_B1;
    b = dtpDR_A_B1;
    c = dtDylos_F1_B1;
    d = dtDylos_F2_B1;
    e = dtpDR_F_B1;

    initialtime = datenum(initialtime_B1);
    finaltime  = datenum(finaltime_B1);
    Time_adjust = B1_F1_adjust;

    DateTimedylos_A_new    = DateTime_dylosA(a);
    DylosSmall_A_new      = DylosSmall_dylosA(a);
    DylosLarge_A_new      = DylosLarge_dylosA(a);
    DateTimepDR_A_new      = DateTime_pDRA(b);
    pDRconc_A_new         = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3

    DateTimedylos_F1_new   = DateTime_dylosF1(c);
    DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
    DylosSmall_F1_new     = DylosSmall_dylosF1(c);
    DylosLarge_F1_new     = DylosLarge_dylosF1(c);
    DateTimepDR_F_new      = DateTime_pDRF(e);
    pDRconc_F_new         = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3

    DateTimedylos_F2_new   = DateTime_dylosF2(d);
    DylosSmall_F2_new     = DylosSmall_dylosF2(d);
    DylosLarge_F2_new     = DylosLarge_dylosF2(d);

    pDR_A_conversion = rA(1,1)/(nanmean(pDRconc_A_new)); % Respirable Mass/Mean
raw pDR
    pDR_F_conversion = rF(1,1)/(nanmean(pDRconc_F_new));
```

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```matlab
  Resp_A(1) = rA(1,1);
  Resp_F(1) = rF(1,1);
  Inh_A(1) = iA(1,1);
  Inh_F(1) = iF(1,1);

  DailyAvg_pDR_A_MassC(1)  = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
  DailyAvg_pDR_A(1)        = nanmean(pDRconc_A_new);
  DailyAvg_DylosSmall_A(1)  = nanmean(DylosSmall_A_new);
  DailyAvg_DylosLarge_A(1)  = nanmean(DylosLarge_A_new);
  DailyAvg_pDR_F_MassC(1)  = nanmean(pDRconc_F_new)*pDR_F_conversion;
  DailyAvg_pDR_F(1)        = nanmean(pDRconc_F_new);
  DailyAvg_DylosSmall_F1(1)  = nanmean(DylosSmall_F1_new);
  DailyAvg_DylosLarge_F1(1)  = nanmean(DylosLarge_F1_new);
  DailyAvg_DylosSmall_F2(1)  = nanmean(DylosSmall_F2_new);
  DailyAvg_DylosLarge_F2(1)  = nanmean(DylosLarge_F2_new);

%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  for i=initialtime:TimeAdj:finaltime
    x_A = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
    y_A = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);

    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%         B2           %%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new
```

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```
a = dtDylos_A_B2;
b = dtpDR_A_B2;
c = dtDylos_F1_B2;
d = dtDylos_F2_B2;
e = dtpDR_F_B2;

initialtime = datenum(initialtime_B2);
finaltime  = datenum(finaltime_B2);
Time_adjust = B2_F1_adjust;

DateTimedylos_A_new     = DateTime_dylosA(a);
DylosSmall_A_new      = DylosSmall_dylosA(a);
DylosLarge_A_new      = DylosLarge_dylosA(a);
DateTimepDR_A_new      = DateTime_pDRA(b);
pDRconc_A_new          = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3

DateTimedylos_F1_new    = DateTime_dylosF1(c);
DateTimedylos_F1_new    = DateTimedylos_F1_new + Time_adjust;
DylosSmall_F1_new      = DylosSmall_dylosF1(c);
DylosLarge_F1_new      = DylosLarge_dylosF1(c);
DateTimepDR_F_new       = DateTime_pDRF(e);
pDRconc_F_new          = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3

DateTimedylos_F2_new    = DateTime_dylosF2(d);
DylosSmall_F2_new      = DylosSmall_dylosF2(d);
DylosLarge_F2_new      = DylosLarge_dylosF2(d);

pDR_A_conversion = rA(2,1)/(nanmean(pDRconc_A_new)); % Respirable Mass/Mean
raw pDR
pDR_F_conversion = rF(2,1)/(nanmean(pDRconc_F_new));
Resp_A(2) = rA(2,1);
Resp_F(2) = rF(2,1);
Inh_A(2) = iA(2,1);
Inh_F(2) = iF(2,1);

DailyAvg_pDR_A_MassC(2)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
DailyAvg_pDR_A(2)        = nanmean(pDRconc_A_new);
DailyAvg_DylosSmall_A(2)   = nanmean(DylosSmall_A_new);
DailyAvg_DylosLarge_A(2)   = nanmean(DylosLarge_A_new);
DailyAvg_pDR_F_MassC(2)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
DailyAvg_pDR_F(2)        = nanmean(pDRconc_F_new);
DailyAvg_DylosSmall_F1(2)  = nanmean(DylosSmall_F1_new);
DailyAvg_DylosLarge_F1(2)  = nanmean(DylosLarge_F1_new);
DailyAvg_DylosSmall_F2(2)  = nanmean(DylosSmall_F2_new);
DailyAvg_DylosLarge_F2(2)  = nanmean(DylosLarge_F2_new);

%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

for i=initialtime:TimeAdj:finaltime
  x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
  y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
  x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
  y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
  y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);
```

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```matlab
    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%         B3          %%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_B3;
  b = dtpDR_A_B3;
  c = dtDylos_F1_B3;
  d = dtDylos_F2_B3;
  e = dtpDR_F_B3;

  initialtime = datenum(initialtime_B3);
  finaltime  = datenum(finaltime_B3);
  Time_adjust = B3_F1_adjust;

  DateTimedylos_A_new    = DateTime_dylosA(a);
  DylosSmall_A_new      = DylosSmall_dylosA(a);
  DylosLarge_A_new      = DylosLarge_dylosA(a);
  DateTimepDR_A_new      = DateTime_pDRA(b);
  pDRconc_A_new        = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3

  DateTimedylos_F1_new   = DateTime_dylosF1(c);
  DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
  DylosSmall_F1_new      = DylosSmall_dylosF1(c);
  DylosLarge_F1_new      = DylosLarge_dylosF1(c);
  DateTimepDR_F_new      = DateTime_pDRF(e);
  pDRconc_F_new        = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3

  DateTimedylos_F2_new   = DateTime_dylosF2(d);
  DylosSmall_F2_new      = DylosSmall_dylosF2(d);
```

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```matlab
    DylosLarge_F2_new      = DylosLarge_dylosF2(d);

   pDR_A_conversion = rA(3,1)/(nanmean(pDRconc_A_new)); % Respirable Mass/Mean
raw pDR
   pDR_F_conversion = rF(3,1)/(nanmean(pDRconc_F_new));
   Resp_A(3) = rA(3,1);
   Resp_F(3) = rF(3,1);
   Inh_A(3) = iA(3,1);
   Inh_F(3) = iF(3,1);

   DailyAvg_pDR_A_MassC(3)  = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
   DailyAvg_pDR_A(3)        = nanmean(pDRconc_A_new);
   DailyAvg_DylosSmall_A(3)  = nanmean(DylosSmall_A_new);
   DailyAvg_DylosLarge_A(3)  = nanmean(DylosLarge_A_new);
   DailyAvg_pDR_F_MassC(3)  = nanmean(pDRconc_F_new)*pDR_F_conversion;
   DailyAvg_pDR_F(3)        = nanmean(pDRconc_F_new);
   DailyAvg_DylosSmall_F1(3) = nanmean(DylosSmall_F1_new);
   DailyAvg_DylosLarge_F1(3) = nanmean(DylosLarge_F1_new);
   DailyAvg_DylosSmall_F2(3) = nanmean(DylosSmall_F2_new);
   DailyAvg_DylosLarge_F2(3) = nanmean(DylosLarge_F2_new);

%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  for i=initialtime:TimeAdj:finaltime
    x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
    y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);

    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%          P1          %%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
```

```matlab
    clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
    clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_P1;
  b = dtpDR_A_P1;
  c = dtDylos_F1_P1;
  d = dtDylos_F2_P1;
  e = dtpDR_F_P1;

  initialtime = datenum(initialtime_P1);
  finaltime  = datenum(finaltime_P1);
  Time_adjust = P1_F1_adjust;

  DateTimedylos_A_new   = DateTime_dylosA(a);
  DylosSmall_A_new      = DylosSmall_dylosA(a);
  DylosLarge_A_new      = DylosLarge_dylosA(a);
  DateTimepDR_A_new     = DateTime_pDRA(b);
  pDRconc_A_new         = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3

  DateTimedylos_F1_new  = DateTime_dylosF1(c);
  DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
  DylosSmall_F1_new     = DylosSmall_dylosF1(c);
  DylosLarge_F1_new     = DylosLarge_dylosF1(c);
  DateTimepDR_F_new     = DateTime_pDRF(e);
  pDRconc_F_new         = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3

  DateTimedylos_F2_new  = DateTime_dylosF2(d);
  DylosSmall_F2_new     = DylosSmall_dylosF2(d);
  DylosLarge_F2_new     = DylosLarge_dylosF2(d);

  pDR_A_conversion = rA(10,1)/(nanmean(pDRconc_A_new)); % Respirable
Mass/Mean raw pDR
  pDR_F_conversion = rF(10,1)/(nanmean(pDRconc_F_new));
  Resp_A(10) = rA(10,1);
  Resp_F(10) = rF(10,1);
  Inh_A(10) = iA(10,1);
  Inh_F(10) = iF(10,1);

  DailyAvg_pDR_A_MassC(10)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
  DailyAvg_pDR_A(10)         = nanmean(pDRconc_A_new);
  DailyAvg_DylosSmall_A(10)  = nanmean(DylosSmall_A_new);
  DailyAvg_DylosLarge_A(10)  = nanmean(DylosLarge_A_new);
  DailyAvg_pDR_F_MassC(10)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
  DailyAvg_pDR_F(10)         = nanmean(pDRconc_F_new);
  DailyAvg_DylosSmall_F1(10) = nanmean(DylosSmall_F1_new);
  DailyAvg_DylosLarge_F1(10) = nanmean(DylosLarge_F1_new);
  DailyAvg_DylosSmall_F2(10) = nanmean(DylosSmall_F2_new);
  DailyAvg_DylosLarge_F2(10) = nanmean(DylosLarge_F2_new);

%%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  for i=initialtime:TimeAdj:finaltime
```

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```matlab
    x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
    y_A  = find(DateTimedylos_A_new >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);


    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%          P2          %%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_P2;
  b = dtpDR_A_P2;
  c = dtDylos_F1_P2;
  d = dtDylos_F2_P2;
  e = dtpDR_F_P2;

  initialtime = datenum(initialtime_P2);
  finaltime   = datenum(finaltime_P2);
  Time_adjust = P2_F1_adjust;

  DateTimedylos_A_new   = DateTime_dylosA(a);
  DylosSmall_A_new      = DylosSmall_dylosA(a);
  DylosLarge_A_new      = DylosLarge_dylosA(a);
  DateTimepDR_A_new     = DateTime_pDRA(b);
  pDRconc_A_new         = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3

  DateTimedylos_F1_new  = DateTime_dylosF1(c);
  DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
  DylosSmall_F1_new     = DylosSmall_dylosF1(c);
  DylosLarge_F1_new     = DylosLarge_dylosF1(c);
```

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```matlab
DateTimepDR_F_new      = DateTime_pDRF(e);
pDRconc_F_new          = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3

DateTimedylos_F2_new   = DateTime_dylosF2(d);
DylosSmall_F2_new      = DylosSmall_dylosF2(d);
DylosLarge_F2_new      = DylosLarge_dylosF2(d);

pDR_A_conversion = rA(11,1)/(nanmean(pDRconc_A_new)); % Respirable
Mass/Mean raw pDR
pDR_F_conversion = rF(11,1)/(nanmean(pDRconc_F_new));
Resp_A(11) = rA(11,1);
Resp_F(11) = rF(11,1);
Inh_A(11) = iA(11,1);
Inh_F(11) = iF(11,1);

DailyAvg_pDR_A_MassC(11)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
DailyAvg_pDR_A(11)         = nanmean(pDRconc_A_new);
DailyAvg_DylosSmall_A(11)  = nanmean(DylosSmall_A_new);
DailyAvg_DylosLarge_A(11)  = nanmean(DylosLarge_A_new);
DailyAvg_pDR_F_MassC(11)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
DailyAvg_pDR_F(11)         = nanmean(pDRconc_F_new);
DailyAvg_DylosSmall_F1(11) = nanmean(DylosSmall_F1_new);
DailyAvg_DylosLarge_F1(11) = nanmean(DylosLarge_F1_new);
DailyAvg_DylosSmall_F2(11) = nanmean(DylosSmall_F2_new);
DailyAvg_DylosLarge_F2(11) = nanmean(DylosLarge_F2_new);

%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

for i=initialtime:TimeAdj:finaltime
  x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
  y_A  = find(DateTimedylos_A_new >=i & DateTimedylos_A_new <i+TimeAdj);
  x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
  y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
  y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);

  pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
  pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
  DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
  DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
  pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
  pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
  DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
  DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
  DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
  DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

  DateTimeAll(j)=i;
  j=j+1;

  clear x_A y_A x_F y_F1 y_F2
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%         P3             %%%%%%%%%%%%%%%%%%%%
```

```matlab
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new


 a = dtDylos_A_P3;
 b = dtpDR_A_P3;
 c = dtDylos_F1_P3;
 d = dtDylos_F2_P3;
 e = dtpDR_F_P3;


 initialtime = datenum(initialtime_P3);
 finaltime  = datenum(finaltime_P3);
 Time_adjust = P3_F1_adjust;


 DateTimedylos_A_new    = DateTime_dylosA(a);
 DylosSmall_A_new     = DylosSmall_dylosA(a);
 DylosLarge_A_new     = DylosLarge_dylosA(a);
 DateTimepDR_A_new     = DateTime_pDRA(b);
 pDRconc_A_new        = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3


 DateTimedylos_F1_new  = DateTime_dylosF1(c);
 DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
 DylosSmall_F1_new     = DylosSmall_dylosF1(c);
 DylosLarge_F1_new     = DylosLarge_dylosF1(c);
 DateTimepDR_F_new     = DateTime_pDRF(e);
 pDRconc_F_new         = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3


 DateTimedylos_F2_new  = DateTime_dylosF2(d);
 DylosSmall_F2_new     = DylosSmall_dylosF2(d);
 DylosLarge_F2_new     = DylosLarge_dylosF2(d);


 pDR_A_conversion = rA(12,1)/(nanmean(pDRconc_A_new)); % Respirable
Mass/Mean raw pDR
 pDR_F_conversion = rF(12,1)/(nanmean(pDRconc_F_new));
 Resp_A(12) = rA(12,1);
 Resp_F(12) = rF(12,1);
 Inh_A(12) = iA(12,1);
 Inh_F(12) = iF(12,1);


 DailyAvg_pDR_A_MassC(12)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
 DailyAvg_pDR_A(12)       = nanmean(pDRconc_A_new);
 DailyAvg_DylosSmall_A(12)   = nanmean(DylosSmall_A_new);
 DailyAvg_DylosLarge_A(12)   = nanmean(DylosLarge_A_new);
 DailyAvg_pDR_F_MassC(12)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
 DailyAvg_pDR_F(12)       = nanmean(pDRconc_F_new);
 DailyAvg_DylosSmall_F1(12)  = nanmean(DylosSmall_F1_new);
 DailyAvg_DylosLarge_F1(12)  = nanmean(DylosLarge_F1_new);
 DailyAvg_DylosSmall_F2(12)  = nanmean(DylosSmall_F2_new);
```

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```matlab
    DailyAvg_DylosLarge_F2(12)  = nanmean(DylosLarge_F2_new);

%%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  for i=initialtime:TimeAdj:finaltime
    x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
    y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new  >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new  >=i & DateTimedylos_F2_new <i+TimeAdj);

    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%       P4          %%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


  clear DateTimedylos_A_new DylosSmall_A_new DylosLarge_A_new
DateTimepDR_A_new pDRconc_A_new
  clear DateTimedylos_F1_new DylosSmall_F1_new DylosLarge_F1_new
DateTimepDR_F_new pDRconc_F_new
  clear DateTimedylos_F2_new DylosSmall_F2_new DylosLarge_F2_new
DateTimepDR_F_new pDRconc_F_new

  a = dtDylos_A_P4;
  b = dtpDR_A_P4;
  c = dtDylos_F1_P4;
  d = dtDylos_F2_P4;
  e = dtpDR_F_P4;

  initialtime = datenum(initialtime_P4);
  finaltime  = datenum(finaltime_P4);
  Time_adjust = P4_F1_adjust;

  DateTimedylos_A_new   = DateTime_dylosA(a);
  DylosSmall_A_new     = DylosSmall_dylosA(a);
  DylosLarge_A_new     = DylosLarge_dylosA(a);
  DateTimepDR_A_new    = DateTime_pDRA(b);
  pDRconc_A_new        = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3
```

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```matlab
    DateTimedylos_F1_new   = DateTime_dylosF1(c);
    DateTimedylos_F1_new   = DateTimedylos_F1_new + Time_adjust;
    DylosSmall_F1_new      = DylosSmall_dylosF1(c);
    DylosLarge_F1_new      = DylosLarge_dylosF1(c);
    DateTimepDR_F_new      = DateTime_pDRF(e);
    pDRconc_F_new          = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3

    DateTimedylos_F2_new   = DateTime_dylosF2(d);
    DylosSmall_F2_new      = DylosSmall_dylosF2(d);
    DylosLarge_F2_new      = DylosLarge_dylosF2(d);

  pDR_A_conversion = rA(18,1)/(nanmean(pDRconc_A_new)); % Respirable
Mass/Mean raw pDR
  pDR_F_conversion = rF(18,1)/(nanmean(pDRconc_F_new));
  Resp_A(18) = rA(18,1);
  Resp_F(18) = rF(18,1);
  Inh_A(18) = iA(18,1);
  Inh_F(18) = iF(18,1);

  DailyAvg_pDR_A_MassC(18)   = nanmean(pDRconc_A_new)*pDR_A_conversion; %pDR
raw *(Respirable Mass/Mean raw pDR) = Respirable Mass
  DailyAvg_pDR_A(18)         = nanmean(pDRconc_A_new);
  DailyAvg_DylosSmall_A(18)  = nanmean(DylosSmall_A_new);
  DailyAvg_DylosLarge_A(18)  = nanmean(DylosLarge_A_new);
  DailyAvg_pDR_F_MassC(18)   = nanmean(pDRconc_F_new)*pDR_F_conversion;
  DailyAvg_pDR_F(18)         = nanmean(pDRconc_F_new);
  DailyAvg_DylosSmall_F1(18) = nanmean(DylosSmall_F1_new);
  DailyAvg_DylosLarge_F1(18) = nanmean(DylosLarge_F1_new);
  DailyAvg_DylosSmall_F2(18) = nanmean(DylosSmall_F2_new);
  DailyAvg_DylosLarge_F2(18) = nanmean(DylosLarge_F2_new);

%%%%%%%%%%%%%%%%%%%%%%%%%%% Time averaging %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  for i=initialtime:TimeAdj:finaltime
    x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
    y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F  = find(DateTimepDR_F_new   >=i & DateTimepDR_F_new   <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);

    pDRtimeAvg_A_MassC(j)=nanmean(pDRconc_A_new(x_A))*pDR_A_conversion;
    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A));
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F_MassC(j)=nanmean(pDRconc_F_new(x_F))*pDR_F_conversion;
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F));
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;
```

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```matlab
        clear x_A y_A x_F y_F1 y_F2
    end



    end

    %%%%%%%%%%%%%%%%%%%%%%%%%% Transpose %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    clear a b c d e

    DateTimeAll = DateTimeAll';
    pDRtimeAvg_A_MassC =pDRtimeAvg_A_MassC';
    pDRtimeAvg_A = pDRtimeAvg_A';
    DylosSmalltimeAvg_A = DylosSmalltimeAvg_A';
    DylosLargetimeAvg_A = DylosLargetimeAvg_A';
    pDRtimeAvg_F_MassC = pDRtimeAvg_F_MassC';
    pDRtimeAvg_F = pDRtimeAvg_F';
    DylosSmalltimeAvg_F1 = DylosSmalltimeAvg_F1';
    DylosLargetimeAvg_F1 = DylosLargetimeAvg_F1';
    DylosSmalltimeAvg_F2 = DylosSmalltimeAvg_F2';
    DylosLargetimeAvg_F2 = DylosLargetimeAvg_F2';


    DailyAvg_pDR_A_MassC   = DailyAvg_pDR_A_MassC';
    DailyAvg_pDR_A       = DailyAvg_pDR_A';
    DailyAvg_DylosSmall_A  = DailyAvg_DylosSmall_A';
    DailyAvg_DylosLarge_A  = DailyAvg_DylosLarge_A';
    DailyAvg_pDR_F_MassC   = DailyAvg_pDR_F_MassC';
    DailyAvg_pDR_F       = DailyAvg_pDR_F';
    DailyAvg_DylosSmall_F1  = DailyAvg_DylosSmall_F1';
    DailyAvg_DylosLarge_F1  = DailyAvg_DylosLarge_F1';
    DailyAvg_DylosSmall_F2  = DailyAvg_DylosSmall_F2';
    DailyAvg_DylosLarge_F2  = DailyAvg_DylosLarge_F2';


    Resp_A = Resp_A';
    Resp_F = Resp_F';
    Inh_A  = Inh_A';
    Inh_F  = Inh_F';
```

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Plot Data

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%  Title:  Plot Data                        %%%%%
%%%%%  Author: Sam Jones & Sinan Sousan          %%%%%
%%%%%  Date:  December 30, 2014 – March 10, 2015       %%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

Method1 = 1;
Method2 = 0;

Plot1 = 1;
Plot2 = 1;

k = [];
k(1:length(DylosSmalltimeAvg_A)) = 1 ;
k(length(DylosSmalltimeAvg_A)+1:length(DylosSmalltimeAvg_A)+length(DylosSmall
timeAvg_F1)) = 2 ;
k(length(DylosSmalltimeAvg_A)+length(DylosSmalltimeAvg_F1)+1:length(DylosSmal
ltimeAvg_A)+length(DylosSmalltimeAvg_F1)+length(DylosSmalltimeAvg_F2)) = 3 ;
DeviceIndex = k';

DylosSmall_All =
[DylosSmalltimeAvg_A;DylosSmalltimeAvg_F1;DylosSmalltimeAvg_F2];
DylosLarge_All =
[DylosLargetimeAvg_A;DylosLargetimeAvg_F1;DylosLargetimeAvg_F2];
pDR_All_MassC  = [pDRtimeAvg_A_MassC;pDRtimeAvg_F_MassC;pDRtimeAvg_F_MassC];
pDR_All_Raw   = [pDRtimeAvg_A;pDRtimeAvg_F;pDRtimeAvg_F];
DateTimeAll   = [DateTimeAll;DateTimeAll;DateTimeAll];

DA_DylosSmall_All =
[DailyAvg_DylosSmall_A;DailyAvg_DylosSmall_F1;DailyAvg_DylosSmall_F2];
DA_DylosLarge_All =
[DailyAvg_DylosLarge_A;DailyAvg_DylosLarge_F1;DailyAvg_DylosLarge_F2];
DA_pDR3_All_MassC =
[DailyAvg_pDR_A_MassC;DailyAvg_pDR_F_MassC;DailyAvg_pDR_F_MassC];
DA_pDR2_All_MassC = [DailyAvg_pDR_A_MassC;DailyAvg_pDR_F_MassC];
DA_Resp3      = [Resp_A;Resp_F;Resp_F];
DA_Resp2      = [Resp_A;Resp_F];
DA_Inh3      = [Inh_A;Inh_F;Inh_F];
DA_Inh2      = [Inh_A;Inh_F];

[zzz1,zzz2]=Remove_NaN(DylosSmalltimeAvg_F1,DylosSmalltimeAvg_F1);


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%  Method 1    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if(Method1)

[PMConcentration2_5_All, PMConcentration10_All, PMConcentration0_5to10_All] =
DylosConversion1(DylosSmall_All,DylosLarge_All); %spits out ug/m^3
```

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```matlab
%[DA_PMC_2_5_All, DA_PMC_10_All, DA_PMC_0_5to10_All] =
DylosConversion1(DA_DylosSmall_All,DA_DylosLarge_All); %spits out ug/m^3
DA_PMC_2_5_All = DA_DylosSmall_All * 0.055 + 46.5;
DA_PMC_10_All = DA_DylosLarge_All * 0.25 + 51.0;

%Plot 1
x1 = DA_Resp2;
y1 = DA_Inh2;
x2 = DA_Resp2;
y2 = DA_pDR2_All_MassC;
x3 = DA_Inh2;
y3 = DA_pDR2_All_MassC;
x4 = DA_Resp3;
y4 = DA_PMC_2_5_All;
x5 = DA_Inh3;
y5 = DA_PMC_2_5_All;
x6 = DA_pDR3_All_MassC;
y6 = DA_PMC_2_5_All;
x7 = DA_Resp3;
y7 = DA_PMC_10_All;
x8 = DA_Inh3;
y8 = DA_PMC_10_All;
x9 = DA_pDR3_All_MassC;
y9 = DA_PMC_10_All;
x10= DA_PMC_2_5_All;
y10= DA_PMC_10_All;


%Plot 2
a1 = pDR_All_Raw;
b1 = DylosSmall_All;
a2 = pDR_All_Raw;
b2 = DylosLarge_All;
a3 = DylosSmall_All;
b3 = DylosLarge_All;


c1 = pDR_All_MassC;
d1 = PMConcentration2_5_All;
c2 = pDR_All_MassC;
d2 = PMConcentration10_All;
c3 = PMConcentration2_5_All;
d3 = PMConcentration10_All;

end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%   Method 2   %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if(Method2)

[DylosSmall_All_80,DylosLarge_All_80,pDR_All_Raw_80,pDR_All_MassC_80,DA_Dylos
Small,DA_DylosLarge,DA_pDR,z_slope_small,z_intercept_small,z_slope_large,z_in
tercept_large] =
DylosConversion2(DylosSmall_All,DylosLarge_All,pDR_All_Raw,pDR_All_MassC,Date
TimeAll,DeviceIndex);
```

```matlab
%Plot 1
x1 = DA_Resp2;
y1 = DA_Inh2;
x2 = DA_Resp3;
y2 = DA_pDR;
x3 = DA_Inh3;
y3 = DA_pDR;
x4 = DA_Resp3;
y4 = DA_DylosSmall;
x5 = DA_Inh3;
y5 = DA_DylosSmall;
x6 = DA_pDR;
y6 = DA_DylosSmall;
x7 = DA_Resp3;
y7 = DA_DylosLarge;
x8 = DA_Inh3;
y8 = DA_DylosLarge;
x9 = DA_pDR;
y9 = DA_DylosLarge;
x10= DA_DylosSmall;
y10= DA_DylosLarge;

%Plot 2
a1 = pDR_All_Raw;
b1 = DylosSmall_All;
a2 = pDR_All_Raw;
b2 = DylosLarge_All;
a3 = DylosSmall_All;
b3 = DylosLarge_All;


c1 = pDR_All_MassC_80;
d1 = DylosSmall_All_80;
c2 = pDR_All_MassC_80;
d2 = DylosLarge_All_80;
c3 = DylosSmall_All_80;
d3 = DylosLarge_All_80;

end

if(Plot1) %Big plot all locations
figure
  subplot(5,5,1)
  axis square
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.05 .5],'string','Respirable')
  subplot(5,5,7)
  axis square
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.1 .5],'string','Inhalable')
  subplot(5,5,13)
  axis square
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.2 .5],'string','pDR')
  subplot(5,5,19)
  axis square
  set(gca,'XtickLabel',[],'YtickLabel',[]);
```

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```matlab
  text('Position',[.1 .5],'string','Dylos : Small Particles')
  subplot(5,5,25)
  axis square
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.1 .5],'string','Dylos : Large Particles')
%Respirable vs Inhalable
subplot(5,5,6)
  [x1,y1]=Remove_NaN(x1,y1);
  scatter(x1,y1)
  axis square
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,2)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x1,y1);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Respirable vs pDR
subplot(5,5,11)
  [x2,y2]=Remove_NaN(x2,y2);
  scatter(x2,y2)
  axis square
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,3)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x2,y2);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Inhalable vs pDR
subplot(5,5,12)
  [x3,y3]=Remove_NaN(x3,y3);
  scatter(x3,y3)
  axis square
  lsline
```

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```matlab
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,8)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x3,y3);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Respirable vs Dylos Small
subplot(5,5,16)
  [x4,y4]=Remove_NaN(x4,y4);
  scatter(x4,y4)
  axis square
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,4)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x4,y4);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Inhalable vs Dylos Small
subplot(5,5,17)
  [x5,y5]=Remove_NaN(x5,y5);
  scatter(x5,y5)
  axis square
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,9)
```

```matlab
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x5,y5);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%pDR vs Dylos Small
subplot(5,5,18)
  [x6,y6]=Remove_NaN(x6,y6);
  scatter(x6,y6)
  axis square
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,14)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x6,y6);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Respirable vs Dylos Large
subplot(5,5,21)
  [x7,y7]=Remove_NaN(x7,y7);
  scatter(x7,y7)
  axis square
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,5)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x7,y7);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Inhalable vs Dylos Large
subplot(5,5,22)
  [x8,y8]=Remove_NaN(x8,y8);
  scatter(x8,y8)
  axis square
```

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```matlab
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,10)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x8,y8);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%pDR vs Dylos Large
subplot(5,5,23)
  [x9,y9]=Remove_NaN(x9,y9);
  scatter(x9,y9)
  axis square
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(5,5,15)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x9,y9);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Dylos Small vs Dylos Large
subplot(5,5,24)
  [x10,y10]=Remove_NaN(x10,y10);
  scatter(x10,y10)
  axis square
  lsline
  %xlim([0 1500]);
  %ylim([0 1500]);
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
```

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```
subplot(5,5,20)
  axis square
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(x10,y10);
  R_squared=R^2 ;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
end

if(Plot2)
figure
subplot(3,3,1)
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.1 .5],'string','pDR Raw')
subplot(3,3,5)
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.1 .5],'string','Dylos : Small Particles Raw')
subplot(3,3,9)
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.1 .5],'string','Dylos : Large Particles Raw')
%pDR vs Dylos Small
subplot(3,3,4)
  [a1,b1]=Remove_NaN(a1,b1);
  scatter(a1,b1,'.','k')
  lsline
subplot(3,3,2)
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(a1,b1);
  R_squared = R^2;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%pDR vs Dylos Large
subplot(3,3,7)
  [a2,b2]=Remove_NaN(a2,b2);
  scatter(a2,b2,'.','k')
  lsline
subplot(3,3,3)
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(a2,b2);
  R_squared = R^2;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Dylos Small vs Dylos Large
  subplot(3,3,8)
  [a3,b3]=Remove_NaN(a3,b3);
  scatter(a3,b3,'.','k')
  lsline
subplot(3,3,6)
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(a3,b3);
  R_squared = R^2;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
  clear x y

figure
```

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```matlab
subplot(3,3,1)
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.1 .5],'string','pDR Mass Corrected')
subplot(3,3,5)
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.1 .5],'string','Dylos : Small Particles Mass Corrected')
subplot(3,3,9)
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  text('Position',[.1 .5],'string','Dylos : Large Particles Mass Corrected')
%pDR vs Dylos Small
subplot(3,3,4)
  [c1,d1]=Remove_NaN(c1,d1);
  scatter(c1,d1,'.','k')
  lsline
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(3,3,2)
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(c1,d1);
  R_squared = R^2;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%pDR vs Dylos Large
subplot(3,3,7)
  [c2,d2]=Remove_NaN(c2,d2);
  scatter(c2,d2,'.','k')
  lsline
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
     line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(3,3,3)
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(c2,d2);
  R_squared = R^2;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
%Dylos Small vs Dylos Large
  subplot(3,3,8)
  [c3,d3]=Remove_NaN(c3,d3);
  scatter(c3,d3,'.','k')
  lsline
  XL = get(gca, 'XLim');
  YL = get(gca, 'YLim');
  p0 = max(XL(1),YL(1)); %1:1 line
  p1 = min(XL(2),YL(2));
  if p0 < p1
```

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```matlab
    line( [p0 p1], [p0 p1], 'LineStyle', ':');
  else
  end
subplot(3,3,6)
  clear R R_squared
  set(gca,'XtickLabel',[],'YtickLabel',[]);
  R = corr2(c3,d3);
  R_squared = R^2;
  text(.1, .667, ['R^2 = ' num2str(R_squared)])
  clear x y
end

[z1,z2]=Remove_NaN(DylosSmalltimeAvg_F1,DylosSmalltimeAvg_F2);
[stats1] = EPA_Stats(x1,y1,[z1,z2]);
[stats1] = EPA_Stats(x2,y2,[z1,z2]);
[stats1] = EPA_Stats(x3,y3,[z1,z2]);
[stats1] = EPA_Stats(x4,y4,[z1,z2]);
[stats1] = EPA_Stats(x5,y5,[z1,z2]);
[stats1] = EPA_Stats(x6,y6,[z1,z2]);
[stats1] = EPA_Stats(x7,y7,[z1,z2]);
[stats1] = EPA_Stats(x8,y8,[z1,z2]);
[stats1] = EPA_Stats(x9,y9,[z1,z2]);
[stats1] = EPA_Stats(x10,y10,[z1,z2]);
[stats1] = EPA_Stats(a1,b1,[z1,z2]);
[stats1] = EPA_Stats(a2,b2,[z1,z2]);
[stats1] = EPA_Stats(a3,b3,[z1,z2]);
[stats1] = EPA_Stats(c1,d1,[z1,z2]);
[stats1] = EPA_Stats(c2,d2,[z1,z2]);
[stats1] = EPA_Stats(c3,d3,[z1,z2]);
```

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Time Series Plot

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%  Title:  Time Series Plot                       %%%%%%
%%%%%  Author: Sam Jones & Sinan Sousan               %%%%%%
%%%%%  Date:  December 30, 2014 - March 10, 2015      %%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

  a = dtDylos_A_APC1;
  b = dtpDR_A_APC1;
  c = dtDylos_F1_APC1;
  d = dtDylos_F2_APC1;
  e = dtpDR_F_APC1;

  initialtime = datenum(initialtime_APC1);
  finaltime  = datenum(finaltime_APC1);
  Time_adjust = APC1_F1_adjust;

%%% Adjust mass conversion factor below %%%

  j=1;

% Time Average Window
  Date1 = '01/01/2000 00:00:00';
  Date2 = '01/01/2000 00:10:00'; %Change interval to change size of average
  TimeAdj = datenum(Date2)-datenum(Date1);

  DateTimedylos_A_new   = DateTime_dylosA(a);
  DylosSmall_A_new      = DylosSmall_dylosA(a);
  DylosLarge_A_new      = DylosLarge_dylosA(a);
  DateTimepDR_A_new     = DateTime_pDRA(b);
  pDRconc_A_new         = pDRconc_pDRA(b)*1000; %convert from mg/m3 to ug/m3

  DateTimedylos_F1_new  = DateTime_dylosF1(c);
  DateTimedylos_F1_new  = DateTimedylos_F1_new + Time_adjust;
  DylosSmall_F1_new     = DylosSmall_dylosF1(c);
  DylosLarge_F1_new     = DylosLarge_dylosF1(c);
  DateTimepDR_F_new     = DateTime_pDRF(e);
  pDRconc_F_new         = pDRconc_pDRF(e)*1000; %convert from mg/m3 to ug/m3

  DateTimedylos_F2_new  = DateTime_dylosF2(d);
  DylosSmall_F2_new     = DylosSmall_dylosF2(d);
  DylosLarge_F2_new     = DylosLarge_dylosF2(d);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
  %Adjust rA(x,1) for Day. See TimeAvgData for correct number
  pDR_A_conversion = rA(4,1)/(nanmean(pDRconc_A_new)); % Respirable Mass/Mean
raw pDR
  pDR_F_conversion = rF(4,1)/(nanmean(pDRconc_F_new));
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    for i=initialtime:TimeAdj:finaltime
     x_A  = find(DateTimepDR_A_new   >=i & DateTimepDR_A_new   <i+TimeAdj);
```

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```
    y_A  = find(DateTimedylos_A_new  >=i & DateTimedylos_A_new  <i+TimeAdj);
    x_F  = find(DateTimepDR_F_new    >=i & DateTimepDR_F_new    <i+TimeAdj);
    y_F1 = find(DateTimedylos_F1_new >=i & DateTimedylos_F1_new <i+TimeAdj);
    y_F2 = find(DateTimedylos_F2_new >=i & DateTimedylos_F2_new <i+TimeAdj);

    pDRtimeAvg_A(j)=nanmean(pDRconc_A_new(x_A)*pDR_A_conversion);
    DylosSmalltimeAvg_A(j)=nanmean(DylosSmall_A_new(y_A));
    DylosLargetimeAvg_A(j)=nanmean(DylosLarge_A_new(y_A));
    pDRtimeAvg_F(j)=nanmean(pDRconc_F_new(x_F)*pDR_F_conversion);
    DylosSmalltimeAvg_F1(j)=nanmean(DylosSmall_F1_new(y_F1));
    DylosLargetimeAvg_F1(j)=nanmean(DylosLarge_F1_new(y_F1));
    DylosSmalltimeAvg_F2(j)=nanmean(DylosSmall_F2_new(y_F2));
    DylosLargetimeAvg_F2(j)=nanmean(DylosLarge_F2_new(y_F2));

    DateTimeAll(j)=i;
    j=j+1;

    clear x_A y_A x_F y_F1 y_F2
  end

  pDRtimeAvg_A = pDRtimeAvg_A';
  DylosSmalltimeAvg_A = DylosSmalltimeAvg_A';
  DylosLargetimeAvg_A = DylosLargetimeAvg_A';
  pDRtimeAvg_F = pDRtimeAvg_F';
  DylosSmalltimeAvg_F1 = DylosSmalltimeAvg_F1';
  DylosLargetimeAvg_F1 = DylosLargetimeAvg_F1';
  DylosSmalltimeAvg_F2 = DylosSmalltimeAvg_F2';
  DylosLargetimeAvg_F2 = DylosLargetimeAvg_F2';


%%% Mass Conversion %%%
[PMConcentration2_5_A, PMConcentration10_A, PMConcentration0_5to10_A] =
DylosConversion1(DylosSmalltimeAvg_A,DylosLargetimeAvg_A); %spits out ug/m^3
[PMConcentration2_5_F1, PMConcentration10_F1, PMConcentration0_5to10_F1] =
DylosConversion1(DylosSmalltimeAvg_F1,DylosLargetimeAvg_F1); %spits out
ug/m^3
[PMConcentration2_5_F2, PMConcentration10_F2, PMConcentration0_5to10_F2] =
DylosConversion1(DylosSmalltimeAvg_F2,DylosLargetimeAvg_F2); %spits out
ug/m^3


[x1,y1,z1]=Remove_NaN_timeseriesA(pDRtimeAvg_A,PMConcentration2_5_A,DateTimeA
ll);

[x2,y2,z2]=Remove_NaN_timeseriesA(pDRtimeAvg_A,PMConcentration10_A,DateTimeAl
l);

[x3,y3,z31,z32]=Remove_NaN_timeseriesF(pDRtimeAvg_F,PMConcentration2_5_F1,PMC
oncentration2_5_F2,DateTimeAll);

[x4,y4,z41,z42]=Remove_NaN_timeseriesF(pDRtimeAvg_F,PMConcentration10_F1,PMCo
ncentration10_F2,DateTimeAll);

%%%%%%% Plot %%%%%
%%% Location 1 %%%
```

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```
figure
plot(x1,y1,x1,z1);
figure
plot(x2,y2,x2,z2);
%%% Location 2 %%%
figure
plot(x3,y3,x3,z31,x3,z32);
figure
plot(x4,y4,x4,z41,x4,z42);
```

Functions

```matlab
function [PMConcentration2_5, PMConcentration10, PMConcentration0_5to10] =
DylosConversion1(a,b)

int32 PMConcentration2_5;
int32 PMConcentration10;

density = 1.45; %g/cm3
rPM2_5 = 1.66; %um
rPM10 = 2.61;  %um


density1 = density*1000000;   %ug/cm3
density2 = density1/(10000^3); %ug/um3
Volume2_5 = (4/3)*pi*((rPM2_5)^3); %4/3 * pi *r^3
Volume10 = (4/3)*pi*(rPM10)^3;
ParticleMass2_5 = Volume2_5*density2; %v * (m/v) = mass per particle
ParticleMass10 = Volume10*density2;

diff = a - b; %0.5 to 2.5ug/m3

%0.01 ft3 -> m3 by 3531.5
PMConcentration0_5to10 = a*3531.5*ParticleMass2_5;
PMConcentration2_5 = diff*3531.5*ParticleMass2_5;
PMConcentration10 = b*3531.5*ParticleMass10;

function [a,b,c,d,e,f,g,h,i,j,k] =
DylosConversion2(Ds,Dl,pDR,pDR_MassC,DateTimeAll,DeviceIndex)

  temp_Ds  = Ds(~isnan(pDR));
  temp_Dl  = Dl(~isnan(pDR));
  temp_pDR_MassC = pDR_MassC(~isnan(pDR));
  temp_pDR = pDR(~isnan(pDR));

  temp1_pDR = temp_pDR(~isnan(temp_Ds));
  temp_pDR_MassC1 = temp_pDR_MassC(~isnan(temp_Ds));
  temp1_Dl = temp_Dl(~isnan(temp_Ds));
  temp1_Ds = temp_Ds(~isnan(temp_Ds));

  Ds = temp1_Ds;
  Dl = temp1_Dl;
  pDR = temp1_pDR;
  pDR_MassC = temp_pDR_MassC1;

  Xround = round((length(Ds)*0.2));
  [dylos_s_20,idx] = datasample (Ds,Xround,'Replace',false);
  idx = idx';
  length1 = (1:length(Ds))';
  idx1 = ~ismember(length1, idx)';

  dylos_s_80 = Ds(idx1);
  dylos_l_20 = Dl(idx);
```

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```matlab
dylos_l_80 = Dl(idx1);
pdr_20 = pDR(idx);
pdr_80 = pDR(idx1);
pDR_MassC_20 = pDR_MassC(idx);
pDR_MassC_80 = pDR_MassC(idx1);
DateTimeAll_80 = DateTimeAll(idx1);
DeviceIndex_80 = DeviceIndex(idx1);

clear m q slop intercept
[m,q]=myregr(dylos_s_20,pDR_MassC_20);
slop_small = m(1);
intercept_small = q(1);
xdylos_s_80 = (dylos_s_80*slop_small)+intercept_small;

clear m q slop intercept
[m,q]=myregr(dylos_l_20,pDR_MassC_20);
slop_large = m(1);
intercept_large = q(1);
xdylos_l_80 = (dylos_l_80*slop_large)+intercept_large;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
 i = 1;
for j=1:1:3
  clear date_idx
  date_idx = find(DateTimeAll_80 > datenum(2013,12,13,8,0,0) & DateTimeAll_80
< datenum(2013,12,14,10,0,0) & DeviceIndex_80 == j);
  Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
  Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
  Daily_pdr_80(i)  = nanmean(pDR_MassC_80(date_idx));
  i = i+1;

  clear date_idx
  date_idx = find(DateTimeAll_80 > datenum(2013,12,16,8,0,0) & DateTimeAll_80
< datenum(2013,12,17,10,0,0) & DeviceIndex_80 == j);
  Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
  Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
  Daily_pdr_80(i)  = nanmean(pDR_MassC_80(date_idx));
  i = i+1;

  clear date_idx
  date_idx = find(DateTimeAll_80 > datenum(2013,12,18,8,0,0) & DateTimeAll_80
< datenum(2013,12,19,10,0,0) & DeviceIndex_80 == j);
  Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
  Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
  Daily_pdr_80(i)  = nanmean(pDR_MassC_80(date_idx));
  i = i+1;

  clear date_idx
  date_idx = find(DateTimeAll_80 > datenum(2013,12,21,8,0,0) & DateTimeAll_80
< datenum(2013,12,22,10,0,0) & DeviceIndex_80 == j);
  Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
  Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
  Daily_pdr_80(i)  = nanmean(pDR_MassC_80(date_idx));
  i = i+1;
```

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```
    clear date_idx
    date_idx = find(DateTimeAll_80 > datenum(2013,12,26,8,0,0) & DateTimeAll_80
< datenum(2013,12,27,10,0,0) & DeviceIndex_80 == j);
    Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
    Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
    Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
    i = i+1;

    clear date_idx
    date_idx = find(DateTimeAll_80 > datenum(2013,12,31,8,0,0) & DateTimeAll_80
< datenum(2014,01,01,10,0,0) & DeviceIndex_80 == j);
    Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
    Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
    Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
    i = i+1;

    clear date_idx
    date_idx = find(DateTimeAll_80 > datenum(2013,12,31,8,0,0) & DateTimeAll_80
< datenum(2014,01,01,10,0,0) & DeviceIndex_80 == j);
    Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
    Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
    Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
    i = i+1;

    clear date_idx
    date_idx = find(DateTimeAll_80 > datenum(2014,01,10,8,0,0) & DateTimeAll_80
< datenum(2014,01,11,10,0,0) & DeviceIndex_80 == j);
    Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
    Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
    Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
    i = i+1;

    clear date_idx
    date_idx = find(DateTimeAll_80 > datenum(2014,01,17,8,0,0) & DateTimeAll_80
< datenum(2014,01,18,10,0,0) & DeviceIndex_80 == j);
    Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
    Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
    Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
    i = i+1;

    clear date_idx
    date_idx = find(DateTimeAll_80 > datenum(2014,01,22,8,0,0) & DateTimeAll_80
< datenum(2014,01,23,8,0,0) & DeviceIndex_80 == j);
    Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
    Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
    Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
    i = i+1;

    clear date_idx
    date_idx = find(DateTimeAll_80 > datenum(2014,01,24,8,0,0) & DateTimeAll_80
< datenum(2014,01,25,8,0,0) & DeviceIndex_80 == j);
    Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
    Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
    Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
    i = i+1;
```

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```
clear date_idx
date_idx = find(DateTimeAll_80 > datenum(2014,01,26,8,0,0) & DateTimeAll_80
< datenum(2014,01,27,8,0,0) & DeviceIndex_80 == j);
Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
i = i+1;


clear date_idx
date_idx = find(DateTimeAll_80 > datenum(2014,01,20,8,0,0) & DateTimeAll_80
< datenum(2014,01,21,10,0,0) & DeviceIndex_80 == j);
Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
i = i+1;


clear date_idx
date_idx = find(DateTimeAll_80 > datenum(2014,02,03,8,0,0) & DateTimeAll_80
< datenum(2014,02,04,10,0,0) & DeviceIndex_80 == j);
Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
i = i+1;


clear date_idx
date_idx = find(DateTimeAll_80 > datenum(2014,02,10,8,0,0) & DateTimeAll_80
< datenum(2014,02,11,10,0,0) & DeviceIndex_80 == j);
Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
i = i+1;


clear date_idx
date_idx = find(DateTimeAll_80 > datenum(2014,02,17,8,0,0) & DateTimeAll_80
< datenum(2014,02,18,10,0,0) & DeviceIndex_80 == j);
Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
i = i+1;


clear date_idx
date_idx = find(DateTimeAll_80 > datenum(2014,02,24,8,0,0) & DateTimeAll_80
< datenum(2014,02,25,10,0,0) & DeviceIndex_80 == j);
Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
i = i+1;


clear date_idx
date_idx = find(DateTimeAll_80 > datenum(2014,02,26,8,0,0) & DateTimeAll_80
< datenum(2014,02,27,8,0,0) & DeviceIndex_80 == j);
Daily_dylos_s_80(i) = nanmean(xdylos_s_80(date_idx));
Daily_dylos_l_80(i) = nanmean(xdylos_l_80(date_idx));
Daily_pdr_80(i)   = nanmean(pDR_MassC_80(date_idx));
```

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```matlab
    i = i+1;
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

a = xdylos_s_80;
b = xdylos_l_80;
c = pdr_80;
d = pDR_MassC_80;
e = Daily_dylos_s_80';
f = Daily_dylos_l_80';
g = Daily_pdr_80';
h = slop_small;
i = intercept_small;
j = slop_large;
k = intercept_large;


function y = EPA_Stats(X,Y,Z)

  B = mean(((Y- X)./(X))*100);
  di = (((Y- X)./(X)));
  total = numel(X);
  df = total -1;
  eov = sqrt((sum((di - B).^2))/df);
  percnt = 95;
  prob = (1 - percnt/100)*2;
  t = tinv(percnt/100,df);

  U90Cl = B + t * (eov/(sqrt(total)));
  L90Cl = B - t * (eov/(sqrt(total)));



  r = corr2(X,Y);
  rmse=sqrt(sum((X-Y).^2)/numel(X));

  [m,q]=myregr(X,Y);

  slop = m(1);
  sloperr = m(2);

  intercept = q(1);
  intercepterr = q(2);



  for ii =1:length(Y)
    STDSDylos(ii)  = std(Z(1,:));
    meanAllDylos(ii) = mean(Z(1,:));
    CVsubDylos(ii)  = STDSDylos(ii) ./ meanAllDylos(ii);
```

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```matlab
        STDSDylosPDR(ii)  = std([X(ii),Y(ii)]);
        meanDifflDylosPDR(ii) = X(ii)-Y(ii);
    end

    stdFINDylos = mean(STDSDylos);
    meanFinDylos = mean(meanAllDylos);
    CVFinDylos   = mean(CVsubDylos);



    stdFINDylosPDR = mean(STDSDylosPDR);
    meanDiffFinDylosPDR = mean(meanDifflDylosPDR);
    stdDiffFinDylosPDR = std(meanDifflDylosPDR);
    r = corr2(X,Y);
    rmse=sqrt(sum((X-Y).^2)/numel(X));

    [md nd] = size(Z);
    display('X-Sampler Reference')
    display('Y-Sampler Measurment')
    display(['Data Pairs ',num2str(total)])
    display(['Bias ',num2str(B)])
    display(['Lower 95% Confidence Level ',num2str(L90Cl)])
    display(['Upper 95% Confidence Level ',num2str(U90Cl)])
    display(['Slop X coef ', setstr(177), ' Std Err. ', num2str(slop), ' '
,setstr(177),' ' ,num2str(sloperr)])
    display(['Y Intercept ', setstr(177), ' Std Err. ', num2str(intercept), ' '
,setstr(177),' ' ,num2str(intercepterr)])
    display(['r ',num2str(r)])
    display(['r2 ',num2str(r^2)])
    display(['rmse(ug/m3) ',num2str(rmse)])
    display(['Average ratio ', setstr(177), ' Std. Dev. ',
num2str(mean(X)/mean(Y)), ' ' ,setstr(177),' ' ,num2str(std(X./Y))])
    display(['Mean difference (ug/m3) ', setstr(177), ' Std. Dev. ',
num2str(meanDiffFinDylosPDR), ' ' ,setstr(177),' '
,num2str(stdDiffFinDylosPDR)])
    display(' ')
    display('Precision Calculation for Measurment')
    display(['Number of Samplers ' num2str(nd)])
    display(['Average Concentration ', setstr(177),' Std. Dev. ;(ug/m3)',
num2str(meanFinDylos), ' ' ,setstr(177),' ' ,num2str(stdFINDylosPDR)])
    display(['Concentration Range (ug/m3)', num2str(min(min(Y))), '-'
,num2str(max(max(Y)))])
    display(['Coefficient of Variation ',num2str(CVFinDylos*100)])
    y = 1;
end
```

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APPENDIX B: INTERCOMPARISONS BETWEEN DAILY RECORDINGS

FOR ALL INSTRUMENTS

Comparison between all instruments are displayed on one graph. For the scatterplots, the instrument on the x-axis corresponds with the label heading above the column, while the instrument on the y-axis corresponds to the label heading to the right of the row. Likewise the slope, intercept, and coefficient of determination (R^2) of the linear regression are present in the upper right of the figure. They read similarly to the scatterplots, with the interception of the labels being the descriptors of that scatterplot. For example DC1100 small and respirable mass, the scatterplot is at [1:4] and the slope, intercept, and R^2 is at [4:1] for Figure B - 1. The figures are followed by a table showing descriptive statistics.
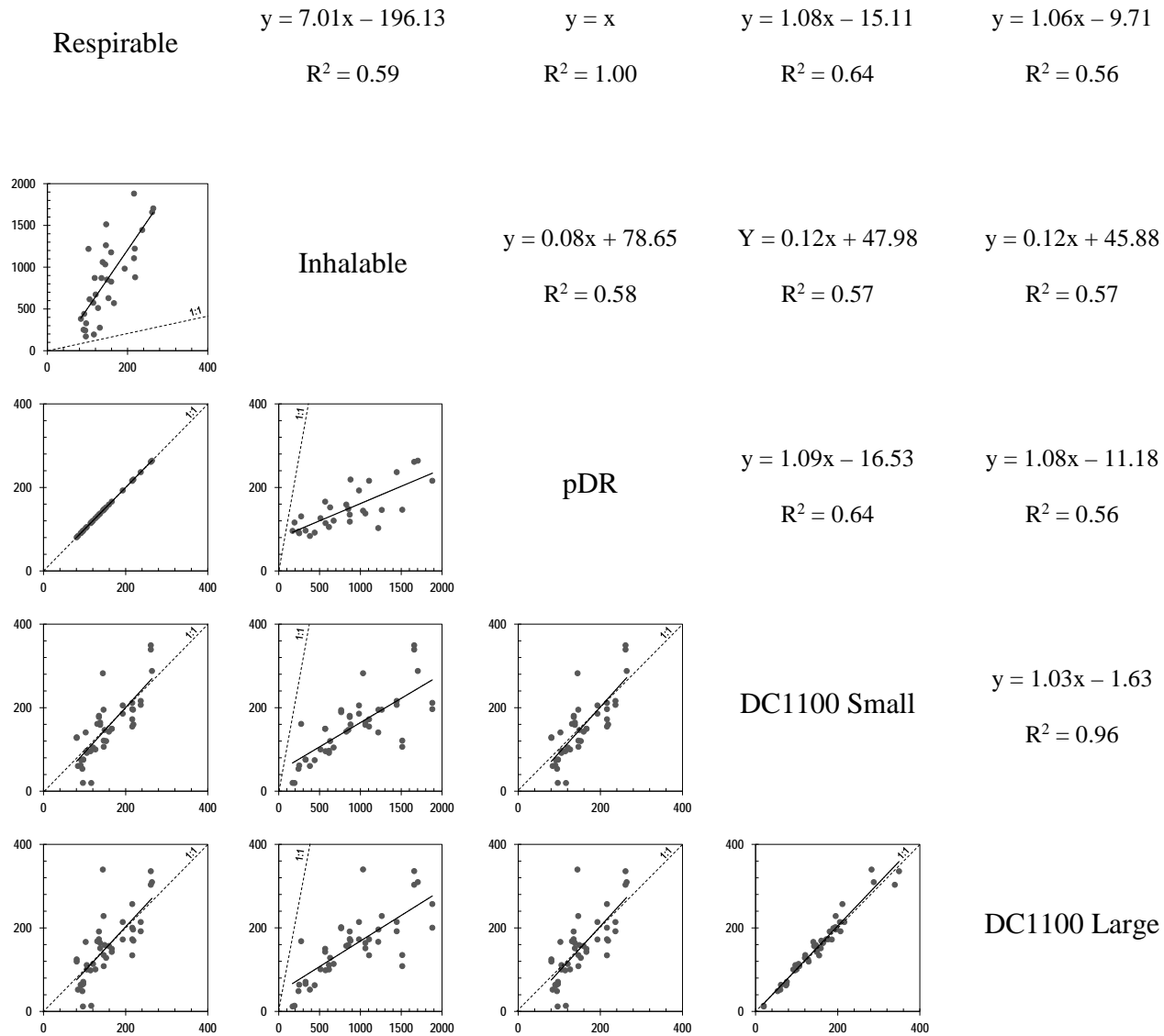
Figure B - 1: Physical property method (Method 1) comparisons for all instruments from December 13, 2013 to February 27, 2014

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Table B - 1: Physical property method (Method 1) summary table for all instruments

X-Sampler	Y-Sampler	Data pairs	Avg. Bias, %	Lower 95% confidence limit	Upper 95% confidence limit	Slope X coef ± Std. Err	Y Intercept ± Std. Err	r	R^2	rmse	Average ratio ± Std. Dev.	Mean difference ± Std. Dev
Respirable	Inhalable	32	453.18	316.55	589.81	7.01 ± 1.07	-196.13 ± 169.85	0.77	0.59	826.51	0.18 ± 0.13	-706.67 ± 435.51
Respirable	pDR	31	0.00	0.00	0.00	1 ± 0	0 ± 0	1.00	1.00	0.00	1 ± 0	0 ± 0
Inhalable	pDR	30	-77.02	-101.08	-52.96	0.08 ± 0.01	78.66 ± 12.62	0.76	0.58	812.72	5.65 ± 2.43	686.38 ± 442.64
Respirable	DC1100$_{small, MC}$	43	-3.06	-3.86	-2.27	1.10 ± 0.16	-20.92 ± 25.27	0.80	0.64	44.29	1.02 ± 0.96	3.17 ± 44.70
Inhalable	DC1100$_{small, MC}$	43	-81.44	-102.36	-60.51	0.13 ± 0.18	39.94 ± 17.52	0.75	0.57	863.53	5.91 ± 2.32	752.09 ± 429.34
pDR	DC1100$_{small, MC}$	42	-2.89	-3.65	-2.13	1.13 ± 0.17	-23.25 ± 25.95	0.80	0.64	44.68	1.02 ± 0.97	2.70 ± 45.14
Respirable	DC1100$_{large, MC}$	43	-1.17	-1.49	-0.85	1.120.19	-17.86 ± 30.29	0.75	0.56	51.39	1.00 ± 1.59	0.21 ± 52.00
Inhalable	DC1100$_{large, MC}$	43	-81.31	-102.20	-60.42	0.14 ± 0.02	36.72 ± 19.11	0.75	0.57	859.00	5.77 ± 2.76	748.43 ± 426.58
pDR	DC1100$_{large, MC}$	42	-0.96	-1.23	-0.69	1.14 ± 0.20	-20.61 ± 31.11	0.75	0.56	51.89	1.00 ± 1.60	-0.31 ± 52.52
DC1100$_{small, MC}$	DC1100$_{large, MC}$	45	0.00	-0.03	0.03	1.03 ± 0.03	-1.63 ± 5.66	0.98	0.96	16.39	0.98 ± 0.15	-3.21 ± 16.25

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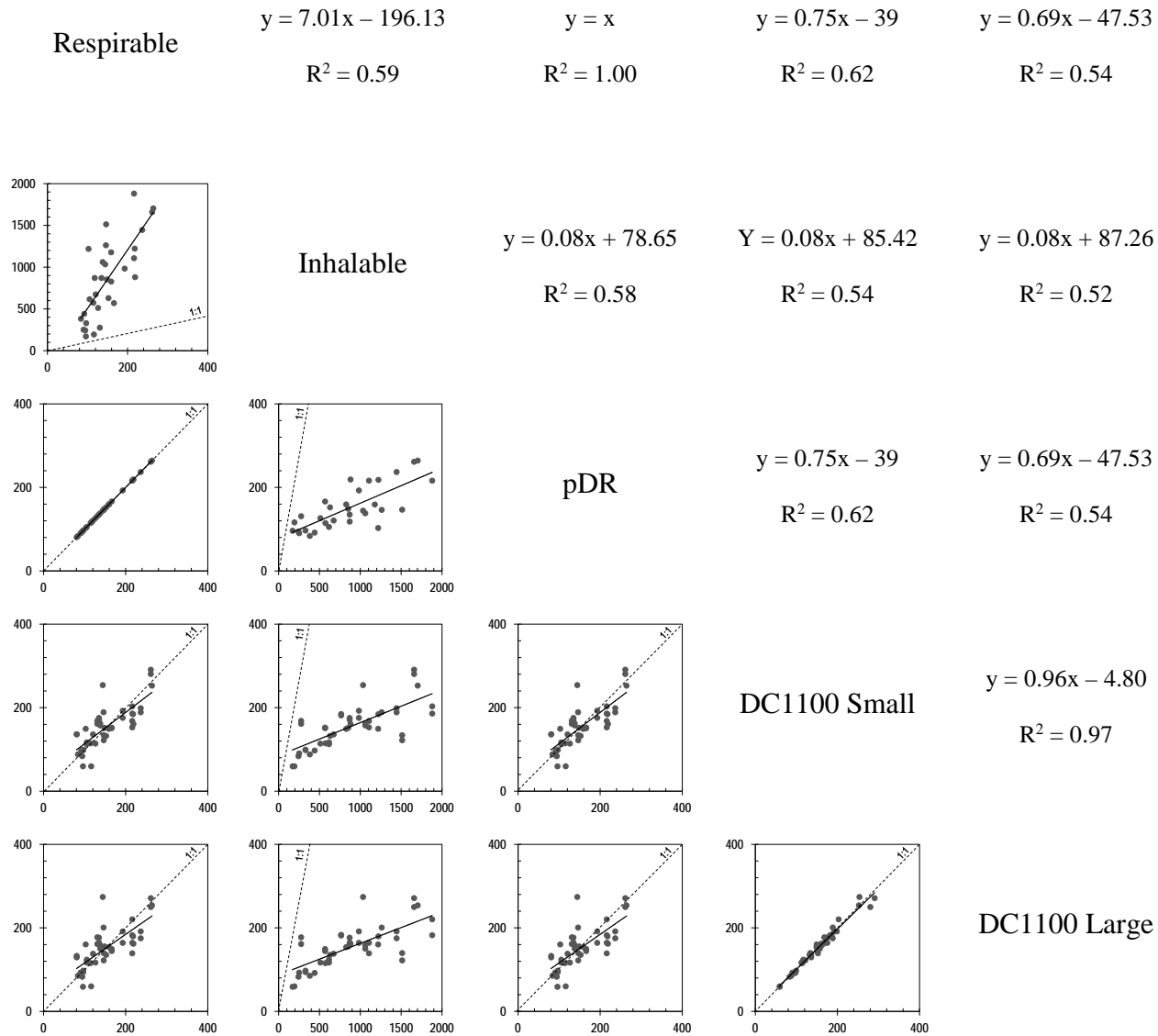
Figure B - 2: Regression method (Method 2) comparisons for all instruments from December 13, 2013 to February 27, 2014

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Table B - 2: Regression method (Method 2) summary table for all instruments

X-Sampler	Y-Sampler	Data pairs	Avg. Bias, %	Lower 95% confidence limit	Upper 95% confidence limit	Slope X coef ± Std. Err	Y Intercept ± Std. Err	r	R^2	rmse	Average ratio ± Std. Dev.	Mean difference ± Std. Dev
Respirable	Inhalable	32	453.18	316.55	589.81	7.01 ± 1.07	-196.13 ± 1.07	0.77	0.59	826.51	0.18 ± 0.13	706.67 ± 435.51
Respirable	pDR	31	0	0	0	1 ± 0	0 ± 0	1	1	0	1 ± 0	0 ± 0
Inhalable	pDR	32	-77.48	-100.83	-54.12	0.08 ± 0.01	78.27 ± 12.50	0.77	0.59	826.51	5.71 ± 2.37	706.67 ± 435.51
Respirable	DC1100$_{small,MC}$	44	3.63	2.71	4.55	0.78 ± 0.12	33.39 ± 18.53	0.78	0.62	34.62	1.00 ± 0.26	0.49 ± 35.02
Inhalable	DC1100$_{small,MC}$	44	-78.33	-98.21	-58.45	0.09 ± 0.01	75.06 ± 12.54	0.73	0.54	859.26	5.73 ± 2.29	735.44 ± 449.49
pDR	DC1100$_{small,MC}$	44	3.63	2.71	4.55	0.78 ± 0.12	33.39 ± 18.53	0.78	0.62	34.62	1.00 ± 0.26	0.49 ± 35.02
Respirable	DC1100$_{large,MC}$	44	3.32	2.48	4.17	0.3 ± 0.13	40.85 ± 20.02	0.74	0.54	37.89	1.00 ± 0.27	0.65 ± 38.33
Inhalable	DC1100$_{large,MC}$	44	-78.36	-98.25	-58.48	0.09 ± 0.01	76.53 ± 12.71	0.72	0.52	860.81	5.76 ± 2.28	736.37 ± 450.96
pDR	DC1100$_{large,MC}$	44	3.32	2.48	4.17	0.73 ± 0.13	40.85 ± 20.02	0.74	0.54	37.89	1.00 ± 0.27	0.65 ± 38.33
DC1100$_{small,MC}$	DC1100$_{large,MC}$	46	-0.52	-0.65	-0.39	0.96 ± 0.02	4.80 ± 4.02	0.99	0.97	8.59	1.01 ± 0.04	1.11 ± 8.61

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APPENDIX C: TIME SERIES GRAPHS USING PHYSICAL PROPERTY

METHOD DC1100 AND MASS CORRECTED PDR-1200

Time series graphs were creating to compare Method 1 (density and particle diameter) mass conversion of DC1100 along with respirable mass corrected pDR. This appendix is organized by run day, run location, and DC1100 particle size.

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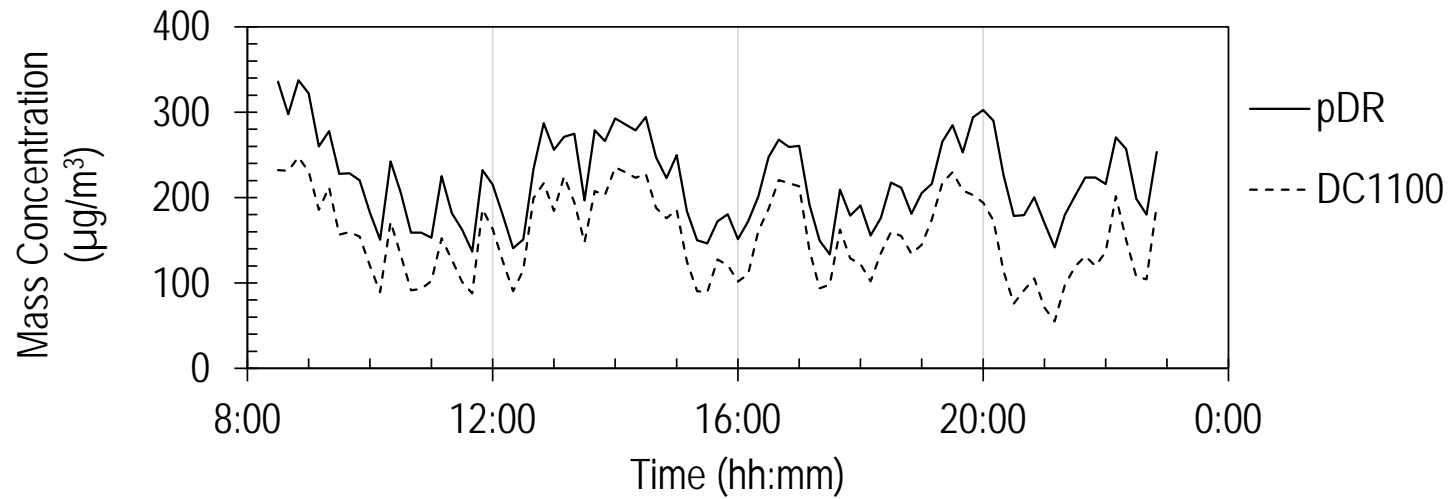
Figure C - 1: Location 1, DC1100 small particles (December 13- 14)
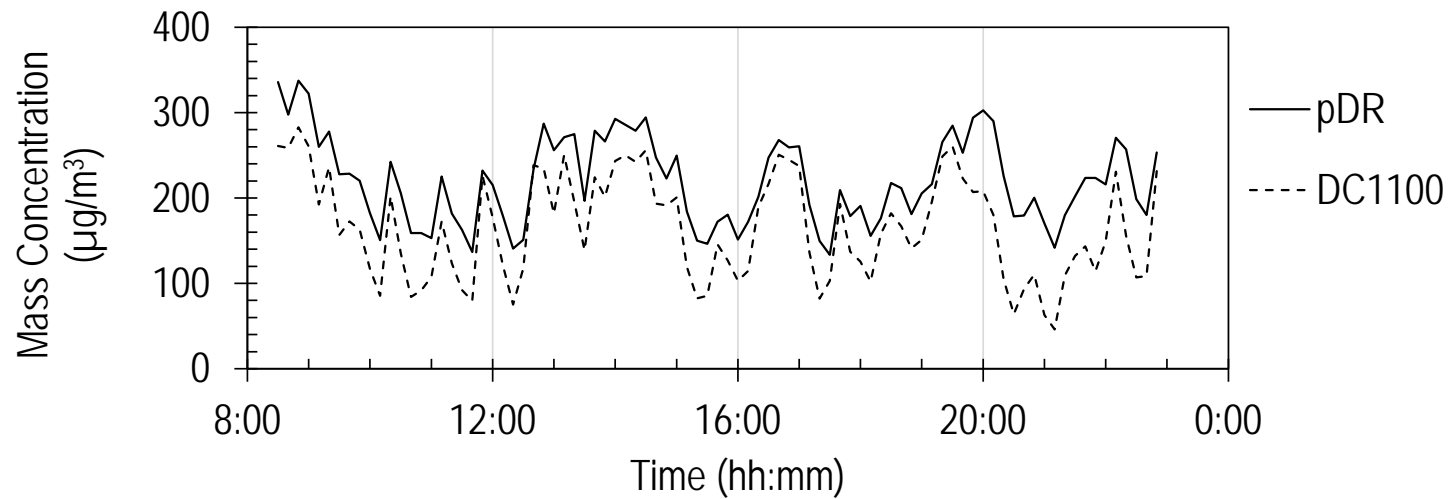
Figure C - 2: Location I, DC1100 large particles (December 13 - 14)

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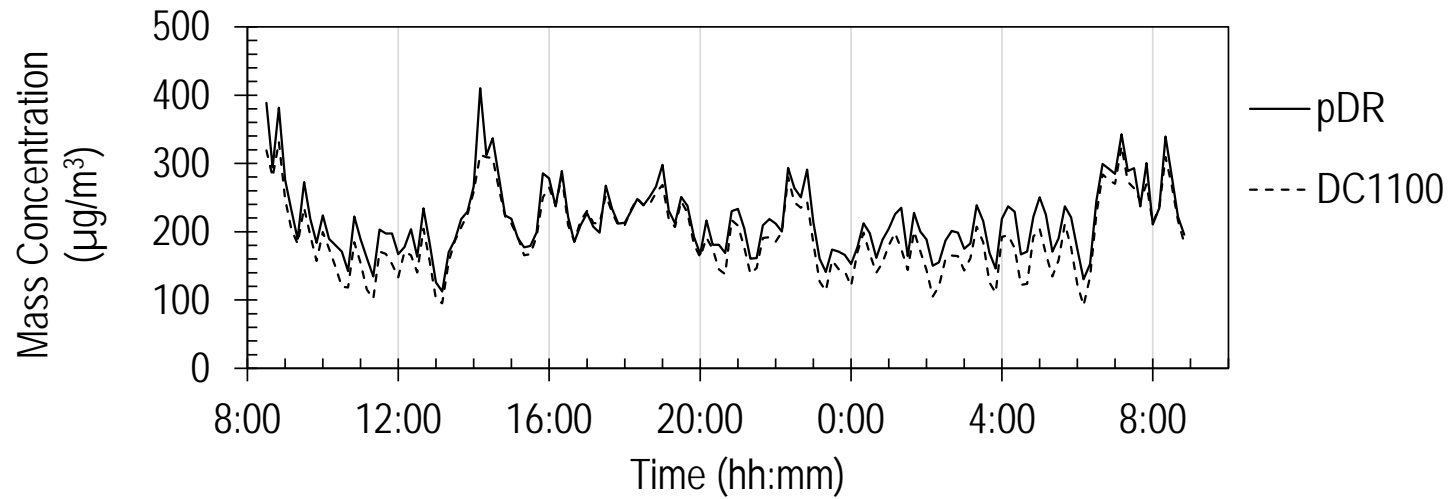
Figure C - 3: Location I, DC1100 small particles (December 16 - 17)
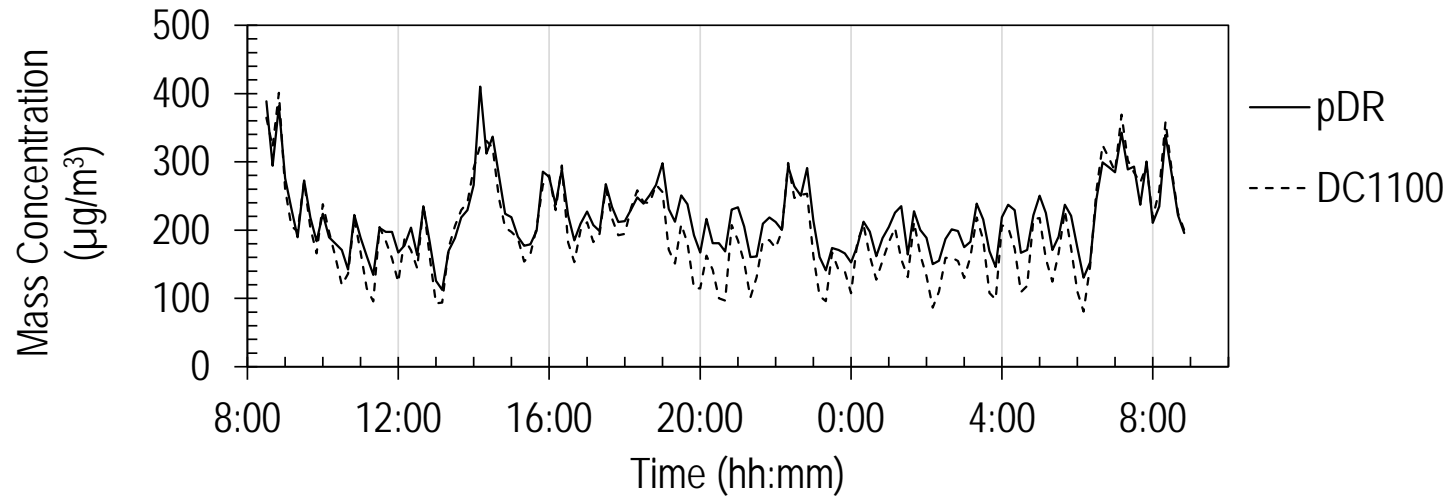
Figure C - 4: Location I, DC1100 large particles (December 16 - 17)

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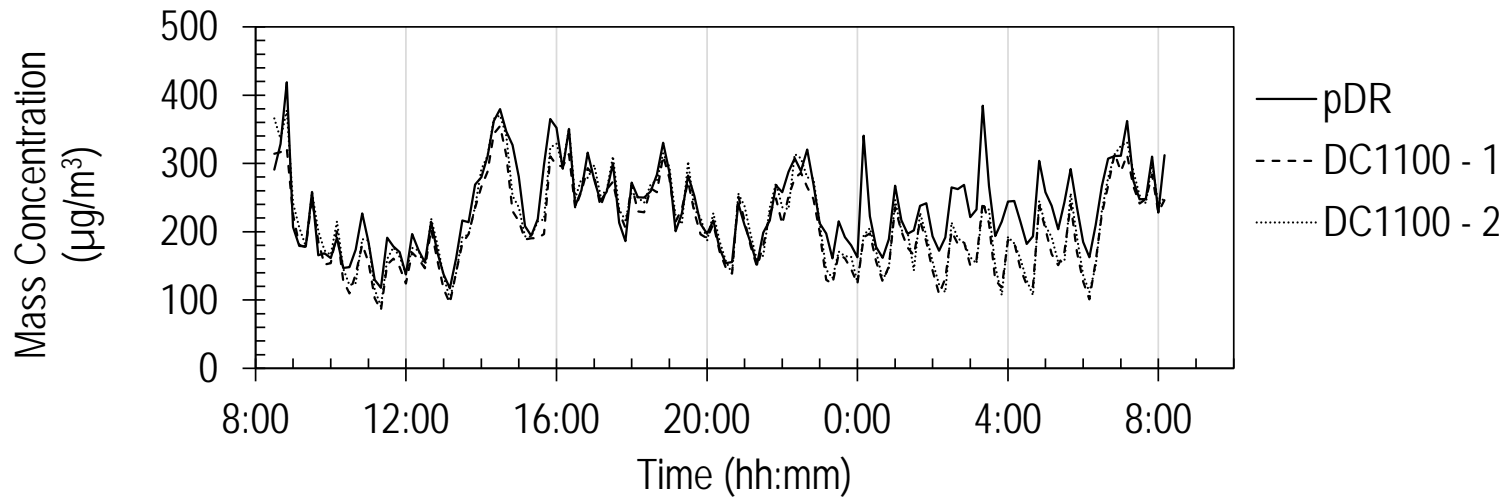
Figure C - 5: Location II, DC1100 small particles (December 16 - 17)
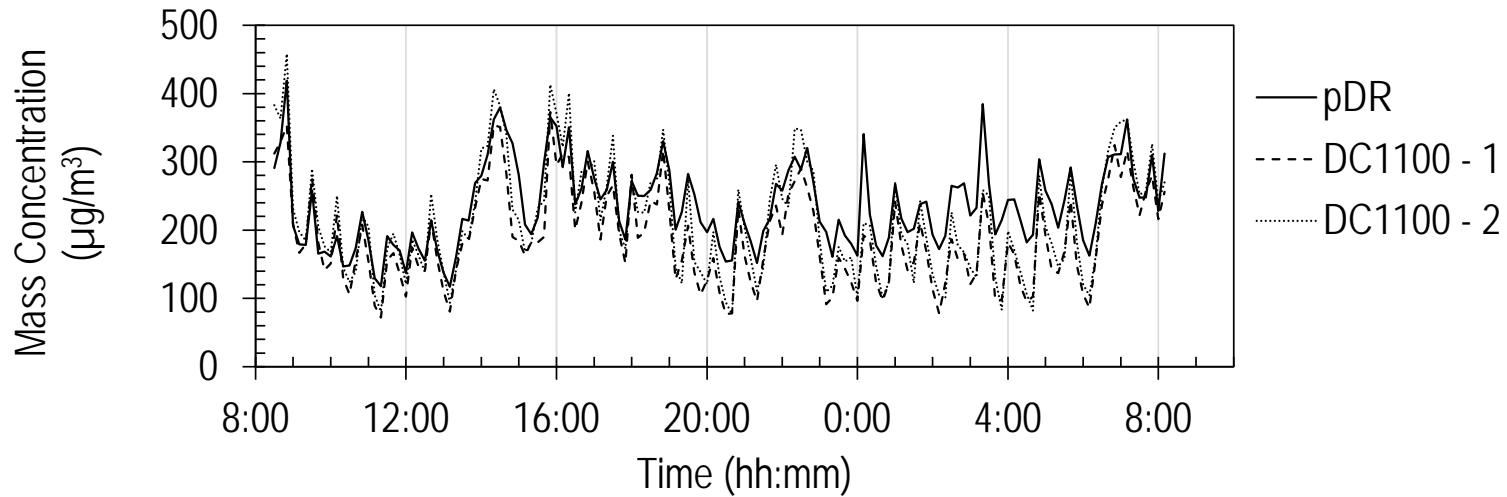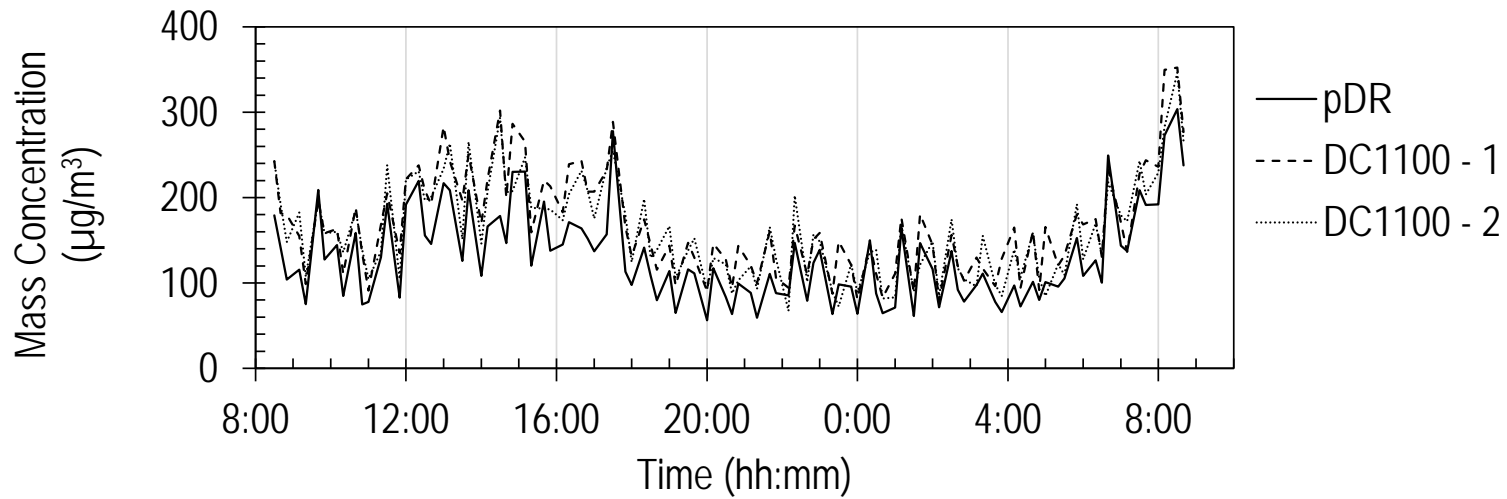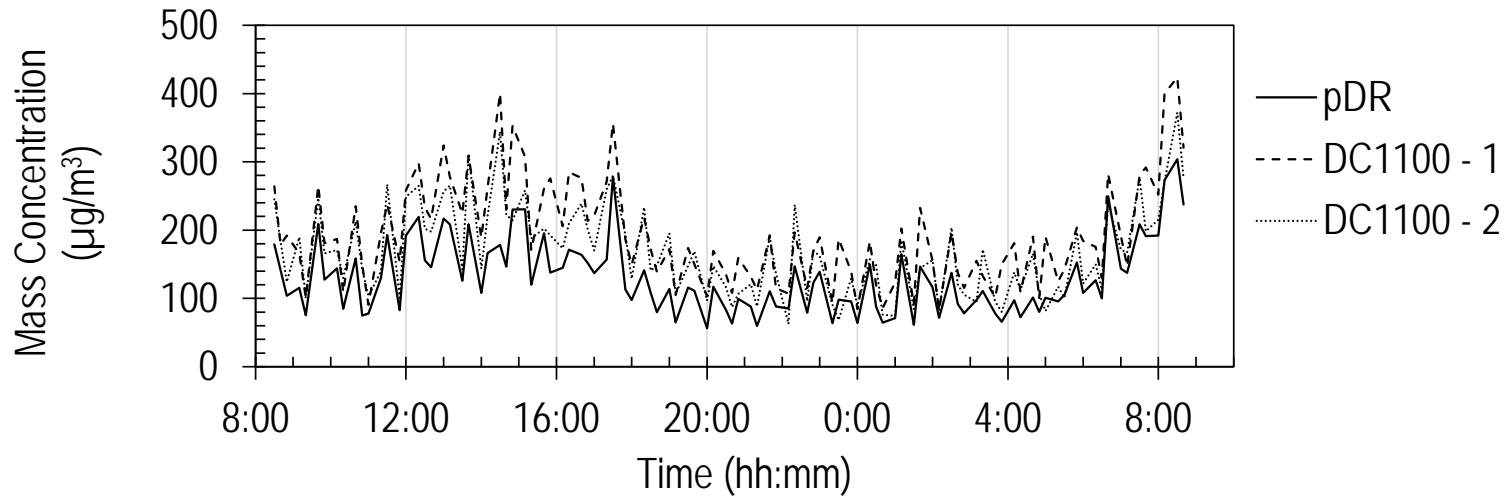

Figure C - 6: Location II, DC1100 large particles (December 16 - 17)
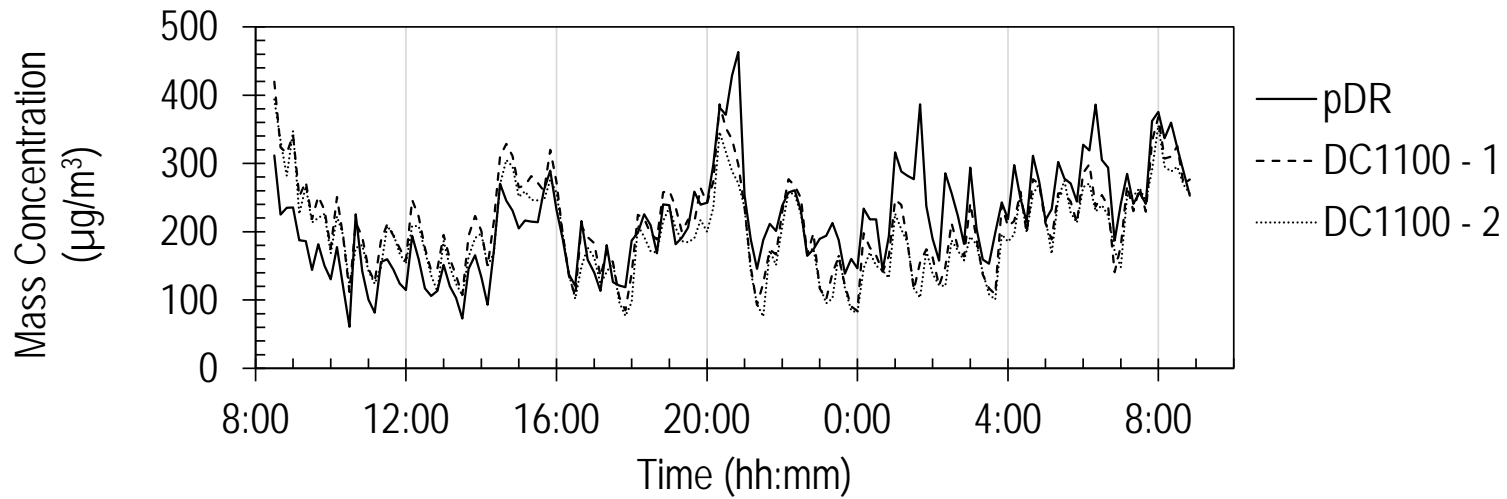
Figure C - 7: Location II, DC1100 small particles (December 18 - 19)
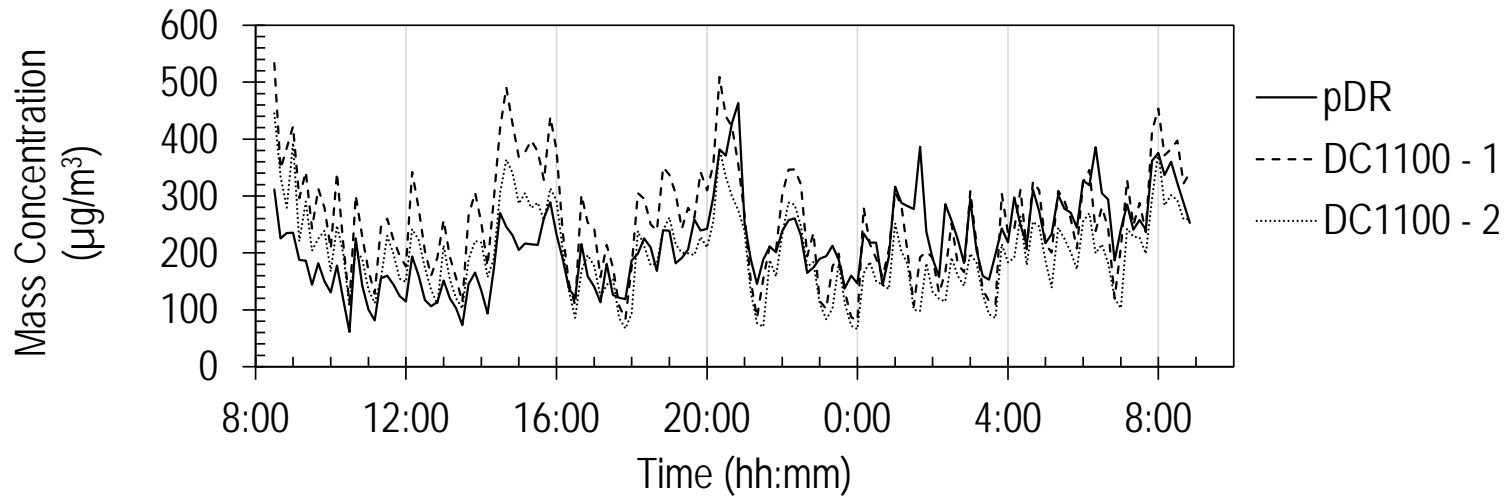
Figure C - 8: Location II, DC1100 large particles (December 18 - 19)
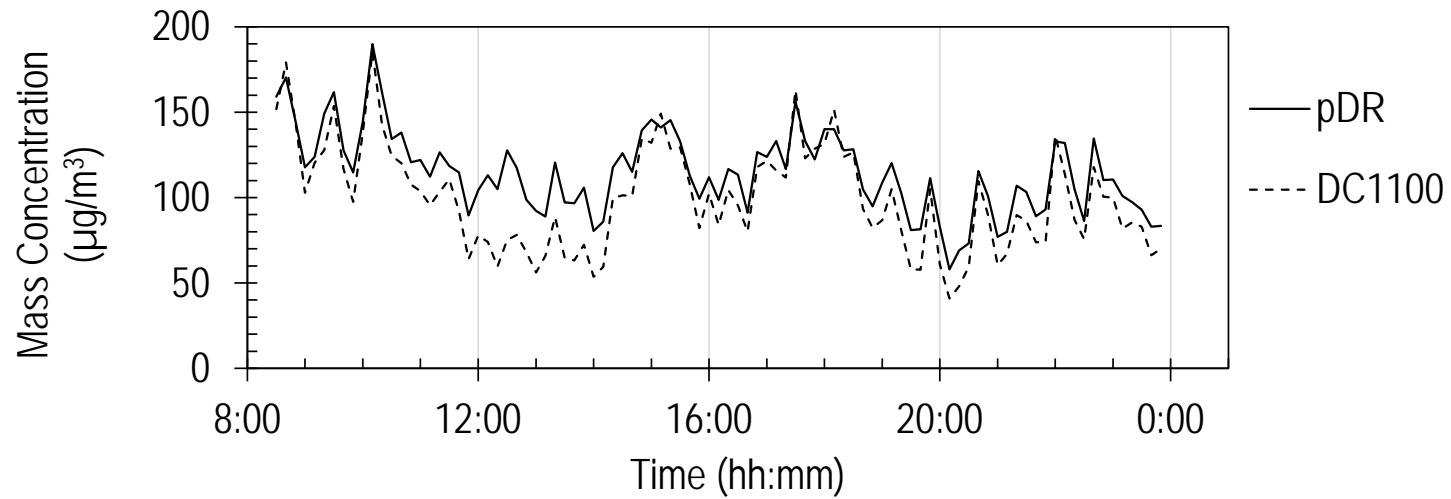
Figure C - 9: Location I, DC1100 small particles (December 21 - 22)
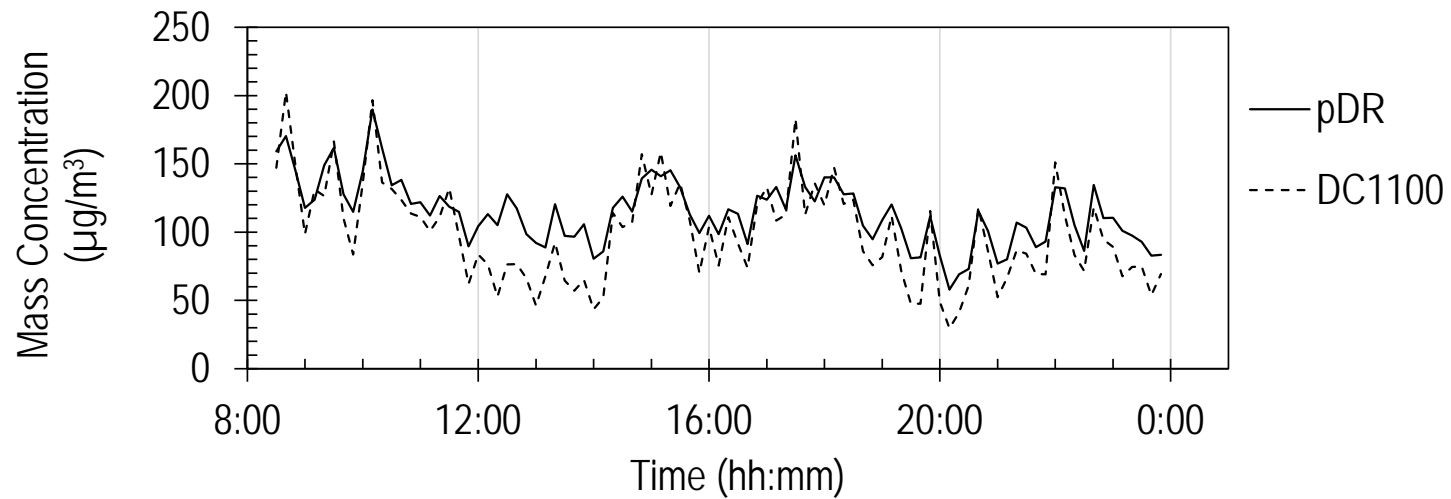
Figure C - 10: Location I, DC1100 large particles (December 21 - 22)

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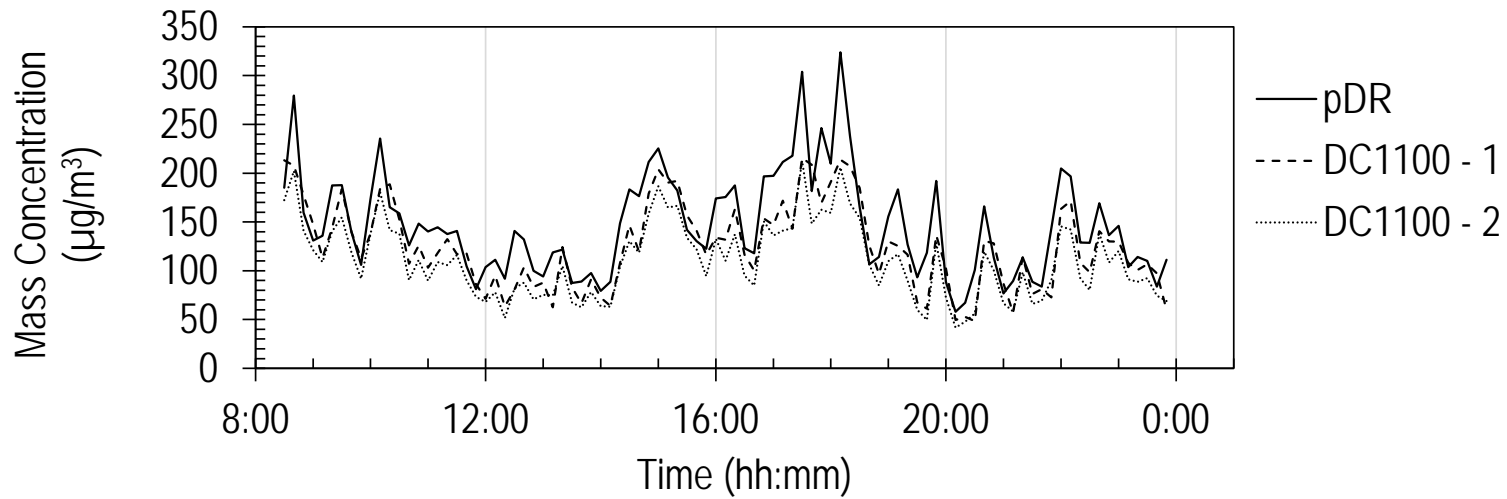
Figure C - 11: Location II, DC1100 small particles (December 21 - 22)
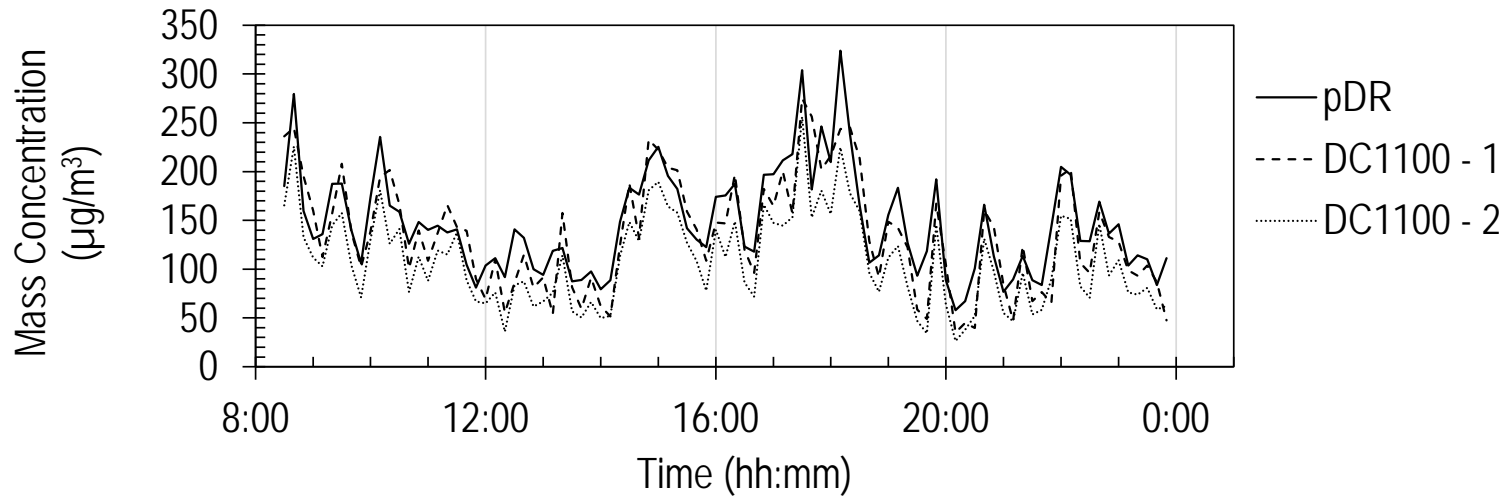
Figure C - 12: Location II, DC1100 large particles (December 21 - 22)
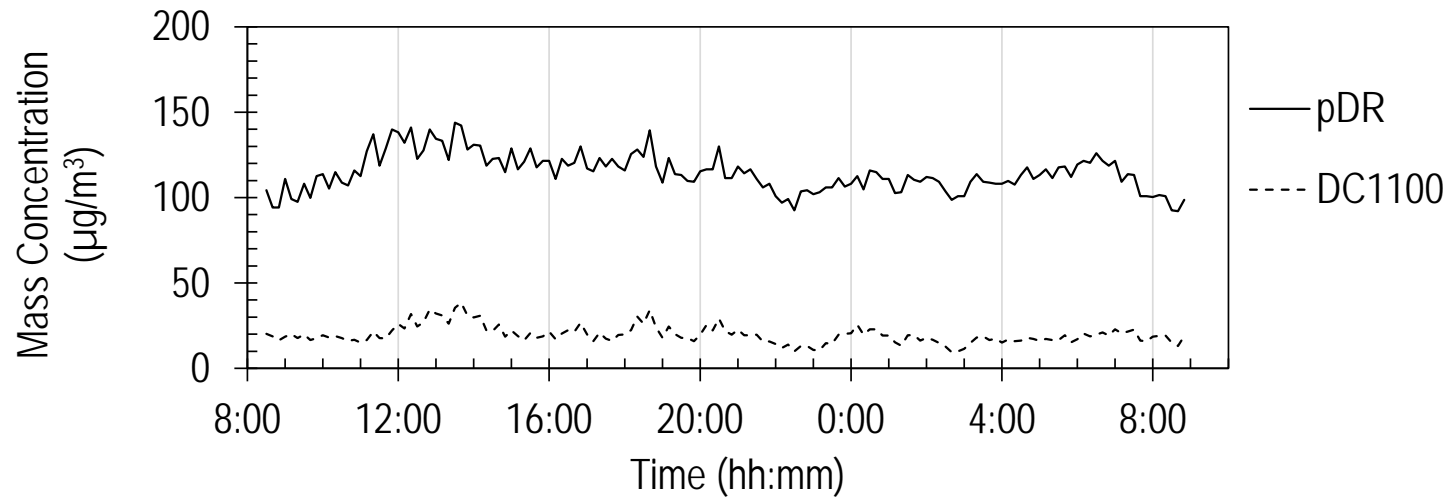
Figure C - 13: Location I, DC1100 small particles (December 31 – January 1)
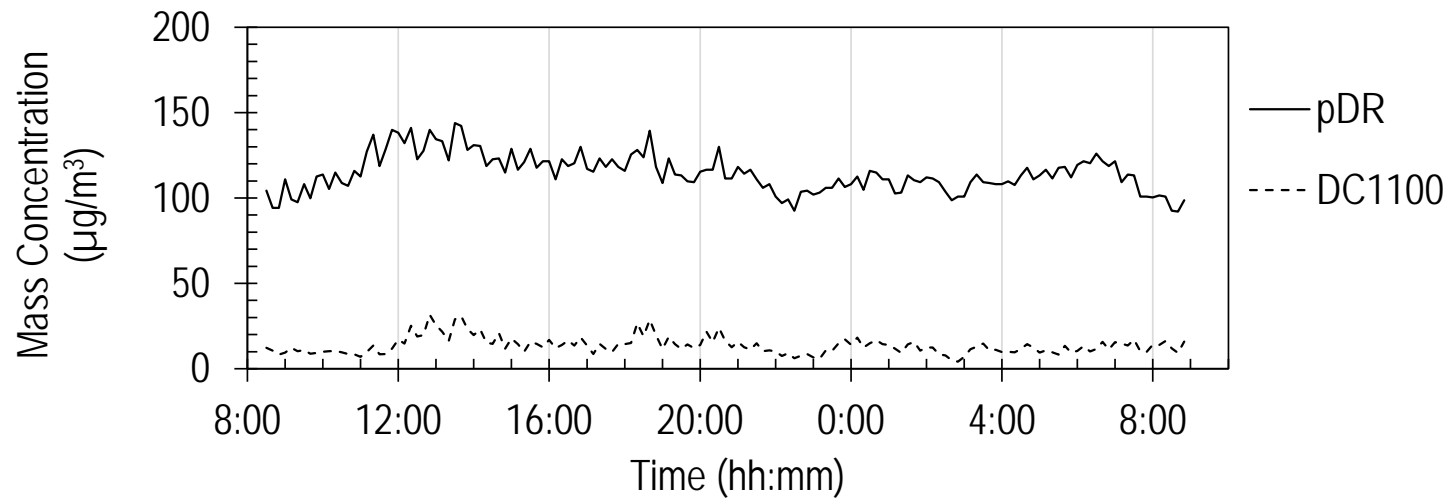
Figure C - 14: Location I, DC1100 large particles (December 31 – January 1)

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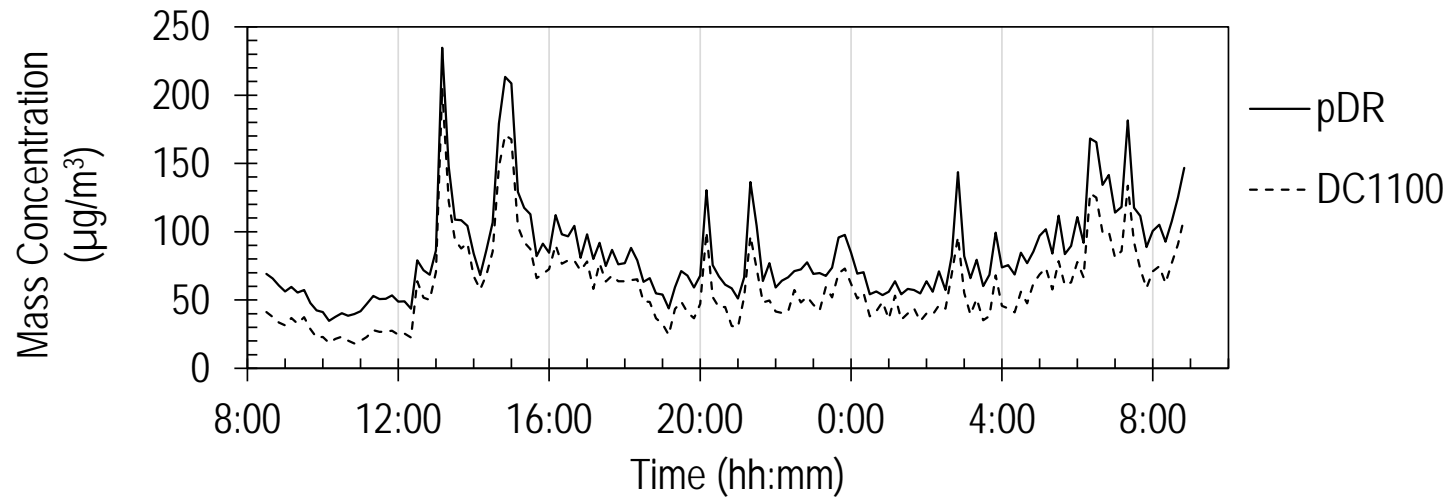
Figure C - 15: Location I, DC1100 small particles (January 10 – 11)
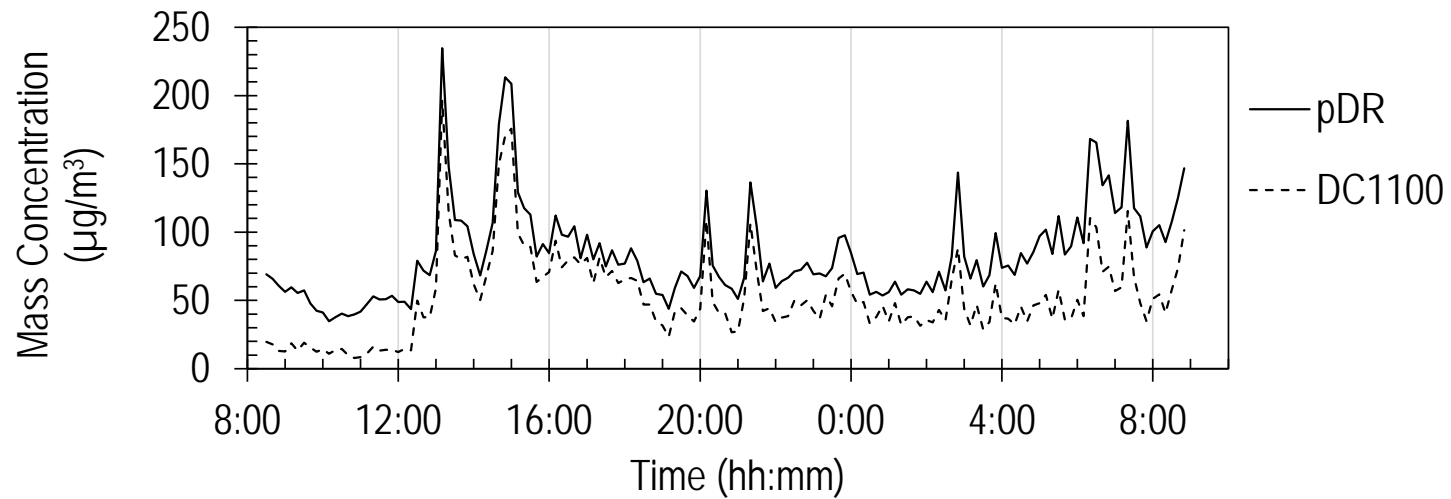
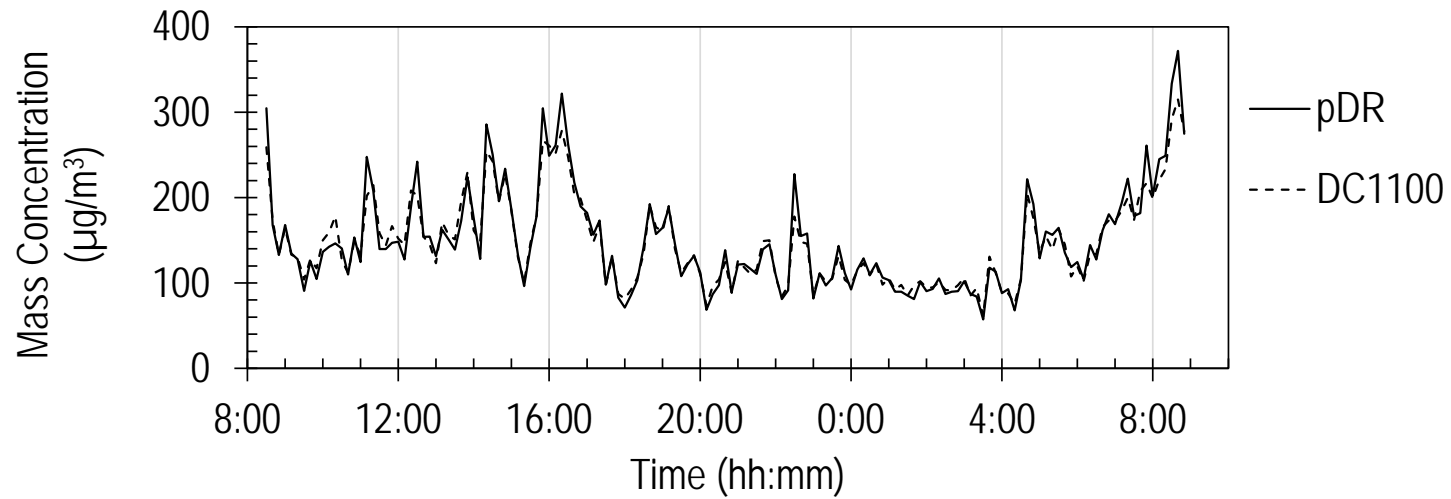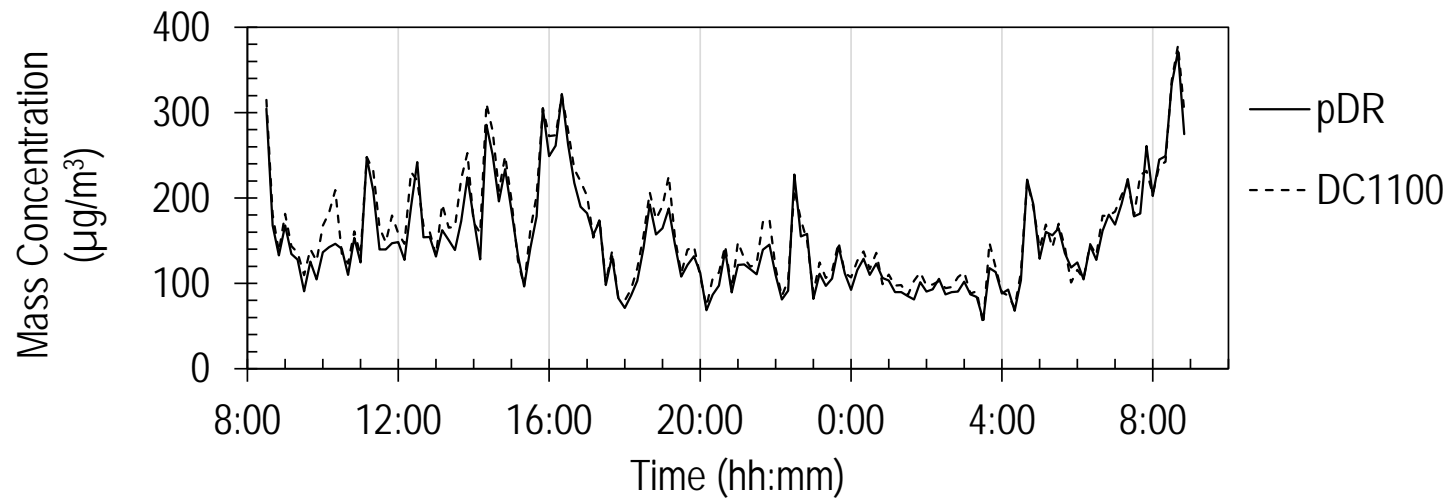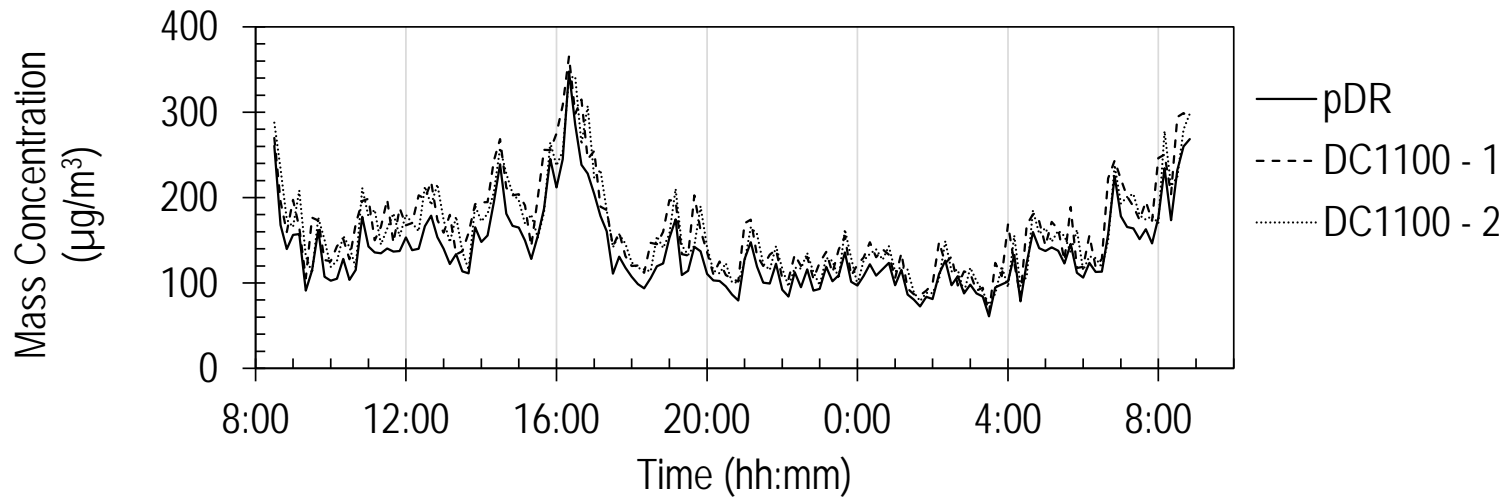Figure C - 16: Location I, DC1100 large particles (January 10 – 11)

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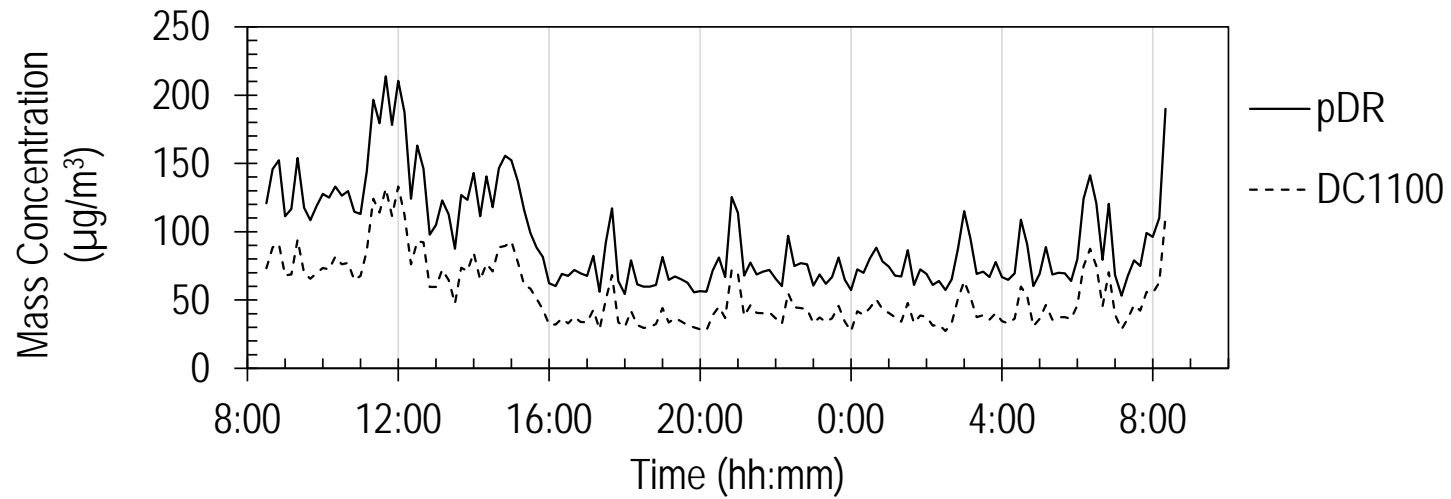
Figure C - 17: Location I, DC1100 small particles (January 17 – 18)
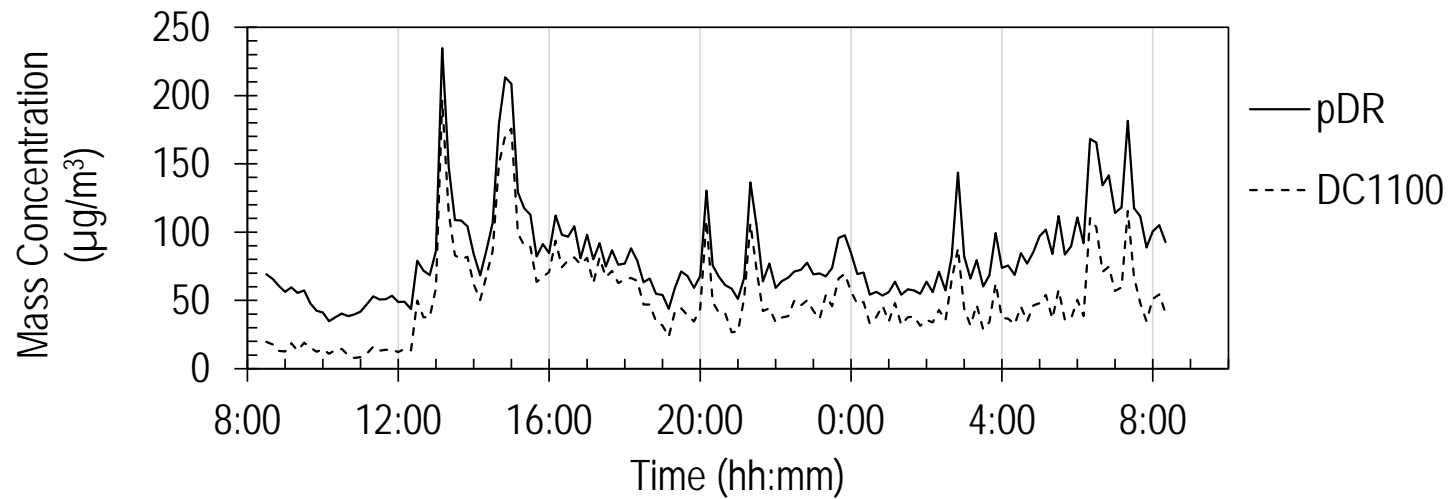
Figure C - 18: Location I, DC1100 large particles (January 17 – 18)

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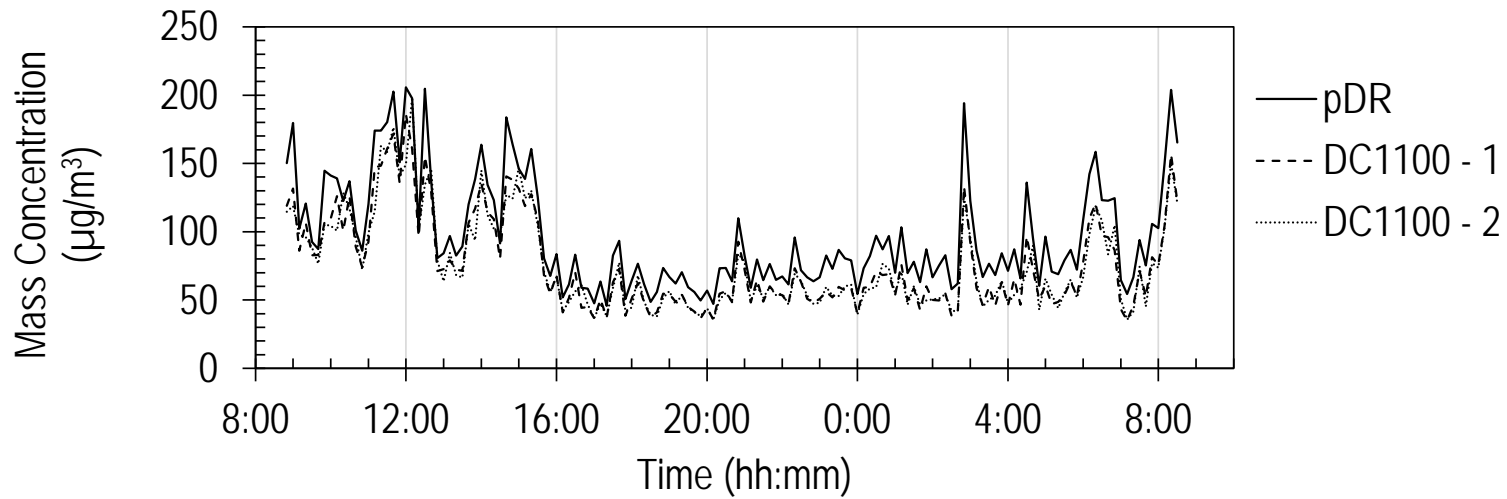
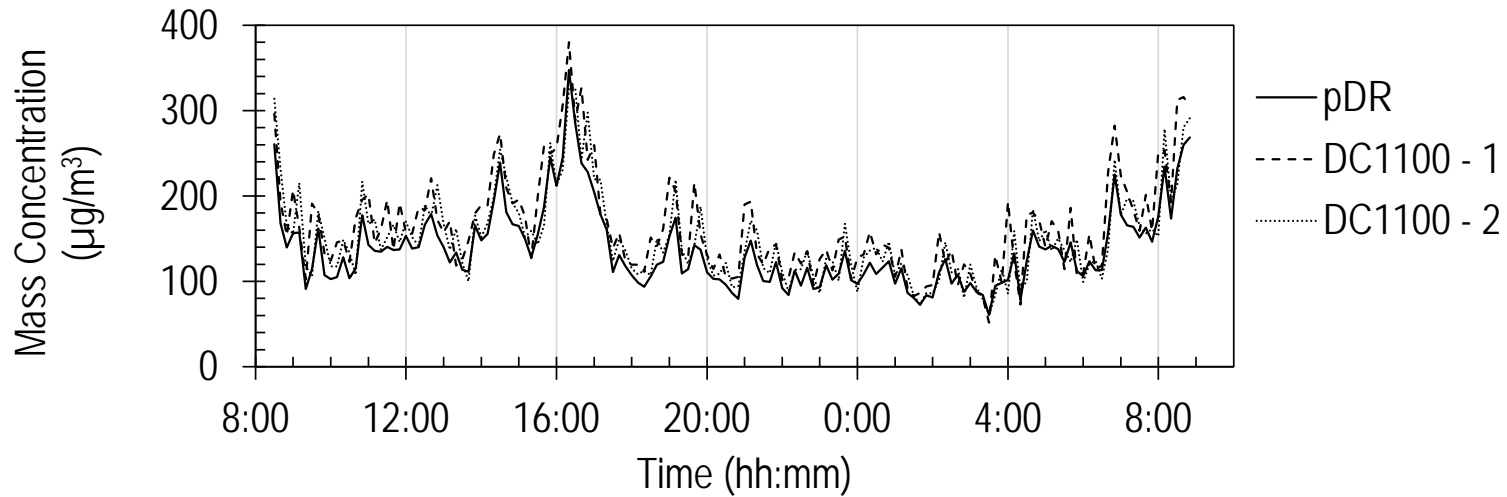Figure C - 19: Location II, DC1100 small particles (January 17 – 18)
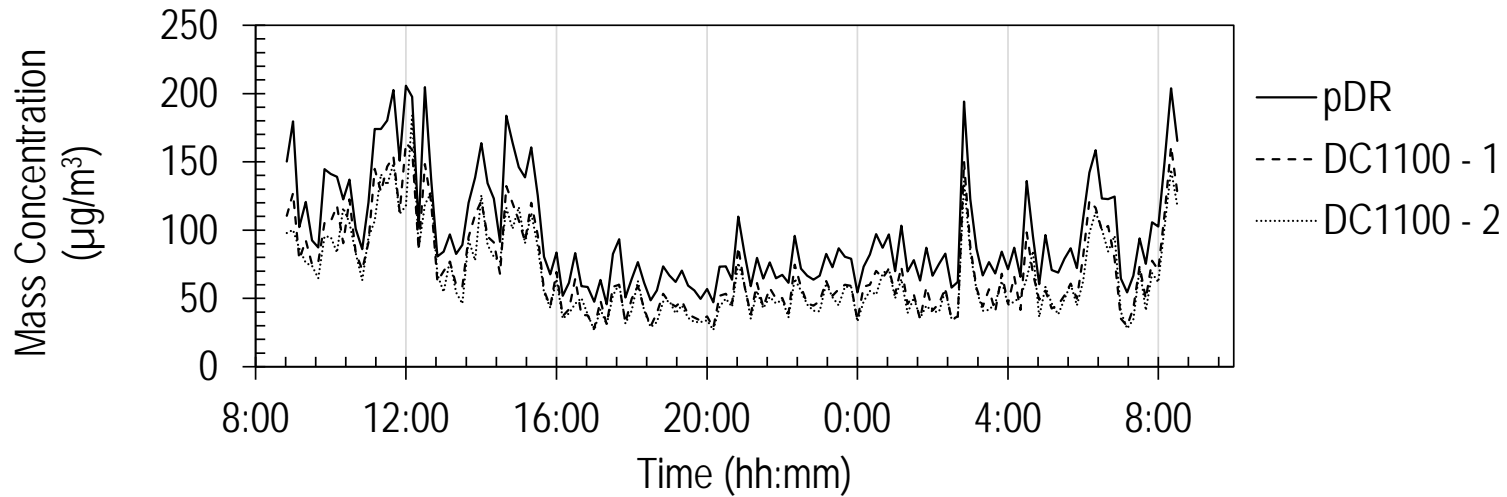
Figure C - 20: Location II, DC1100 large particles (January 17 – 18)

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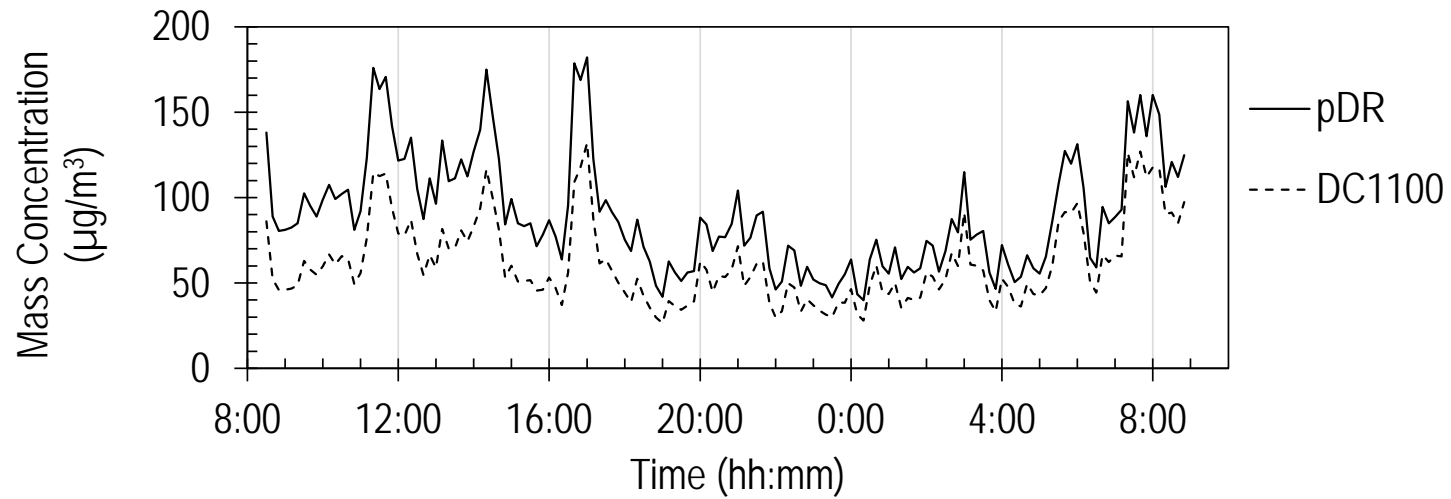
Figure C - 21: Location I, DC1100 small particles (January 20 – 21)
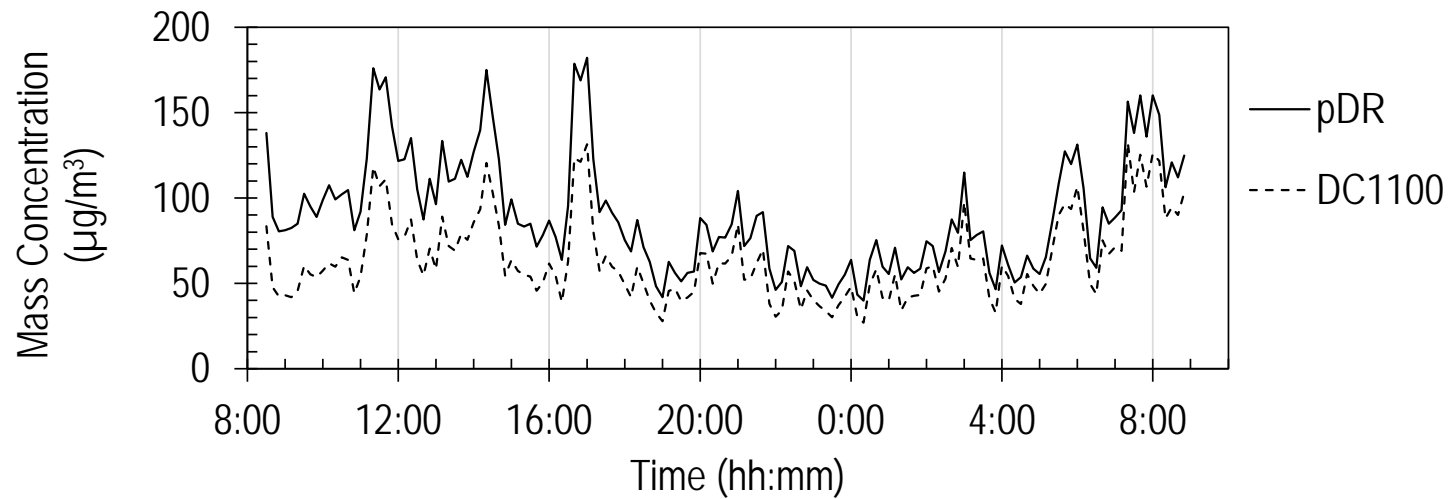
Figure C - 22: Location I, DC1100 large particles (January 20 – 21)

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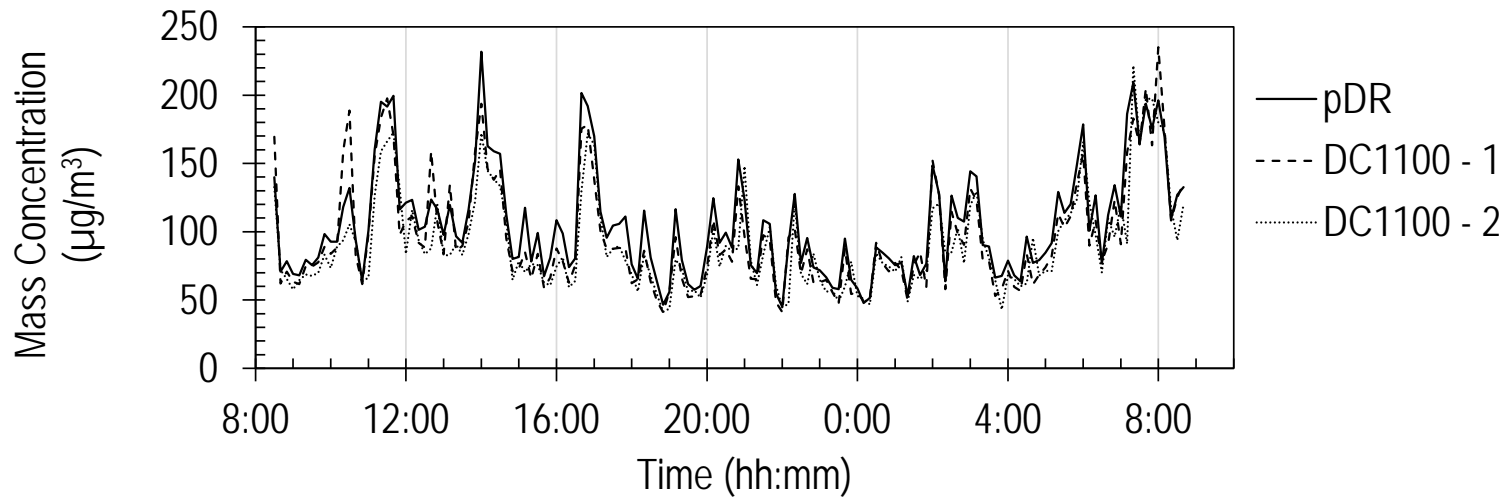
Figure C - 23: Location II, DC1100 small particles (January 20 – 21)
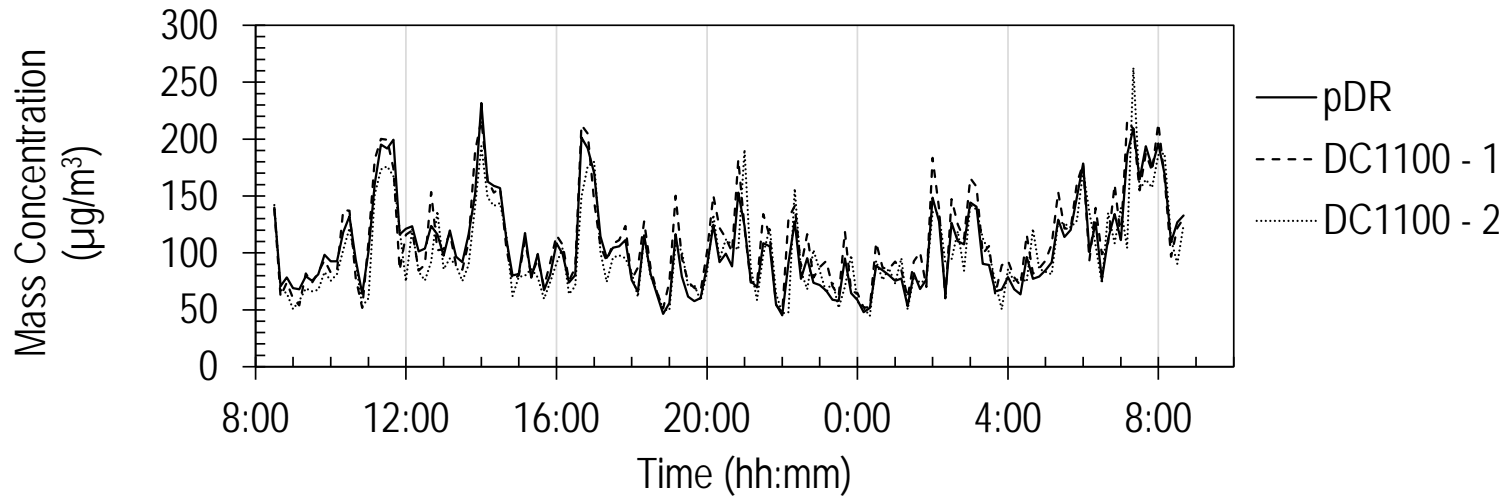
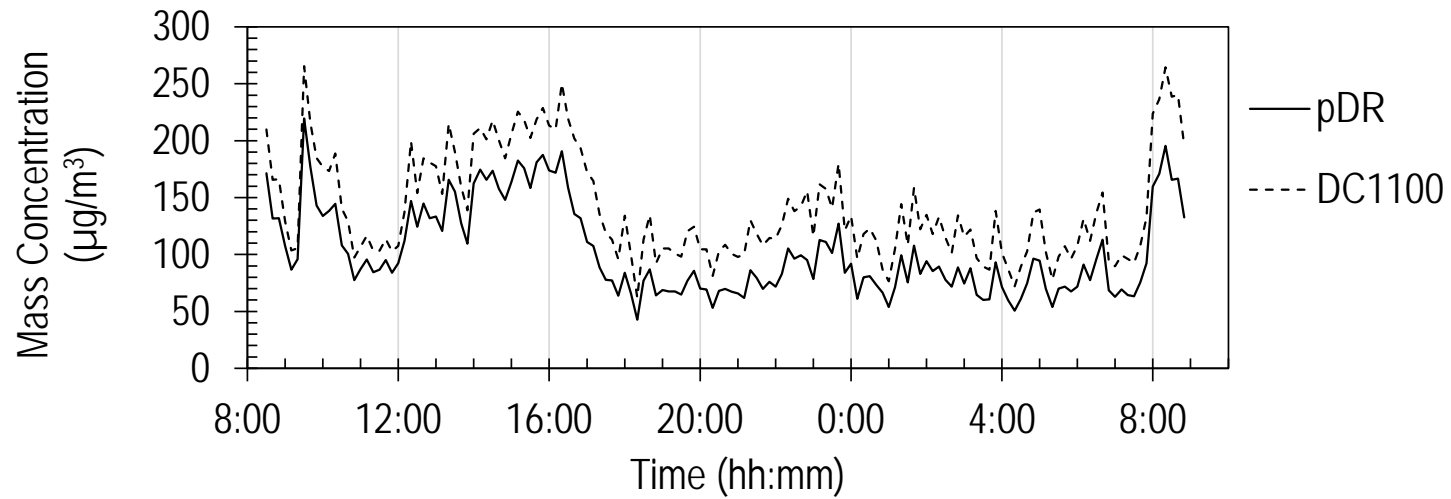Figure C - 24: Location II, DC1100 large particles (January 20 – 21)

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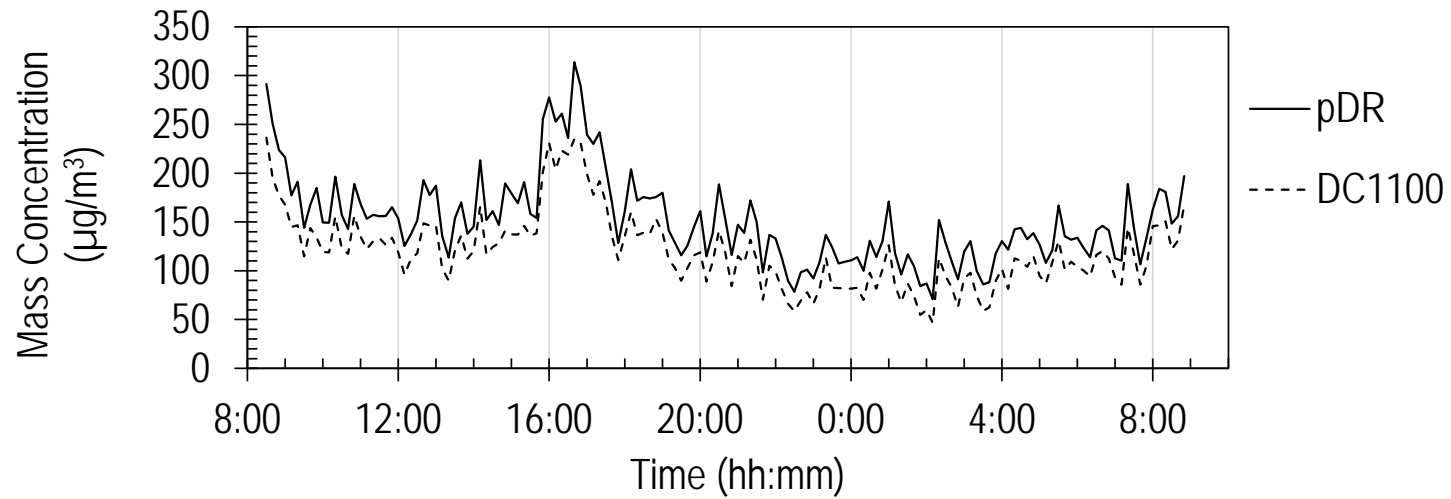
Figure C - 25: Location I, DC1100 small particles (January 22 – 23)
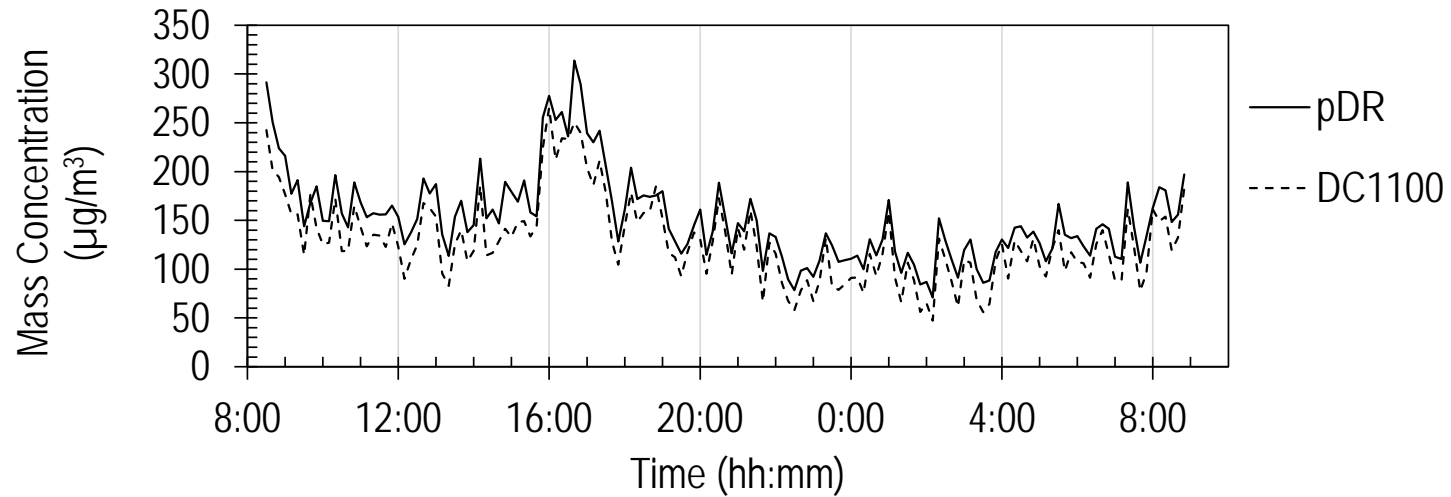
Figure C - 26: Location I, DC1100 large particles (January 22 – 23)

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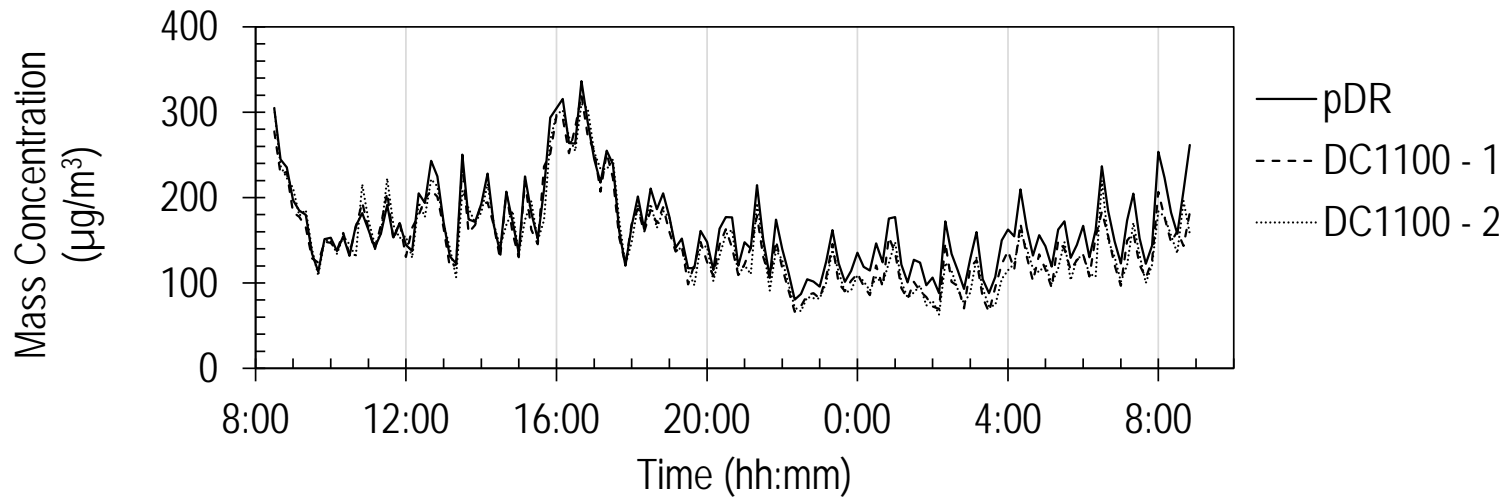
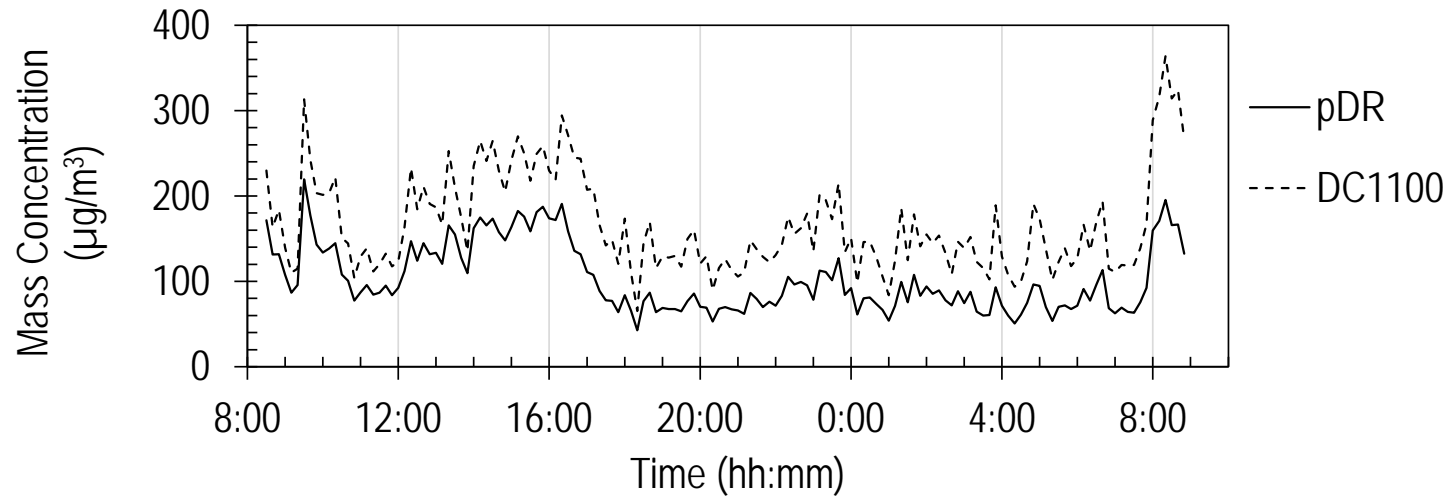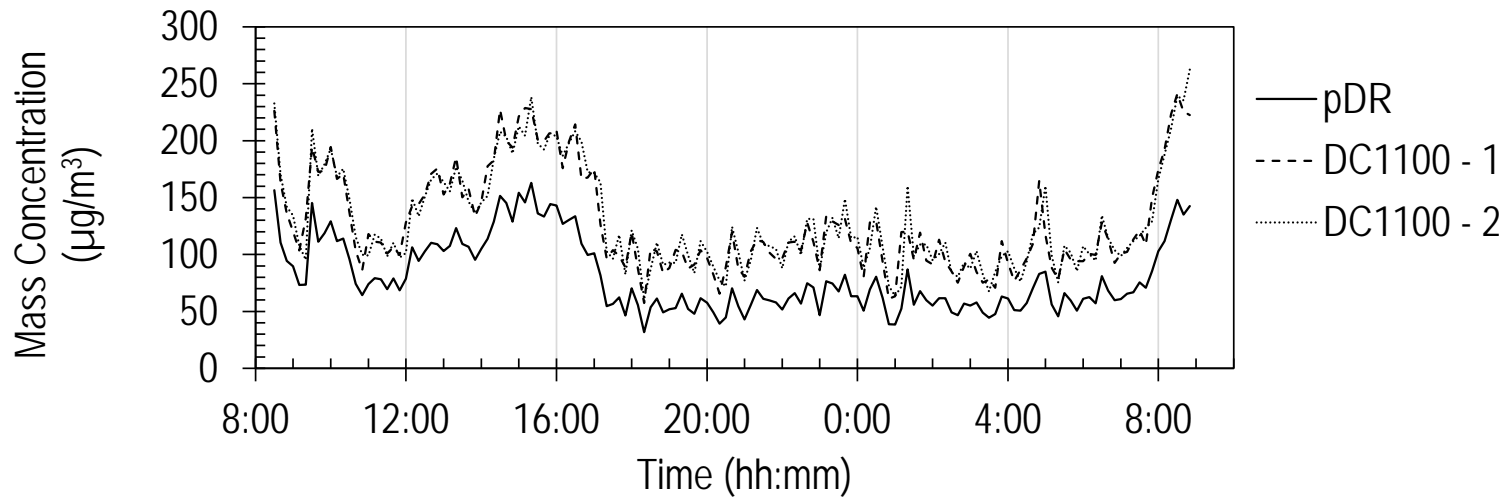Figure C - 27: Location II, DC1100 small particles (January 22 – 23)
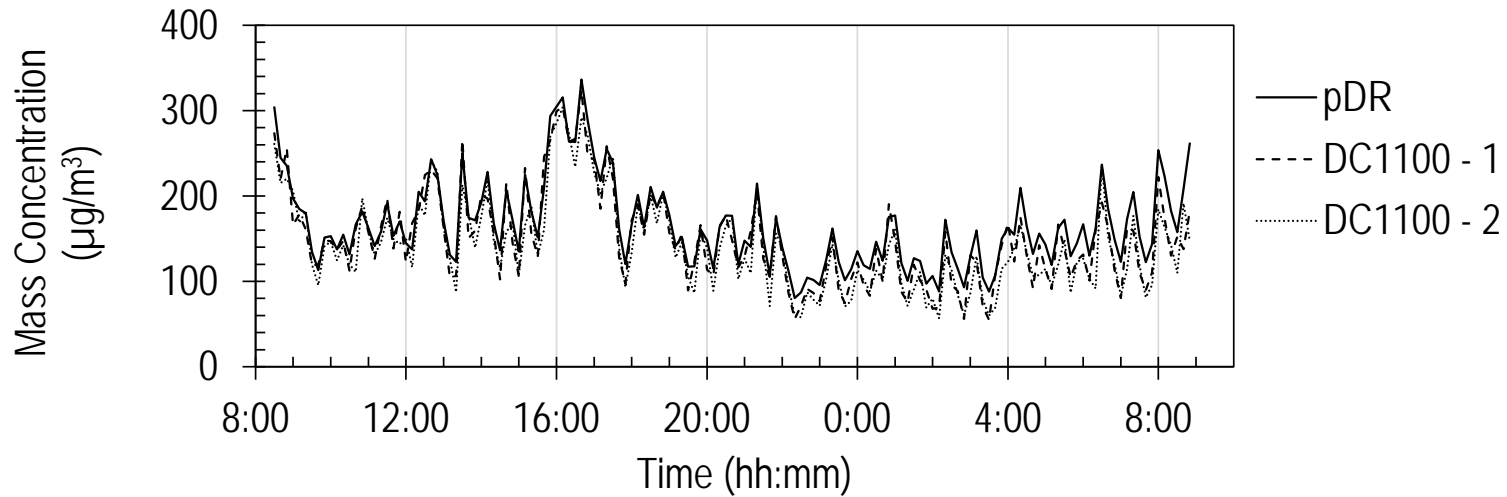
Figure C - 28: Location II, DC1100 large particles (January 22 – 23)
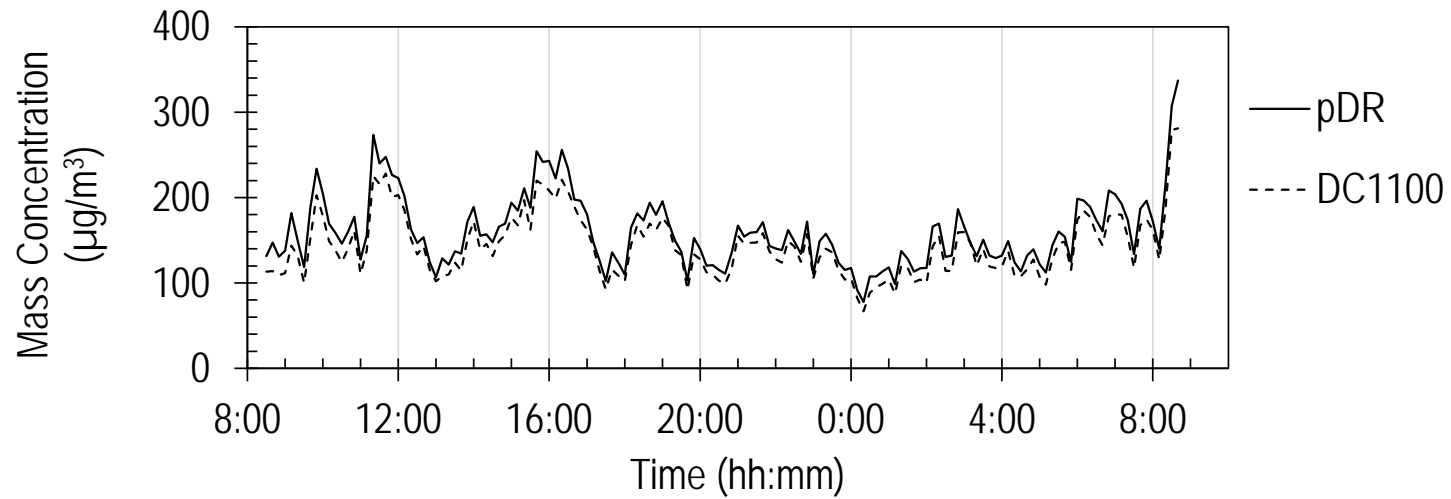
Figure C - 29: Location I, DC1100 small particles (January 26 – 27)
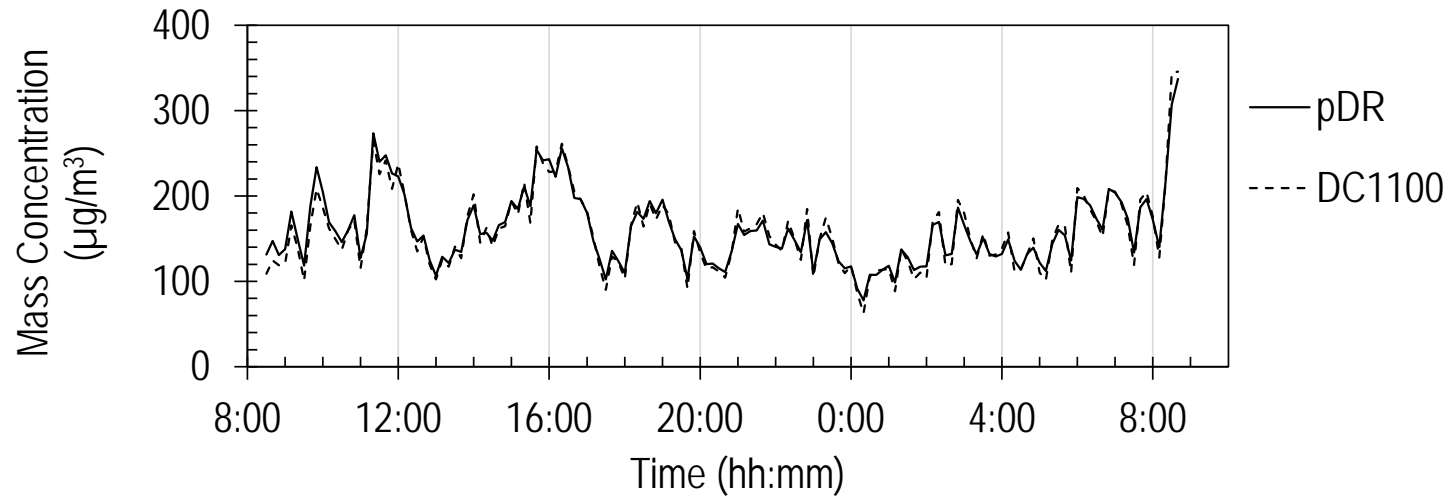
Figure C - 30: Location I, DC1100 large particles (January 26 – 27)

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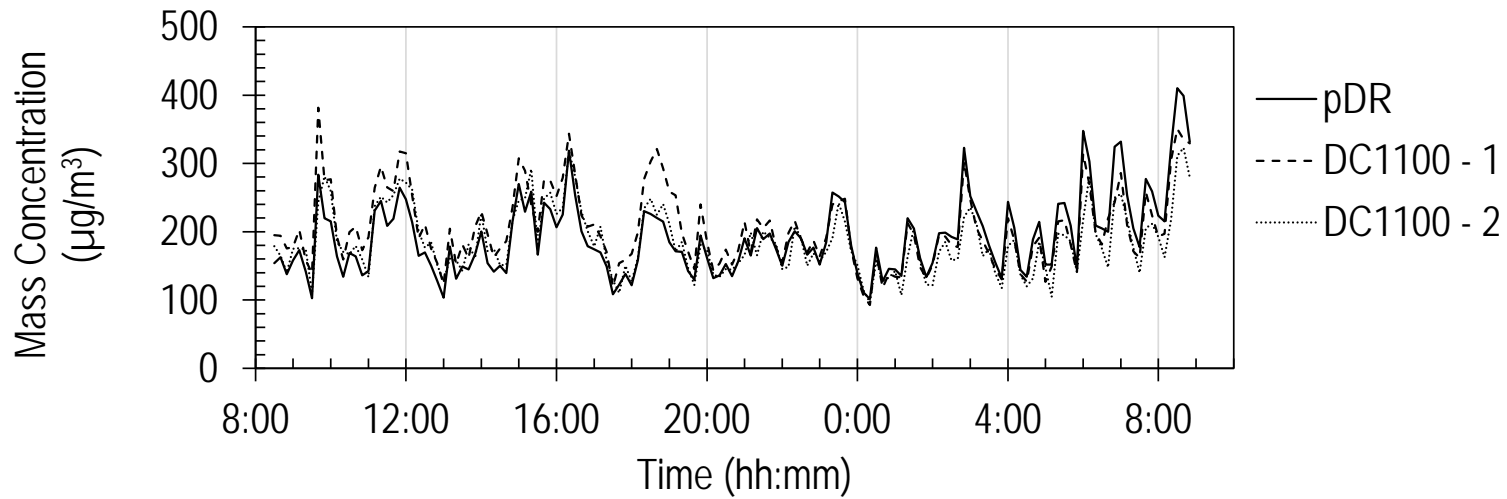
Figure C - 31: Location II, DC1100 small particles (January 26 – 27)
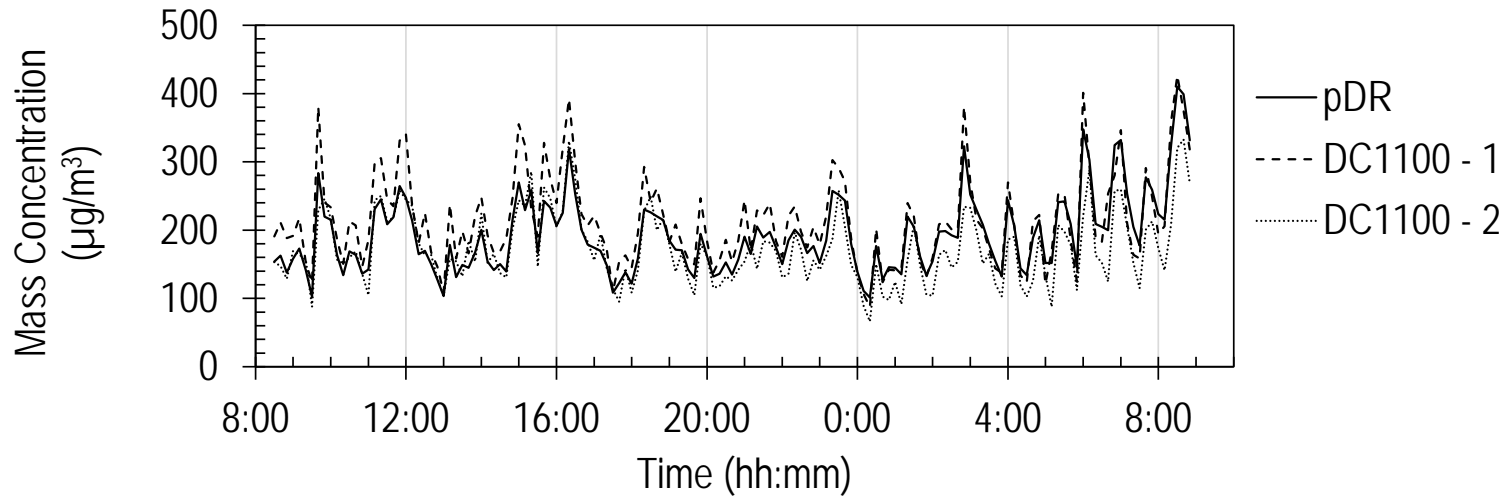
Figure C - 32: Location II, DC1100 large particles (January 26 – 27)

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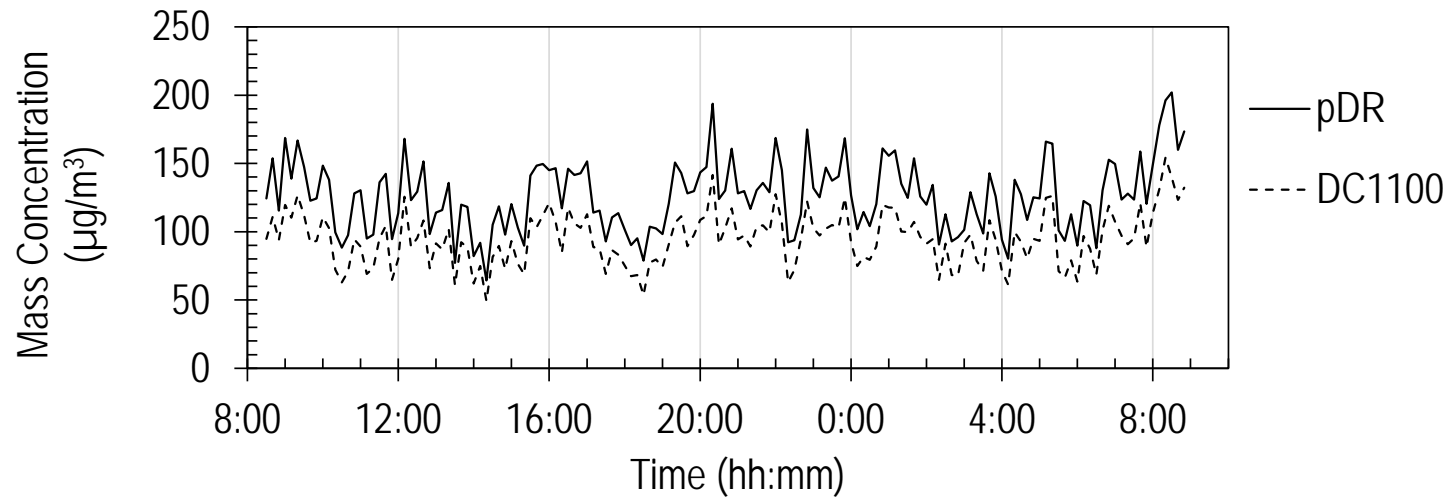
Figure C - 33: Location I, DC1100 small particles (January 28 – 29)
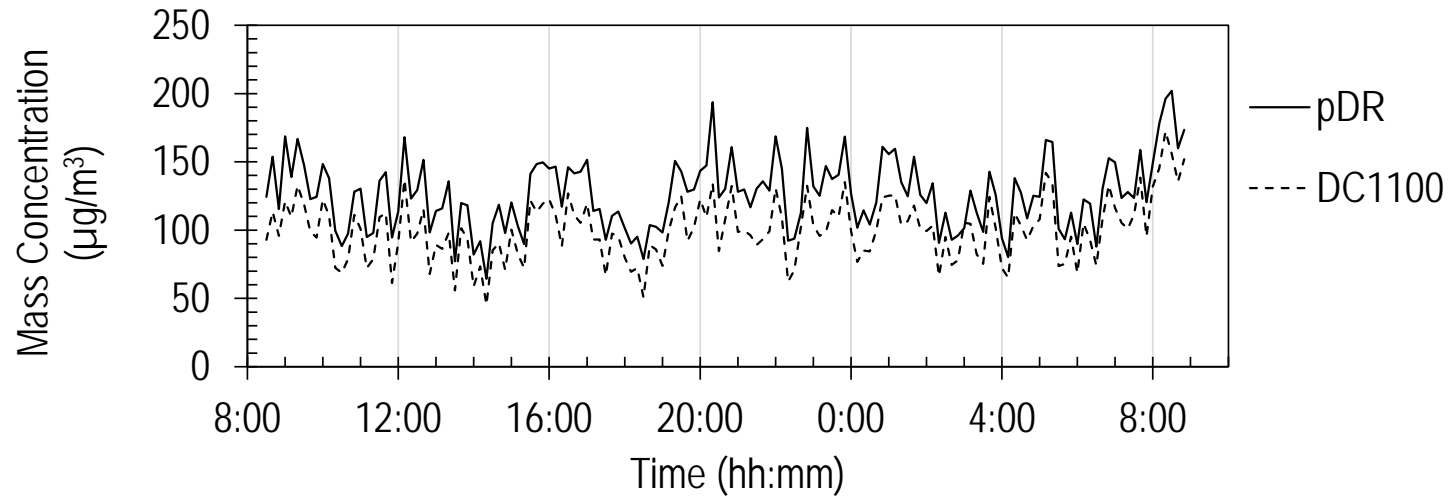
Figure C - 34: Location I, DC1100 large particles (January 28 – 29)

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Figure C - 35: Location II, DC1100 small particles (February 3 – 4)

Figure C - 36: Location II, DC1100 large particles (February 3 – 4)

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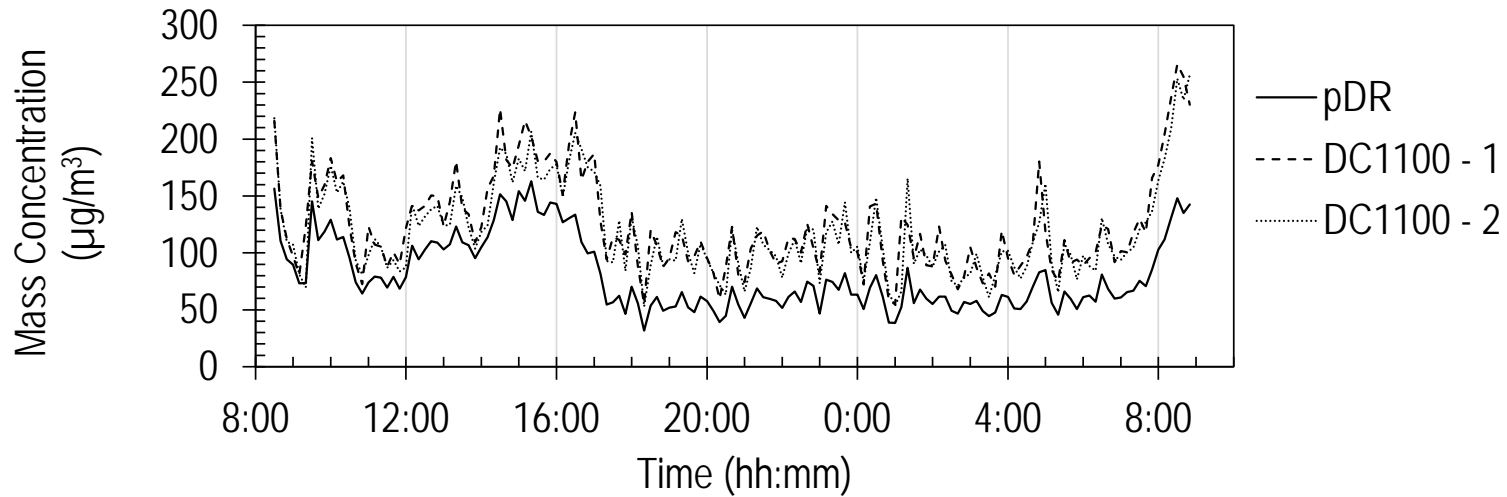Figure C - 37: Location I, DC1100 small particles (February 10 – 11)

Figure C - 38: Location I, DC1100 large particles (February 10 – 11)

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Figure C - 39: Location II, DC1100 small particles (February 10 – 11)

Figure C - 40: Location II, DC1100 large particles (February 10 – 11)

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Figure C - 41: Location I, DC1100 small particles (February 17 – 18)

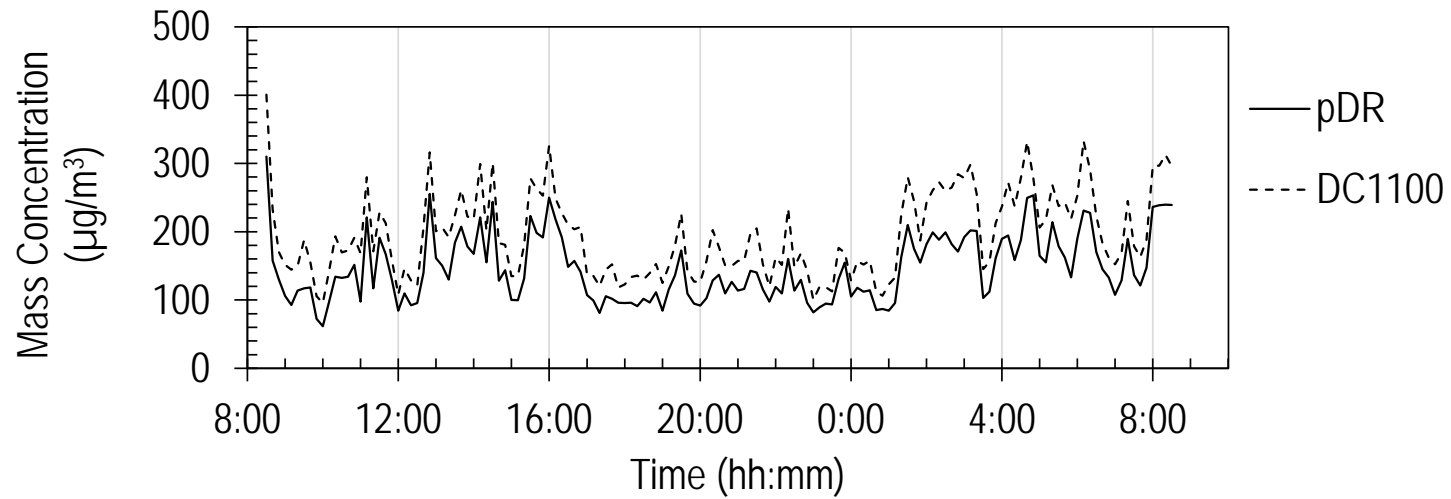Figure C - 42: Location I, DC1100 large particles (February 17 – 18)

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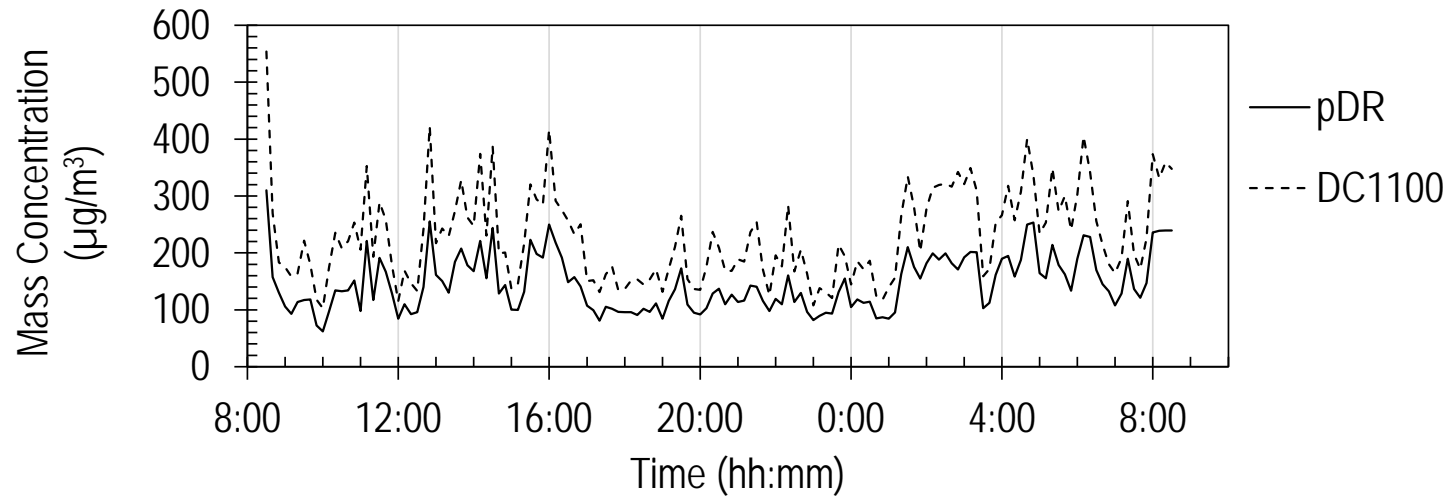Figure C - 43: Location II, DC1100 small particles (February 17 – 18)

Figure C - 44: Location II, DC1100 large particles (February 17 – 18)

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Figure C - 45: Location I, DC1100 small particles (February 24 – 25)

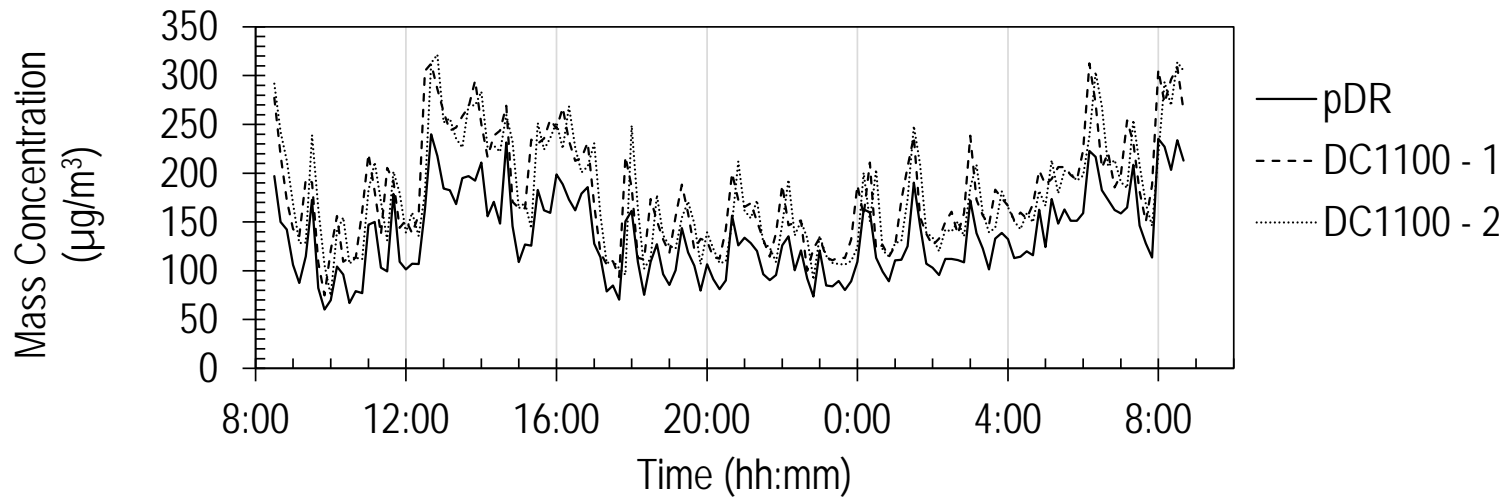Figure C - 46: Location I, DC1100 large particles (February 24 – 25)

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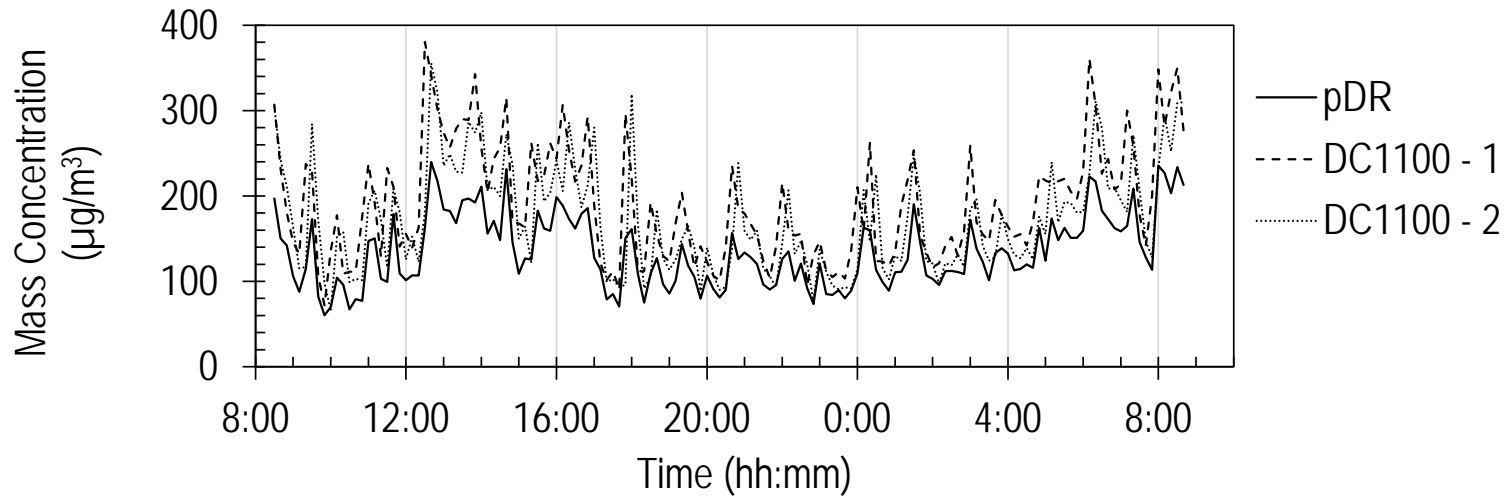Figure C - 47: Location II, DC1100 small particles (February 24 – 25)

Figure C - 48: Location II, DC1100 large particles (February 24 – 25)
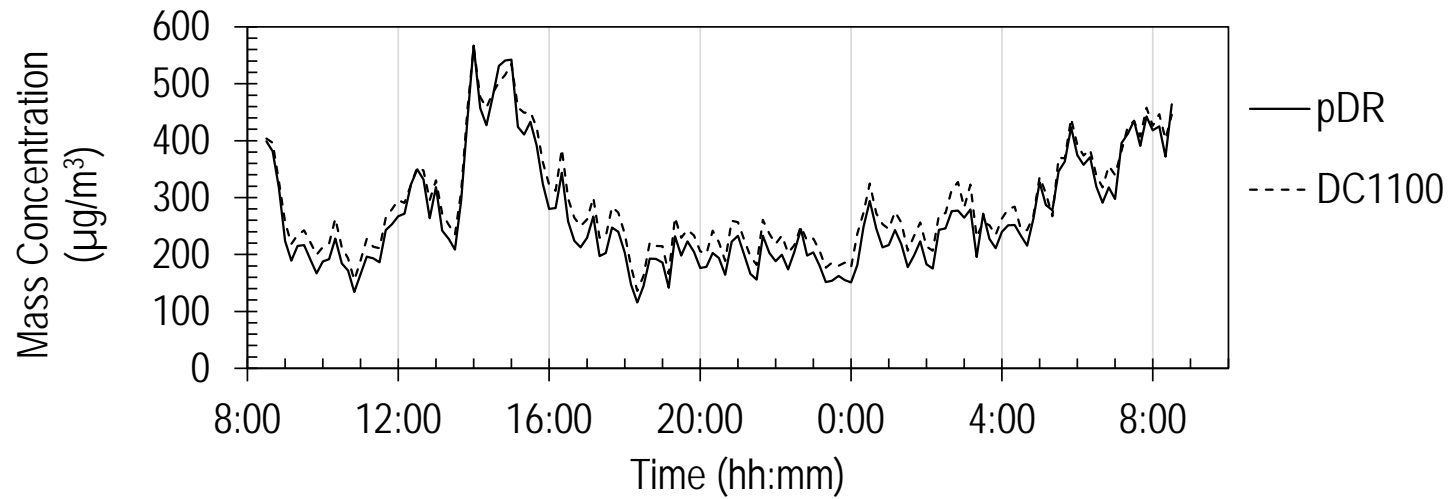
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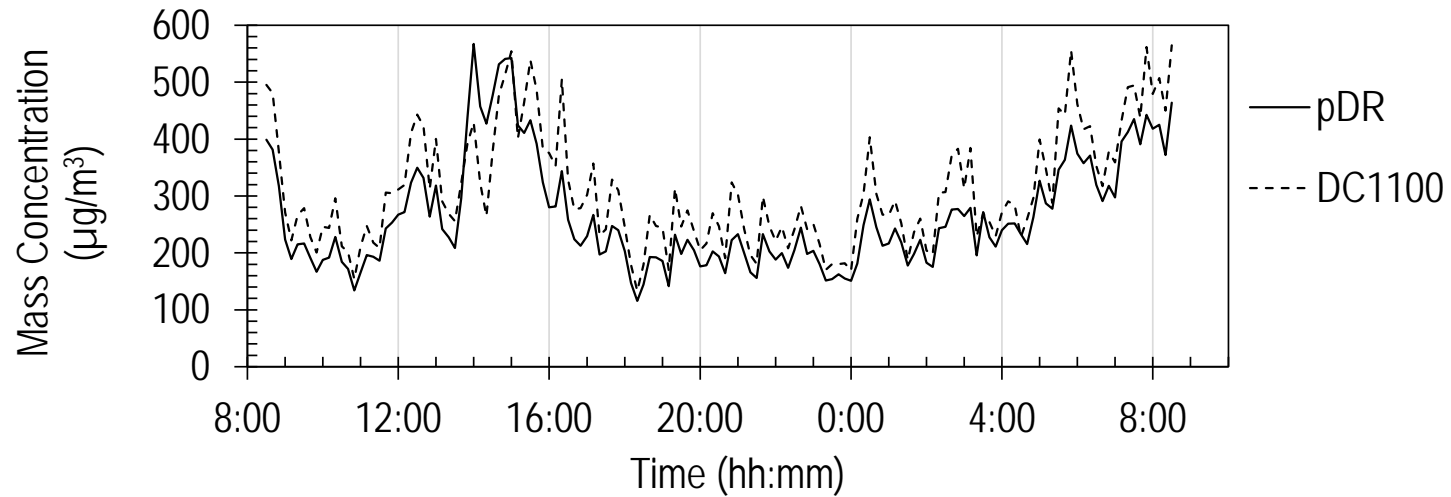Figure C - 49: Location I, DC1100 small particles (February 26 – 27)

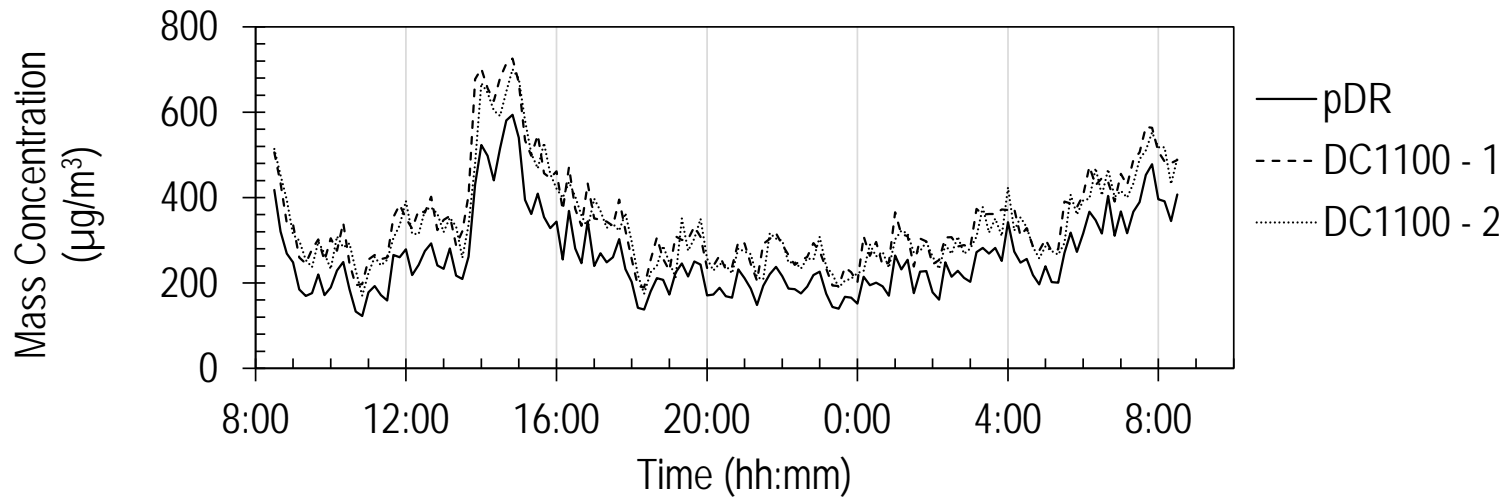Figure C - 50: Location I, DC1100 large particles (February 26 – 27)

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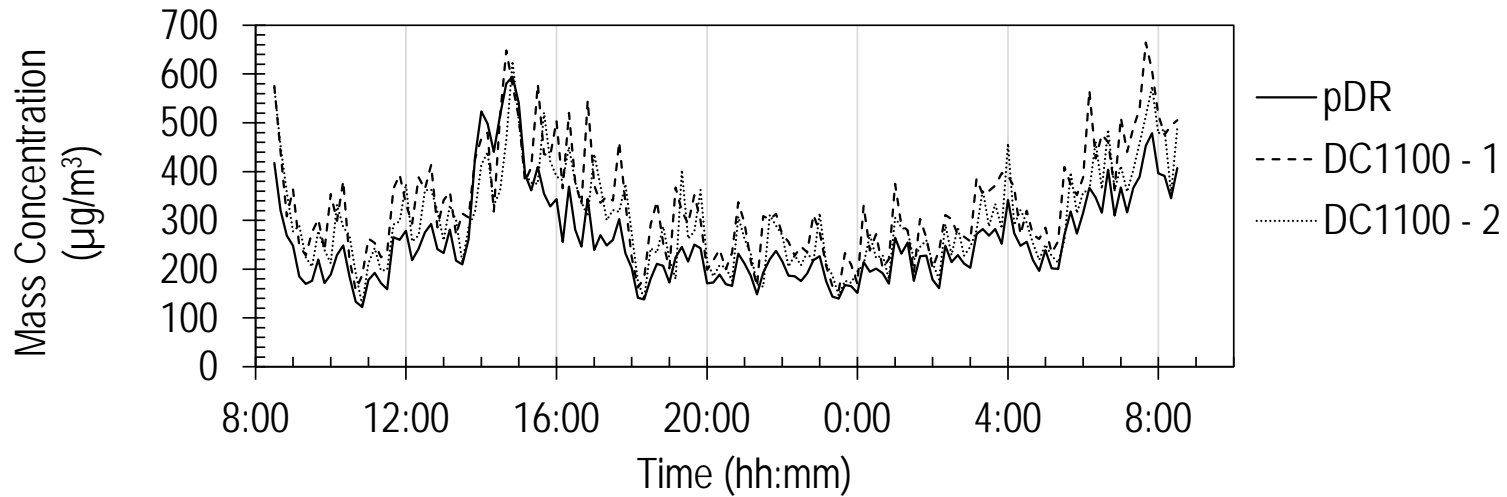Figure C - 51: Location II, DC1100 small particles (February 26 – 27)

Figure C - 52: Location II, DC1100 large particles (February 26 – 27)

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