Comparative Study of Methods for Quantifying Wood Smoke in the UK Atmosphere

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Abstract

The thesis investigates the inorganic aerosol concentrations and wood smoke tracer potassium and levoglucosan concentrations in Birmingham, UK. Also a multi-wavelength aethalometer was utilized as a carbonaceous aerosol detector to directly measure the local wood smoke PM mass and traffic PM mass. To achieve this, daily $PM_{2.5}$ inorganic ions sodium, ammonium, potassium, magnesium, calcium, chloride, nitrate, sulphate, and organic compound levoglucosan were measured over a period of more than one and half years at four sampling locations. There were: (1) Elms road, University of Birmingham; (2) North Kilworth Mill Observatory Site; (3) Churchill Pumping Station Site; and (4) Budbrooke, Warwick Sampling Site.

Correlation analysis, regression analysis, and seasonal variation were examined for those inorganic and organic elements and compounds. The results were used to provide comprehensive spatial and temporal distributions, intra-site and inter-site comparison differentiations.

Wood smoke potassium and levoglucosan were used as wood smoke tracer to determine the local resident wood smoke PM mass concentrations in this thesis. Budbrooke, Warwick Sampling Site for example, a mean value of 62ng m^{-3} wood smoke potassium was measured at winter periods but the mean value of only 17ng m^{-3} was measured during summer periods. This significant difference demonstrated a frequent wood smoke activity in this area during winter periods. Also a multi-wavelength aethalometer was used as wood smoke mass detector to measure the local resident wood smoke PM mass and local traffic PM mass concentrations. These three methods have their unique processes of acquiring the wood smoke mass concentrations, thus the results from these method have considerable variations. Therefore these three methods have inter-compared with each other to achieve better wood smoke concentrations results in order to obtain the best method of measuring local wood smoke mass.

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Chapter 1

Introduction

1.1 Background

Airborne particulate matter (PM) is consistently connected with serious impacts on human health (Dockery et al., 1993; Pope et al., 2002). One study (Wilson and Spengler, 1996) suggested that an increase of 0.5 – 1.5% of total mortality in short term exposure and up to 5% of total mortality in long term exposure was discovered with an increase of 10µg m^{-3} PM_{10} mass concentrations. Studies of particulate matter, mostly fine fraction (aerodynamic diameter less than 2.5µm), showed an increasing impact linking to human health (Clark et al, 2011; Bell et al., 2011; Ma et al., 2011). Especially respiratory and cardiovascular health effects associated with fine particulate matter exposure have been demonstrated in large urban cohort studies (Dockery et al., 1993; Pope et al., 2002). As one of the significant sources of fine particulate matter, wood smoke emissions contribute significantly to human health impact. Wood smoke from residential heating and cooking can result in moderate but sustained exposures to indoor PM (Ward et al., 2007). Christopher et al. (2009) showed that human urine samples from residential wood smoke areas contained higher levoglucosan concentrations. This indicated that the indoor wood smoke emissions did affect the human circulatory system and urinary system.

Airborne particulate matter is highly diverse in size and chemical composition, and is a mixture of solid and liquid particles (Morgan et al., 1970). It is usually characterized as PM_{10} (aerodynamic diameter less than 10µm) and $PM_{2.5}$ (aerodynamic diameter less than 2.5µm). This sampling standards for PM_{10} are following the EPA definition: particles capable of penetrating to the thoracic region of the respiratory system (USEPA, 1987). This definition is followed by the implementation of the EPA's PM_{10} Ambient Air Monitoring Reference and Equivalent Methods Regulation (Federal Register, 1987). The $PM_{2.5}$, known as "High risk", is defined as it can penetrate deep into the lung (USEPA, 1999). PM_{10} mass of 50µg m^{-3} per 24hours value has been utilized as UK air quality standard (EPAQS, 1995). The atmospheric aerosol chemical composition includes iron-rich dusts, sea-salt particles, soil dust, nitrate, sulphate, ammonium, elemental carbon and some organics (Harrison and Yin, 2000; Yin and Harrison, 2008). Those chemical components may vary based on many factors like locations, climate, agriculture or industrial level and traffic. Many studies (Andrade et al., 1994; Harrison et al., 1997; Balachandran et al., 2000; Castanho and Artaxo, 2001) have attempted to characterize this matter in terms of its trace metal content as well as investigating the presence of mutagenic chemical as a simple aerosol component. More commonly, however, it is classified as two main components: primary particulate and secondary particulate. Primary particulate represents the emissions directly released to the atmosphere such as traffic emissions, industrial emissions and natural released dust. Secondary particulate, consists of 25% to 50% (Airborne Particles Expert Group, 1999) of the total mass of PM_{10}, and represents the reaction products of chemical oxidation products such as NH_3, SO_2 and NO_X.

1.2 Wood smoke emissions

1.2.1 Global aspect of wood smoke emissions

Wood smoke emissions represent an important global source of particles and gases to the atmosphere. Because of the increasing expense of fossil fuel in the 1990s and the desire to use renewable fuels to combat global warming, the production of wood fuel used in Europe (Figure 1.1a) started to increase. Wood smoke aerosol has become an important factor to influence the radiation budget and the air quality level. Andreae (Andreae et al., 1996) estimated that biomass burning could be responsible for as much as 45% of the global emission of black carbon to the atmosphere, which is highly efficient in absorbing solar radiation (Kuhlbusch and Crutzen, 1996; Martins et al., 1998). Wood smoke particles can also act as cloud condensation nuclei (CCN). This can be an indirect way of changing the radiation budget of the Earth.

Figure 1.1b shows the wood fuel production in one of my sampling location BWSS. The wood fuel production increased a lot from 100 m^3 in 2009 to 350m^3 in 2010 represent the huge wood fuel demand in UK central area.

Nearly two-thirds of renewable energy sources (RES) in the European Union (EU) stem from biomass, including wastes (Fisher et al., 2001). In the future, increasing biomass use is considered to be essential in meeting the targets set out by the EU (Faaij, 2006). Wood fuel is one of the important biomass energies in the future thus wood smoke emission may be one of the key environmental pollutants in the future.

Figure 1.1a Wood production in Europe

(Source: http://www.earth-policy.org/Indicators/Forest/2006_data.htm)

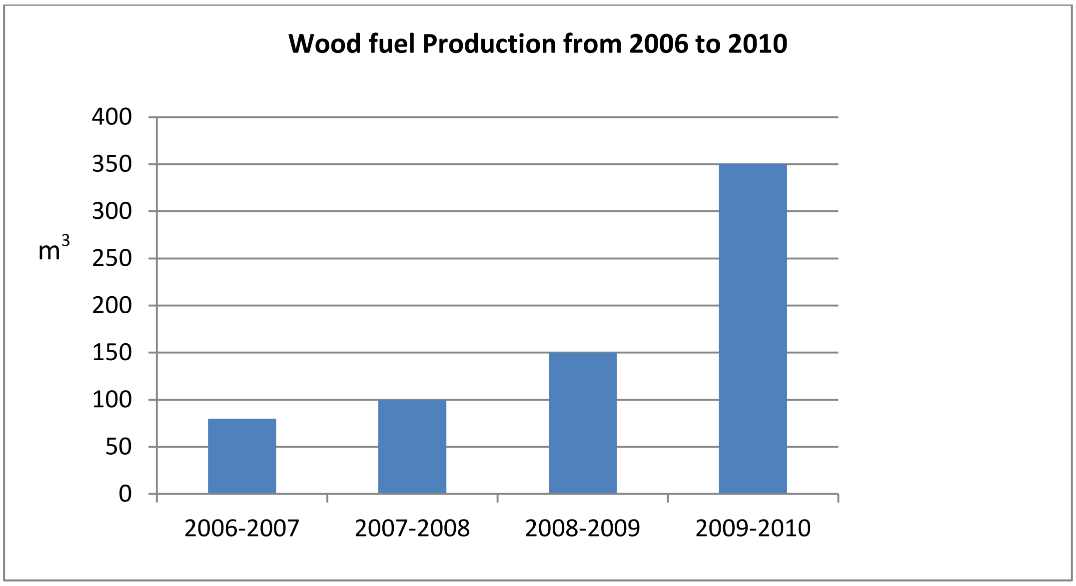


Figure 1.1b Wood fuel production from BWSS site(Data is from the manager at BWSS)

Biomass burning is happening all over the world. Fire is a key to the earth system process which affects ecosystems, land-surface properties, the carbon cycle, atmospheric chemistry, aerosols and human activities. Humans manage fire cautiously, but still there were billions tonnes of biomass fuel burned annually by natural or human mistakes. Figure 1.2 shows the satellite images taken in autumn 2003. The biomass burning mostly happened in Latin America for forest fires, North America, South East Asia and Middle East for wood burning, Africa and Australia for savanna fires.

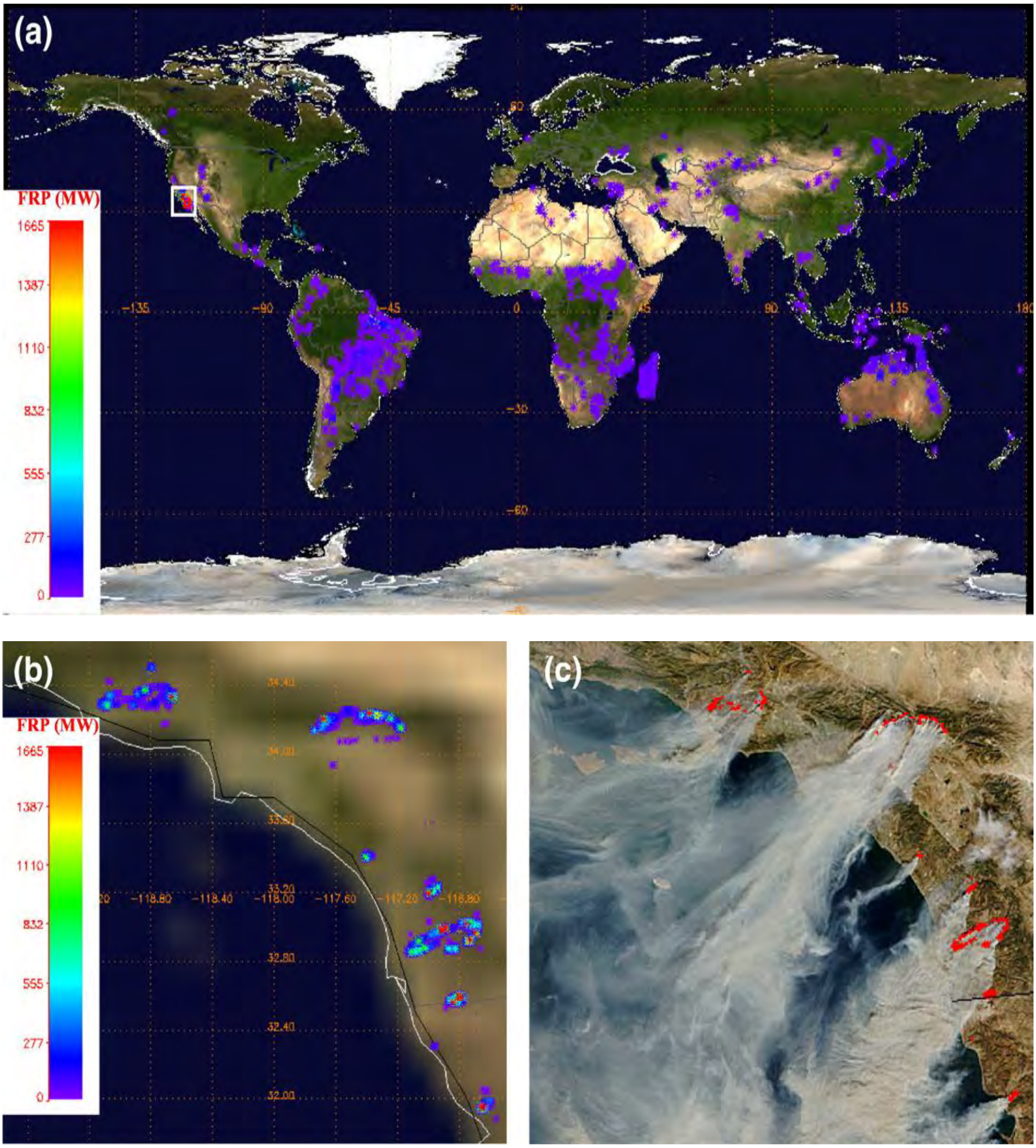


Figure 1.2 Biomass burning activities in the world. This daytime fire measurement was captured on 26th October 2003. (a) The colour-coded fire radioactive power (FRP) values of fire pixels was detected throughout the globe plotted over a MODIS-derived true-colour image, with a white box delineating the most intense hotspot of that day, which occurred in California, USA. (b) A closer view of the FRP distribution of the California fires (white box in a). (c) A true-colour image of the same fire scene, the red pixel indicates the real fire, and the thick smoke was released into the atmosphere.

(Sources: http://alg.umbc.edu/usaq/)

Besides the human induced fire and natural savanna fire, there are still many places burning biomass for various activities, such as forest clearing for agriculture use, ranching, shifting cultivation and agricultural waste burning. Seiler and Crutzen (1980) research showed us that 200 million people has been involved in shifting agriculture land worldwide in 1960s with an annual clearing of 900 to 2500 Tg dry matter, which is equals to 400 to 1100 Tg of carbon. 75% of those fires have taken place in tropical secondary forests and humid savannas. The balance of the ecosystem has now been damaged by forest clearing actions. Because of the frequent biomass burning, the affected ecosystems often cannot recover to their original condition and the net release of carbon to the atmosphere will keep increasing. Another action which greatly contributes to the biomass is burning wood for fuel, charcoal and agricultural waste burning. In developing countries, fuel wood and agricultural wastes are still playing a dominant role for energy sources as cooking and heating. In some places burning wood for fuel even support industrial activities. This huge amount of wood use in every year is difficult to estimate. Scurlock and Hall (1990) estimated that the annual per person biofuel need was about 500kg in urban and 1000 kg in rural regions, and that perhaps 2/3 of the rural energy used in China came from agricultural wastes. Because of the high growth rate of the population in developing countries, this energy need is also growing at a high rate. And this large amount of biomass burning will release a great amount of carbonaceous particles. Although the emissions from biomass burning combustion are dominated by carbon dioxide, many products of incomplete combustion that play important roles in atmospheric chemistry are emitted too, for example CO, H_2, CH_4, organic acids and compounds containing nitrate and sulphate.

1.2.2 Composition of wood smoke and choice of chemical tracers.

Wood smoke has complex chemical composition. It consists of a mixture of low molecular weight carbon based gases and many large molecular weight organic compounds in the particles (John, 2003). The indoor pollution caused by wood smoke is mainly carbon monoxide. The concentration of carbon monoxide in the emission from indoor wood burning can prove fatal results if released into an enclosed space. Besides carbon monoxide, other gases emitted include methane, ethane, propane and other low molecular weight organic gases. In the view of Peter (2005) the priority air pollutants such as nitrate and nitrite, in the form of condensed phase, are only emitted in very small quantities by wood burning. And sulphate, one of the more typical ions in atmosphere pollutants, showed no relation to wood smoke in long range transport due to the large variations in outdoor concentrations. But William (1989) in Portland reported that nitric oxide and nitrogen dioxide are found in very hot wood combustion flames, and sulphur dioxide is a common air pollutant from wood burning stoves that has known airway irritating effects. Therefore there is a significant loss occurs during long range transport for wood burning emission components.

The major aerosol components include inorganic components and carbonaceous species. The major source of primary carbonaceous aerosols is wood burning, from forest burning in the summer and the wood fuel burning in the winter (Sapkota et al., 2005). The samples collected from wood smoke consisted mainly of potassium salts, ''tar balls'', organic particles, soot, minor amounts of mineral dust, sea salt, and ammonium sulphate. The actual image of those particles are presented in Figure 1.3 (Jia, 2003).

Potassium is a common primary inorganic particulate aerosol component. The sources for potassium are from biomass burning, soil dust and sea-salt (Pio, 2003). The combustion of wood contains K^+ as a major component. It releases great quantities of potassium-rich particles. The biomass burning potassium particles are mainly in the $PM_{2.5}$ fraction thus the biomass burning aerosols can be identified by the potassium ratio of $PM_{2.5}$ to $PM_{2.5\text{-}10}$ particles. By determining the sea-salt potassium and local soil potassium, the local wood smoke potassium can be estimated by subtracting the sea-salt potassium and local soil potassium from fine potassium.

Potassium salts are the most common inorganic components of the smoke from wood burning. They mainly include KCl, K_2SO_4 and KNO_3. The excess fine potassium which is not attributable to soil or sea salt is an indicator of wood smoke (Andreae, 1983). Potassium salts are ranged from 20 nm to 1.5 μm in diameter, with most from 100 to 600 nm. The high abundance of potassium salts was observed in vegetation fires in the Amazon Basin by Yamasoe (2000), who reported that K, Cl, and SO_4 were the dominant species in the aerosol particles in the plumes from such fires.

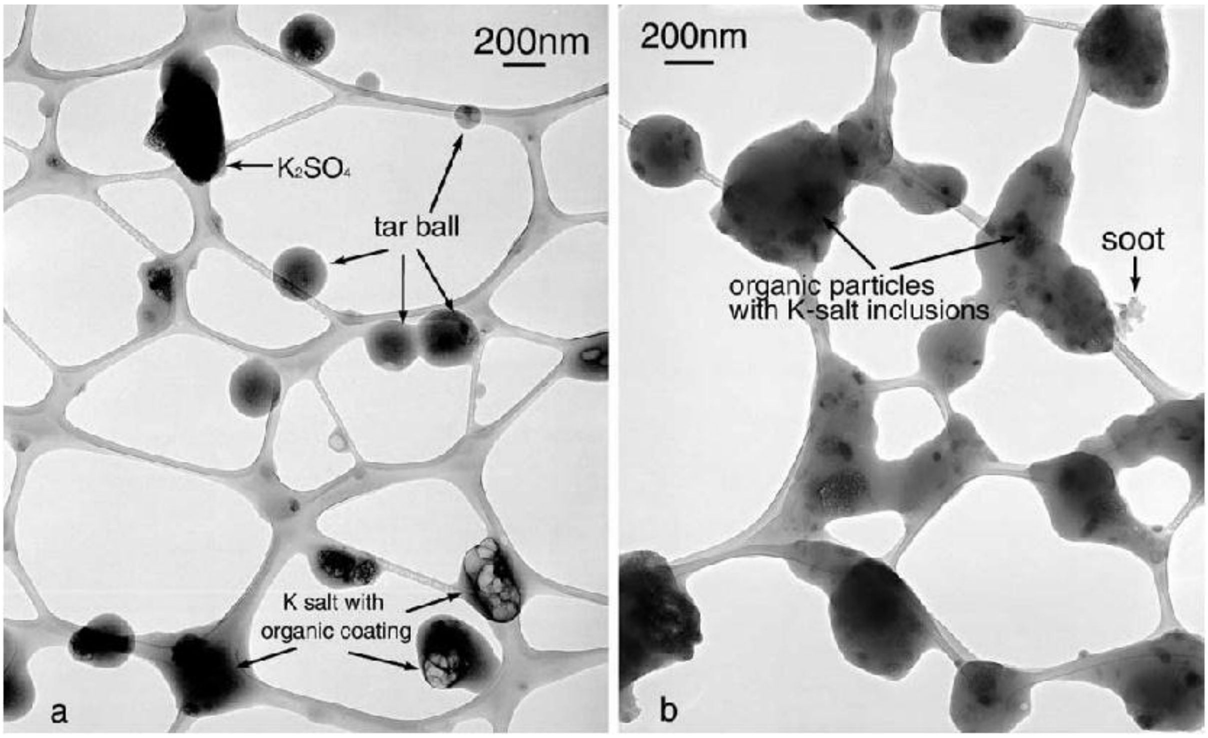


Figure 1.3 Electron microscope picture of tar balls, K salts and organic particles (Jia, 2003)

"Tar balls" and organic particles are the common particles in the smoke from wood fuel burning too. "Tar ball" is a spherical, amorphous carbonaceous particle. Besides carbon, "Tar balls" also contain potassium, oxygen, sulfur, and silicon (Posfai et al., 2003). The other organic particles which do not have a spherical morphology contain minor amounts of potassium, chlorine, and sulphur. "Tar balls" and organic particles have a similar diameter ranging from 50 to 500 nm, with a few particles larger than 1 µm. "Tar balls" or organic particles with or without potassium salts, are most abundant particle types in wood smoke. They accounted for 70% to 83% of the total particle numbers in the wood smoke (Jia, 2003).

Soot particles are typically about 20 to 60 nm in diameter, comprising mainly elemental carbon and organic compounds. Most contain potassium and minor amount of silicon. The potassium enrichment in soot is an important tracer for biomass burning.

Mineral dust, sea-salt and ammonium sulphate can also be measured in wood burning smoke but the amounts are very small. Some are mainly measured in coarse particles. The NaCl in sea-salt is often reduced because it reacts with sulfuric acid, nitric acid and NO_x in the atmosphere and transforms into Na_2SO_4 and $NaNO_3$.

Large amounts of volatile and gaseous carbonaceous particles are emitted from wood burning (Simoneit, 2002), and other combustion processes. However, it is hard to quantify exactly how many pollutants come from wood burning.

It is very difficult to select an ideal tracer for the wood smoke source because the wood smoke composition is very complicated. But tracers are necessary factor for estimating wood smoke source and quantity. Tracers of wood smoke are elements, compounds or gases that come from wood burning in characteristic amounts or ratios. Measurement of these tracers in the environment can be used to estimate the amount of air pollution from wood burning. Khalil et al. (1983) have given a brief checklist for us to choose tracers; an ideal tracer should have four main characteristics:

■ Uniqueness-- that it comes from only one type of source;
■ Constancy-- that operational and environmental condition at the source do not affect the emission factor;
■ Inertness-- that the tracer is not lost between the source and the receptor any more or less than the pollutant of interest;
■ High precision of measurement -- we can measure its concentrations exactly.

In reality no tracers for any sources can satisfy all those 4 characteristics. But there are some good components which can satisfy most of them, the first one is methyl chloride. Methyl chloride is a useful tracer of wood burning because its emission factor is less affected by combustion temperature (Khalil, 1983), and it has no other sources in most areas where wood burning is a source of air pollution (Edgerton, 1985). The known sources of methyl chloride are purely natural including the oceans, fungal activity in soils and rotting of wood mostly in the tropics, and a few other minor sources. There is a sizable background concentration of methyl chloride, which is about 600 pptv. The excess created by wood burning is relatively small (10–20%). This small residual, along with the lack of high precision of measurement can cause uncertainties in estimating wood burning pollution using methyl chloride.

Levoglucosan ($C_6H_{10}O_5$) is another major organic component emitted in fine smoke particulate matter from biomass burning. It is generally accompanied by other monosaccharide derivatives and biomarker compounds (such as mannosan and galactosan). Levoglucosan with the associated biomarkers can be utilized as specific indicators for the presence of emissions from biomass burning in samples of atmospheric fine particulate matter. Levoglucosan is emitted at such high concentrations that could be detected in aerosol particulate matter at considerable distances from the combustion sources, and those can let it track the biomass burning in the global scale. But when the wood burning combustion temperature is higher, levoglucosan will decompose and then cannot be measured accurately. The measured concentration of levoglucosan will be lower than thereal value.

Potassium and Chloride are inorganic tracers for wood smoke. The fraction of soluble potassium not related to sea-salt and soil dust has been used as a qualitative tracer for biomass combustion (Cachier et al., 1991). As sea-salt and the soil dust can be easily quantified, potassium is an excellent tracer for wood smoke. But the difficulty of measuring local soil potassium real value makes a very difficult quantification process of potassium concentrations released by wood smoke. The value deducted might be greater or less than it should be. The measurement will be inaccurate. Chloride is also produced in burning wood fuel, but the instability of chloride and variety of the sources make it hard to distinguish between sources, therefore chloride is not an ideal tracer for wood fuel burning.

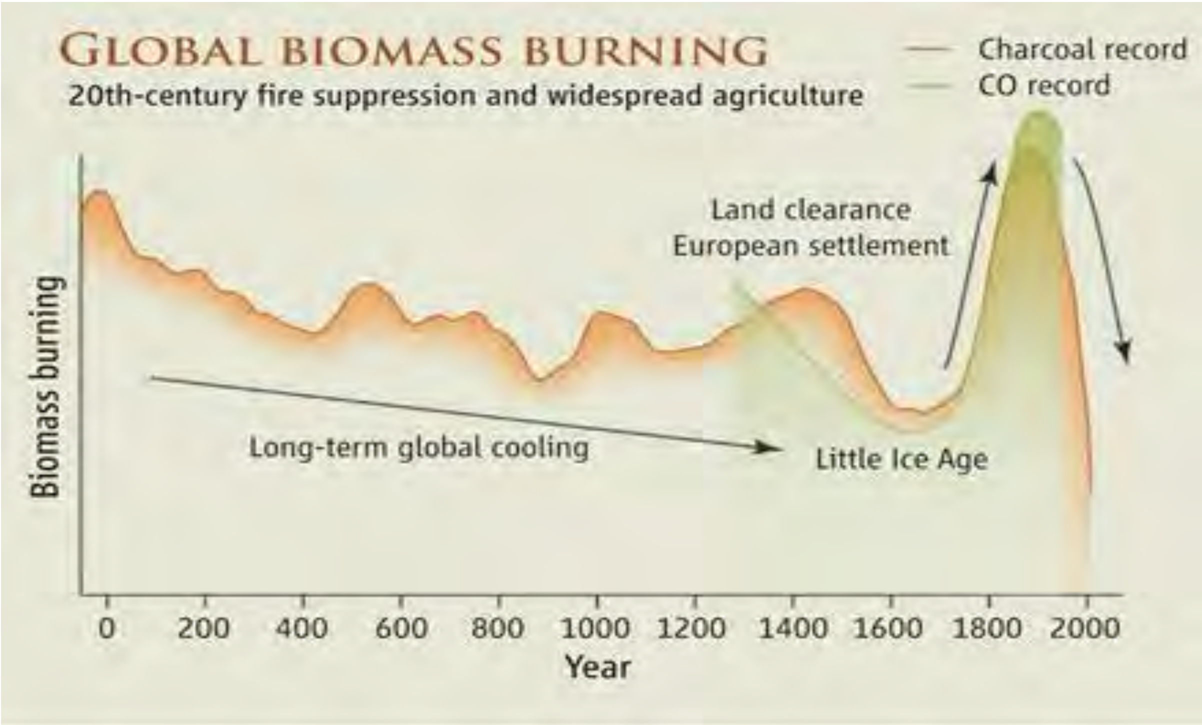
Elemental carbon and organic carbon ratio (EC/OC ratio) is another tracer for wood smoke. The ratio of elemental carbon and organic carbon can also be an indicator of the combustion temperature. High temperature combustion is likely to produce more elemental carbon and low temperature combustion would produce more organic carbon. Therefore the ratio of elemental carbon and organic carbon can be used to distinguish the wood smoke pollutants between cool burning and hot burning. However, as vehicle engine combustion can produce organic carbon too, it is difficult to distinguish the carbon from those sources, making it unreliable to use EC/OC ratio to trace wood smoke.

^{14}C is a radioactive isotope of carbon. It can be used to distinguish combustion products of wood fuel and fossil fuel. Through photosynthesis, vegetation will constantly absorb ^{14}C at a certain daily amount during its lifetime. After the vegetation dies, due to the attenuation of ^{14}C, the concentration level of ^{14}C will continuously reduce in its tissues. Therefore by measuring the quantity of ^{14}C in the vegetation it can be worked out whether it is from ancient vegetation or contemporary vegetation. Thus, the attenuation of ^{14}C can distinguish the "new burning" and "old burning". New burning indicates wood burning and biomass burning. Old burning indicates burning fossil fuel.

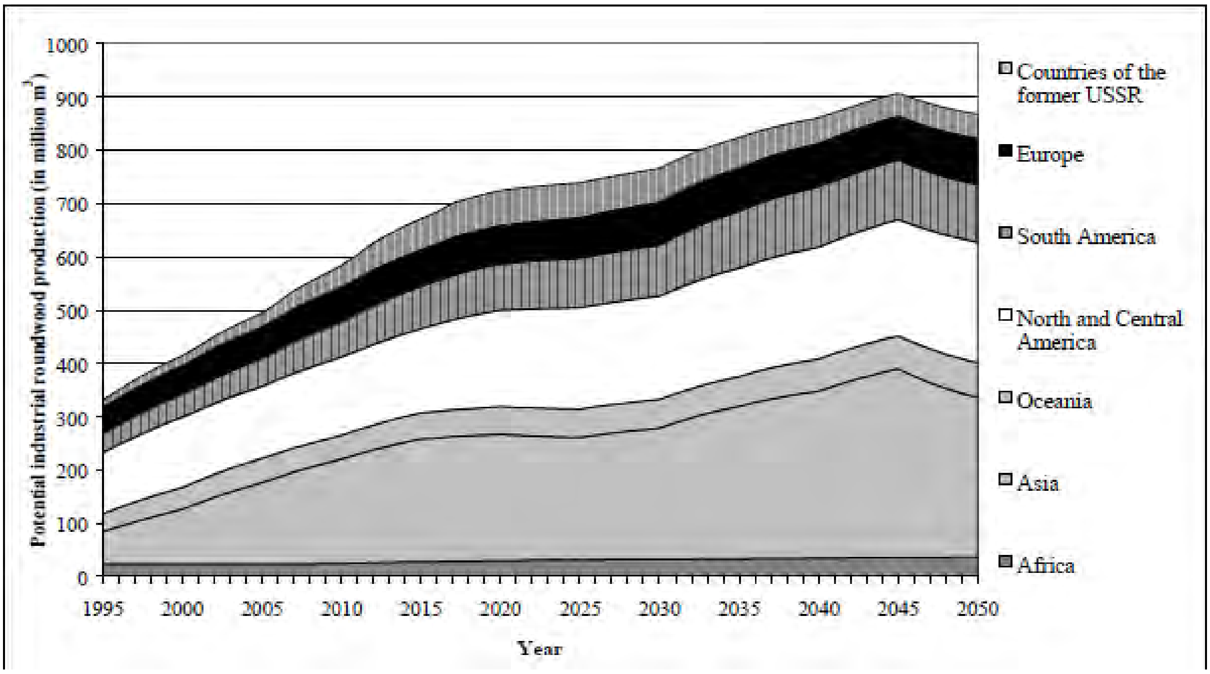
1.3 Previous study on wood smoke emissions

In 2004, more than two billion people used wood fuel for warming and cooking in the world (Warwick and Doig, 2004), and about 18% of the total biomass burning was caused by burning wood fuel. The growing fossil fuel price starting from 1990 made people start to consider wood as their energy fuel, thus wood smoke has become an unavoidable source in the atmosphere. In parts of the U.S., where wood is the predominant heating fuel, wood burning contributes up to 80% of the total $PM_{2.5}$ concentrations in residential areas in the winter (McDonald et al., 2000). In Sweden, Johannesson et al. (2002) found a significant difference of mass concentrations of outdoor $PM_{2.5}$ between one area where domestic wood burning was prevalent and one area where district gas and electric heating was dominant. The average concentrations at two different sites were 6.2±0.2μg m^{-3} for a domestic wood burning area and 4.5±0.2μg m^{-3} for a gas and electric heating area.

Given the increasing wood fuel consumption in the world (Figure 1.4a), it is necessary to develop methods to measure the wood fuel combustion emissions to the atmosphere. Monitoring the wood fuel tracers, wood smoke potassium and levoglucosan are the common methods to observe atmospheric wood smoke concentration levels. Figure 1.5 lists studies measuring the wood smoke organic tracer levoglucosan concentrations. Although those studies did not directly measure the wood smoke concentrations or levoglucosan to wood smoke conversion factor, it is still possible to demonstrate wood burning activities all around the world. The greatest wood smoke burning activities were in the Amazon basin in Brazil, but only during the dry season. In the wet season the wood burning activities drop significantly to 1/3 - 1/10 of the dry season value. Following the Amazon basin dry season, U.S. and China also have a lot of wood burning activities. In U.S. forest fire was the main source of levoglucosan. In China, human activities like burning agricultural waste, wood fuel and forest fire play a dominant role in biomass burning activities.



(a)



(b)

Figure 1.4 (a) History of biomass burning and (b) Estimated wood fuel production from 1995 to 2050.
(a : Source: 'http://www.sciencemag.org/content/330/6011/1636/F1.expansion.html')
(b: Source: Christopher, 2000)

Biomass type Sampling background	Location(state,season)	Levoglucosan(ngm^{-3}) Mean(Range)	Reference
Rice straw	Taiwan, burning season	572(310-1080)	James et al., 2008
Rice straw	Taiwan, winter	1582	Engling et al., 2009
Rice straw	Spain	74(58-129)	Viana et al., 2008
Wheat stubble	U.S.(Washington & Idaho)	78	Jimenez et al., 2006
Firewood	U.S.(Fresno)	1375	Schauer et al, 2001
Forest	U.S.(Montana)	3152(1726-6091)	Wardet al. , 2006
Agricultural waste	U.S.(California/Fresno)	202	Reinehart et al., 2006
Agricultural waste	Korea	1754	Park et al., 2006
Agricultural waste	China(Hong Kong, winter)	190(35-489)	Wan & Yu, 2007
Agricultural waste	China(GuangZhou)	480(120-950)	Wang et al., 2007
Agricultural waste	China(Beijing, Winter)	78	He, 2006
Rice straw	China(Beijing)	307(110-806)	Zhang et al., 2008
Local	Terceura Island (Azores)	5.2(0.3-19.2)	Puxbaum et al., 2007
local	Portugal (Aveiro)	517(19.6-1651)	Puxbaum et al., 2007
Continental mountain	France (Puy de Dome)	17(1.6-46.5)	Puxbaum et al., 2007
Rural mountain	German (Schauinsland)	24.4(7.2-55.5)	Puxbaum et al., 2007
Free troposphere	Austria (Sonnblick)	7.8(<0.7-55.6)	Puxbaum et al., 2007
Local	Hungary (K-Puszta)	309(13-922)	Puxbaum et al., 2007
Local	Chichi-jima(Japan)	1.8(0.017-15)	Michihiro et al., 2010
Local	German (Mainz)	1200	Linuma et al., 2007
Forest	Brazil(Rondonia,dry season)	907(80-5800)	Schkolnik & Rudich, 2005
Forest	Brazil(Rondonia,wet season)	(30-550)	Schkolnik & Rudich, 2005
Forest	Brazil(Rondonia,dry season)	2006(446-4106)	Zdrahal et al., 2002

Figure 1.5 Comparison of ambient fine-particle ($PM_{2.5}$) levoglucosan concentrations

The profiles of organic compounds derived from wood combustion have become available in several studies (Fine et al., 2001; Fine et al., 2002; Fine et al., 2004; Schauer et al., 2001). Those studies indicate that there are a large number of potential chemical tracers available for wood burning (Simoneit, 2002). In addition, the most recent studies have used radiocarbon (^{14}C) for the assessment of the wood combustion-derived particulate fraction (Szidat et al., 2006).

The calculation of the contribution of wood combustion to fine particle mass is challenging. The published studies on controlled tests showed that the emissions of different tracers as well as mass, and OC, vary considerably depending on the type of wood burnt and the experimental conditions (Purvis et al., 2000). Recent research (Sanna et al., 2008) which did some sampling in Prague, Helsinki, Duisburg and Amsterdam showed that the contribution of wood combustion to $PM_{2.5}$ was the highest in Prague, where the calculated contributions ranged between 27% and 53%, with a mean value of 37%. In Helsinki, Finland, the mean value contribution of biomass combustion to $PM_{2.5}$ was 17% with a range from 8.0% in the summer to 25% in the autumn. But in Duisburg and Amsterdam, the contribution was influenced by some local sources and long range transported wood combustion aerosols, therefore there is no mean result for wood combustion which contributes to atmosphere particulate matter in those two locations. Puxbaum et al. (2007) found high relative concentrations of wood smoke in organic matter (68 and 47%) in winter conditions in Puszta, Hungary and Aveiro, Portugal. He also found that wood smoke was a very important constituent of the organic material in the middle and west European background with summer contributions to organic matter at around 1 - 6%, while winter contributes to around 20% at the elevated mountain sites and 47 - 68% at rural flat terrain sites, excluding secondary organic aerosol from wood combustion sources (Puxbaum et al., 2007).

Another method to quantify wood smoke particles has been developed recently. Scientists (Jeong et al., 2004; Hand et al., 2005; Park et al., 2006) found out that organic compounds in wood smoke aerosol can result a UV light absorption measured at the 370nm wavelength. Another study (Kirchstetter et al., 2004) also reported that a lower ratio of the aerosol light absorption at 370nm compared to 880nm is found in traffic aerosol dominated conditions. To conclude the findings, Sandradewi et al., (2008ab) developed experiments using a multi-wavelength aethalometer to simultaneously measure 7 wavelengths (λ = 370, 470, 520, 590, 660, 880 and 950 nm) in order to quantify the wood smoke aerosol and traffic aerosol together. They found a strong systematic diurnal cycle of the aerosol light absorption parameters at 370nm and 880nm and finally provided a modified power law approximation of the wavelength dependence of the aerosol light absorption.

1.4 Aims and objectives of this research.

1.4.1 Aim and objective of this research

The aim of this project is to develop a comprehensive method of identifying and quantifying the contribution to air pollution by particulate matter from wood fuel burning in the atmosphere in Birmingham, UK. Three independent procedures ((levoglucosan analysis, fire particle potassium analysis and multi-wavelength aethalometer) are applied in this study to measure the concentrations of local wood smoke tracers and black carbon aerosols. Inter-comparisons of independent simultaneously collected datasets will be carried out and a recommendation of appropriate conversion factors from the tracers' concentrations to the atmospheric wood smoke concentrations will be introduced. Also this study will evaluate the data collected from water soluble ions in airborne particles, in order to understand particle sources and composition.

1.4.2 Brief view of the structure of this thesis

Chapter 1 provides background information on airborne particulate matter and global biomass burning situations. Chapter 2 describes the sampling protocols including location and sampling time, sampling equipment, analytical methods and statistical analysis methods. Chapter 3 evaluates the water soluble ion concentrations in airborne particles, potential sources, and seasonal variation in different sampling locations and also demonstrates both calculation methods of wood smoke potassium from water soluble potassium in locally sampled wood smoke. Chapter 4 assesses the wood smoke organic tracer levoglucosan's potential sources, temporal, spatial and seasonal variation patterns in different sampling locations. Chapter 5 uses a multi-wavelength aethalometer to directly measure the local wood smoke concentration, and then estimate the atmospheric wood smoke particle concentrations. Chapter 6 inter-compares wood smoke potassium, levoglucosan and wood smoke particle concentrations resulting from the multi-wavelength aethalometer. Finally Chapter 7 summarises the findings of this thesis.

Chapter 2

Experimental design and analytical procedures

The aim of the research is to produce a comprehensive method to identify and quantify the contribution of PM by wood fuel burning in the atmosphere in Birmingham, UK. It will not only investigate the water soluble ions, and organic tracer concentrations related to local wood smoke level, but also examine the methods to measure the wood smoke concentrations. Therefore the thesis will first report the regular water soluble ions and levoglucosan collected in sampling areas, then present the aethalometer wood smoke particle mass concentrations, and finally inter-compare three methodologies used to measure the wood smoke concentration. The three methodologies are: (1) to use inorganic element wood smoke potassium as a tracer to convert it to wood smoke concentrations; (2) to use the organic compound levoglucosan as a tracer; and (3) to use the aethalometer to directly measure the black carbon to obtain wood smoke concentrations. In order to do so, Partisol Sampler, High Volume Sampler and Digitel High Volume Sampler are adopted in this study to collect inorganic and organic aerosols. Also a multi-wavelength aethalometer is adopted to measure different wavelength to determine the wood smoke PM mass concentrations and traffic PM mass concentrations.

Therefore this chapter is going to present the experimental and analytical procedures of the whole research. First, the details of the sampling locations for collecting the wood smoke samples will be described; then the sampling equipment used to take the inorganic and organic samples will be explained; finally, the experimental methods of acquiring the final dataset for analytical work will be discussed.

2.1 Sampling locations, sampling period and sampling equipments

The following four sampling locations have been chosen to obtain water soluble ions and wood smoke tracers (Figure 2.1).

2.1.1. Elms Road Observatory Site (EROS)

The EROS site(Latitude = 52.455^{O}N and Longitude = 1.930^{O}W,) is located on the north perimeter of the estate of University of Birmingham. The main sources of heating in this area are non-wood burning origins. The nearest major road is Bristol Road, A38, which is about 800 metres away from the above site. Burning waste wood activities were carried out about every two months at an open fire source (100 metres away from the north) during winter time only. The open fire normally lasted for about 3 to 5 hours during the day. Sampling was taken from 1st June 2008 to 1st April 2010 at EROS, starting at GMT 12:00pm every day. The equipments setups were Dichotomous Partisol Sampler and High Volume Sampler. The High Volume Sampler filters were changed manually therefore there was no sample during weekends and holidays. The meteorology dataset was acquired from the Quinton, Birmingham weather station (Latitude = 52.454^{O}N, Longitude = -1.979^{O}W).

2.1.2 North Kilworth Mill Observatory Site (NKMOS)

The NKMOS site (Latitude = 52.433^{O}N and Longitude = 1.103^{O}W) is located 50 km east of the city of Birmingham and 20 km south of Leicester. It situated at the north east of the village of South Kilworth and 10 km south west of North Kilworth. The nearest main traffic sources are the M1, 5 km west of the site (routing traffic from the south to the north passing between Northampton, Leicester and Nottingham) and the A14, 5 km south of the site (routing traffic between Birmingham and Cambridge). In this local resident area wood fuel heating system is the main system for winter warming. But there is no obvious open fire source near it. Sampling was carried out from 14th February 2009 to 10th August 2009, starting at GMT 12:00pm. The sampling equipment setup was a single channel Partisol Sampler. The meteorology dataset was acquired from the Tythorn Hill, Wigston, weather station (Latitude = 52.580 ^{O}N, Longitude = 1.116^{O}W).

2.1.3 Churchill Pumping Station Site (CPSS)

The CPSS site(Latitude = 52.420 and Longitude = 2.192^{O}W) is selected as a rural background site, which is located approximately 20 km west of Birmingham and surrounded mostly by grass/unused land with the nearest (about 200 m) traffic pollution arising from the A451 during a north-westerly wind direction. Sampling was carried out from 11th March 2009 to 25th April 2009, starting at GMT 12:00pm every day. The equipment setup was Dichotomous Partisol Sampler. The meteorology dataset was acquired from the Stourbridge weather station (Latitude = 52.450^{O}N, Longitude = 2.134^{O}W)

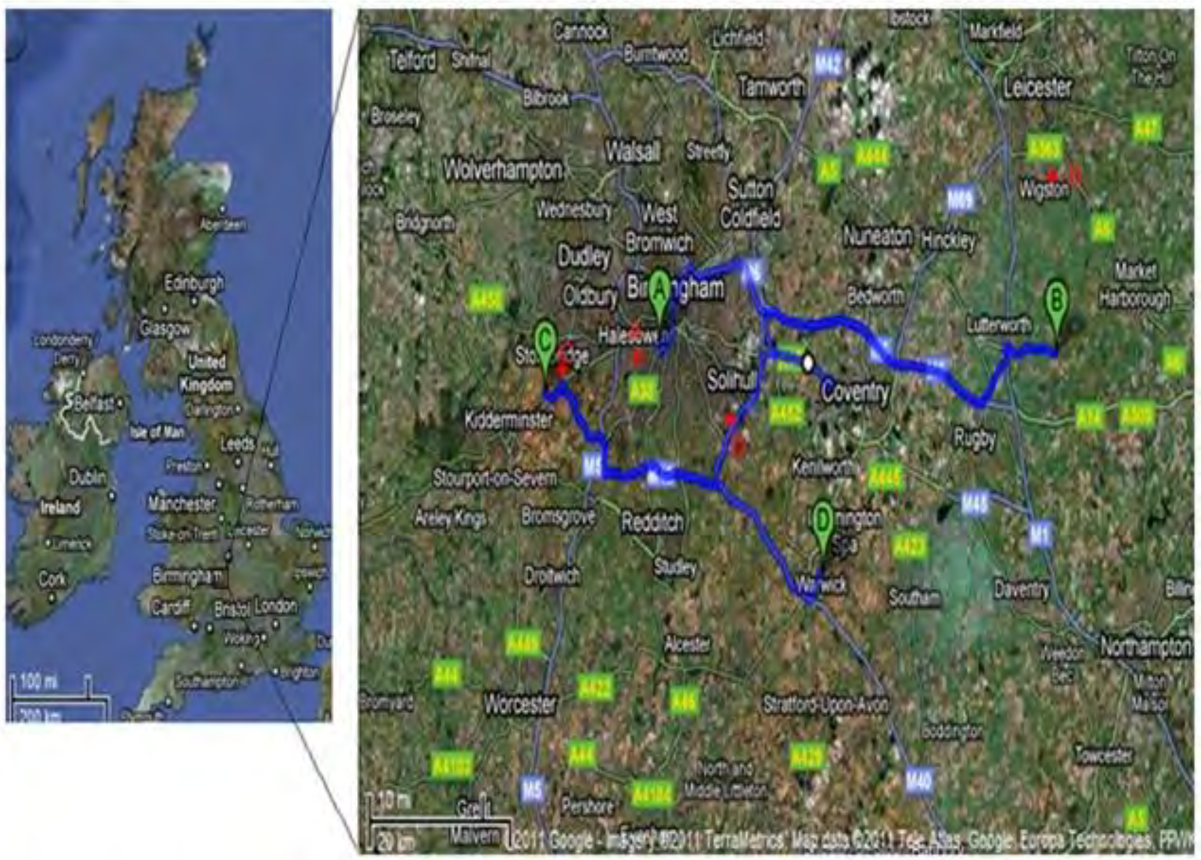
2.1.4 Budbrooke, Warwick Sampling Site (BWSS)

The BWSS site(Latitude = 52.283^{O}N and Longitude = 1.633^{O}W) is a rural village in Budbrooke, Warwick, located at the rural area in central England to obtain local wood burning aerosol. It is 55 km of south east of the city of Birmingham and 4 km of the west of the city of Warwick. In this area, the predominant source for heating in winter and usual cooking is burning wood. There are also approximately four to six local woodcutter and sawmills which are based on wood harvesting and wood selling. Those businesses sometimes set up some open fires to burn their waste wood; this activity produces large amount of wood smoke. The sampling site is located in one of the woodcutter and sawmill sites in this area. In this sawmill there is sometimes an open fire source burning waste wood for about 4-6 hours during the day, it is about 50 metres north of the sampling location. The tree type being burned in this location is made up by 60% of hard wood and 40% of soft wood. This combination is very efficiency as wood fuel, as it is easy to be ignited and can last for a longer time compared with pure soft wood. The nearest traffic sources are M40, 3 km south of the site (routing traffic from the west to the south passing between Birmingham, Warwick and Oxford) and the A46, 1.5 km east of the site (routing traffic between Coventry and Evesham). Sampling was carried out from 19th November 2009 to 08th April 2010, starting at GMT 12:00pm every day. The meteorology dataset was acquired from the Monkspath, Solihull weather station (Latitude = 52.390^{O}N, Longitude = 1.782^{O}W)

The equipment setup was a Dichotomous Partisol Sampler, Digitel High Volume Sample and multi-wavelength aethalometer. The aethalometer was stopped between 24th December 2009 and 18th January 2010. The Partisol Sampler and the Digitel High Volume Sampler were stopped for two days on 19th December 2009 and on 3rd February 2010.

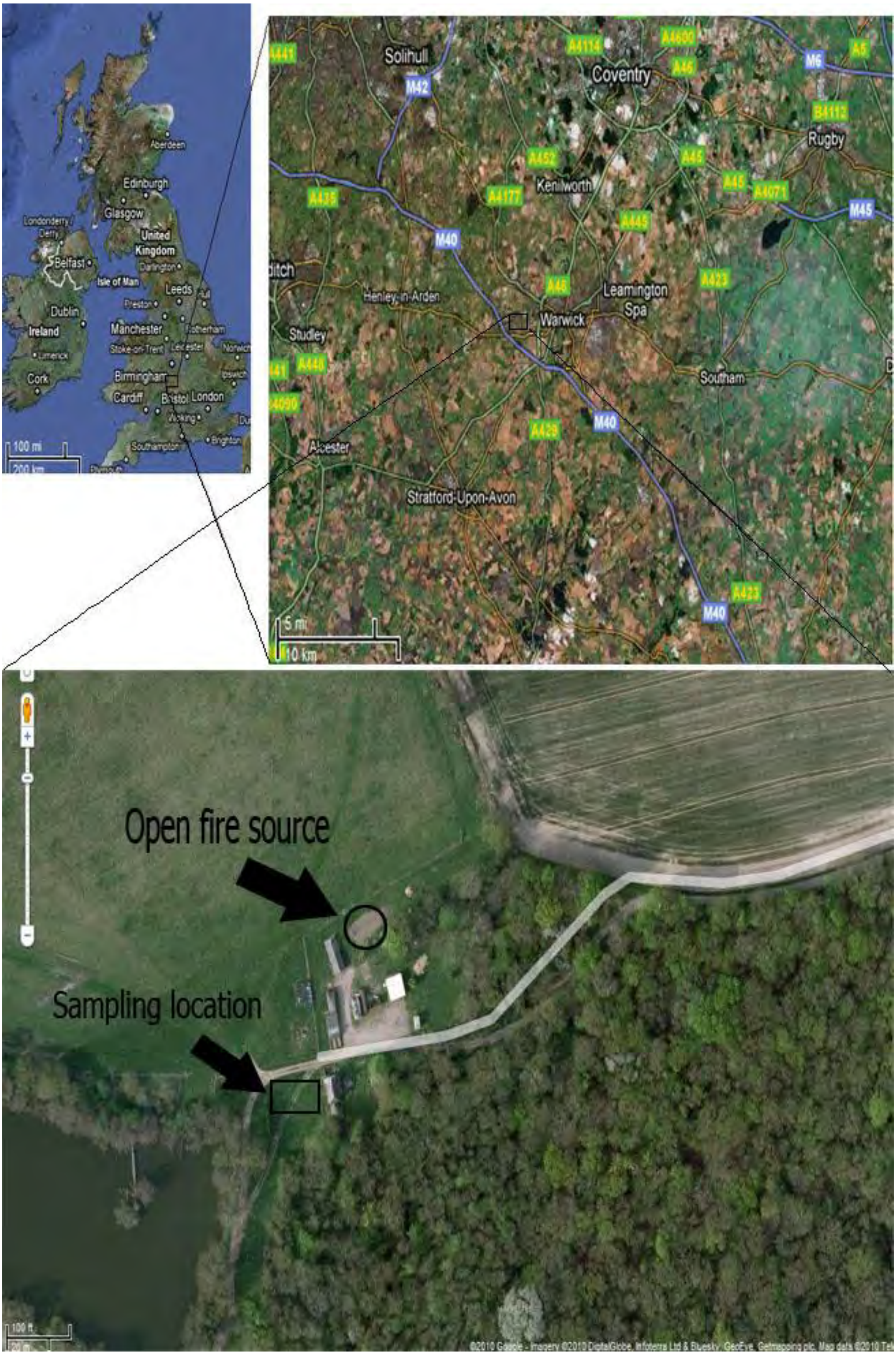
The multi-wavelength aethalometer is not a waterproof design, therefore it was installed in a metal container. The three sampler inlets were set at 2 metres above the ground level. Each inlet head was approximately 2 to 3 metres away from the other inlet. The nearest open fire source was within 50 metres to the north of the sampling site (Figure 2.2a). In the winter period, there was a campfire which burned waste wood fuel almost every week at that location. Also there was a wood burning house located 8 metres to the east, which used wood fuel for warming the house and cooking. Especially, it has a different heating system to create hot water for daily use. To the south is a small forest area. To the west and the north is a grass area, and there is a sand soil dust road to the east approximately 1 km in length. The majority of the soil particles collected by the samplers might come from this road.

The local meteorology daily dataset was acquired from the British Atmospheric Data Centre (http://badc.nerc.ac.uk/home/index.html). The meteorology measurement stations have also been presented in Figure 2.1 as red dots for each sampling site. The results of the meteorology dataset will be presented and discussed in the discussion chapters.



Source: maps.google.co.uk

Figure 2.1 Sampling locations; the red dots represent the weather station locations which measuring the corresponding sampling locations.
(A: EROS B: NKMOS C: CPSS D: BWSS)



(a)

Figure 2.2a Location of BWSS UK measurement sites.

(b)

Figure 2.2b A view of the BWSS site from ground level

Sampling locations	Sampling equipments	Sampling periods
EROS	High Volume sampler Dichotomous Partisol sampler	1st June 2008 -- 1st April 2010
NKMOS	Single channel Partisol sampler	14th February 2009 -- 10th August 2009
CPSS	Dichotomous partisol sampler	11th March 2009 -- 25th April 2009
BWSS	Digitel High-Volume sampler Dichotomous partisol sampler Multi-wavelength aethalometer	19th December 2009 -- 8th April 2010

Table 2.1 Sampling equipment and sampling periods in each locations

2.2 Sampling equipment

2.2.1 Partisol Sampler

The Rupprecht and Patashnick Dichotomous Partisol-Plus Model 2025 Sequential Air Sampler (Partisol sampler) provides a convenient means of collecting high quality samples of fine and coarse ambient particulate matter (PM). It splits a PM_{10} sample stream into fine ($PM_{2.5}$) and coarse (particles between 2.5 and 10 microns in size) fractions using a U.S. EPA-designed virtual impactor for the additional 2.5 micron cutpoint. The Partisol sampler uses a R&P PM_{10} inlet operating at 16.7L min^{-1} to provide the initial particle size cutoff of 10μm. The virtual impactor is located underneath the inlet, using two separate flow controllers to split the PM_{10} sample stream into fine ($PM_{2.5}$) and coarse(particles between 2.5 and 10 microns in size) fractions by drawing the air at 15L min^{-1} and 1.67L min^{-1} respectively. Therefore the total volume for the Partisol sampler was 24m^3 per day, for the fine fraction flow rate 21.6 m^3 per day and the coarse fraction 2.4 m^3 per day.

The function of the single channel Partisol sampler is the same as the Dichotomous Partisol, but it can only use either a $PM_{2.5}$ or PM_{10} inlet sampling one channel at a time. In this study a $PM_{2.5}$ inlet was used. The flow rate for the $PM_{2.5}$ channel was 24 m^3 per day.

The filter exchange system can store up to 16 filters by holding them in a magazine. The Partisol sampler collects fine and coarse particles on two 47mm diameter filters simultaneously. The filters are changed automatically to the flow position at the pre-set time. In this study, polypropylene-backed PTFE filters were used to collect the fine and coarse particles.

2.2.2 High Volume Sampler

A Graseby-Andersen High-Volume sampler was used to collect levogluocosan at the EROS site. A $PM_{2.5}$ inlet on top of the sampler collected fine particles. This sampler operates at a flow rate of 0.9 m^3 min^{-1} (1152 m^3 per day). The sampler uses a 20.3cm by 25.4cm (8" by 10") QM-A Whatman quartz fibre filter, but only one fourth of the filter was extracted and analyzed because the concentration was too high. The filter change is operated manually so there were only weekday samples during the sampling periods, and the sampler was stopped during the weekends.

2.2.3 Digitel High Volume Sampler

A Digitel Elektronik GmbH Digitel High Volume Sampler was utilised in this study. It contains an inlet head on top of the sampler with an exchangeable probe for collecting $PM_{2.5}/PM_{10}$ particles. The sampling probes ($PM_{2.5}/PM_{10}$) are designed as a single stage impactor. In this study, the $PM_{2.5}$ sampling inlet was used to collect fine airborne particles. Compared with the old high volume sampler, the Digitel high volume sampler has an automatic filter changer to change the filter without operator intervention. The instrument can be programmed to sample for any period of the time required, then start and complete automatically. QM-A Whatman 150mm diameter glass fibre filters were used (filter aerosol area 140mm). The sampling flow rate is approximately 500L min^{-1}, so the total volume of the Digitel High Volume Sampler was 720m^3 per day. The Digitel High Volume Sampler has a container of 15 filters stretched in filter holders. The filters are changed automatically to the flow position at the pre-set time.

2.2.4 Multi-wavelength aethalometer

The Magee Scientific Multi-wavelength Aethalometer (□ = 370, 470, 520, 590, 660, 880 and 950 nm) is the foremost instrument for the real-time measurement of optically-absorbing ‘Black’ or ‘Elemental’ carbon aerosol particles. The multi-wavelength aethalometer draws the air sample through the inlet port at 4 L min^{-1} using a small internal pump. The flow rate is monitored by an internal mass flow meter and is stabilized electronically to the set point value entered in software.

The aethalometer can collect the sample onto a quartz fiber filter tape, and at the same time perform a continuous optical analysis. Each filter tape contains 1500 spots for holding the samples. The tape does not move when it is sampling, it will only move to the next spot when the current spot reaches a certain density. In urban areas it needs approximately 3 - 5 spots a day but in the rural areas one spot can last for one day or even longer. The analysis gives one new reading every 5 minutes.

There are two kinds of inlet heads which can be applied in the aethalometer. The ‘High Sensitivity’ (‘HS’) sampling inlet head provides a collecting spot area of 0.5 cm^2, while the ‘Extended Range’ (‘ER’) sampling inlet head collects on a spot of 1.67 cm^2. In this study, the ‘Extended Range’ sampling inlet head was applied to collect $PM_{2.5}$ aerosol samples.

2.3 Analytical procedures and analysis equipment

2.3.1 Experimental detection limits and average value calculations

All the experimental detection limits are determined using the standard technique, described by Zhou's (Zhou, 1998). Standard blank filters were extracted and analysed during all analytical procedures. A value of three time standard deviation indicates the Detection Limit. All the sample results were well above the detection limits and they have been subtracted by the average value of the blanks.

The average/mean value in this study is defined as arithmetic mean value, which is calculated as the sum of the numbers divided by the number of samples for this dataset.

2.3.2 Inorganic potassium analysis methodology

In order to determine the concentrations of water-soluble potassium, a Dichotomous Partisol sampler was used. PTFE filters were conditioned for 24 hours (20℃, 40% humidity in balance room), and then loaded on to the Partisol Sampler. Usually every two sets ($PM_{2.5}$ and $PM_{2.5–10}$) of cartridge of filters were delivered from the laboratory to the sampling sites and were changed every 2 weeks time. $PM_{2.5}$ and $PM_{2.5–10}$ masses were obtained by weighing the PTFE filters before and after exposure using a Sartorius Model MC5 microbalance. Each filter was weighted three times to minimize the experimental error. After the air samples were weighed, PTFE filters were then placed in the 10ml glass tube waiting for extraction. The PTFE filters then were wetted with propan-2-ol (0.2 ml) and extracted using 10ml distilled de-ionised water (DDW) with mechanical agitation for 40 minutes to ensure complete dissolution of the water-soluble aerosol. After extraction, all the samples were sealed with a cap, sealed again with parafilm, and then kept in the 4°C refrigerator within a sealed plastic box until analyzed by Ion chromatography (IC) to obtain anion and cation results.

Anion species chloride, nitrate and sulphate were analysed using a Dionex DX2000 Ion Chromatography system with an AS4A-SC analytical column and a GP40 gradient pump, which generated a single eluent from two different solutions, de-ionised, distilled water (DDW) and potassium hydroxide solution (0.1M). The same sample solution was also used for the determination of the cations sodium, ammonium, potassium, magnesium and calcium, using a Dionex DX500 Ion Chromatography system fitted with a CS12A analytical column. 20 mM Methane Sulphonate Acid (MSA) was used as solution for the cation analysis.

The calibration was achieved using numbers of blank filters and the external standards of known concentrations ranged from 0.05ppm to 20ppm from a 1000ppm stock solution. The blank filters were extracted following the same as the aerosol filters. The stock solutions contained sodium chloride, potassium chloride, ammonium chloride, magnesium chloride and calcium chloride for cations and sodium nitrate, sodium chloride and ammonium sulphate for anions. The detection limits for those ions (ng m^{-3}) were 8.97(Na^+), 9.20(NH_4^+), 6.59 (K^+), 3.34(Mg^{2+}), 10.95(Ca^{2+}), 7.33(Cl^-), 10.50(NO_3^-) and 5.57(SO_4^{2-}). Those figures were calculated by three time standard deviations of the blank samples.

The sample concentration results from the Ion Chromatography need to be converted to the concentration in the air. The concentrations in the air were calculated as follows:

The fine particle mass concentration was calculated by:

$$\boldsymbol{C_f = \frac{M_f}{V_f}}$$

The coarse particle mass concentration was calculated by:

$$\boldsymbol{C_c = \frac{M_c}{V_t} - \frac{V_c}{V_t} C_f}$$

Where:

C_f is the mass concentration of the fine particle fraction

C_c is the mass concentration of the coarse particle fraction

M_f is the mass collected on the fine particle fraction filter

M_c is the mass collected on the coarse particle fraction filter

V_f is the volume of air sampled through the fine particle fraction filter

V_c is the volume of air sampled through the coarse particle fraction filter

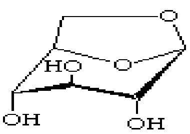
V_t is the volume of air sampled through both the fine and coarse particle fraction filter

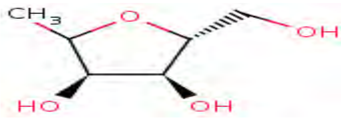
2.3.3 Soil sample analytical procedures

In order to measure the potassium from biomass burning, local soil samples were needed to determine the soil potassium and soil calcium so that the potassium can be distinguished from the soil source. At the EROS site, the soil samples were collected at around 200 metres away from the sampling locations. Four soil samples were collected in each direction. So in total 16 soil samples were obtained from north, west, east and south side individually. The sample intervals were about 50 metres in one direction. The soil samples were collected within 600 metres distance from those air samplers at the BWSS site. Four samples were collected in each direction, therefore 16 soil samples were obtained in total. The sample intervals were about 100 metres in one direction. At the NKMOS and CPSS sites, the soil samples were taken 200 metres from the sampling locations. Four soil samples were collected in each direction.

All the soil samples (approximately 200g each) were taken from the soil surface, and sealed in the plastic bags. All the samples were immediately dried in foil paper at constant room temperature for approximately 1 to 2 weeks after delivery back to the laboratory. When the samples were completely dried, they were then physically crushed and sieved by 1mm, 125μm and 20μm sieves. Afterwards 0.1g samples were put in the 20ml glass bottles then extracted by DDW and mechanical shaking for 40 minutes. Finally the extracted samples were filtered through PTFE filters and finally analyzed by Ion Chromatography (IC) to measure the water soluble cation. The weight process was carried out by Sartorius Model MC5 microbalance in the temperature and humidity controlled balance room.

2.3.4 Levoglucosan analytical methodology

The High Volume Sampler was used to collect the organic wood smoke tracer levoglucosan ($C_6H_{10}O_5$, 

). The High Volume Sampler and Digitel High Volume Sampler, used QM-A Whatman quartz fibre filters (20.3cm by 25.4cm) and QM-A Whatman glass fibre filter (diameter 150 mm, filter aerosol area 140mm) to collect the organic aerosol. The flow rates were 900 L min^{-1} and 500 L min^{-1}, respectively. The collection time for each sample was typically 24 hours. Filter exchange took place at 12:00pm every day. All the filters were pre-combusted at 500 °C for 12 hours before use. Besides the actual samples, a number of blank filters were also pre-combusted and extracted following the same method as the aerosol filters. All the filters were sealed in the foil paper and put in a metal box, then transported between the sampling location and the laboratory. Only 1/4 of the filter was extracted to examine the levoglucosan concentration, because the whole filter would probably have had too high concentration for the analysis. Before extraction, an internal standard (methyl-beta-D-xylopyranoside, $C_6H_{12}0_5$, 

) was spiked on to the aerosol filter to correct for losses during sample extraction and concentration. The internal standard was spiked onto the filter for 4 hours before extraction. The spiked standard solution was evenly distributed on to the filter paper. The internal standard was prepared in methanol and sealed in a 10ml glass vial then sealed again with parafilm. The detection m/z after derivatization for this internal standard was 204 and 217, which was the same as levoglucosan 204, 217 and 333. The rest of the high volume filters (3/4) were cut to $1.5\times1cm^2$ areas for carbonaceous compounds analysis.

The spiked filter parts were extracted three times, each time for 20 minutes with 30 mL of dichloromethane under ultrasonic agitation. The first extraction was performed under acidic conditions by addition of acetic acid (200 µL). The combined dichloromethane extracts were reduced with a rotary evaporator (400 hPa, 25 °C) to approximately 5-10 mL. Then the concentrated extracts were filtered through a PTFE filter and completely dried under a stream of nitrogen. Finally, the dried samples were redissolved in pyridine (200 µL) then kept at 4°C until derivatization.

Aliquots of 50uL of the sample solutions were taken out and derivatized by trimethylsilylation mixture (40µL). After derivatization, 10 L recovery standard (1ppm) was added to the sample and a total of 100uL was analyzed by GC/MS. In this study, 1-phenyl dodecane ($C_{18}H_{30}$, ) was applied as a recovery standard. The addition of a recovery standard was to compensate for injection volume effects and variations in the GC/MS detector response.

The derivatization process was carried out by the trimethylsilylation mixture, which was mixed with 99% of N-methyl-N-trimethylsilyltrifluor-oacetamide (MSTFA) and 1% trimethylchlorosilane (TMCS). The trimethylsilylation mixture was freshly made before the

derivatization process. Each time 10 samples were added the trimethylsilylation mixture. Then the derivatization process was performed in a sealed vial for 60 minutes at 80°C in a dry heater block. After derivatization, the sealed vials were opened to add the recovery standard, and then those 10 samples were immediately analyzed by GC/MS.
The calibration was carried out by an internal calibration standard procedure. The calibration range was from 0.05ppm to 10ppm from a 1000ppm stock solution. The calibration standard levoglucosan were weighted with a Sartorius Model MC5 microbalance then prepared with methanol. To each level of the calibration standard was added 1ppm internal standard and 1ppm recovery standard. The entire calibration standards were stored in 10ml glass vial then sealed with parafilm, kept at 4°C until analysed by the GC/MS with the aerosol samples.

Quantification was carried out by GC/MS and was based on an internal standard calibration procedure with appropriate recovery and blank corrections. A sample volume of 1.0 µL was injected into a split/splitless injector, operated in the splitless mode at a temperature of 250 °C. The carrier gas was helium at a pressure of 120 kPa. The temperature program was started at 45 °C for 4 minutes, a gradient of 20 °C min^{-1} was used up to 100 °C, followed by 10 minutes at this temperature, then the temperature increased to 315 °C at 5 °C min^{-1} and was held for 20 minutes. The m/z ratios for the ions used in the GC/MS analysis are 204, 217 and 333.

After analysis by the GC/MS, the aerosol samples were first calibrated by the recovery standard, and then again by the internal standard. The internal standard calibration process was based on the following equations:

$$\boldsymbol{RRF} = \frac{\boldsymbol{A_{NAT}}}{\boldsymbol{A_{IS}}} \times \frac{\boldsymbol{C_{IS}}}{\boldsymbol{C_{NAT}}}$$

$$\boldsymbol{Conc} = \frac{\boldsymbol{A_{NAT}}}{\boldsymbol{A_{IS}}} \times \frac{\mathbf{1}}{\mathbf{RRF}} \times \frac{\boldsymbol{M_{IS}}}{\boldsymbol{SS}}$$

Where
RRF=relative response factor for the target pollutant
A_{NAT}=peak area of target pollutant in sample
A_{IS}=peak area of internal standard in sample

C_{IS}=concentration of the internal standard in the standard

C_{NAT}=concentration of target compound in the standard

M_{IS}=mass of internal standard added to sample

SS= Sample size

Conc=target sample concentration

2.3.4.1 Levoglucosan accuracy and precision and inter comparison with Kings college sample results

To measure the levoglucosan reproducibility, four standard reference material (SRM) samples were extracted following the same aerosol samples procedure to measure the recovery rates. Weighing was carried out with a Sartorius Model MC5 microbalance. 50mg of each SRM was extracted and then analysed using GC/MS together with the aerosol samples to measure the recovery rate.

To measure the levoglucosan reproducibility, the reproducibility of the combined derivatization and analysis, as derived from four consecutive experiments with a standard reference meterials (SRM), was carried out during sampling campaign. The SRM dust was 1649b. 1mg 1649b SRM contains 81.1±0.1μg/g levoglucosan. 50mg of SRM was extracted and then analysed by GC/MS to measure the recovery rate. Linear calibration curves were obtained in the range 0.05-5 ng μL^{-1} for levoglucosan. The correlation coefficients of this calibration were better than 0.998. The final recovery rates for four SRM samples were 121%, 121%, 120% and 123%, respectively (Table 2.1).

Table 2.1 SRM levoglucosan recovery ratios

μg/mL	Result	Levoglucosan in SRM	Recovery rate%
SRM1	4.908	4.056	121%
SRM2	4.932	4.076	121%
SRM3	4.862	4.051	120%
SRM4	5.024	4.084	123%
Average	4.932	4.067	121%
Stdev	0.068	0.016	0.013

These results were slightly higher than the certified concentration values, but the reproducibility ratio was stable (relatively 121%). Therefore the concentration results for the levoglucosan were reliable. So the uncertainties in the laboratory determination of levoglucosan concentrations were estimated to be around 21% based on the recovery rate. Furthermore, six aerosol samples, taken by Kings College in London, analysed with the aerosol samples in this study to inter-compare the levoglucosan extraction methods (Figure 2.3). The linear regression correlation coefficient is very high (R^2= 0.962), but the results from University of Birmingham were lower than those from Kings College.

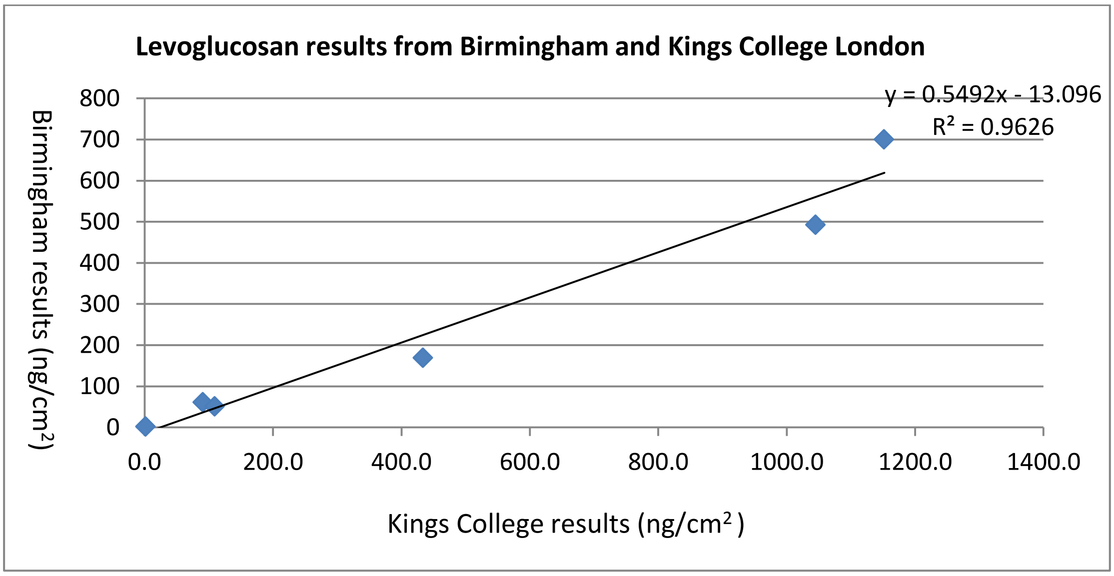
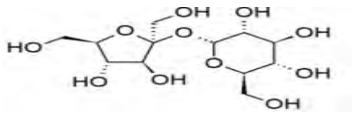


Figure 2.3 Levoglucosan Birmingham versus Kings College inter-comparison results

The measurement methodology from Kings College is different from this study. Quantification of the levoglucosan was undertaken at NILU, (Norway), as described in Dye and Yttri (Dye and Ytri, 2005). Briefly, a 2 cm^2 punch from each quartz fibre filter was soaked in tetrahydrofuran (2 ml) and subjected to ultrasonic agitation (30 min). The filter extract was then filtered through a syringe filter (0.45 µm) to remove PM and filter parts. Each filter was extracted twice. The extracted volumes were pooled and evaporated to a total volume of 1 ml in an N_2 atmosphere. Before analysis the sample solvent elution strength was adapted to the mobile phase by adding Milli-Q water (0.8 ml). The concentrations of levoglucosan were determined using High Performance Liquid Chromatography (HPLC) in combination with HRMS-TOF (High Resolution Mass Spectrometry Time-of-Flight) operated in the negative electrospray mode. The compound separation was performed with two series-connected reversed-phase C18 columns (Atlantis dC18, Waters). Levoglucosan was identified on the basis of retention time and mass spectra of authentic standards and quantification was performed using isotope labelled standards of levoglucosan. The limit of quantification for the method at a signal to noise ratio of ten is approximately 30 ng injected of levoglucosan. The uncertainties in the laboratory determination of levoglucosan concentrations were estimated to be around 5%.

2.3.5 Organic carbon (OC) and element carbon (EC) analytical procedure

A Sunset Laboratory Inc. Thermal/Optical Carbon Analyser was used in this study. The analyzer used the EUSAAR Protocol(European Supersites for Atmospheric Aerosol Research, www.eusaar.net) to determination the organic carbon (OC) and elemental carbon (EC) on particulates collected on quartz fibre filters. OC is analysed at the beginning during the initial non-oxidising temperature ramp from 75–700 °C under a helium atmosphere. Then the initial OC is converted to carbon dioxide in the oven under a hydrogen atmosphere. In addition the carbon dioxide is converted to methane by a heated nickel catalyst. The methane is finally measured by a flame ionisation detector (FID). The second temperature ramp ranging from 550 to 850 °C is going to analyse EC after the OC is measured. EC and pyrolysis products are oxidised with the carrier gas switched to a helium/oxygen mixture then the oxidised products are carried through the system and measured with the same method as OC. A laser light is used to monitor the light transmission through the filter during the OC/EC analysis. This laser can determine the split point to separate the EC formed by charring and the original EC from the sample. The split point is when the laser absorbance equals the initial laser absorbance after the elemental carbon oxidized off.

The samples were cut from the glass fibre filter by Digitel high volume sampler. Sucrose ($C_{12}H_{22}O_{11}$, 

) were used as the external standards in calibration curves with known concentrations ranging from 0.4μg ml^{-1} to 4μg ml^{-1}. The detection limits were 0.30 μg m^{-3} for OC and 0.20 μg m^{-3} for EC, with a method uncertainty of 8% (at 99% confidence level). It was noted that the methodology may cause some overestimation of EC due to charring of OC during pyrolysis (Schmid et al., 2001).

2.3.6 Multi-wavelength aethalometer sampling and analytical methodology

Sandradewi's publication (Sandradewi et al., 2008a; Sandradewi et al., 2008b) demonstrated the multi-wavelength aethalometer can be used to analyse aerosol light absorption for the quantification of wood burning and traffic emission contributions to particulate matter. These studies follow the same protocol and then try to compare it with other methods for the wood smoke quantification.

The aethalometer is very easy to install and take samples. Each tape filter can take approximately 5 months sample without changing. The 5 minutes sample data measurement is recorded in the SD disk in csv form. Every day at 0:00am a new csv file is automatically created. The SD disk can store up to 1G files and each csv file is about 120kb so theoretically the SD disk can store up to 8333 csv files.

The attenuations (ATN) at 7 different wavelengths (λ = 370, 470, 520, 590, 660, 880 and 950 nm) is measured on the quartz tape filter. This is defined for each wavelength as

$$ATN = 100 \ln\left(\frac{I_0}{I}\right) \qquad (2.1)$$

Where:
I and I_0 are beam intensity before and after attenuation (ATN) from the particle-laden quartz tape filter.

After calculated the ATN value for each wavelength, and the values of aerosol attenuation coefficient (b_{ATN}) can be calculated by the following equation.

$$b_{ATN} = \frac{A \, \Delta ATN}{Q \, \Delta t} \qquad (2.2)$$

Where:
A is the filter spot size 1.67 cm^2
Q is the flow rate 3.8L min^{-1}
Δt is the sampling time 5 minutes

When the filter is loading particles, the existing particles may “shadow” the freshly-collected ones. The new particles are not exposed to the same intensity of the light, thus it won’t make the same contribution to ATN per unit mass. Therefore it needs to be corrected by using the following equations:

$$b_{abs} = \frac{b_{ATN}}{C\,R(ATN)} \tag{2.3}$$

$$R(ATN) = \left(\frac{1}{f} - 1\right)\frac{\ln(ATN) - \ln(10)}{\ln(50) - \ln(10)} + 1 \tag{2.4}$$

Where C = 2.14

f is determined by comparing the values of b_{abs} before and after the filter change.

C = 2.14 was used as empirically determined from "pure" palas soot, diesel soot and diesel soot mixed with $(NH_4)_2SO_4$ particles (Weingartner et al, 2003). This value can apply in this study too.

b_{abs} is the aerosol light absorption coefficient, which is the essential parameter involved in atmospheric radiation budget calculations. In this study(Collaud Coen, 2010), a total of five correction algorithms were given to correct the b_{abs} value. In this study, the Weingartner (Weingartner et al. 2003) correction is applied to correct the attenuation effect due to the filter loading and to determine the calibration constant C for different aerosol types.

The light intensity is related to the absorption coefficient b_{abs} for airborne particles by the Beer-Lambert Law:

$$I = I_o e^{(-b_{abs} x)} \tag{2.5}$$

Where x is the thickness of optical medium.

Furthermore, the absorption coefficient b_{abs} is also related with the wavelength:

$$b_{abs} \propto \lambda^{-\alpha} \tag{2.6}$$

Where α is the Ångström Exponent of the absorption coefficient.

This value can compare with dataset from other studies. Lower value(up to 1.5) was observed during the Saharan dust event(Collaud Coen et al., 2004) and higher value (nearly 2.2) was observed in the wood smoke burning activities area (Kirchstetter et al., 2004). More detailed values will be presented in the analysis chapter.

In this study (Favez et al., 2009), it was assumed that brown carbon and mineral dust do not absorb light at 950 nm, so that light absorption could be attributed solely to black carbon at this wavelength. Black carbon absorption coefficients at other wavelengths could then be estimated using an absorption exponent α. The study(Favez et al., 2009) was also calculated the black carbon contribution to total absorption of 90□□□□at□520mn and 72 ± 6% at 370 nm, which showing the importance of short wavelength absorption by wood smoke carbon.

The result at absorption coefficients $b_{abs}(470)$ and $b_{abs}(950)$ can be used to calculate the wood burning and traffic components $b_{abs}(470)_{wb}$ and $b_{abs}(950)_{traf}$ by using the matrix equations 2.7, 2.8 and 2.9.

$$\frac{b_{abs}(470nm)_{traffic}}{b_{abs}(950nm)_{traffic}} = \left(\frac{470}{950}\right)^{-\alpha_{traffic}} \tag{2.7}$$

$$\frac{b_{abs}(470nm)_{wb}}{b_{abs}(950nm)_{wb}} = \left(\frac{470}{950}\right)^{-\alpha_{wb}} \tag{2.8}$$

$$b_{abs} = b_{abs\,traffic} + b_{abs\,wb} \tag{2.9}$$

Wb = wood burning

Furthermore, Sandradewi (Sandradewi et al., 2008) regressed measured $PM_{2.5}$ values against $b_{abs}(470)_{w}$b and b_{abs} $(950)_{traf}$ using equation 2.10.

$$CM(PM2.5) = c1 \times b_{abs}(950nm)_{traffic} + c2 \times b_{abs}(470nm)_{wb} \tag{2.10}$$

Given the absorption coefficients $b_{abs}(470)$ and $b_{abs}(950)$, the wood burning and traffic components $b_{abs}(470)_{wb}$ and $b_{abs}(950)_{traf}$ are extracted for each 5 minute measurement using the following matrix relations derived from equations 2.7 and 2.8 and the solved using in R cran software.

$$\begin{bmatrix} b_{abs}(470)_{traf} \\ b_{abs}(470)_{wb} \end{bmatrix} = \begin{bmatrix} [illegible] & 1 \\ [illegible] & [illegible] \end{bmatrix} \begin{bmatrix} b_{abs}(470) \\ b_{abs}(950) \end{bmatrix} \tag{2.11}$$

$$\begin{bmatrix} b_{abs}(950)_{traf} \\ b_{abs}(950)_{wb} \end{bmatrix} = \begin{bmatrix} [illegible] & [illegible] \\ [illegible] & 1 \end{bmatrix} \begin{bmatrix} b_{abs}(470) \\ b_{abs}(950) \end{bmatrix} \tag{2.12}$$

This pair of matrix equations are derived by expressing $b_{abs}(470)$ and $b_{abs}(950)$ in terms of either just $b_{abs}(470)_{wb}$ and $b_{abs}(470)_{traf}$ or just $b_{abs}(950)_{wb}$ and $b_{abs}(950)_{traf}$ using equation 2.7

and 2.8. The coefficients used in the inversed-matrices above, are calculated using $\alpha_{traf} = 1.1$ and $\alpha_{wb} = 1.85$

R-cran(http://cran.r-project.org/) software is introduced in this study to conduct the mathematics calculation process. This calculation process is achieved use a computer code which was produced and tested by Dr. David Beddows (The computer codes can be found in appendix). Therefore the csv files created by the aethalometer can be input into the R-cran software so that the local wood smoke $PM_{2.5}$ concentrations and traffic $PM_{2.5}$ concentrations are automatically calculated. The aethalometer calibration is carried out in every two weeks during reboot of the aethalometer equipment. When the aethalometer is warming up, it has a procedure which calibrates the flowmeter response by measuring the flowmeter zero voltage and determining the flow scale factor . These two factors are used during measurements to calculate the actual air flow through the flowmeter.

2.4 Quality assurance and uncertainties analysis

All the vials, bottles, flasks, tweezers and equipment for the sample extraction were cleaned at least 5 times by DDW before use. The standard for inorganic water soluble ions can be found in 2.3.2. The calibration standards and internal standards for levoglucosan can be found in 2.3.4. Because of the high volatility of some aerosol species, all the exposed filters were kept at -18℃ before use or extraction, extracted samples were sealed in appropriate vials and then kept at the 4℃. Three DDW samples were analysed at the beginning of each run to avoid any contamination from previous runs and two DDW samples at the end of run to clean the column for the next run. Also six blank samples (extracted by empty filters) were analysed between the first three DDW samples and the aerosol samples to measure the background noise and to calculate detection limits. The aerosol sample results were all deducted by the mean values of those blank sample results.

Two set of standards were analysed between three DDW samples and six blank samples, and at the end of aerosol samples to reduce experimental measurement errors. All the Partisol samples with a flow rate less than 75% of total 16.7L m^{-3} or sampling periods of less than 75% of total 24h were rejected and excluded from the analysis process. The datasets in this study are presented as $\mu g\ m^{-3}$ and $ng\ m^{-3}$ unless otherwise stated.

The levoglucosan uncertainty evaluation is expressed as the combination of accuracy, air sampling error and the analytical uncertainty. The levoglucosan extraction accuracy has been tested by measuring levoglucosan SRM samples and the result(Table 2.1) is about 21% higher than the real value. This high result is not proofed to be correct therefore the result have not applied a correction. The levoglucosan uncertainty therefore relates to the air sampling volume error and the analytical uncertainty. The typical sampling volume error is about 5%(Data from Prof. R.M. Harrison), and the analytical uncertainty is often expressed by the coefficient of variation, which is 1.4% in this study(Table 2.1). Therefore the combined uncertainty for sampling volume error and the analytical uncertainty is expressed as: $\sqrt{5\%^2 + 1.4\%^2}$ and the result for this is calculation is 5.2%. This result has applied as levoglucosan uncertainty for this study.

The calibration standard coefficient of determination(R^2 value) for the levoglucosan is 0.999, therefore the levoglucosan sample results can be reported to three significant figures. There are no adjustment made to the measurement to account for the reported recovery rates.

The Ion chromatography detection limit is evaluated to be below 10ng/ml, the sampling volume error is about 5% for each ion. Then the analytical uncertainty is evaluated by measure the coefficient of variation from the blank samples which is about 3%. Therefore the overall uncertainty for the determination of atmospheric ion concentrations are estimated to be $\sqrt{5\%^2 + 3\%^2}$, and the result is 5.8%. The calibration standard coefficient of determination(R^2 value) for the cations and anions are 0.9999, the inorganic water soluble ion sample results can be reported to three significant figures.

The Sunset Laboratory Inc. Thermal/Optical Carbon Analyser detection limit and analysis uncertainty were given by the manufacturer, are 0.2μg cm^{-2} and 5%, respectively. Average blank filters 0.8 μg cm^{-2} for OC and 0.2 μg cm^{-2} for EC were subtracted from concentrations obtained for sampled filters.

Chapter 3

Inorganic components analytical results

3.1 Introduction

Airborne particulate matter $PM_{2.5}$ and $PM_{2.5\text{-}10}$ size fractions was sampled from summer 2008 until the end of spring 2010 at EROS, CPSS, NKMOS and BWSS sites in UK West Midlands. Daily samples were analysed for inorganic water soluble ions to obtain wood smoke potassium concentrations. This chapter go examines the relationship between $PM_{2.5}$ water soluble inorganic elements and components. After that, the potassium concentration will be calculated to distinguish the sources between wood smoke, soil and sea-salt. Eight inorganic water soluble $PM_{2.5}$ ion concentrations will be analysed and presented in this chapter, they are Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}, Cl^-, NO_3^- and SO_4^{2-}. The $PM_{2.5\text{-}10}$ size sample will not be analysed in this study because it has limited contribution to the wood smoke tracers. Appendix I, II, III and IV present those eight inorganic water soluble ions concentrations data measured at the four sampling sites.

In this chapter the water soluble inorganic aerosol concentrations from four sampling locations will be presented, and then the temporal variation and spatial variation will be discussed based on the concentration results. Finally the potassium subtracted from sea salt and soil is going to be calculated as wood smoke tracer potassium. The wood smoke potassium concentrations will be presented and the seasonal variation of wood smoke concentrations analysed for all the sampling locations.

3.2 Atmospheric concentrations of water soluble elements and ions

3.2.1 Water soluble inorganic ions concentrations

The daily water soluble inorganic elements and ions sodium, ammonium, potassium, magnesium, calcium chloride, nitrate and sulphate concentration results can be found in Figure 3.1(EROS), Figure 3.2(BWSS), Figure 3.3(NKMOS) and Figure 3.4(CPSS). All of the four sampling locations have been sampled for different periods to obtain cation and anion concentrations. The EROS site has been sampled from June 2008 to April 2010, the

BWSS has been sampled from November 2009 to April 2010, the NKMOS site has been sampled from February 2009 to August 2009, and CPSS site has been only sampled from February 2009 to March 2009. The maximum, average and minimum concentration values are presented in Table 3.1.

Table 3.1 Summarised water soluble concentrations at all sampling sites

Sites	µg m^{-3}	Na	NH4	K	Mg	Ca	Cl	NO3	SO4
EROS	N	436	436	436	436	436	414	407	407
	Max	1.633	5.897	0.558	0.412	0.644	6.68	10.542	12.096
	mean	0.476	1.038	0.124	0.056	0.08	1.129	1.315	2.106
	Min	0.011	0.047	0.006	0.001	0.002	0.036	0.006	0.149
	Std	0.345	0.886	0.09	0.048	0.075	0.95	1.4	1.979
BWSS	N	139	139	139	127	127	112	111	112
	Max	1.148	5.897	0.465	0.095	0.928	2.004	13.192	9.936
	mean	0.293	1.416	0.119	0.024	0.191	0.47	2.319	1.445
	Min	0.012	0.004	0.015	0.0003	0.003	0.043	0.125	0.236
	Std	0.243	1.316	0.098	0.022	0.199	0.364	2.094	1.623
NKMOS	N	113	113	113	113	112	113	104	103
	Max	1.511	6.051	0.406	0.067	0.18	2.137	11.768	14.808
	mean	0.244	1.076	0.047	0.029	0.021	0.419	1.523	2.148
	Min	0.005	0.017	0.0002	0.0001	0.0004	0.007	0.031	0.015
	Std	0.198	1.143	0.063	0.017	0.026	0.31	1.664	2.528
CPSS	N	23	20	23	23	23	23	20	20
	Max	1.067	0.631	0.081	0.016	0.096	1.739	0.756	1.243
	mean	0.25	0.231	0.025	0.004	0.027	0.405	0.361	0.452
	min	0.019	0.01	0.003	0.0003	0.003	0.036	0.008	0.024
	Std	0.286	0.192	0.021	0.004	0.029	0.466	0.25	0.358

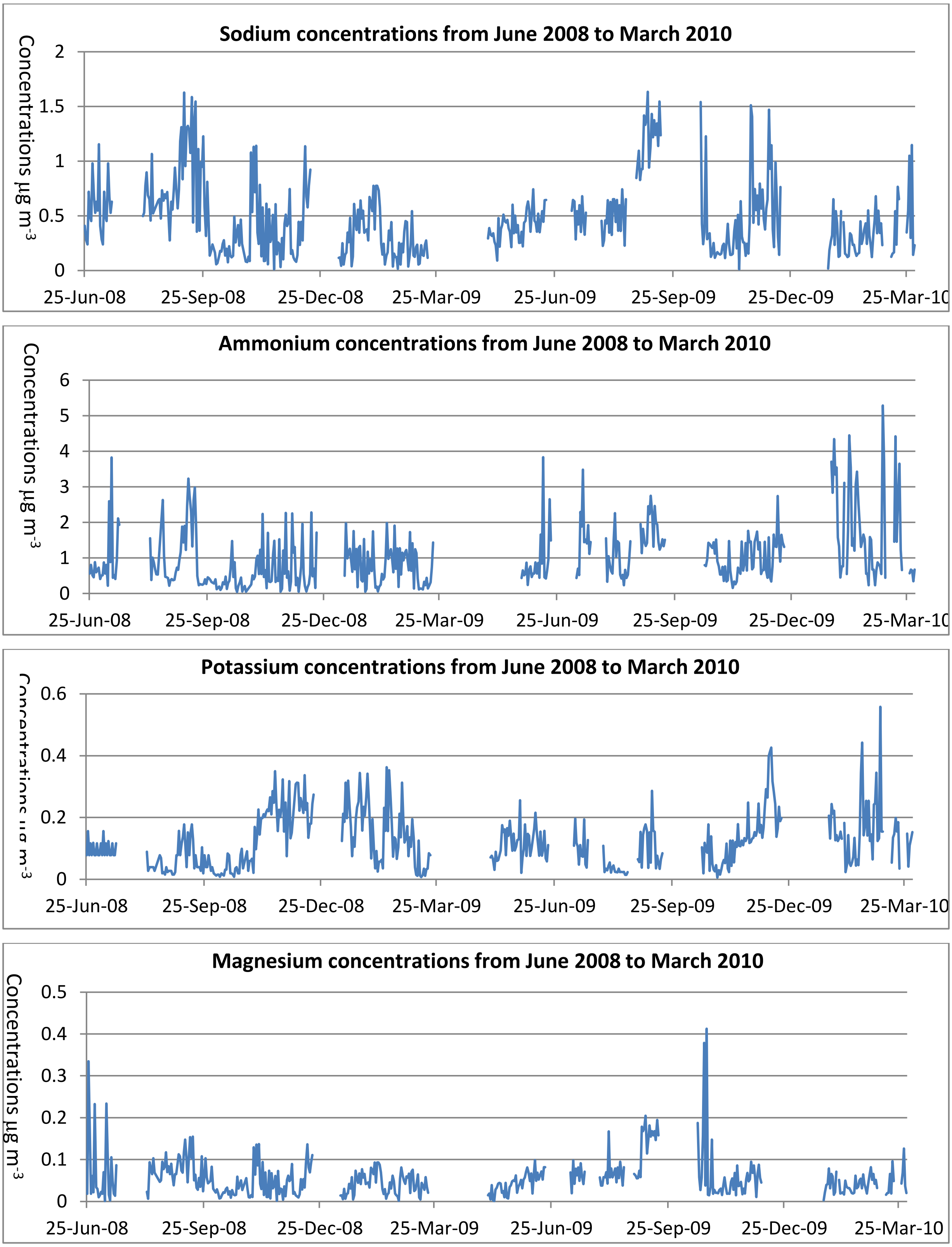


Figure 3.1a EROS dataset from June 2008 to March 2010

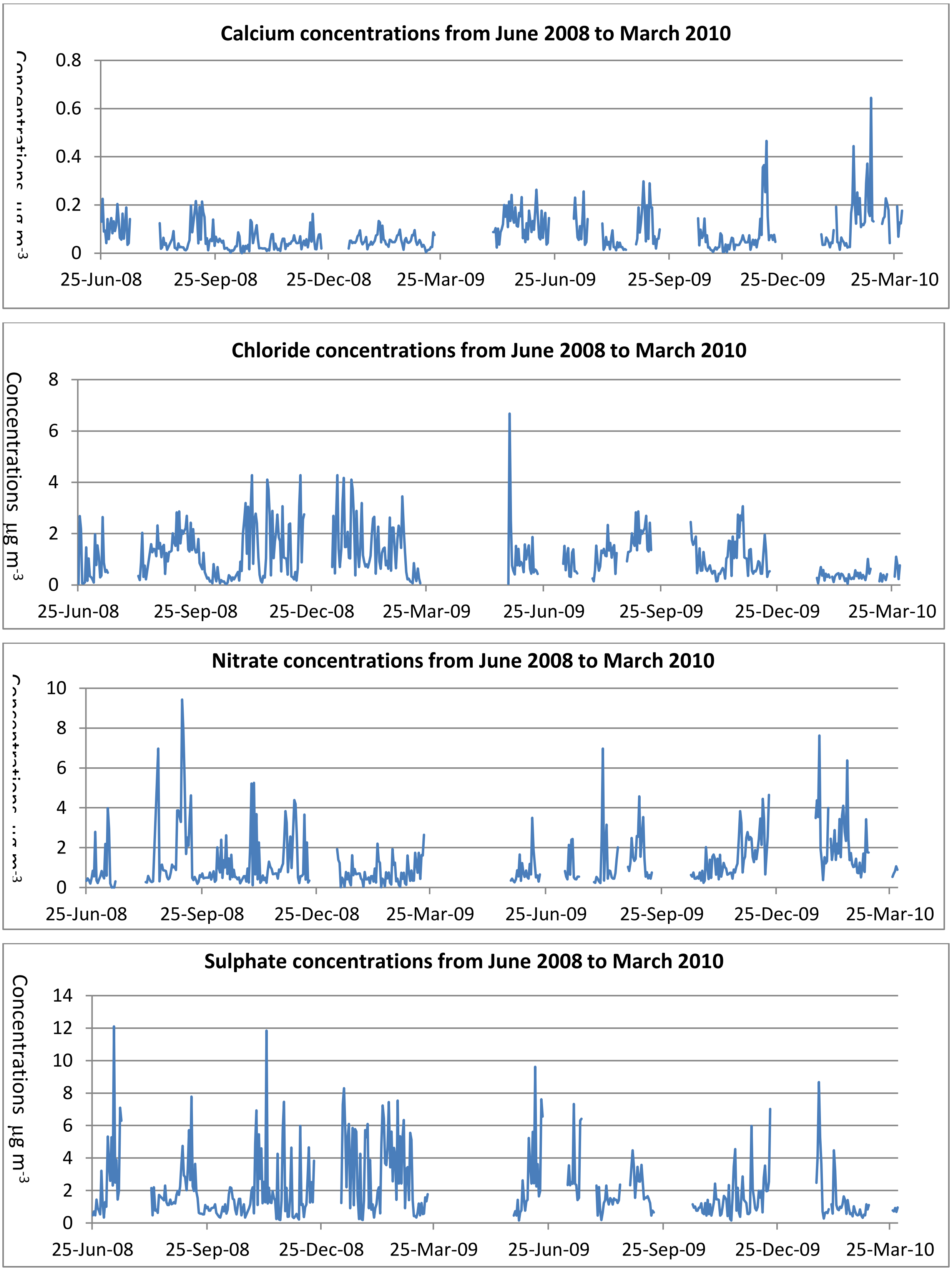


Figure 3.1b EROS dataset from June 2008 to March 2010

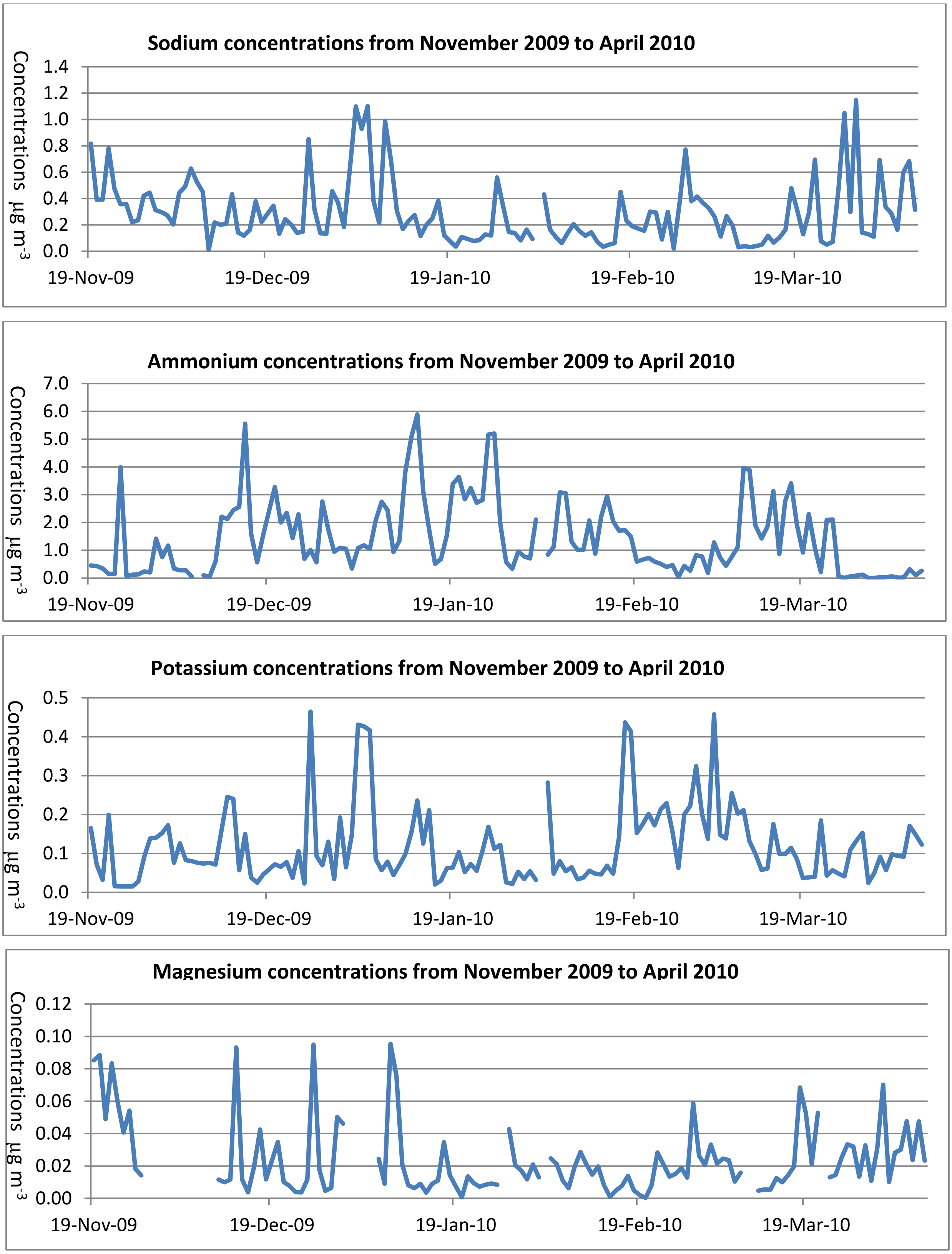
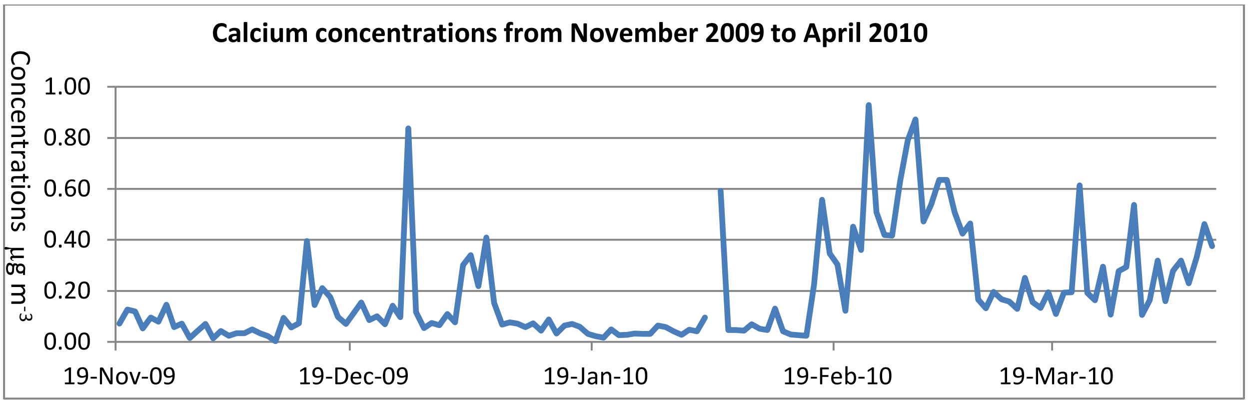
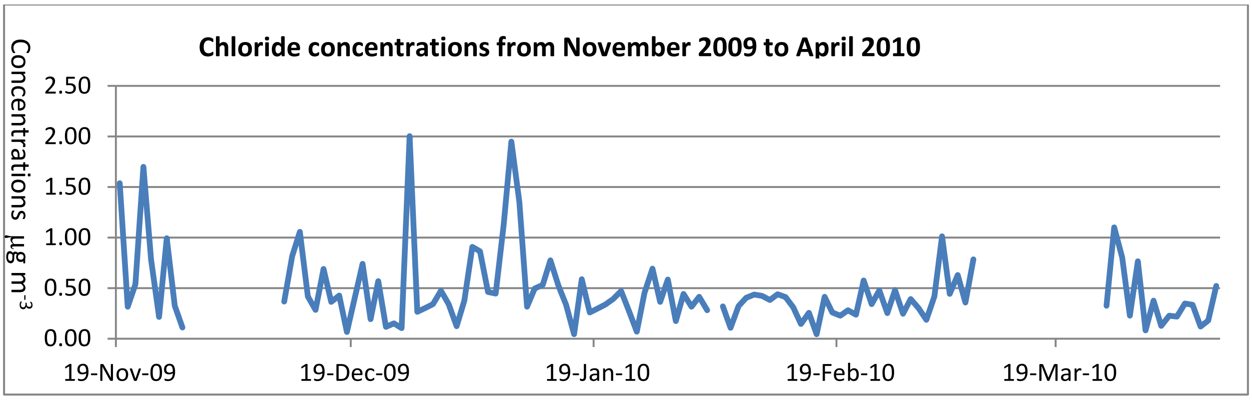
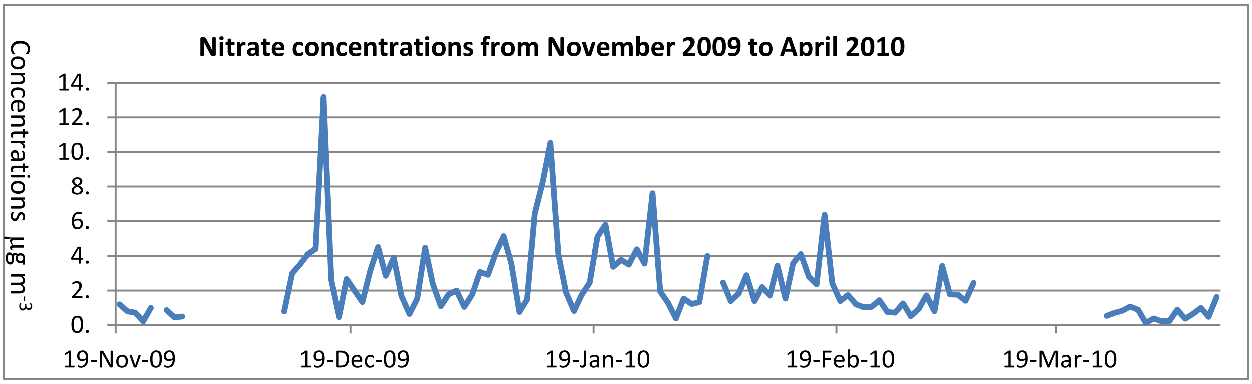


Figure 3.2a BWSS dataset from November 2009 to April 2010







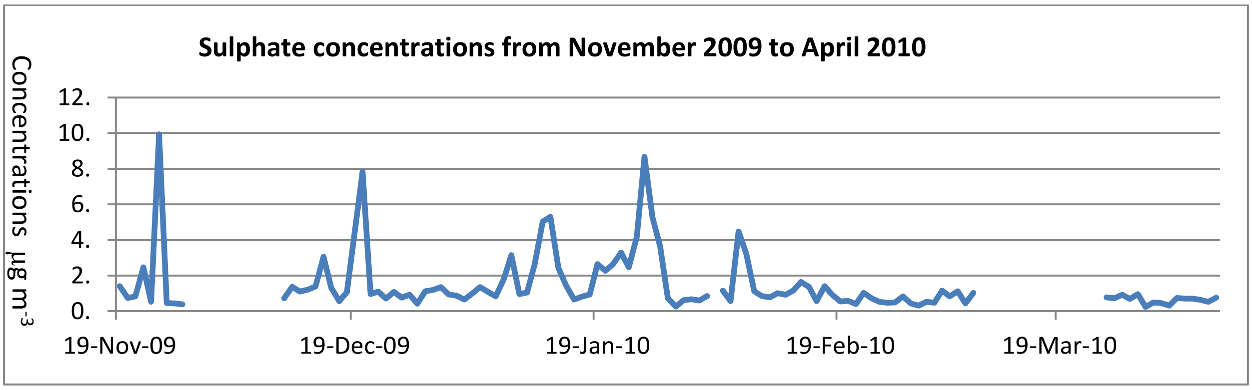


Figure 3.2b BWSS dataset from November 2009 to April 2010

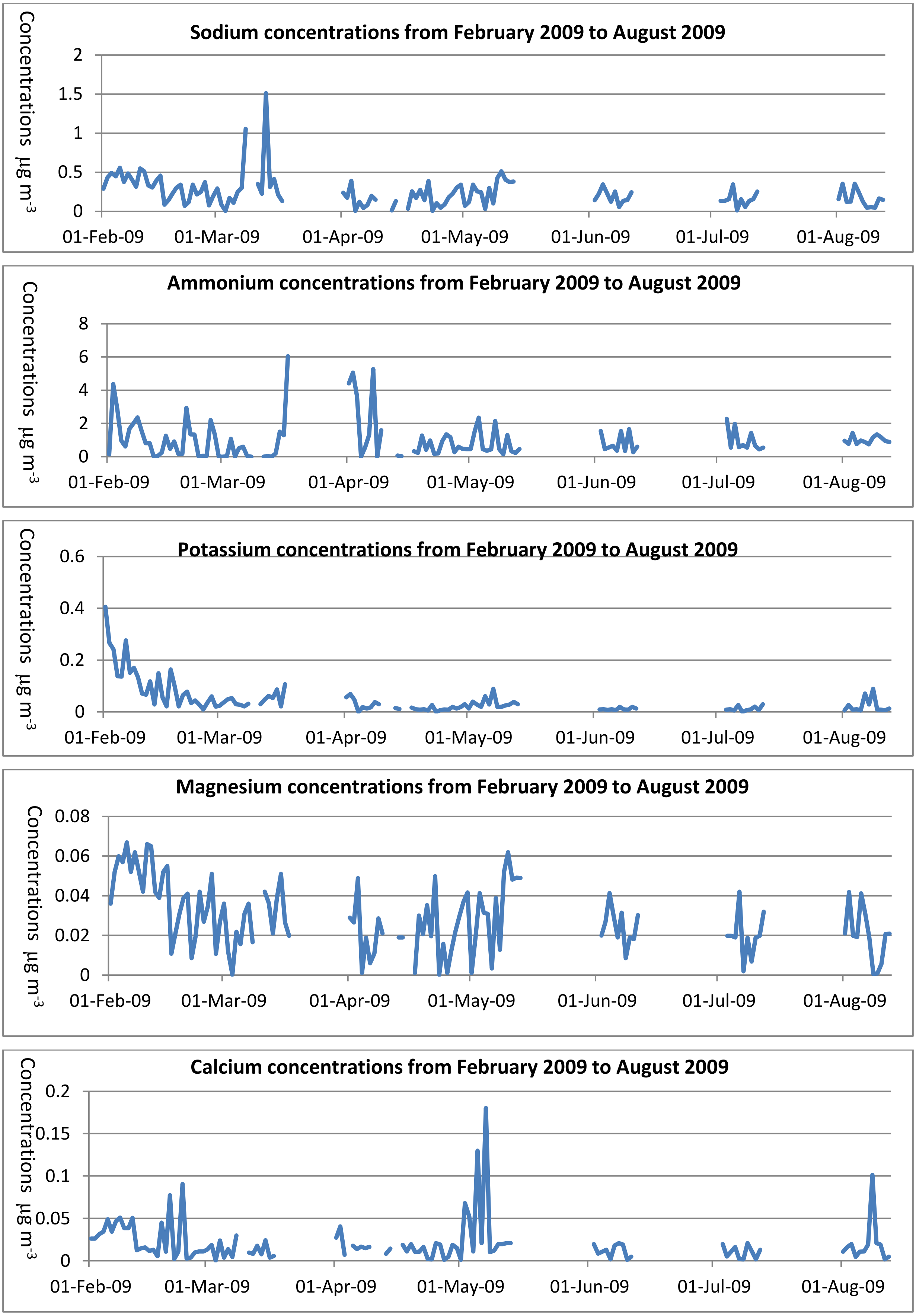


Figure 3.3a NKMOS dataset from February 2009 to August 2009

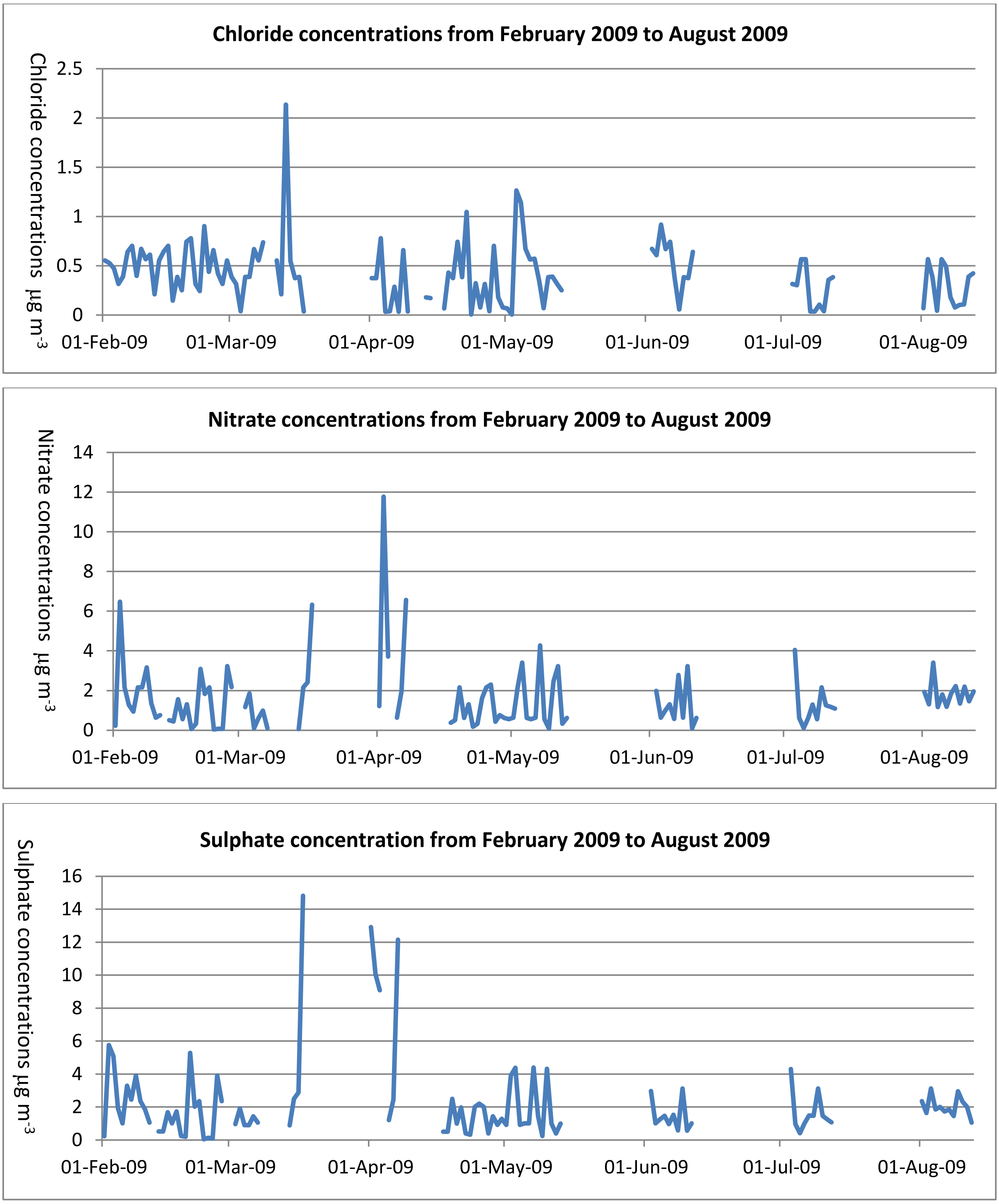
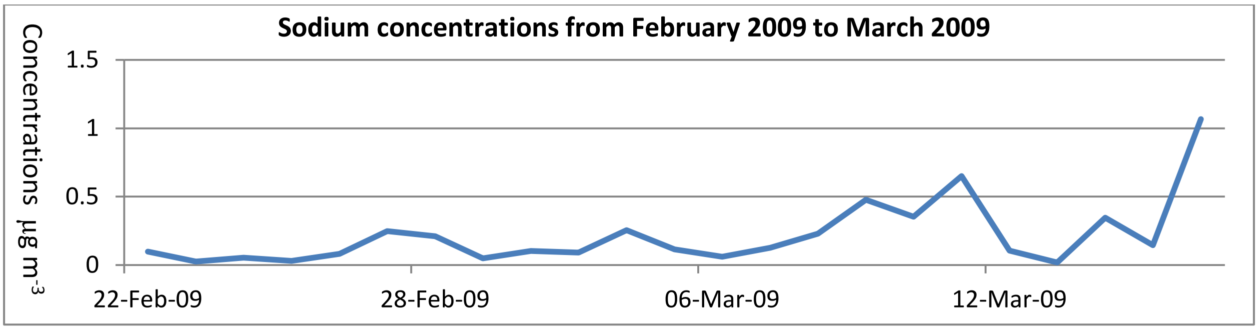
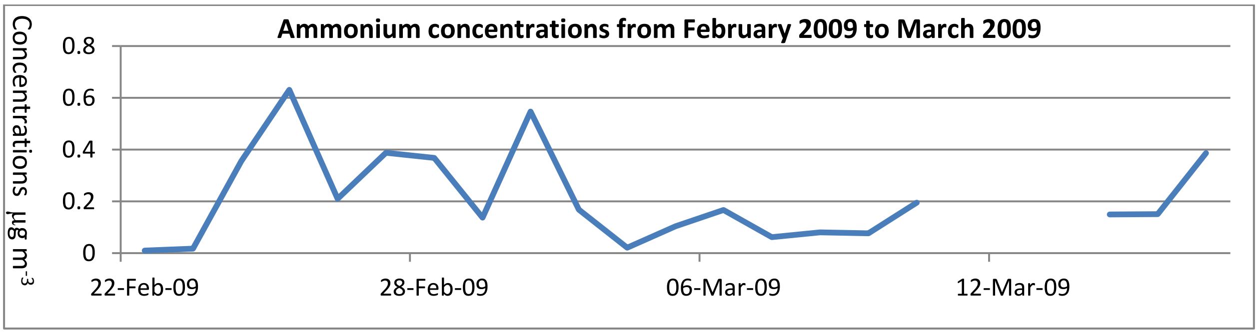
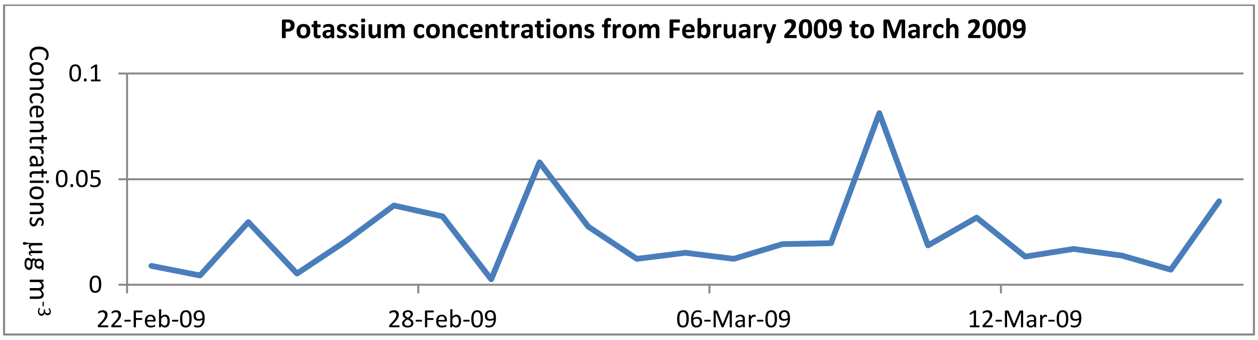
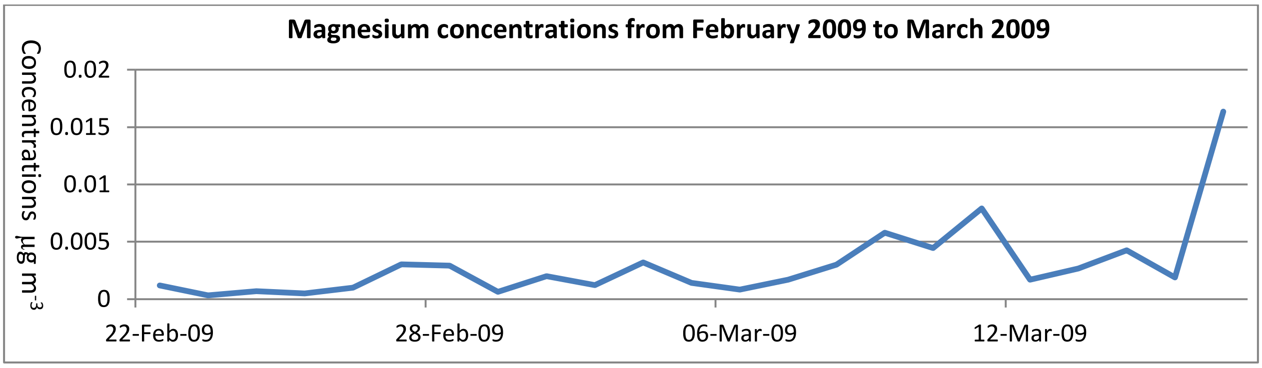


Figure 3.3b NKMOS dataset from February 2009 to August 2009









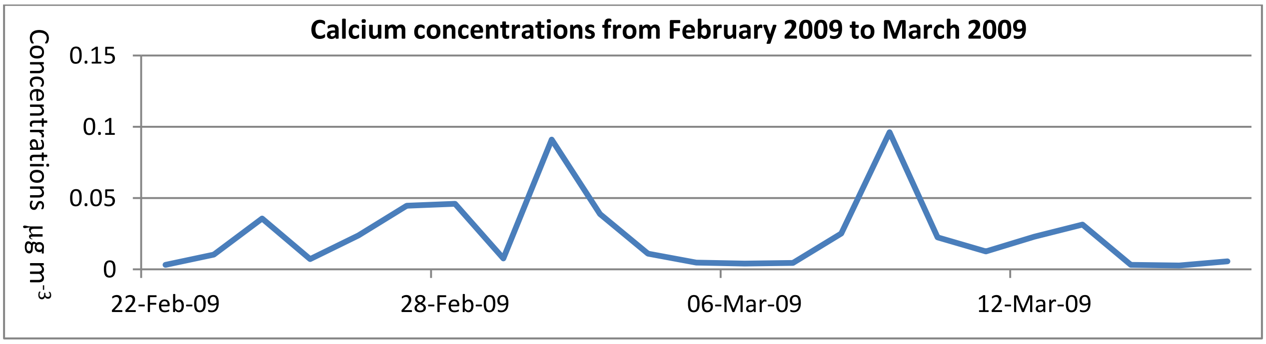


Figure 3.4a CPSS dataset from February 2009 to March 2009

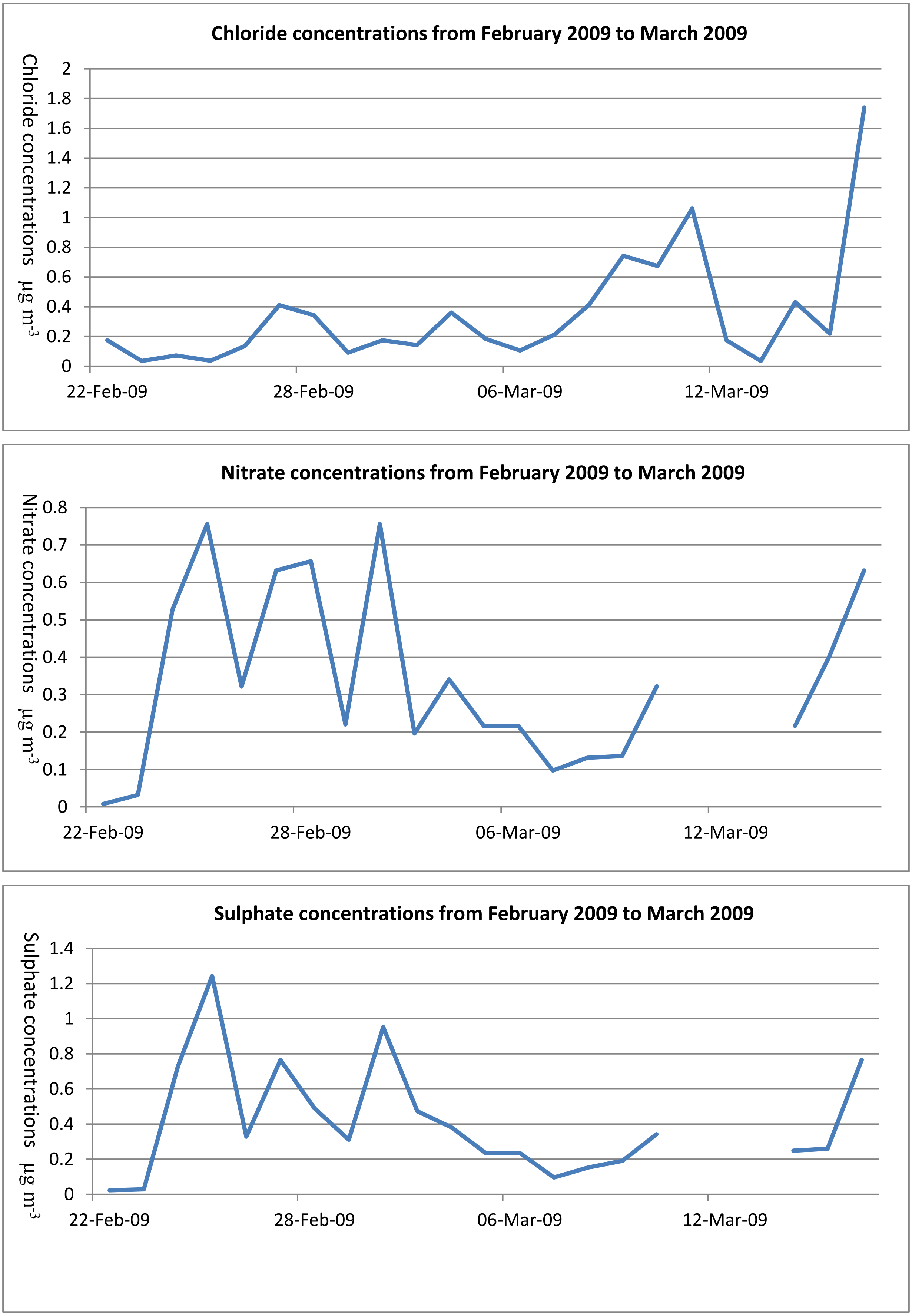


Figure 3.4b CPSS dataset from February 2009 to March 2009

3.2.2 Inorganic water soluble ions frequency distributions

The Kolmogorov-Smirnov goodness of fit test was used to test whether the dataset for each site follows normal distributions. The null hypothesis is applied to examine whether a given data variable is normally distributed. If the null hypothesis is less than 5% then the dataset represents that the sample deviates significantly from a distribution. The dataset from EROS, BWSS and NKMOS site has been tested for normal distributions, the numbers of datas points from CPSS site were not enough so it is not considered for distribution test. The Table 3.2, Table 3.3 and Table 3.4 are the Kolmogorov-Smirnov test results for EROS, BWSS and NKMOS site respectively, they all failed to fit normal distributions and all the curves were skewed right. Therefore a log-normality using the log transformed dataset was introduced to the test, and the result could show a good fit. Figure 3.5, Figure 3.6 and Figure 3.7 are the histograms based on log transformed datasets for the EROS, BWSS and NKMOS sites respectively.

Table 3.2 Kolmogorov-Smirnov test results for a normal distribution of aerosol species (μg m^{-3}) at EROS site.

	Na	NH_4	K	Mg	Ca	Cl	NO_3	SO_4
N	436	436	436	436	436	414	407	407
Max	1.633	5.897	0.558	0.412	0.644	6.680	10.542	12. 0960
Mean	0.476	1.038	0.124	0.056	0.081	1.129	1.315	2.106
Min	0.011	0.047	0.006	0.000	0.002	0.036	0.006	0.149
Std	0.349	0.886	0.091	0.048	0.075	0.950	1.400	1.979
Z-value	2.304	3.419	2.670	6.164	3.727	2.538	3.843	4.083
p-value	0	0	0	0	0	0	0	0

Table 3.3 Kolmogorov-Smirnov test results for a normal distribution of aerosol species (μg m^{-3}) at BWSS site.

	Na	NH_4	K	Mg	Ca	Cl	NO_3	SO_4
N	139	139	139	127	127	112	111	112
Max	1.148	5.897	0.465	0.095	0.928	2.004	13.192	9.936
Mean	0.297	1.416	0.119	0.024	0.191	0.470	2.319	1.445
Min	0.012	0.004	0.015	0.000	0.003	0.043	0.125	0.236
Std	0.246	1.316	0.098	0.022	0.199	0.364	2.094	1.623
Z-value	1.690	1.720	1.599	1.914	2.336	2.147	1.807	3.219
p-value	0.007	0.005	0.012	0.001	0	0	0.003	0

Table 3.4 Kolmogorov-Smirnov test results for a normal distribution of aerosol species (μg m^{-3}) at NKMOS site.

	Na	NH_4	K	Mg	Ca	Cl	NO_3	SO_4
N	113	113	113	113	112	113	104	103
Max	1.511	6.051	0.406	0.067	0.180	2.137	11.768	14.808
Mean	0.244	1.076	0.047	0.029	0.021	0.419	1.523	2.148
Min	0.005	0.017	0.000	0.000	0.000	0.007	0.031	0.015
Std	0.198	1.143	0.063	0.017	0.026	0.310	1.667	2.528
Z-value	1.216	2.013	2.549	1.344	3.010	1.192	1.820	2.354
p-value	0.05	0.001	0	0.05	0	0.017	0.003	0

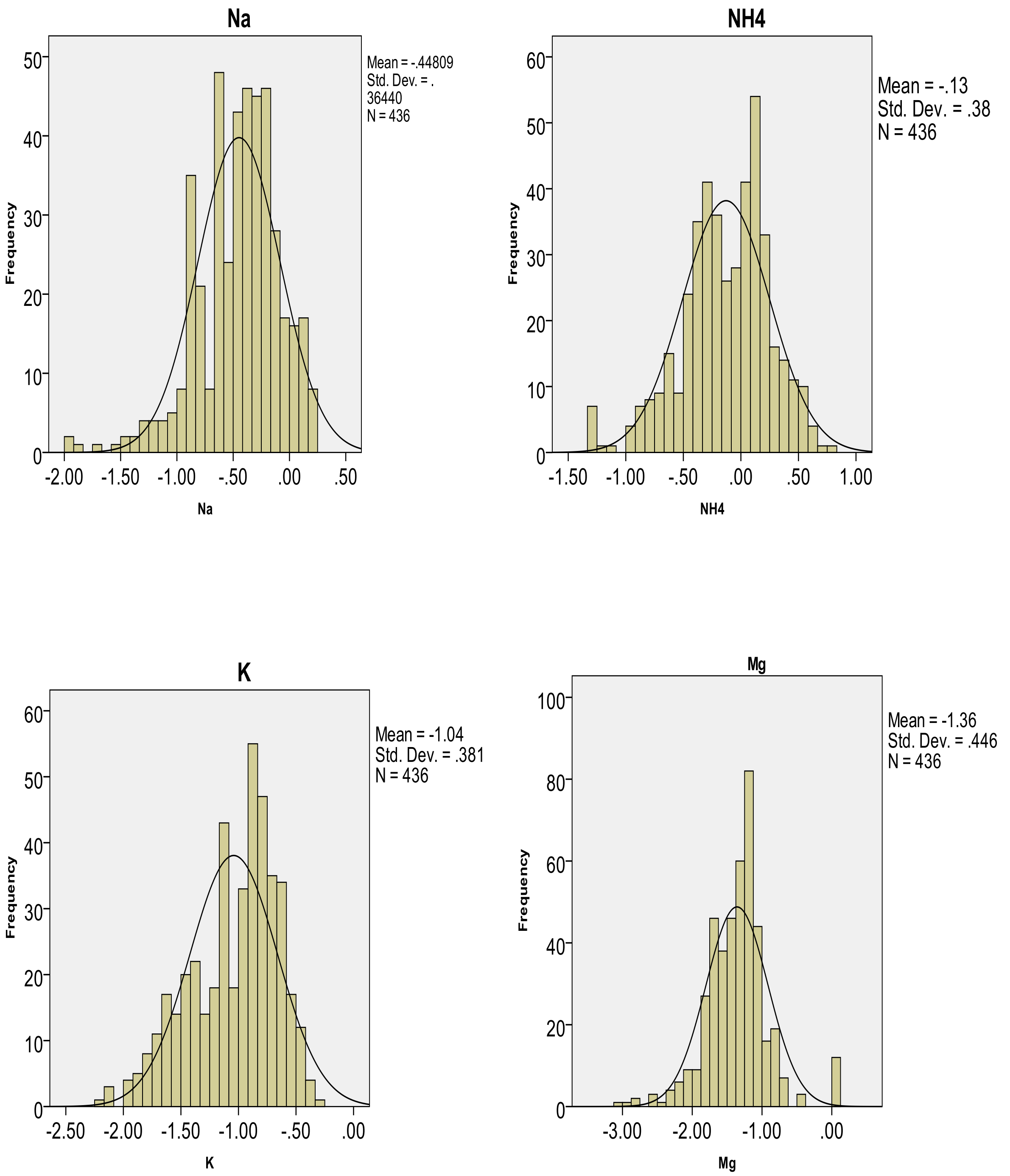


Figure 3.5a EROS water soluble $PM_{2.5}$ ions frequency distributions, the datasets are log-transformed

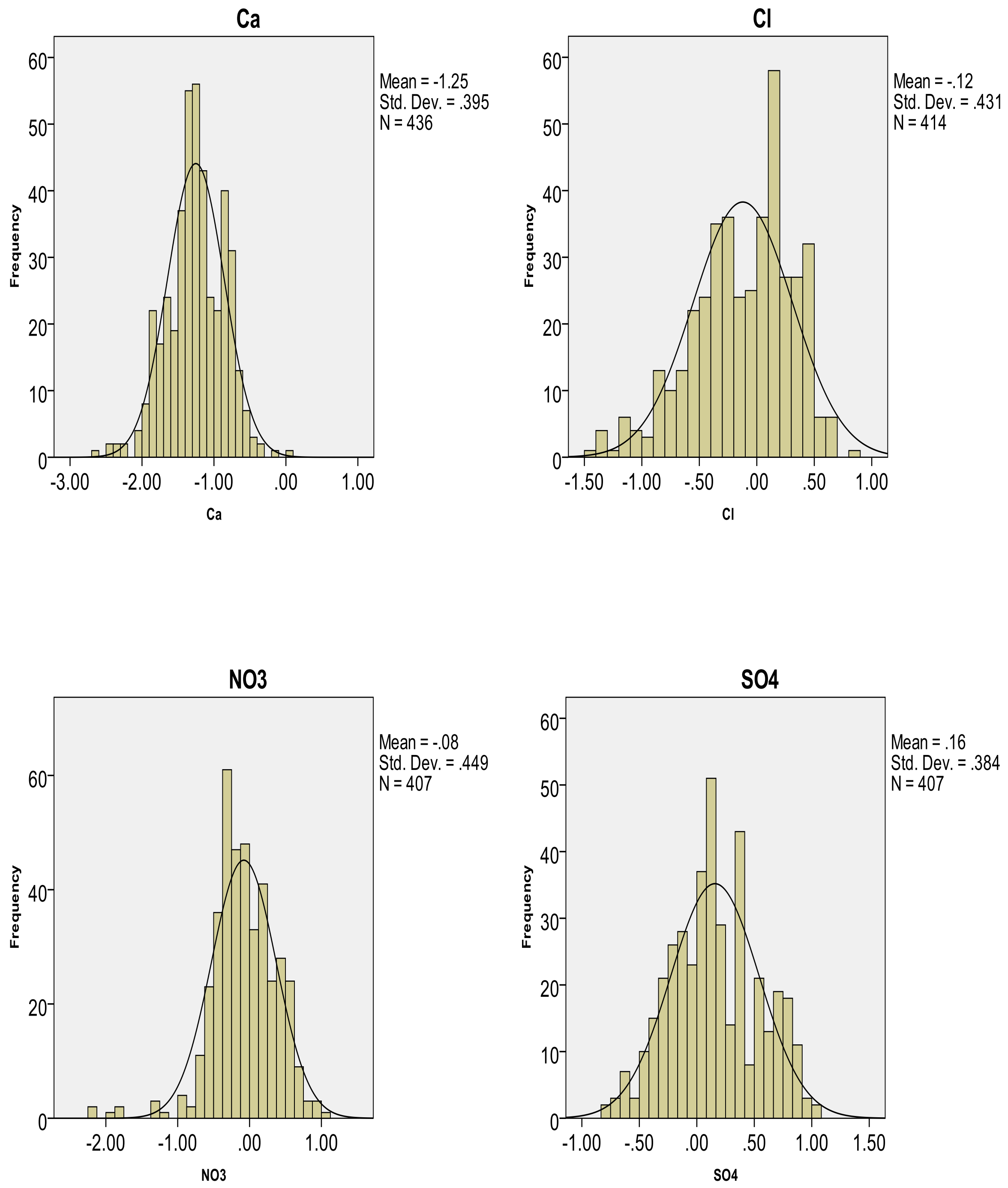


Figure 3.5b EROS water soluble $PM_{2.5}$ ions frequency distributions, the datasets are log-transformed

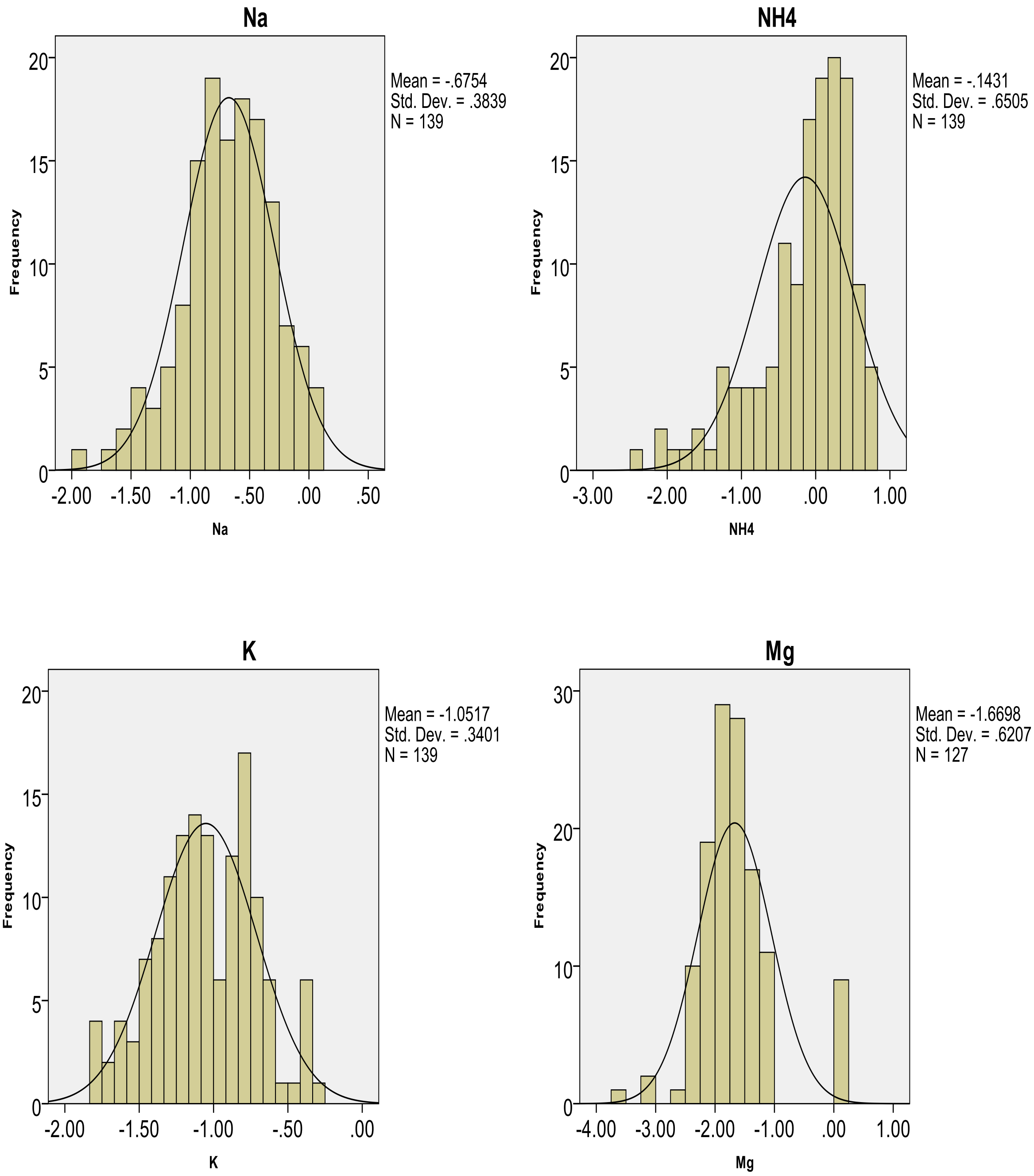


Figure 3.6a BWSS water soluble $PM_{2.5}$ ions frequency distributions, the datasets are log-transformed

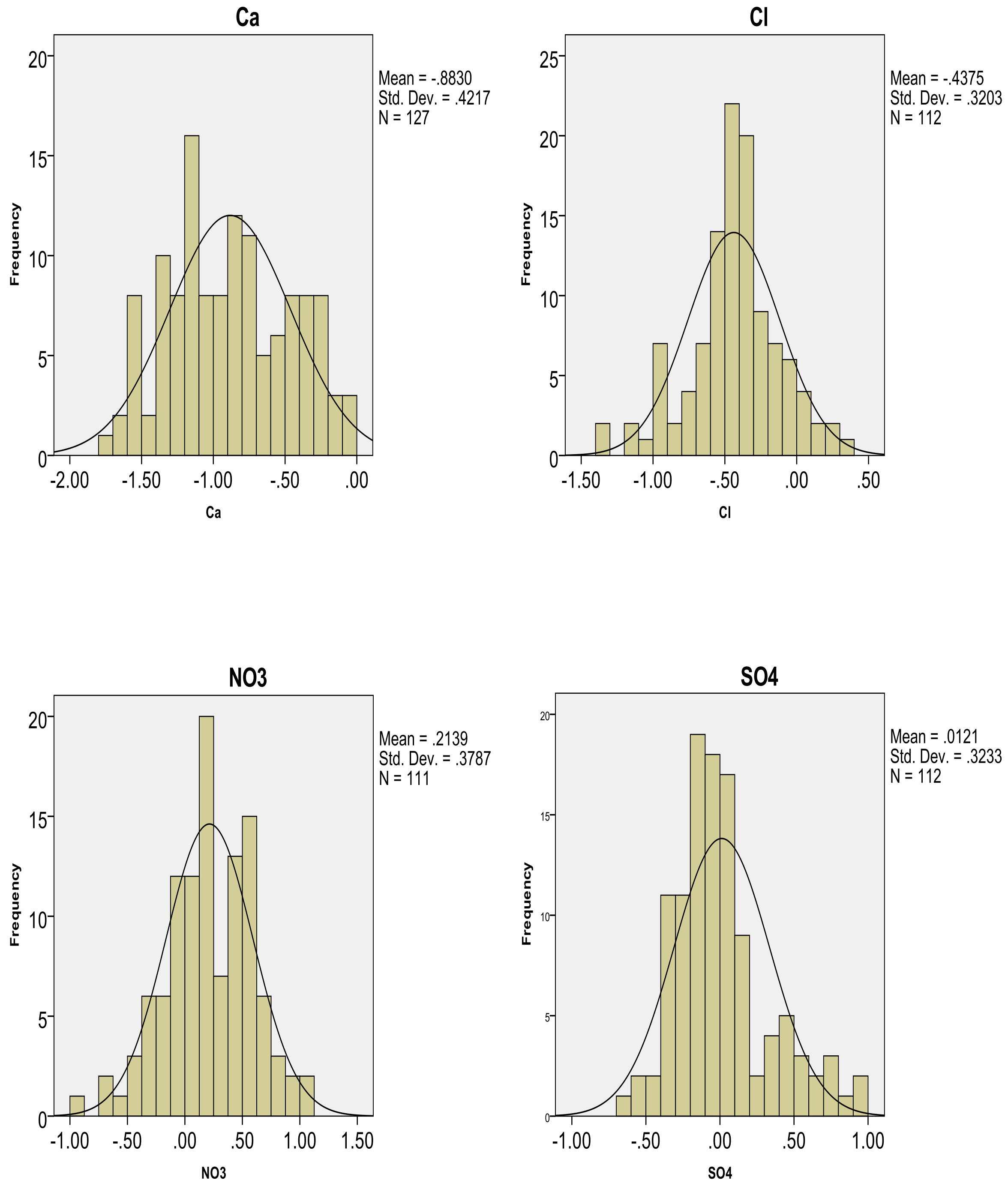


Figure 3.6b BWSS water soluble $PM_{2.5}$ ions frequency distributions, the datasets are log-transformed

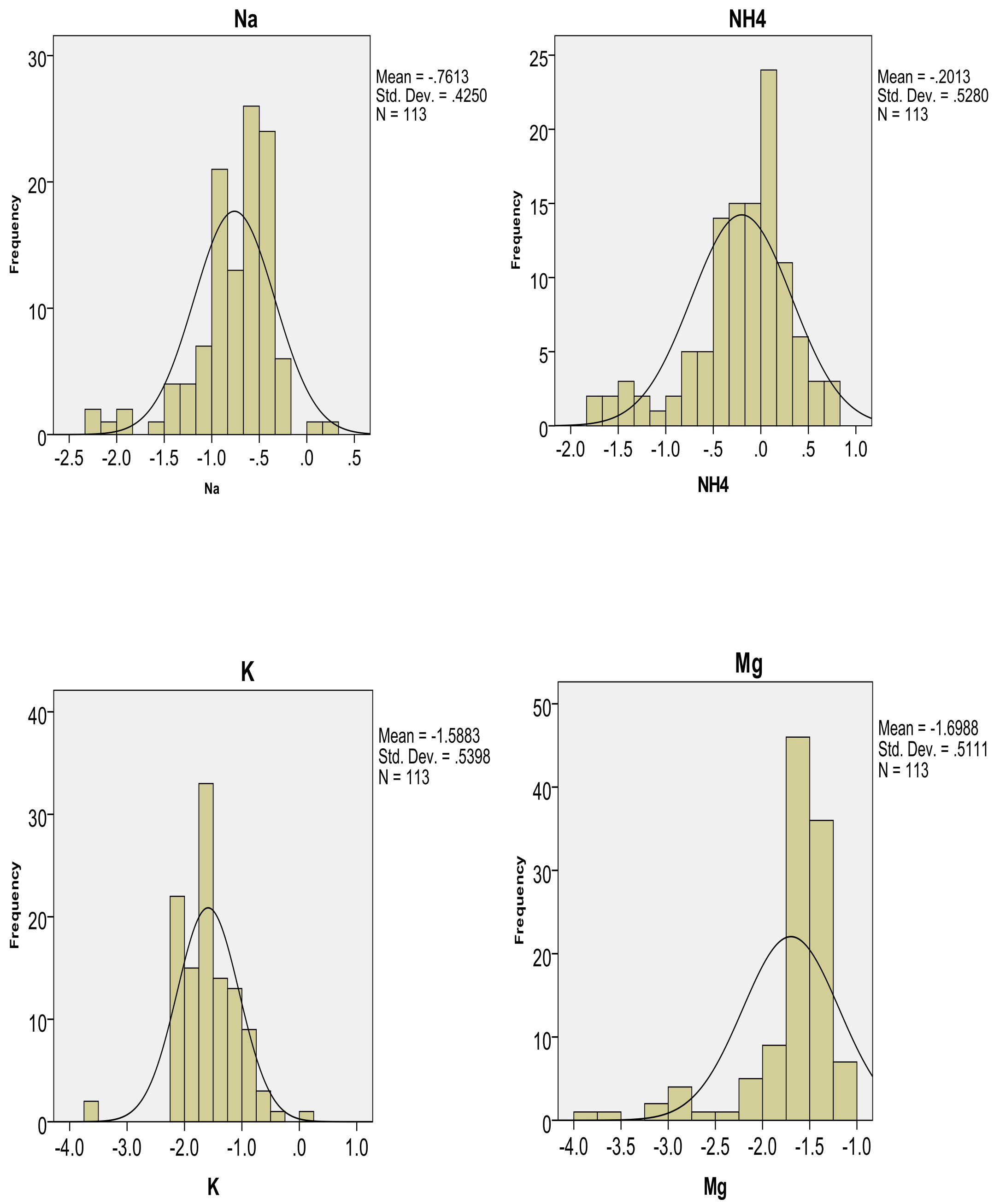


Figure 3.7a NKMOS water soluble $PM_{2.5}$ ions frequency distributions, the datasets are log-transformed

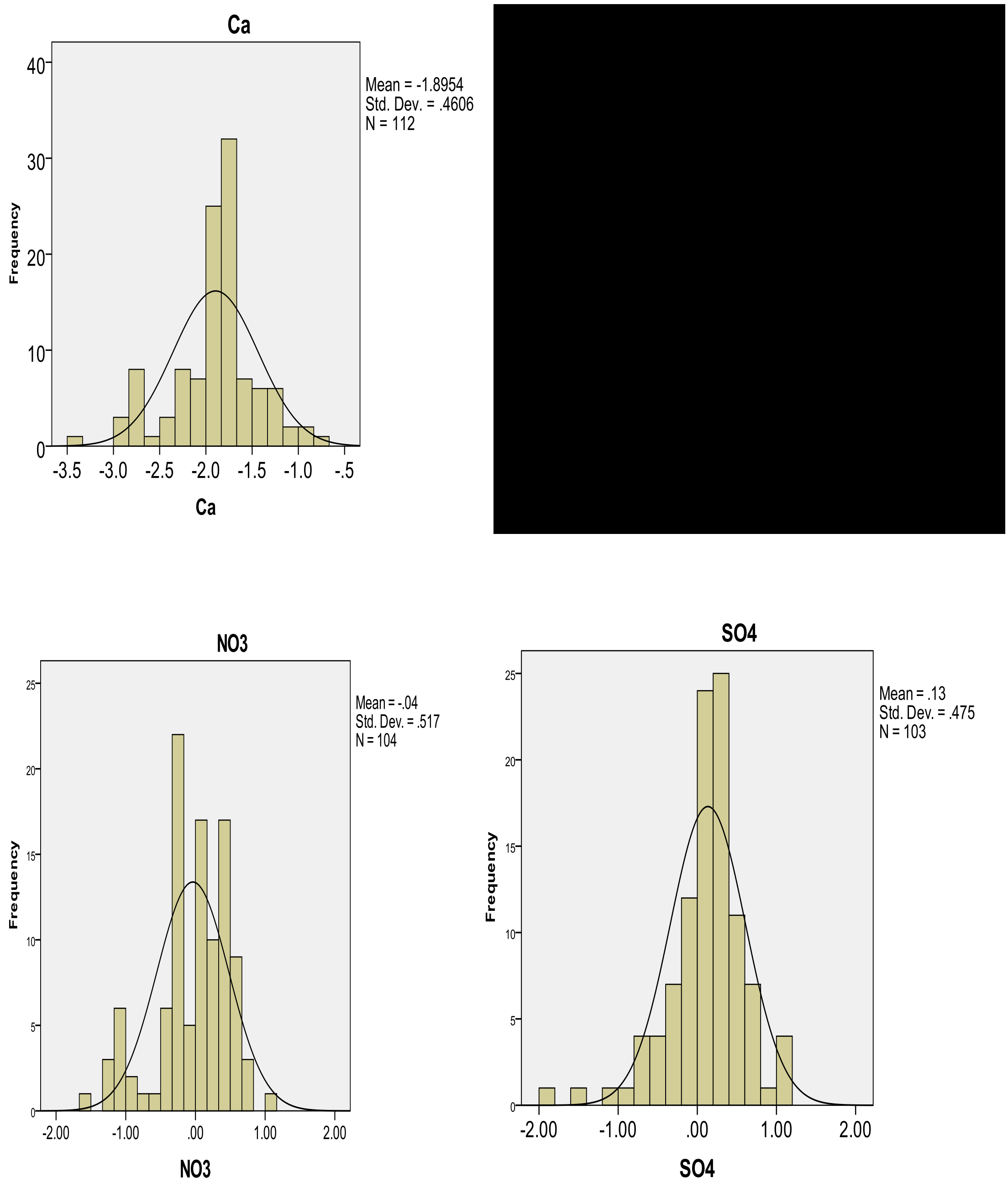


Figure 3.7b NKMOS water soluble $PM_{2.5}$ ions frequency distributions, the datasets are log-transformed

3.2.3 Inorganic water soluble ions chemical balance and ratios

The climate in UK is strongly influenced by the Atlantic Ocean. Sea salt particles are the major components of marine aerosols (Blanchard, 1985), and those particles are spread significant distances a UK area. Figure 3.8, Figure 3.9, Figure 3.10 and Figure 3.11 show the atmospheric $PM_{2.5}$ water soluble ion chemical balance. Figure 3.8a, Figure 3.9a, Figure 3.10a and Figure 3.11a present the potassium, magnesium, calcium versus sodium ratios at EROS, NKMOS, BWSS and CPSS. Figure 3.8c, Figure 3.9b, Figure 3.10b and Figure 3.11b present the ion balances for chloride versus sodium plus magnesium and ammonium versus nitrate plus sulphate at all sampling sites. The potassium versus sodium and calcium versus sodium datasets in Figure 3.8a appear to be made up from two populations of points at EROS, therefore Figure 3.8b presents the ion balance for potassium versus sodium and calcium versus sodium between summer and winter periods. All of the correlations are using RMA linear regression technique, which can reduce the error caused by result uncertainty. Sea salt ratios, which presented by White (White, 1957), are also presented in the $PM_{2.5}$ water soluble ion comparison result figures.

Table 3.5 Inorganic element and ions seawater ratios (White, 1957)

Elements & ions	Ratio
SO_4/Cl	0.14
K/Na	0.036
Mg/Na	0.12
Na/Cl	0.55
Ca/Cl	0.021
Mg/Cl	0.066
Mg/Ca	3.17
K/Ca	0.9428
Ca/Na	0.038

The RMA linear regressions for potassium versus sodium fitting the measured dataset have the form($p \leq 0.05$):

$[K^+] = 0.259[Na^+] + 0.0005$ $R^2 = 0.0007$ EROS

$[K^+] = 0.273[Na^+] - 0.012$ $R^2 = 0.2286$ NKMOS

$[K^+] = 0.430[Na^+] + 0.0007$ $R^2 = 0.1794$ BWSS

$[K^+] = 0.075[Na^+] + 0.0068$ $R^2 = 0.2012$ CPSS

The mean values for $[K^+]/[Na^+]$ at different sites are well above the sea salt ratio 0.036. Highest ratio of 0.430 was obtained at BWSS, where wood fuel burning activities was expected in this local area. Lowest ratio of 0.075 was obtained at CPSS, which is located in unused land.

The RMA linear regressions for magnesium versus sodium are very close to sea salt ratio at all sampling sites with very high correlation ratios at NKMOS and CPSS. The linear regressions fitting the measured dataset have the form($p \leq 0.05$):

$[Mg^{2+}] = 0.139[Na^+] - 0.0167$ $R^2 = 0.1885$ EROS

$[Mg^{2+}] = 0.129[Na^+] - 0.0011$ $R^2 = 0.6405$ NKMOS

$[Mg^{2+}] = 0.085[Na^+] - 0.0014$ $R^2 = 0.0455$ BWSS

$[Mg^{2+}] = 0.127[Na^+] + 0.0034$ $R^2 = 0.9486$ CPSS

The mean values for the ratio $[Mg^{2+}]/[Na^+]$ are 0.139, 0.123, 0.085 and 0.127 at EROS, NKMOS, BWSS and CPSS respectively. Except BWSS, The ratio for other three sites are roughly equal to sea salt ratio 0.12. This indicates that those ions have their main origins of sea salt particles and transported by wind.

The RMA linear regressions for calcium versus sodium fitting the measured dataset have the form($p \leq 0.05$):

$[Ca^{2+}] = 0.216[Na^+] - 0.023$ $R^2 = 0.083$ EROS

$[Ca^{2+}] = 0.164[Na^+] - 0.014$ $R^2 = 0.131$ NKMOS

$[Ca^{2+}] = 0.820[Na^+] - 0.049$ $R^2 = 0.113$ BWSS

$[Ca^{2+}] = 0.107[Na^+] + 0.001$ $R^2 = 0.0004$ CPSS

The mean values for $[Ca^{2+}]/[Na^+]$ at different sites are well above the sea salt ratio 0.038. The highest ratio of 0.820 was obtained at BWSS site and the lowest ratio of 0.107 was obtained at CPSS site.

Chlorides versus sodium plus magnesium concentrations expressed in equivalent m^{-3} are presented in Figure 3.8b, 3.9b, 3.10b and 3.11b. The RMA linear regression equations for the datasets are($p \leq 0.05$) :

$[Cl^-] = 1.16[Na^+ + Mg^{2+}] + 0.0007$ $R^2=0.293$ EROS

$[Cl^-] = 1.004[Na^+ + Mg^{2+}] - 0.0010$ $R^2= 0.278$ NKMOS

$[Cl^-] = 0.853[Na^+ + Mg^{2+}] + 0.0001$ $R^2= 0.125$ BWSS

$[Cl^-] = 0.852[Na^+ + Mg^{2+}] – 0.0004$ $R^2= 0.988$ CPSS

The figures and equations demonstrate that chlorides are mainly correlated with sodium plus magnesium in CPSS only from a common origin in sea salt particles. Compare with sea water ratio 0.95, from EROS and NKMOS are in excess of chlorides associated with sodium plus magnesium, but at BWSS and CPSS, fewer chlorides are associated with sodium plus magnesium.

The ammonium compounds expressed in equivalent m^{-3} are also presented in Figure 3.8b, 3.9b, 3.10b and 3.11b. The RMA linear regression equations for the dataset are($p \leq 0.05$):

$[NH_4^+] = 0.952[NO_3^- + SO_4^{2-}] - 0.004$ $R^2=0.503$ EROS

$[NH_4^+] = 0.844[NO_3^- + SO_4^{2-}] + 0.001$ $R^2= 0.930$ NKMOS

$[NH_4^+] = 1.433[NO_3^- + SO_4^{2-}] - 0.017$ $R^2= 0.750$ BWSS

$[NH_4^+] = 0.948[NO_3^- + SO_4^{2-}] - 0.002$ $R^2= 0.924$ CPSS

The datasets and equations shows a good correlation between $[NH_4^+]$ and $[NO_3^- + SO_4^{2-}]$, with a ratio of nearly 1 except that at BWSS (1.43).

The potassium versus sodium and calcium versus sodium datasets are appear to be made up from two different sets of data at EROS site (Figure 3.8a top graph and bottom graph). Therefore they have been presented separately in Figure 3.8b. It might be the higher concentrations are collected from winter seasons(October to March) and the lower concentrations are collected from summer seasons(April to September) for potassium versus sodium. This is because the wood smoke has contributed to potassium concentrations in winter seasons. The calcium versus sodium presented the opposite phenomenon. Higher concentrations were detected in summer seasons (April to September) and lower concentrations were detected in winter seasons (October to March). This is because the calcium is mainly from the soils and transport by the wind. By consider the UK climate, the winter season is always raining, so it is difficult to carry and transport the wet soil to the atmosphere by wind.

The red plots are indicate the dataset collected from winter periods (from October to April) and the blue plots are indicate the dataset collected from summer periods (from May to September). It clearly distinguishes most of the plots and shows the difference between winter and summer datasets.

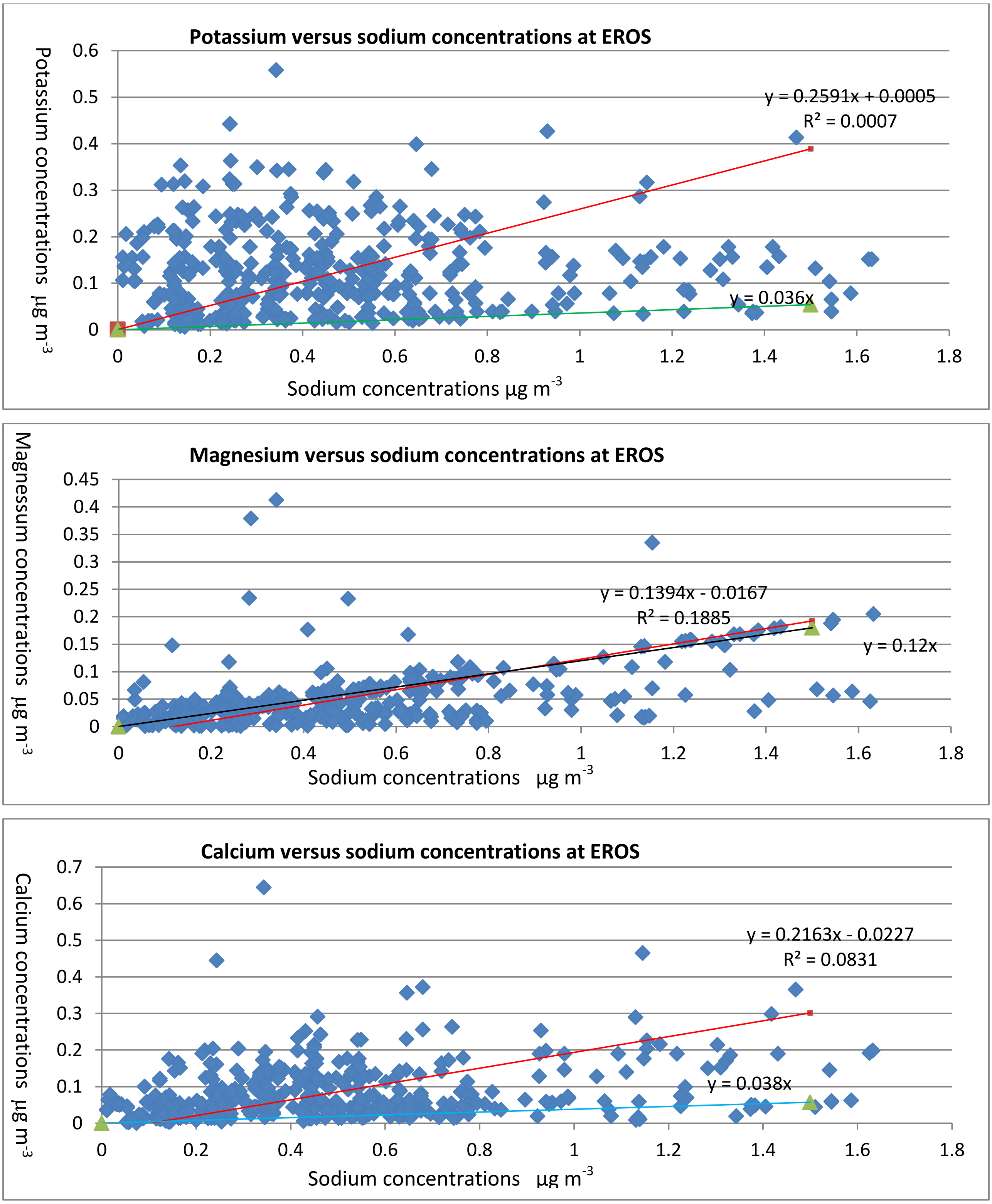
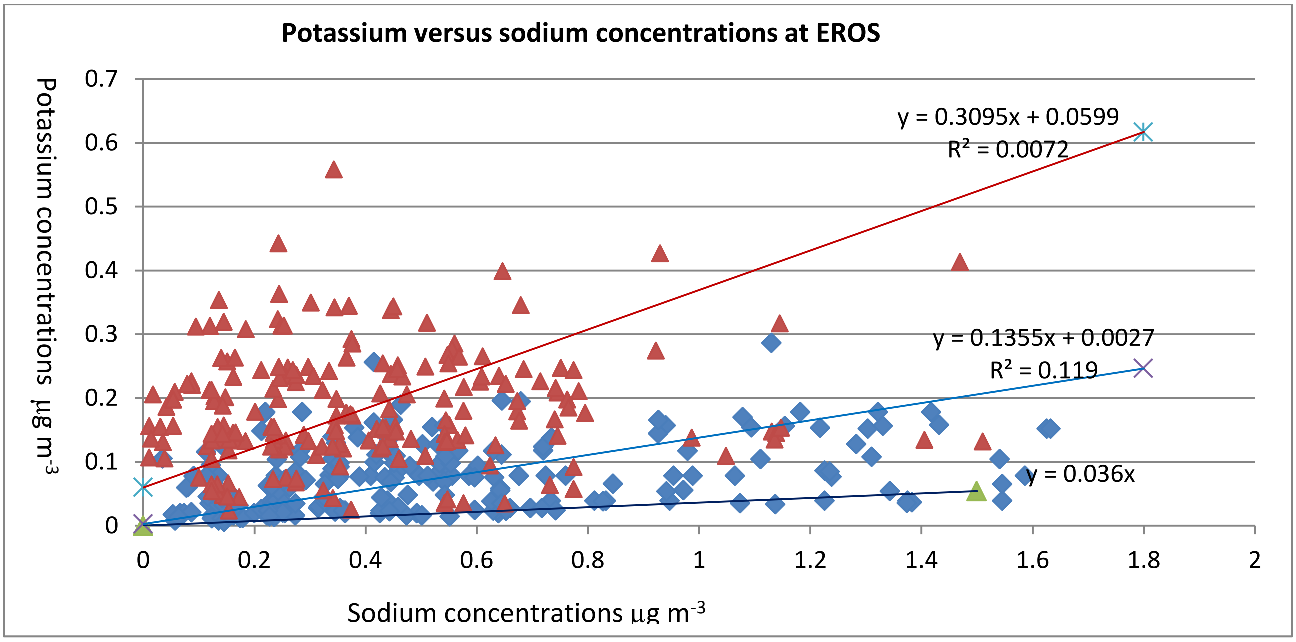


Figure 3.8a Potassium, magnesium and calcium versus sodium concentrations at EROS. The red line indicates the linear regression using RMA technique, the green line shows the sea salt ratios



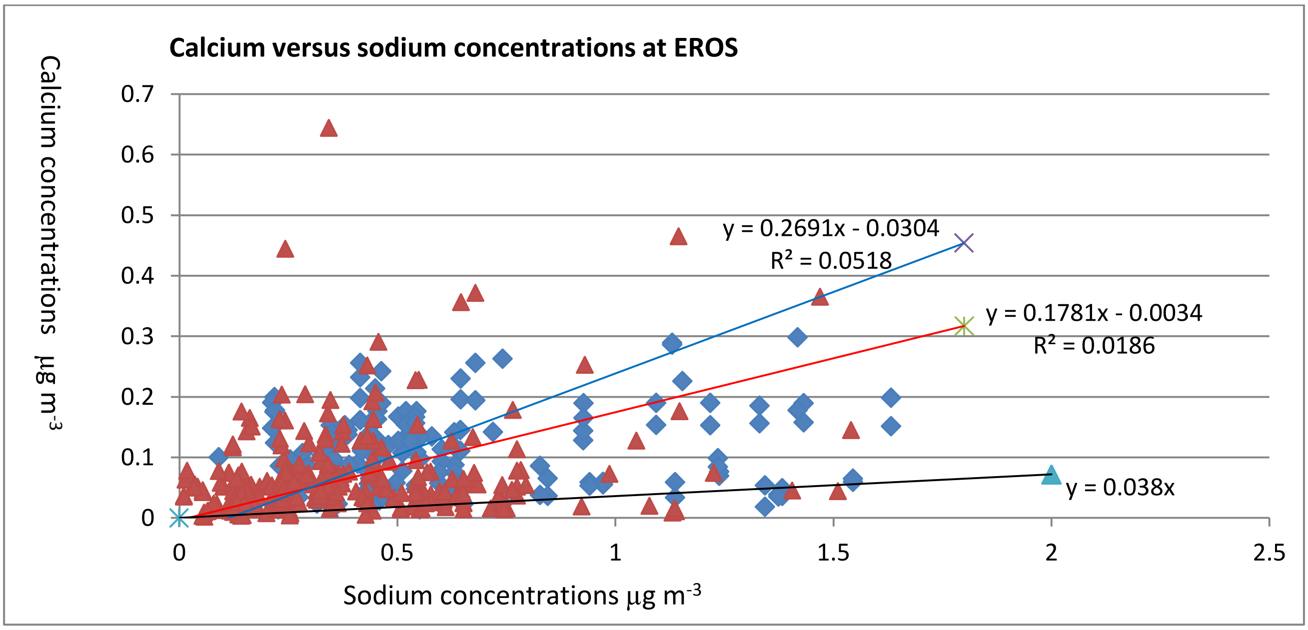
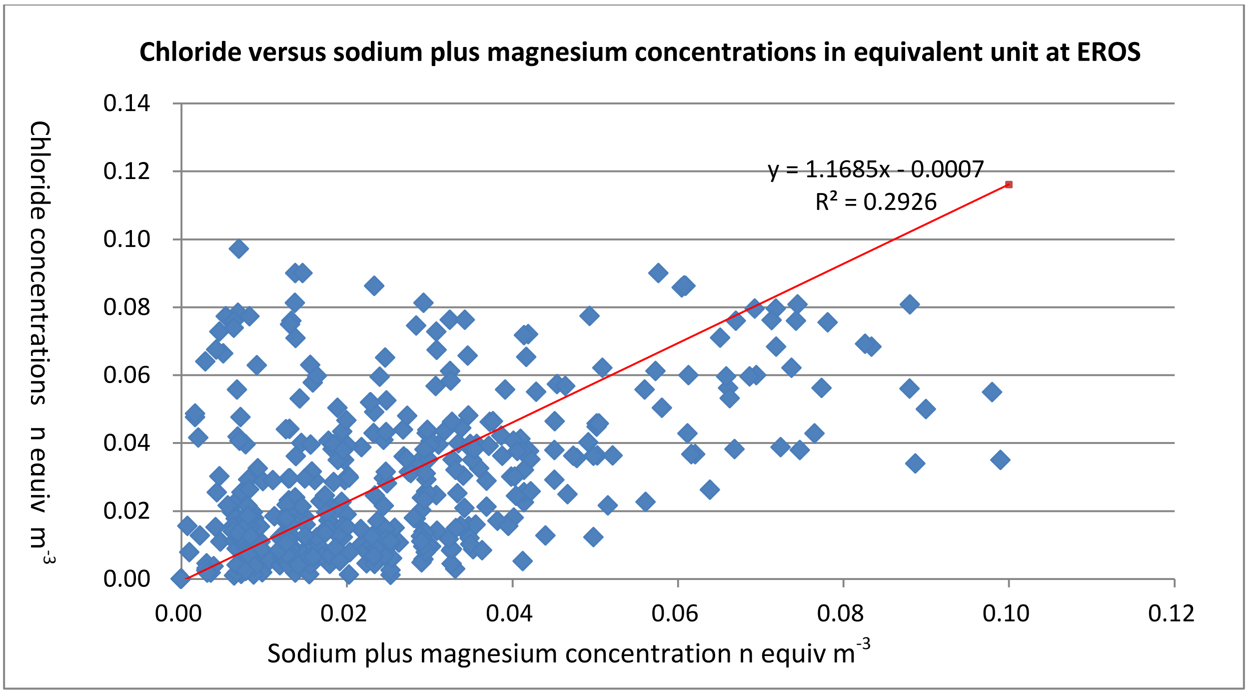


Figure 3.8b Potassium and calcium versus sodium concentrations in summer and winter periods at EROS. The red plots are indicate the dataset from winter periods (from October to April), the blue plots are indicate the dataset from summer periods (from May to September). The black lines at the bottom are the sea salt ratios. The linear regressions are using RMA technique.



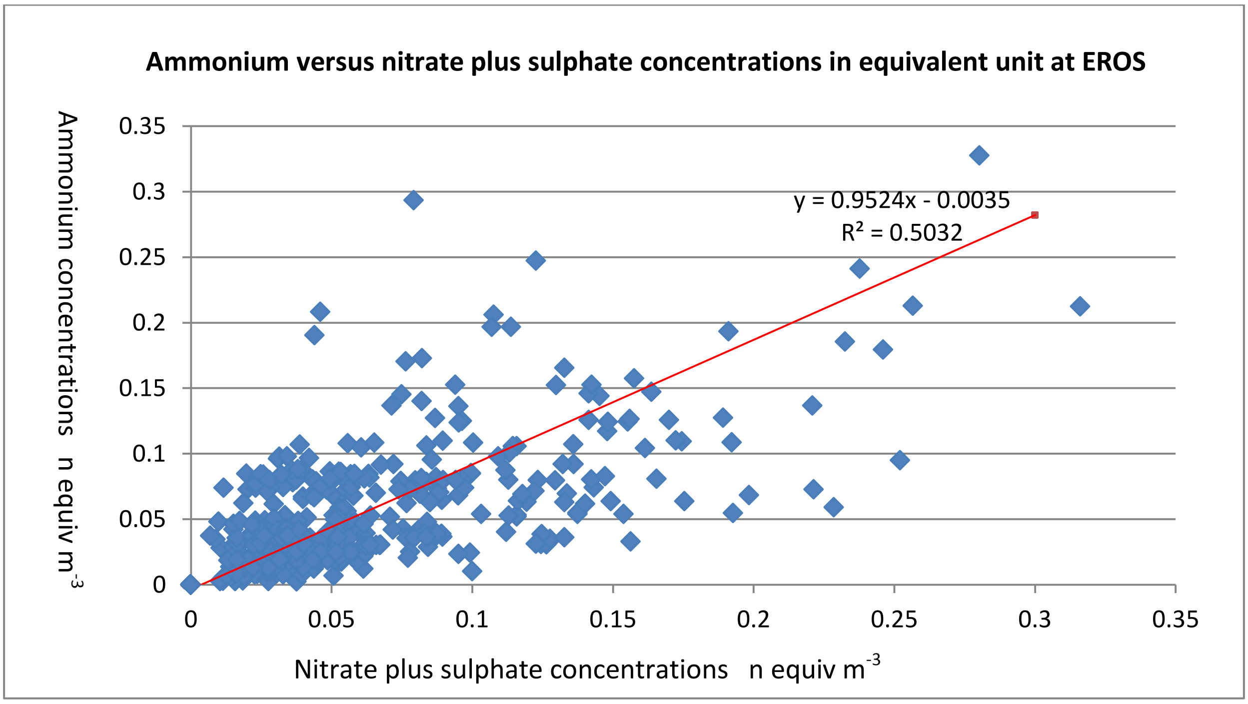


Figure 3.8c Chloride versus sodium plus magnesium concentration and ammonium versus nitrate plus sulphate concentrations at EROS. The units are in equivalent m^{-3}.

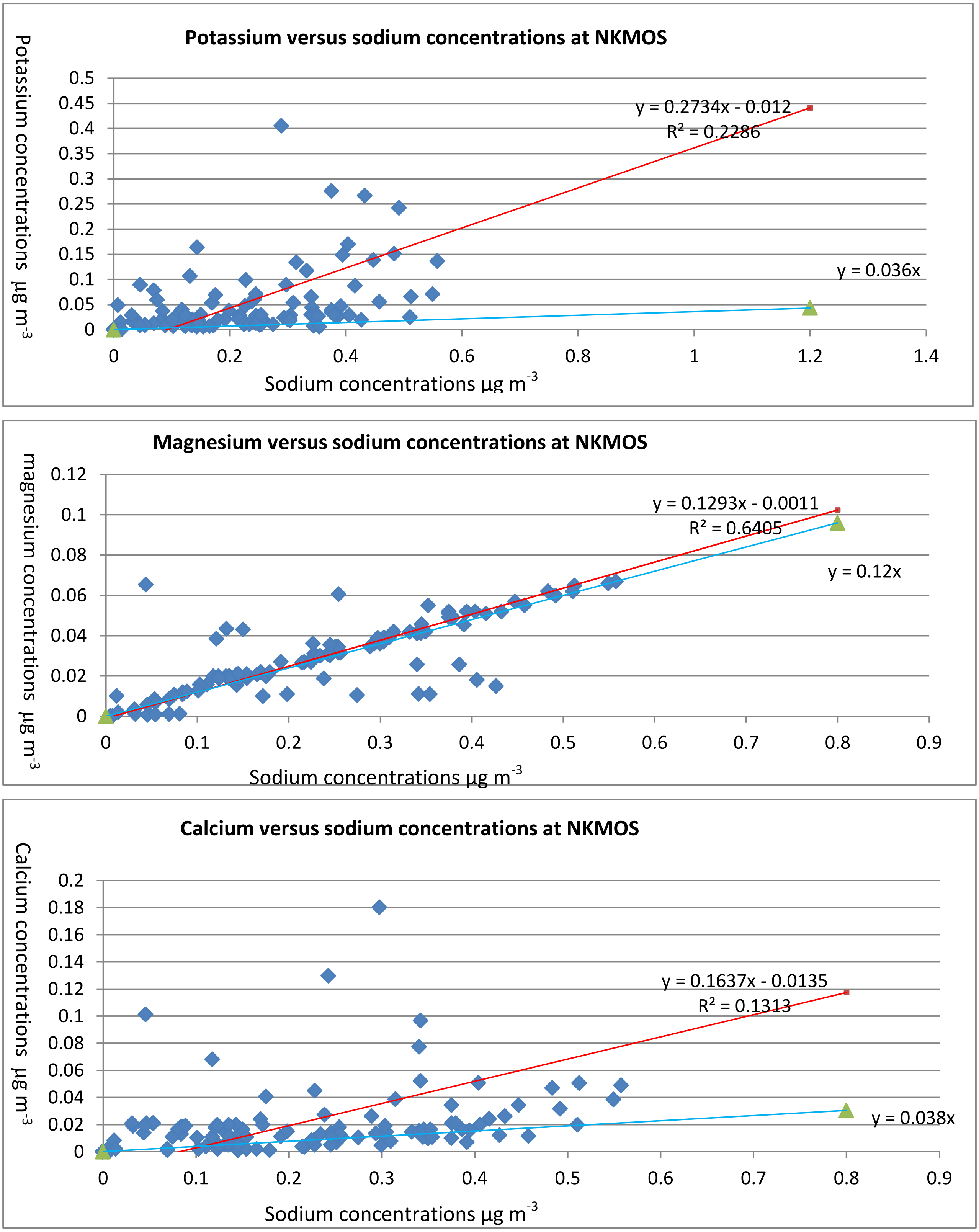
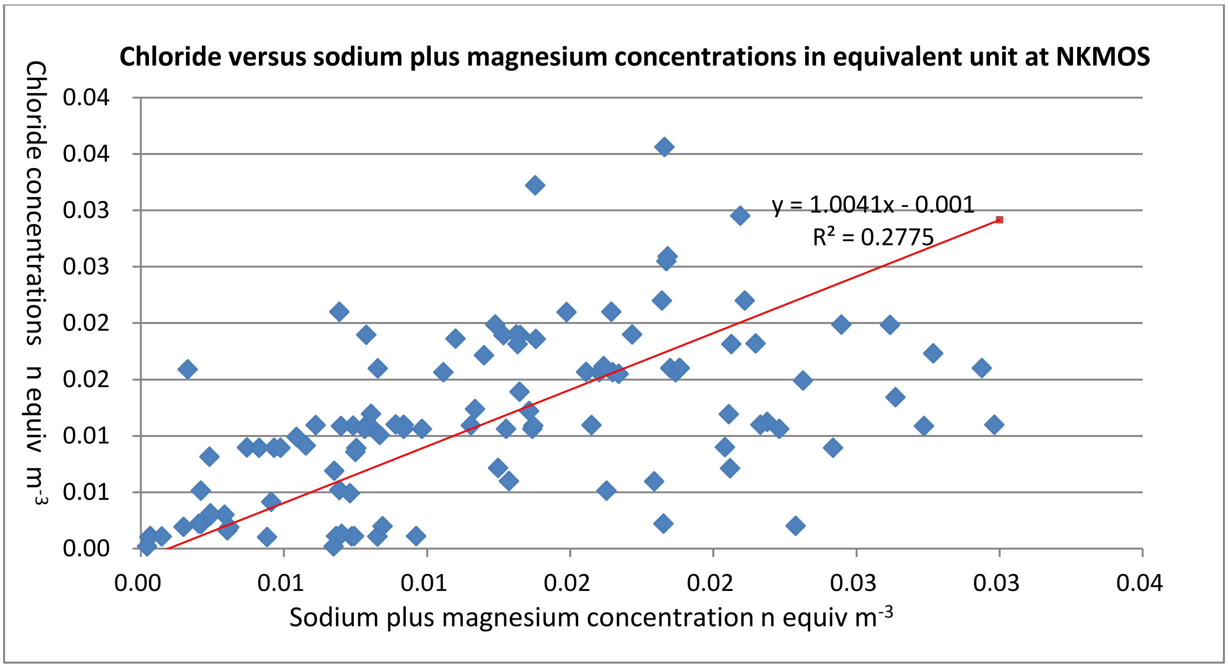


Figure 3.9a Potassium, magnesium and calcium versus sodium concentrations at NKMOS. The red line indicates the linear regression using RMA technique, the green line shows the sea salt ratios



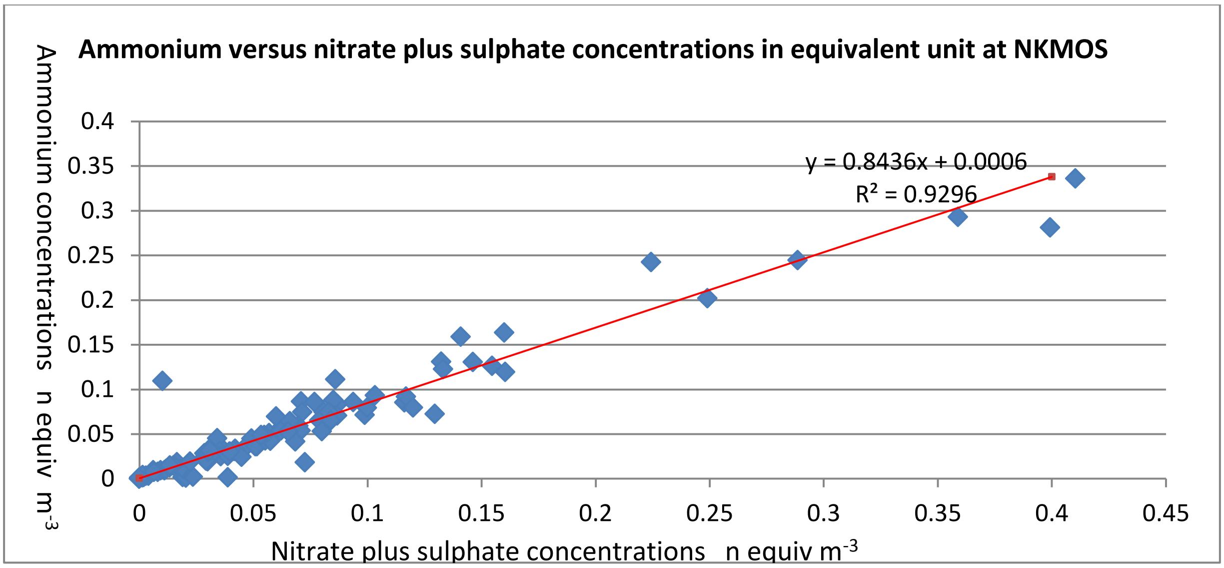


Figure 3.9b Chloride versus sodium plus magnesium concentrationand ammonium versus nitrate plus sulphate concentrations at NKMOS. The units are in equivalent m^{-3}.

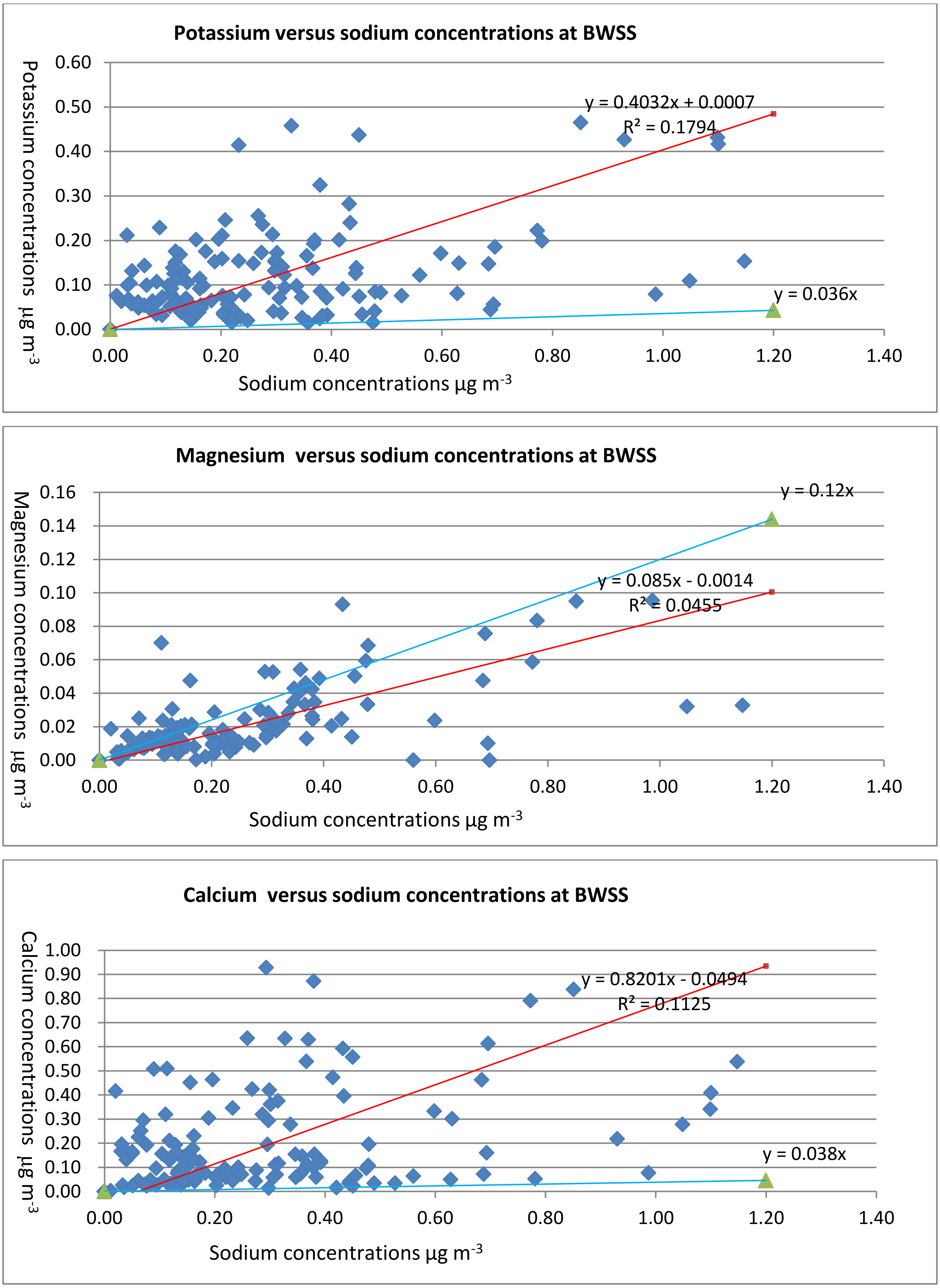
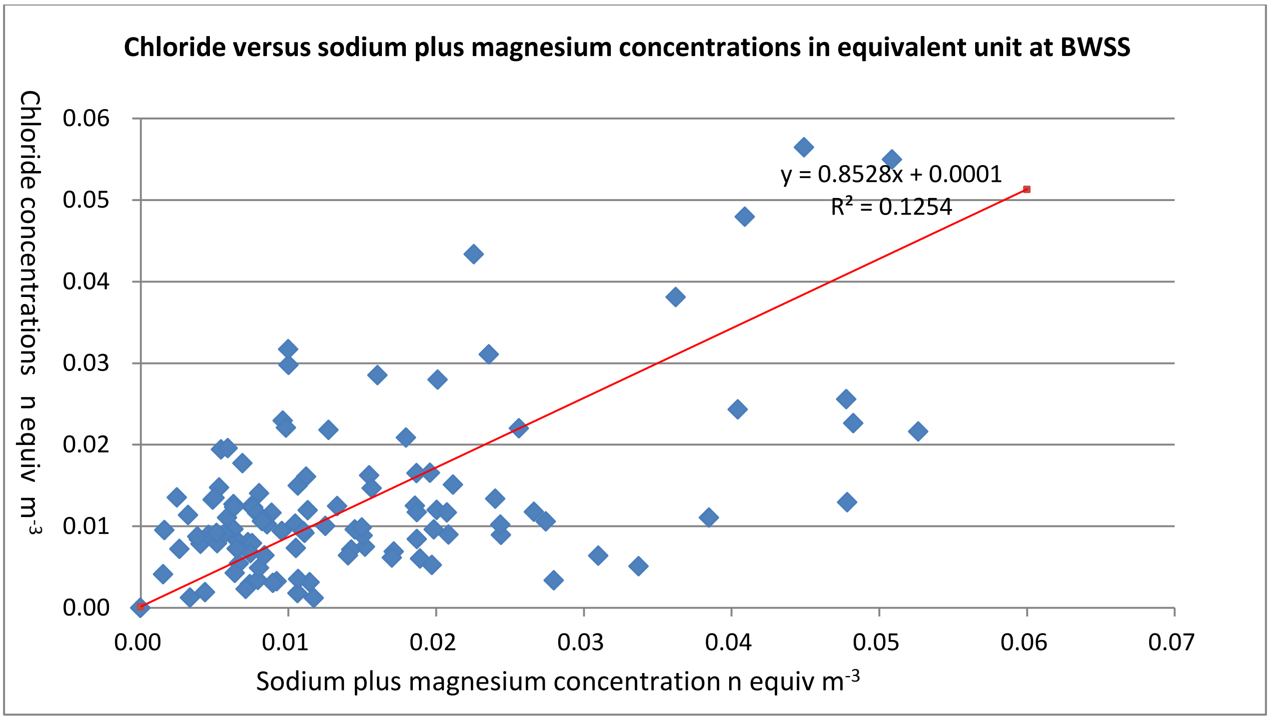


Figure 3.10a Potassium, magnesium and calcium versus sodium concentrations at BWSS. The red line indicates the linear regression using RMA technique, the green line shows the sea salt ratios



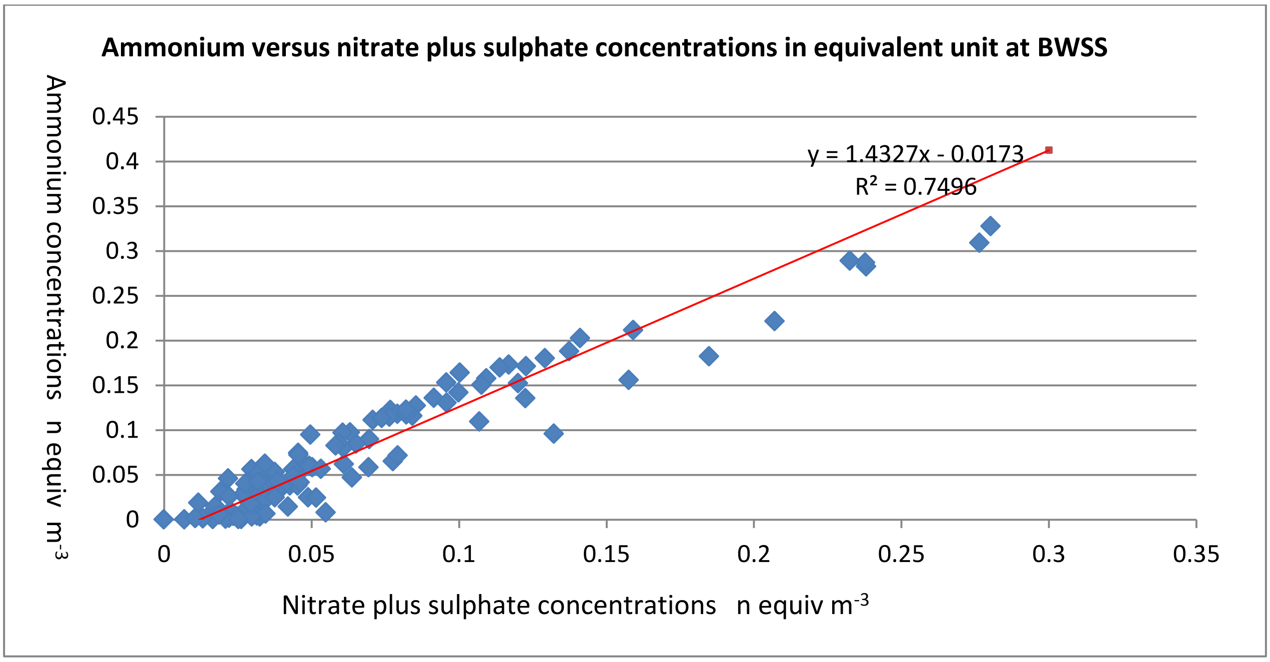


Figure 3.10b Chloride versus sodium plus magnesium concentration and ammonium versus nitrate plus sulphate concentrations at BWSS. The units are in equivalent m^{-3}.

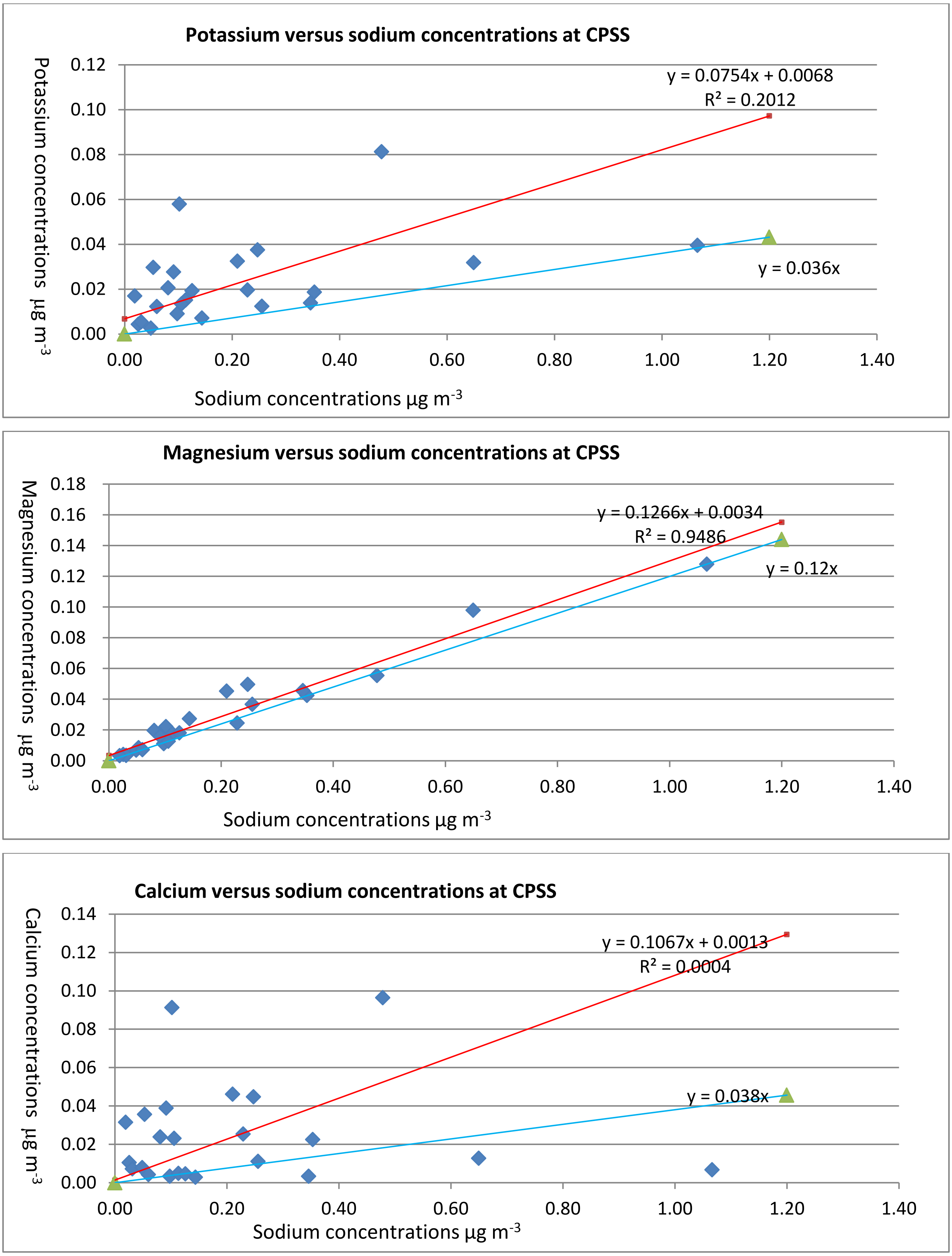
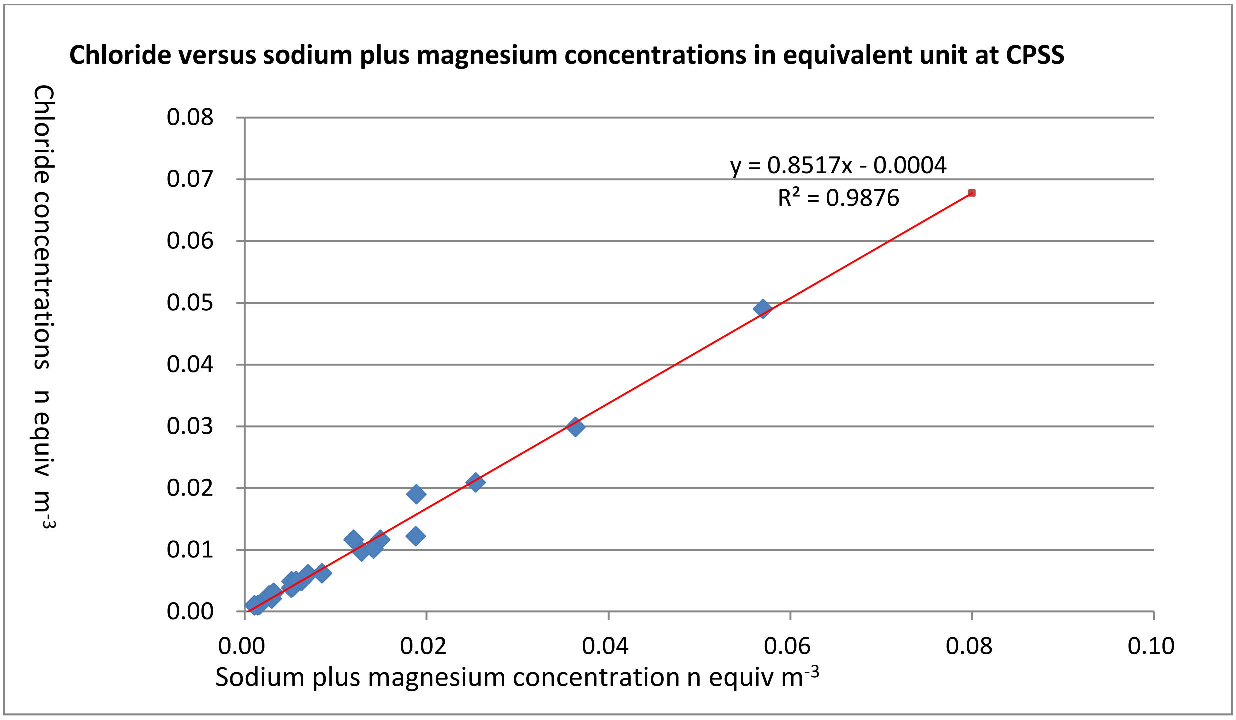


Figure 3.11a Potassium, magnesium and calcium versus sodium concentrations at CPSS. The red line indicates the linear regression using RMA technique, the green line shows the sea salt ratios



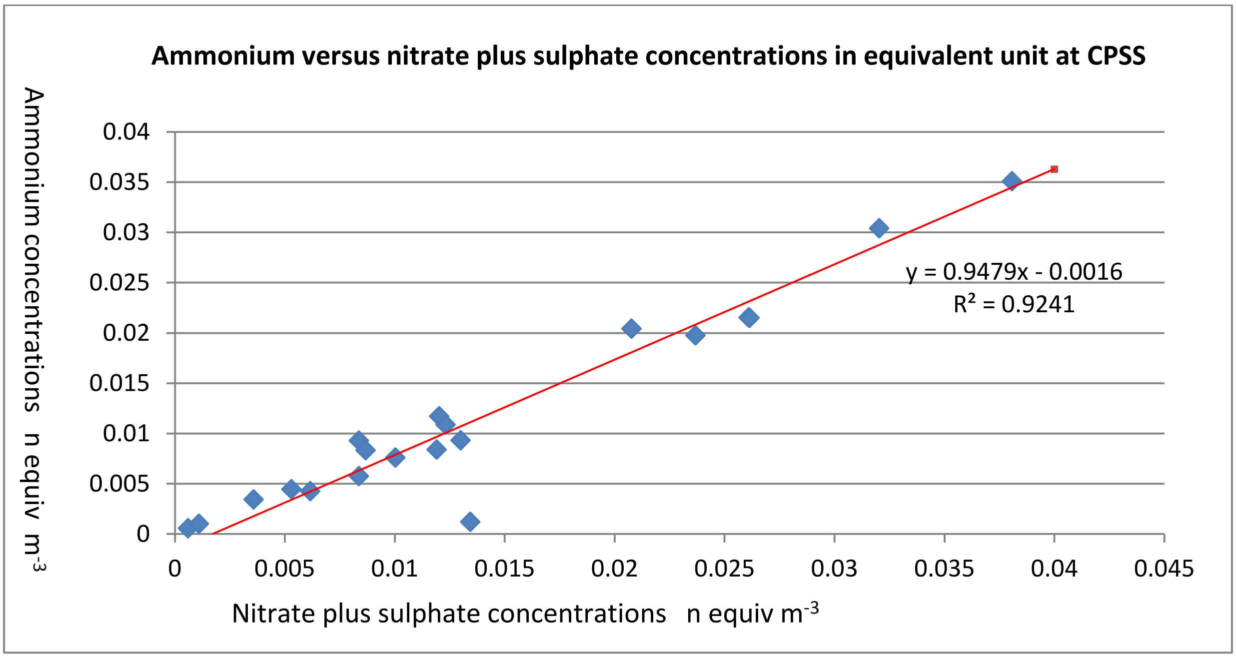


Figure 3.11b Chloride versus sodium plus magnesium concentration and ammonium versus nitrate plus sulphate concentrations at CPSS. The units are in equivalent m^{-3}.

3.2.4 Inorganic water soluble ions seasonal variations

In this study, eight major water-soluble inorganic species were quantified (Na^+, NH_4^+, K^+, Mg^{2+},Ca^{2+}, Cl^-, NO_3^- and SO_4^{2-}). Figure 3.12 and 3.13 shows the seasonal variations of all the inorganic species in the sampling periods. The temporal variation was greater than the spatial variation. The highest sodium peaks were measured in summer 2008 and 2009 at EROS, and the lowest peaks were measured in spring 2009 at EROS. Ammonium highest peaks were measured at the beginning of the spring in 2009 at NKMOS and winter periods in 2009 in BWSS, while the lowest peaks were measured in summer at EROS. Potassium highest peaks were measured in winter period in 2008 and 2009 at EROS, BWSS and NKMOS, and the lowest peaks were measured in summer periods at NKMOS. The highest magnesium peaks were measured in autumn 2009 at EROS. The spatial variation was more significant than temporal variation in calcium dataset. The calcium samples concentrations from BWSS were the highest compared with all other three sampling site. The highest peak of 0.92μg m^{-3} was measured at BWSS with average value of 0.19μg m^{-3} in this site, while for EROS, these two values were 0.644μg m^{-3} and 0.080μg m^{-3}, respectively, which means the concentration at BWSS site is twice the amount of that at EROS site.

The highest chloride concentration was measured in 2008 to 2009 winter periods at EROS with the highest peaks of around 4μg m^{-3}, except from one day in May 2009 when the chloride concentration reached to 6.68μg m^{-3}. This result was also the highest concentrations measured from all sampling sites. Nitrate peaks were evenly distributed during sampling periods and the maximum nitrate concentration 13μg m^{-3} was measured at BWSS in early winter periods. Most of sulphate peaks were measured in 2008 to 2009 winter periods at EROS and NKMOS. The maximum value of 14.8μg m^{-3} was measured at the NKMOS site in February 2009. The lowest sulphate peaks were measured in summer periods at EROS and NKMOS.

From all of sampling dataset the NO_3^- and SO_4^{2-} were the most abundant ions, followed by NH_4^+ and Na^+ (Figure 3.13), which means the main inorganic water soluble ions for this sampling area were primary marine aerosol (NaCl) and secondary inorganic materials [NH_4NO_3+$(NH_4)_2SO_4$]. The average water soluble ion contributions to fine particles were totally different between winter and summer periods. In summer period the NO_3^- and SO_4^{2-} ion concentrations were much lower than that in winter periods. The lowest water soluble ion concentrations were measured in spring and autumn in March, May and October, respectively. The highest sum of eight water soluble ion concentrations were consistently measured in January at EROS, which were 8.5μg m^{-3} in 2009 and 11μg m^{-3} in 2010. The two lowest sums of eight water soluble ion concentrations were measured in October 2008 (3μg m^{-3}) and October 2009 (4μg m^{-3}) respectively.

The eight water soluble inorganic ions concentrations at CPSS (Figure 3.13) were much lower than these in all other sampling sites. Because CPSS is the unused/waste land site for background concentrations measurement, there was no significant spatial variation observed during this research period. The concentrations were 1.5μg m^{-3} and 1.4μg m^{-3} in February and March 2009 in CPSS (Figure 3.13). But for EROS and NKMOS, the concentrations were measured at 6μg m^{-3} and 5.1μg m^{-3} in February, respectively and 4.5μg m^{-3} and 5.5μg m^{-3} in March 2009, respectively.

A previous study (Harrison and Yin, 2010), sampled $PM_{2.5}$ particles in EROS and CPSS to examine the UK urban background and rural sites chemical speciation of $PM_{2.5}$ particles.

Table 3.6 $PM_{2.5}$ anion seasonal pattern from previous study

	μg m^{-3}	EROS(Harrison & Yin)			EROS(This study)		
		N	Mean	Range	N	Mean	Range
Annual	Chloride	≈60	0.47	0.01-2.2	404	1.12	0.04-6.68
	Nitrate	≈60	1.6	0.13-6.6	417	1.31	0.01-10.54
	Sulphate	≈60	2.2	0.41-13.8	417	2.13	0.15-12.61
Summer (April-October)	Chloride	≈30	0.16	0.01-0.51	193	1.12	0.05-4.28
	Nitrate	≈30	1.7	0.13-6.6	193	1.17	0.01-9.42
	Sulphate	≈30	3.5	0.62-13.8	193	1.98	0.15-12.61
Winter November-March)	Chloride	≈30	0.76	0.17-2.2	245	1.14	0.04-6.68
	Nitrate	≈30	1.5	0.16-5.8	238	1.39	0.02-10.54
	Sulphate	≈30	1.1	0.41-2.5	238	2.32	0.15-12.60
	μg m^{-3}	CPSS(Harrison & Yin)			CPSS(This study)		
		N	Mean	Range	N	Mean	Range
Annual	Chloride	≈60	0.47	0.01-2.2	23	0.4	0.04-1.74
	Nitrate	≈60	1.6	0.13-6.6	20	0.36	0.01-0.76
	Sulphate	≈60	2.2	0.41-13.8	20	0.45	0.02-1.24
Summer (April-October)	Chloride	≈30	0.16	0.01-0.51			
	Nitrate	≈30	1.7	0.13-6.6			
	Sulphate	≈30	3.5	0.62-13.8			
Winter November-March)	Chloride	≈30	0.76	0.17-2.2			
	Nitrate	≈30	1.5	0.16-5.8			
	Sulphate	≈30	1.1	0.41-2.5			

The seasonal pattern of anion species can be found in Table 3.6. The study(Harrison and Yin, 2010) was measure the $PM_{2.5}$ samples over one year period from May 2007 to April 2008. Daily fine ($PM_{2.5}$) samples were collected for 5 days (Monday–Friday) at the beginning of each month to represent the whole month dataset. Therefore a total of about 60 sample have been collected in this study. The short sampling campaigns used in this study (five days per month) do not accurately represent long-term continuous measurements. Therefore the dataset compared with this study has wide range of variety even they were measured in the same sampling location and the same extraction methodology. Higher chloride concentration was found in this study, but the nitrate and the sulphate were almost the same. Summer sulphate concentrations were lower in this study, but higher concentrations in winter were found compared with Harrison's (Harrison and Yin, 2010) report. The cation species can be found in table 3.7. The sampling location was the same as this study but the extraction methodology was not. Harrison and Yin ((Harrison and Yin, 2010) used a WD-XRF (Philips MAGIX-PRO automatic sequential wavelength dispersive X-ray fluorescence spectrometer) for the cation analysis. Lower sodium concentrations and higher magnesium concentrations were found in this study, other species(potassium and calcium) were almost the same compared with the previous study (Harrison and Yin, 2010).

Table 3.7 $PM_{2.5}$ cation concentrations from previous study

	μg m-3	EROS(Harrison & Yin)			EROS(This study)		
		N	Mean	Range	N	Mean	Range
Annual	Sodium	≈60	2.47	0.46-9.44	436	0.48	0.01-1.63
	Potassium	≈60	0.15	0.002-1.98	436	0.12	0.006-0.56
	Calcium	≈60	0.08	0.001-0.21	436	0.08	0.002-0.64
	Magnesium	≈60	0.02	0.02-1.16	436	0.09	0.001-0.412
		CPSS(Harrison & Yin)			CPSS(This study)		
		N	Mean	Range	N	Mean	Range
Annual	Sodium	≈60	2.69	0.35-9.19	23	0.25	0.02-1.07
	Potassium	≈60	0.1	0.002-0.36	23	0.025	0.003-0.08
	Calcium	≈60	0.1	0.001-2.02	23	0.027	0.003-0.096
	Magnesium	≈60	0.18	0.03-0.60	23	0.004	0.0003-0.016

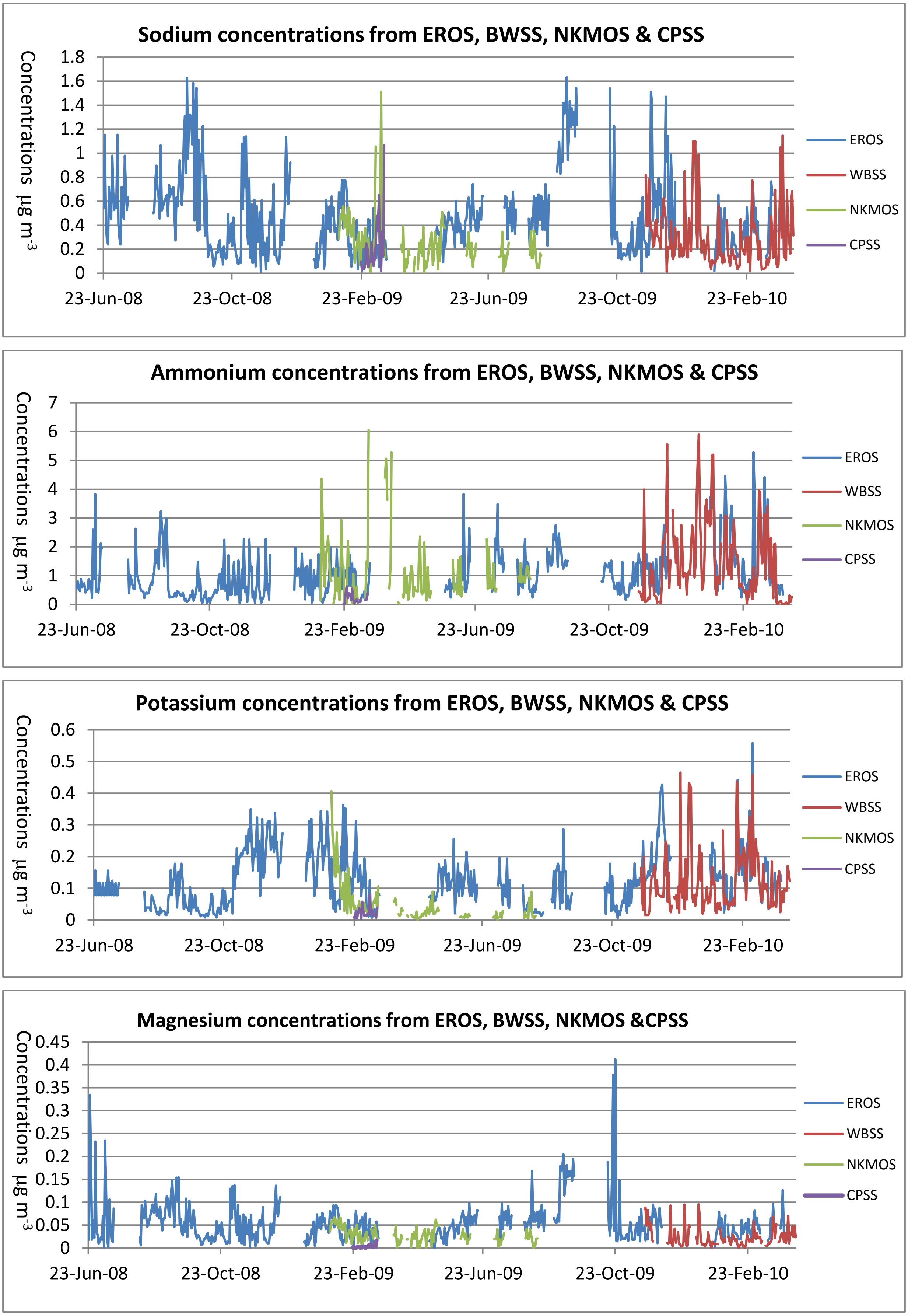


Figure 3.12a Inorganic water soluble ions seasonal variations from all sampling sites

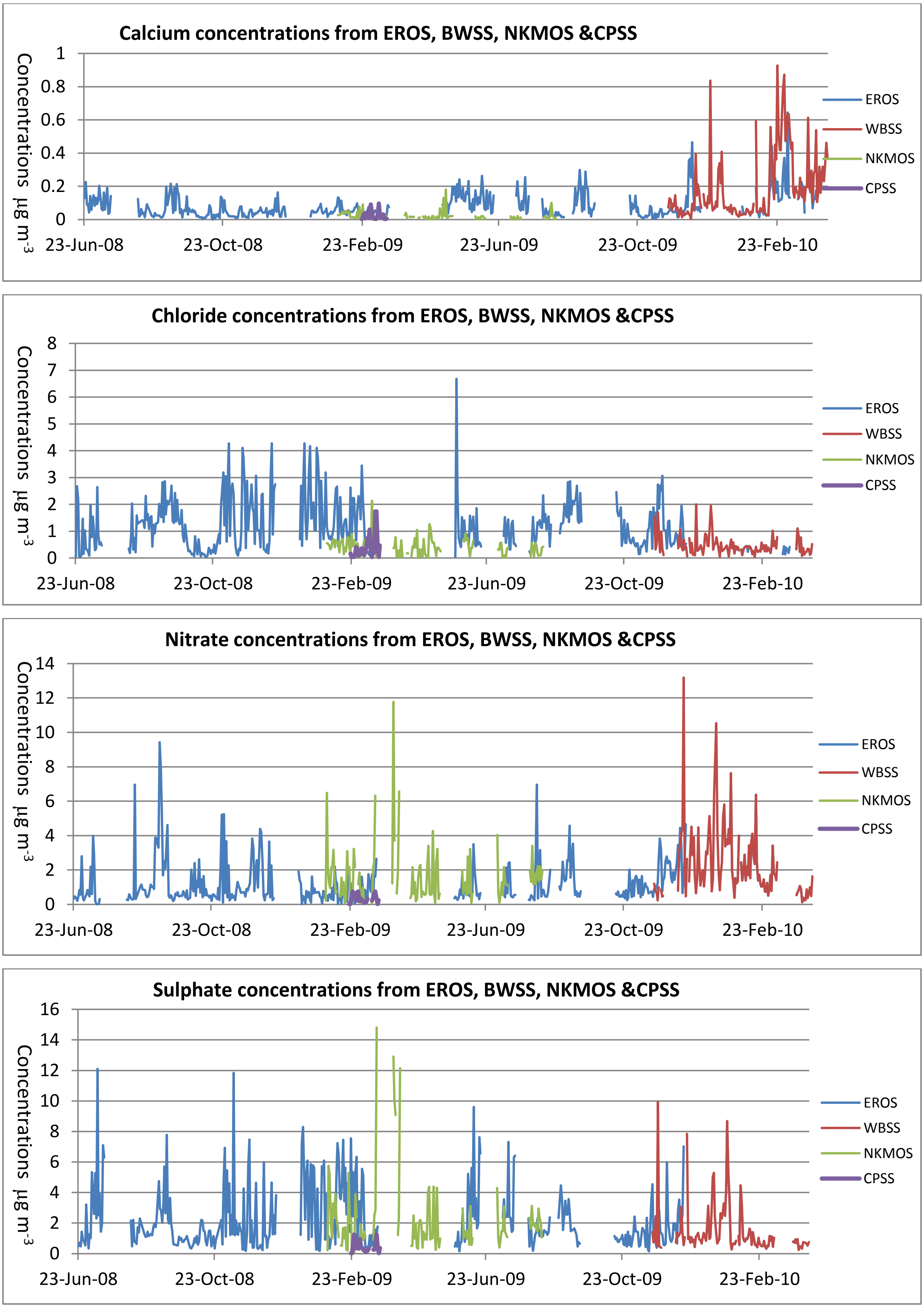


Figure 3.12b Inorganic water soluble ions seasonal variations from all sampling sites

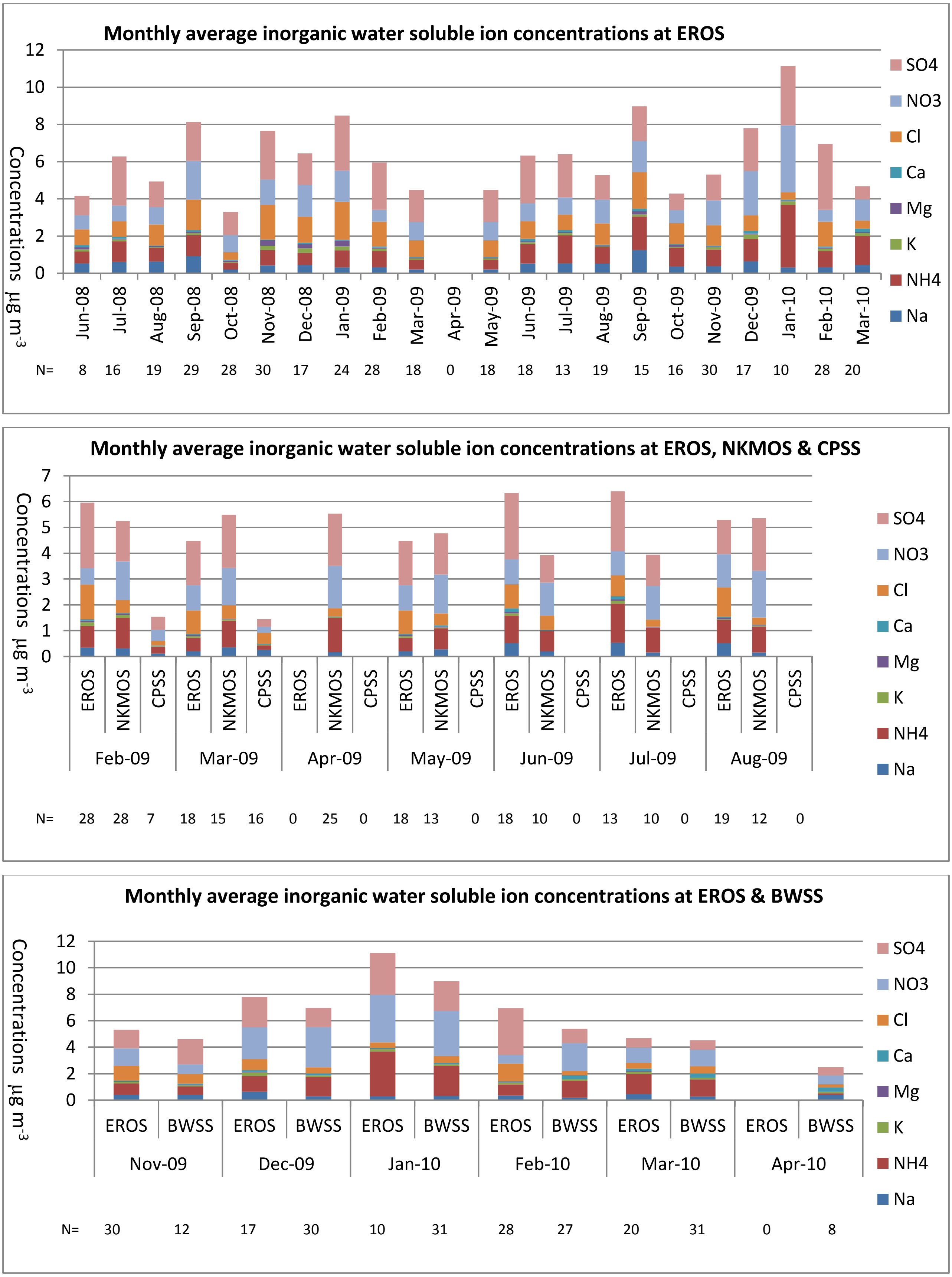


Figure 3.13 Monthly average inorganic water soluble ion in all sampling locations.

3.3 Wood smoke potassium concentrations

Potassium is an important element emitted from biomass burning. The combustion of plant matter, which contains K^+ as a major electrolyte within the cytoplasm, can release great quantities of K-rich particles. Inorganic water soluble potassium is an imporatant wood smoke tracer. The potassium concentrations subtracted from sea-salt potassium and soil dust potassium can be measured as wood smoke potassium.

3.3.1 Wood smoke potassium quantifications

According to Pio's paper (Pio et al., 2008), equation 3.1 can be used to distinguish the potassium from wood smoke, sea salt and soil. In addition, since biomass burning may also emit calcium, its contribution should be subtracted too:

Equation from Pio's paper:

$$K_{ws} = K_{measured} - 0.036\times Na_{measured} - [K/Ca]_{soil} \times (Ca_{nss} - Ca_{ws}) \quad (3.1)$$

Where:

nss = non sea salt

ws = wood smoke

$$K_{ws} = K_{measured} - 0.036\times Na_{measured} - [K/Ca]_{soil} \times Ca_{nss} + [K/Ca]_{soil} \times Ca_{ws} \quad (3.2)$$

According to Pio research (Pio et al., 2008), when burning the wood fuel, a mass ratio of 10 between K^+_{ws} and Ca^{2+}_{ws} was assumed:

Thus $Ca_{ws} = K_{ws} /10$ (3.3)

This K^+_{ws} and Ca^{2+}_{ws} ratio is corresponds to the maximum possible ratio in the relationship between $Knss^+$ and $Canss^{2+}$, which is ranging with an average value of nearly 10 in all the dataset in this study. So the ratio of 10 is applied in this study as K_{ws} /Ca_{ws} ratio.

When combine equation (3.2) and (3.3) together:

$$K_{ws} = K_{measured} - 0.036\times Na_{measured} - [K/Ca]_{soil} \times Ca_{nss} + [K/Ca]_{soil} \times (K_{ws} /10)$$

$$K_{ws} = K_{measured} - 0.036\times Na_{measured} - [K/Ca]_{soil} \times Ca_{nss} + 0.1*[K/Ca]_{soil} \times K_{ws} \quad (3.4)$$

From (3.4) we can conclude:

$K_{ws} - 0.1 \times [K/Ca]_{soil} \times K_{ws} = K_{measured} - 0.036 \times Na_{measured} - [K/Ca]_{soil} \times Ca_{nss}$

$(1-0.1 \times [K/Ca]_{soil}) \times K_{ws} = K_{measured} - 0.036 \times Na_{measured} - [K/Ca]_{soil} \times Ca_{nss}$

$$K_{ws} = (K_{measured} - 0.036 \times Na_{measured} - [K/Ca]_{soil} \times Ca_{nss}) / (1-0.1 \times [K/Ca]_{soil}) \quad (3.5)$$

The soil samples results are in Table 3.8. The average local soil K/Ca ratio is different. They are 0.464, 0.828, 0.602 and 0.506 at BWSS, EROS, CPSS and NKMOS, respectively. In wood smoke potassium calculation process, $\{0.036 \times Na_{measured}\}$ is a sea salt ratio, which is a constant ratio to deduct potassium from sea salt (sea salt ratio can be found in Table 3.5). The $\{1-0.1 \times [K/Ca]_{soil}\}$ is also not a major parameter which influences the wood smoke potassium value. The only parameter which affects factors of data veracity is $\{[K/Ca]_{soil} \times Ca_{nss}\}$, as this ratio can significantly influence the wood smoke potassium concentrations subtracted from atmospheric water soluble potassium.

The soil ratio was significantly influenced by the local environment. Trees and buildings surrounded the sampling locations at EROS, CPSS and NKMOS site, therefore the soil transportations from each direction were hard to be distinguished. The average K/Ca soil ratio was applied in this study and majority of the data were positive. But at BWSS, when the average K/Ca soil ratio (Table 3.8 K/Ca_{BWSS} ratio=0.464) was applied to the equation, the majority of the wood smoke potassium dataset is negative which is illogical. Thus the calculation should use another K/Ca soil ratio. With regards to the local environment (Figure 2.2 in Chapter 2), the soil from south, west and north was hard to transport by wind because the local trees can block the wind direction and the grass can holds the soil so the soil will hardly transport by the wind. The only soil exposure to the wind blow was the east part of the sampling location, there was no tree or grass to cover the soil and that was a large open area. There was also a soil dust road thus the wind can easily carry the soil particles to the sampling location. The average local soil K/Ca ratio from the east was only 0.266 (Table 3.8). The data was even smaller as the location gradually approaching to the air sampling location. When 0.266 has been used as K/Ca soil ratio to calculate wood smoke potassium, the majority of the results were positive (Figure 3.14). From Figure 3.14, it is clear that when the wood smoke potassium dataset was positive (November 2009 to February 2009), it is not correlated with the K/Ca soil ratio, thus the K/Ca ratio change from 0.266 to 0.464 does not affect the wood smoke potassium result very much. But when the dataset is negative (February 2010 to March 2010), the wood smoke potassium changed significantly when the K/Ca soil ratio shifted from 0.266 to 0.464. Because of this result, the ratio of 0.266 was applied as K/Ca soil ratio at BWSS in this study. Therefore the different K/Ca ratio cause about 10% uncertainty of measuring wood smoke potassium when the result is positive.

According to equation 3.5, the potassium from wood smoke can be calculated as follow:

EROS: $K_{ws} = (K_{measured} - 0.036\times Na_{measured} - 0.828 \times Ca_{nss})/ 0.9172$

BWSS: $K_{ws} = (K_{measured} - 0.036\times Na_{measured} - 0.266 \times Ca_{nss})/ 0.9734$

NKMOS: $K_{ws} = (K_{measured} - 0.036\times Na_{measured} - 0.506 \times Ca_{nss})/ 0.9495$

CPSS: $K_{ws} = (K_{measured} - 0.036\times Na_{measured} - 0.602\times Ca_{nss})/ 0.9398$

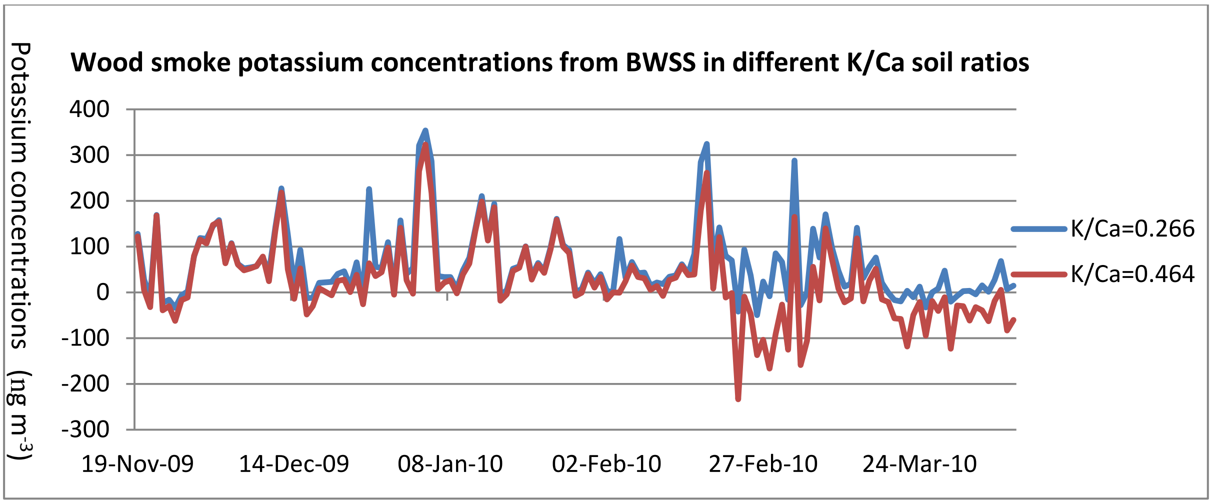


Figure 3.14 Wood smoke potassium concentrations from BWSS in different K/Ca soil ratios

Table 3.8 Potasium & calcium soil samples concentrations from EROS, BWSS CPSS & NKMOS. N=North, W=West, E=east, S=South. Numbers represent different sampling locations regarding the same direction.

BWSS	µg/g K	µg/g Ca	K/Ca	EROS	µg/g K	µg/g Ca	K/Ca
N1	246	226	1.087	N1	9	214	0.042
N2	174	277	0.628	N2	1232	1325	0.930
N3	221	425	0.521	N3	1118	1357	0.824
N4	201	420	0.478	N4	1892	1671	1.132
W1	298	898	0.332	W1	2068	2680	0.772
W2	175	665	0.264	W2	2008	3448	0.582
W3	343	651	0.527	W3	1550	1172	1.323
W4	245	518	0.473	W4	1113	1075	1.035
E1	421	1798	0.234	E1	1014	1270	0.798
E2	251	852	0.294	E2	1012	856	1.183
E3	152	545	0.278	E3	1475	1756	0.840
E4	205	792	0.258	E4	1784	2512	0.710
S1	150	358	0.419	S1	1432	2013	0.711
S2	322	552	0.583	S2	1345	1465	0.918
S3	271	589	0.460	S3	1285	1755	0.732
S4	483	814	0.593	S4	1024	1428	0.717
Average	260	649	0.464	Average	1335	1625	0.828
Minimum	150	226	0.234	Minimum	9	214	0.042
Maximum	483	1798	1.087	Maximum	2068	3448	1.323
Std	92	355	0.205	Std	484	744	0.280

CPSS	µg/g K	µg/g Ca	K/Ca	NKMOS	µg/g K	µg/g Ca	K/Ca
N1	363	573	0.634	N1	367	457	0.804
N2	299	579	0.517	N2	246	474	0.518
N3	350	783	0.447	N3	235	766	0.306
N4	375	701	0.535				
W1	275	501	0.548	W1	174	565	0.307
W2	290	800	0.362	W2	168	476	0.353
W3	518	659	0.786	W3	205	388	0.528
W4	450	587	0.767				
E1	355	505	0.703	E1	478	777	0.616
E2	257	401	0.640	E2	404	856	0.472
E3	357	595	0.599	E3	437	740	0.591
E4	524	646	0.811				
S1	276	301	0.919	S1	388	590	0.657
S2	146	457	0.319	S2	385	684	0.563
S3	214	556	0.384	S3	273	754	0.363
S4	190	289	0.655				
Average	327	558	0.602	Average	313	627	0.506
Minimum	146	289	0.319	Minimum	168	388	0.306
Maximum	524	800	0.919	Maximum	478	856	0.804
Std	104	144	0.167	Std	104	148	0.147

3.3.2 Wood smoke potassium concentrations

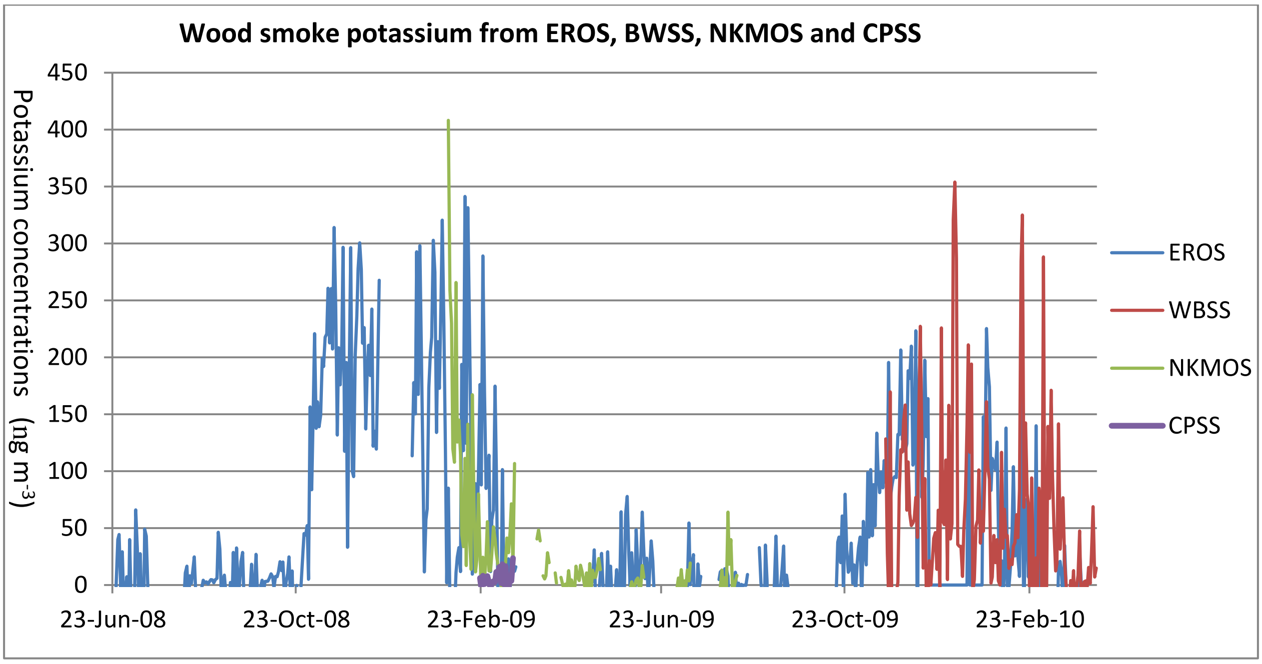


Figure 3.15 Wood smoke potassium concentration from EROS, BWSS, NKMOS and CPSS site.

Based on the calculation above, there are still some negative wood smoke potassium values (does not show on Figure 3.15). This is because the mean value of soil potassium rather than individual true values was deducted from measured fine potassium. Therefore when the true soil potassium value was smaller than the average soil potassium value, and non sea salt potassium was also smaller than the average soil potassium value, the final wood smoke potassium value will be negative. But the negative values will only appear when the non sea salt potassium is very small, and it only happens at summer periods when no wood smoke potassium was detected. Therefore when wood smoke potassium was greatly measured at winter, the negative value would not appear.

According to Figure 3.15, the highest wood smoke potassium of 408ng m^{-3} was measured at NKMOS in Febuary 2009, followed by 354ng m^{-3} at BWSS in January 2010, which were all local wood fuel burning areas. Based on all the sampling sites, wood smoke potassium concentrations had very strong temporal variation changes. In summer seasons (April, May, June, July, August and September) the wood smoke potassium concentrations had very low values, while in winter seasons (October, November, December, January, February and March) the concentrations were comparably higher at all sampling sites. A mean value of

100ng m^{-3} wood smoke potassium was measured at EROS site at winter periods but the mean value of only 5ng m^{-3} was measured during summer periods at EROS. The same changes were also appeared at NKMOS and BWSS site: The mean value of winter (February 2009 and March 2009) periods was 65ng m^{-3} at NKMOS but the mean value of summer periods (April 2009 to August 2009) was only 7 ng m^{-3}; In BWSS, 62ng m^{-3} wood smoke potassium was measured as mean value at BWSS during winter periods(November 2009 to March 2010), but only 17ng m^{-3} was measured at April 2010 as winter periods wood smoke potassium mean value.

The sources of atmospheric aerosol water soluble potassium are sea salt, local soil and wood smoke. Figure 3.16 shows the source distributions from EROS, BWSS, NKMOS and CPSS. The main sources in summer and winter were totally different. In summer period, especially in June and July, 75% of the potassium measured at EROS site was from soil. However, in winter period, wood smoke became the primary source of the potassium. Especially in December 2008 and December 2009, around 210ng m^{-3} and 140ng m^{-3} wood smoke potassium were measured in these two months, with a percentage of 72% and 46% of the total water soluble potassium, respectively. At NKMOS site, the wood smoke potassium was the major component in February 2009 and March 2009. But in spring and summer periods (April 2009, June 2009 and July 2009), the concentration of sea salt potassium was higher than that of the other two sources. It was considered that there was less local wood fuel burning activities around this sampling site in spring and summer periods. At BWSS site, the wood smoke potassium was dominant in this site for the entire winter periods from November 2009 to February 2010. Afterwards 2010, when the wood fuel burning activities were less frequent, the soil potassium became the main source of water soluble potassium. At CPSS site, as this was a background site surrounded mostly by grass/unused land with unknown sources and unknown activities, the potassium concentrations from the three sources were equally the same but in very small quantities. The monthly average water soluble potassium was only 20ng m^{-3} and 22ng m^{-3} in February 2009 and March 2009, respectively.

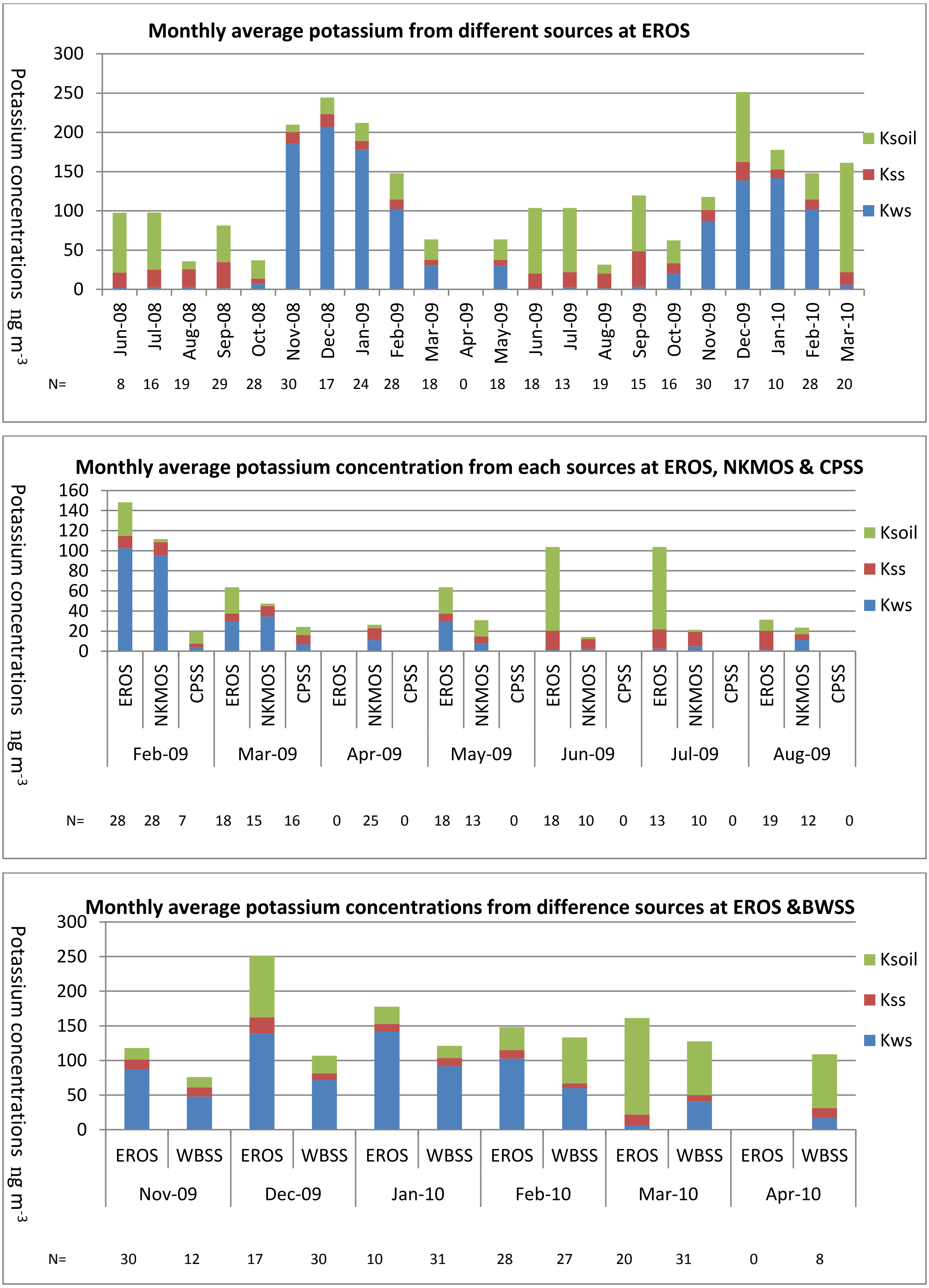


Figure 3.16 Potassium concentrations from each source from EROS, BWSS NKMOS and CPSS site.

Chapter 4

Organic components analytical results

4.1 Introduction

Levoglucosan, mannosan, and galactosan are three main monosaccharide anhydrides (MA), which are released at relatively high concentrations in the particle matter generated from the wood combustion process. They are the product of cellulose combustion (Simoneit, 2002). The majority of MA is levoglucosan, which is also one of the major components for biomass burning tracers. For a representative group of stoves operated in the home under actual operating conditions, one study (Locke, 1988) found that typical wood smoke particles contain 4.6 ± 1.7% w/w levoglucosan. Typically 95% of the MA is levoglucosan, while the mannosan and galactosan are taken very small parts of the MA (Zdrahal, 2002). Therefore in this study, the sample extraction and result analysis was focused on Levoglucosan rather than the MA group.

Several studies have been conducted to identify and quantify individual organic compounds in atmospheric aerosols. Levoglucosan and the related degradation products from cellulose and hemicelluloses can be used as specific and overall indicator compounds for emissions from biomass burning (Simoneit et al., 1999). Those compounds accounted for 0.8-4.0% of atmosphere Organic carbon (OC) and 1.3-6.5% atmosphere wood smoke OC (Pio, 2008). Levoglucosan arises from the pyrolysis of cellulose, the main building material of wood, at temperatures higher than 300 °C. As the best wood smoke tracer, levoglucosan has been studied very well during the last two decades. Reliable analytical methods have been developed to identify and quantify levoglucosan and structurally related compounds in atmospheric aerosols. Several other compounds have been utilized for monitoring biomass burning emissions. For example, diterpenoids (retene, abietic, and pimaric acids) (Ramdahl, 1983; Standley 1994), triterpenones (mainly amyrones and friedelin derivatives), triterpadienes (amyrins) (Simoneit, 1996) have been successfully used as molecular markers for different sources of wood combustion. But those chemicals have disadvantages: unstable and very small amounts in atmosphere. The levoglucosan does not have those disadvantages. It is emitted at large amounts, sufficiently stable, and it is specific released from burning of biomass, thus meeting all important criteria as an ideal molecular marker of wood smoke measurement.

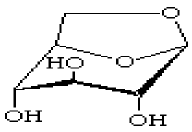
Levoglucosan can decompose over 10 days in acidic conditions, but it is a relatively stable organic composition in the atmosphere (Schkolnik, 2006). However, recent publications (Hennigan et al., 2010; Hoffmann et al., 2010) presented that the stability of levoglucosan was relatively low when it was in aerosol forms and exposed to hydroxyl radicals. Nevertheless, in atmospheric conditions, levoglucosan is still an excellent specific tracer for the emission from biomass burning sources in atmospheric particulate matter.

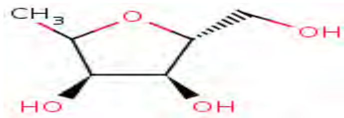
In this study, the primary objective is to identify and quantify the levoglucosan from fine particulate matter in atmospheric aerosols in Birmingham urban and rural areas: EROS site and BWSS site. The experimental methodologies were presented in Chapter 2. The daily levoglucosan concentration results were listed in Appendix V.

4.2 Atmospheric concentrations of Levoglucosan & OC

4.2.1 Levoglucosan atmospheric concentrations

In this study, the analytical methods and data analysis were directed toward levoglucosan, rather than the whole MA group. The direct analysis of mannosan and galactosan was avoided because mannosan and galactosan had been reported to occur in much lower concentrations in aerosols (Simoneit, 1999). Also because mannosan and galactosan have low response factors and poor gas chromatographic behaviour when analyzed without derivatization, despite the fact that the MA are water-soluble, the extraction into a nonpolar organic solvent was preferred because water also extracts polymeric humic-like substances (Decesari, 2000) which would not pass through the gas chromatographic column and cause rapid injector and column deterioration. In this work, dichloromethane has been employed for extraction, because it can easily be evaporated, yielding an anhydrous residue, which is required for subsequent derivatization. Figure 4.1 is an example of levoglucosan GC/MS ion current chromatograms in winter seasons and summer seasons. It can be seen that a separation was obtained between levoglucosan and the internal standard. The advantage of this internal standard is that the m/z detection is almost as same as that of the levoglucosan

($C_6H_{10}O_{5}$, 

). The difference between internal standard and levoglucosan is that there is no m/z value in 333 for internal standard (methyl-beta-D-xylopyranoside, $C_6H_{12}0_5$, 

). The levoglucosan m/z was detected in 204, 217 and 333 while the internal standard m/z was only detected in 204 and 217. The disadvantage of this method is that the retention time for levoglucosan and the internal standard is too close, but fortunately, the majority of the samples were very well separated and the separated peaks were obtained. Some of the samples which had very high concentrations were not separated that well, therefore they had been diluted to achieve a lower concentration value and then a better separation performance on GC (see Figure 4.1). The recovery determination standard (RDS) was only for measuring the samples lost during injection process and also offering a clue of the signal response for each run on the GC/MS. The detection limit for levoglucosan and internal standard were both 0.05ug/ml in this method.

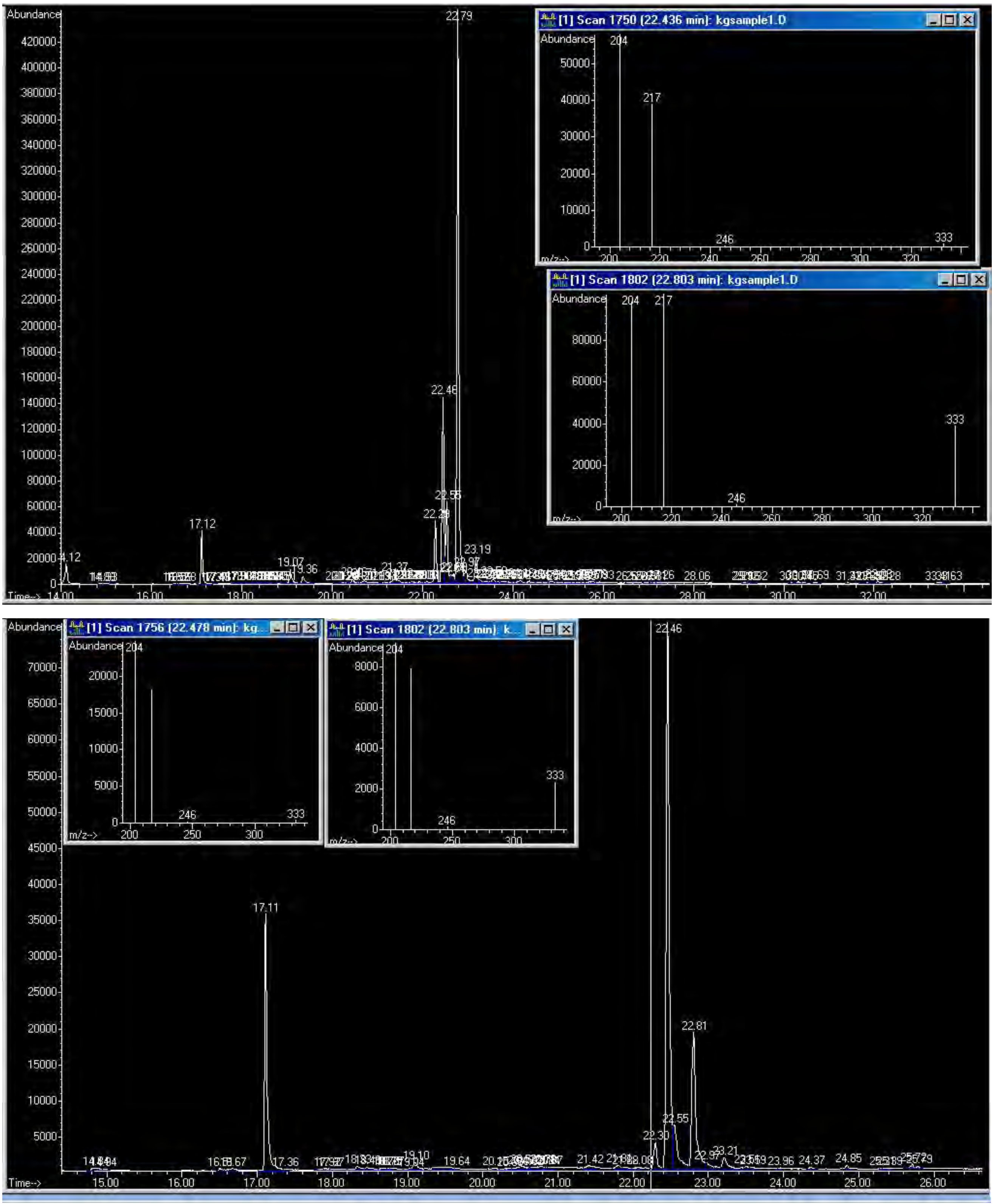


Figure 4.1 GC/MS ion current chromatograms obtained for trimethylsilylated extracts of summer time (bottom picture) and winter time (top picture). Retention time(mins): 17.12= recovery standard. 22.48= internal standard, m/z: 204, 217; 22.79=levoglucosan, m/z: 204, 217 and 333.

The levoglucosan concentrations at EROS and BWSS sites are presented in Figure 4.2. At EROS there was a manual filter change high volume sampler therefore it was not available for weekend datasets. The automatic filter change high volume sampler was setup at BWSS thus the datasets were continuous. The concentrations were much higher at BWSS than EROS, especially in cold periods when wood fuel burning activities happened at BWSS. The peak of levoglucosan clearly dominates the chromatogram for cold period aerosol samples (Figure 4.1). The highest concentration 353ng m^{-3} was measured on 12th December 2009 at BWSS, with an average level of 56.8ng m^{-3} from November 2009 to April 2010. The concentration in middle winter periods was almost 7 times higher than that in April 2010 at BWSS. At EROS, the highest concentration of 98.2ng m^{-3} was measured on 15th December 2009, with an average level of 20.6ng m^{-3} from May 2009 to March 2010, which was almost 4 times higher in cold periods than in warm periods at EROS.

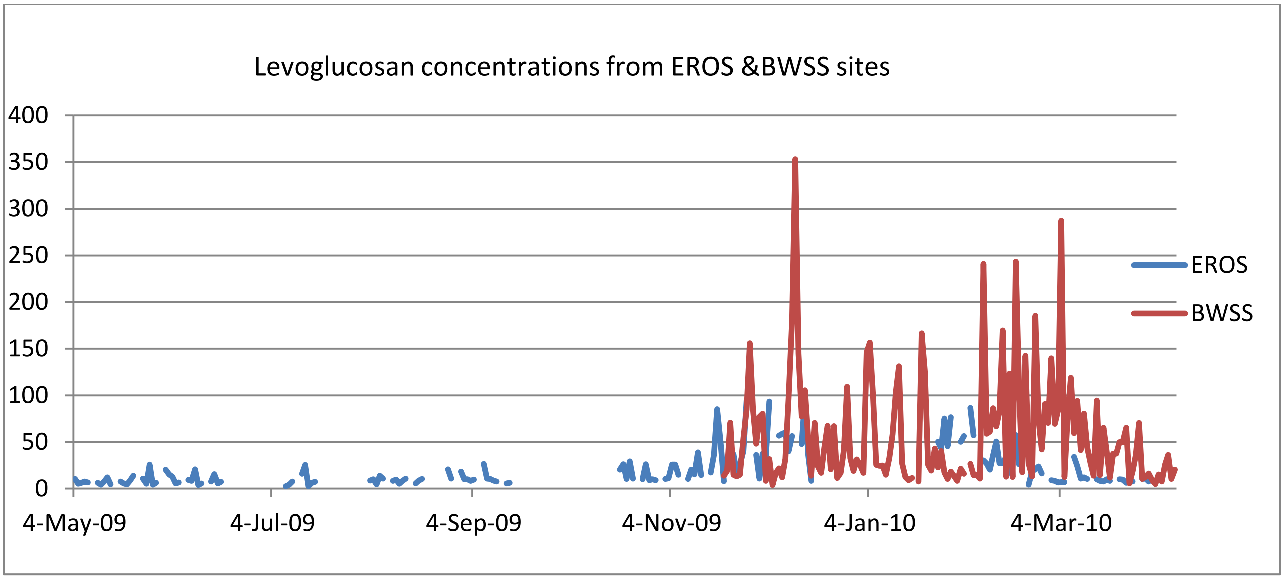


Figure 4.2 Levoglucosan concentrations from EROS site & BWSS site. The sampling periods were from May 2009 to March 2010. The levoglucosan is much higher at BWSS wood burning site.

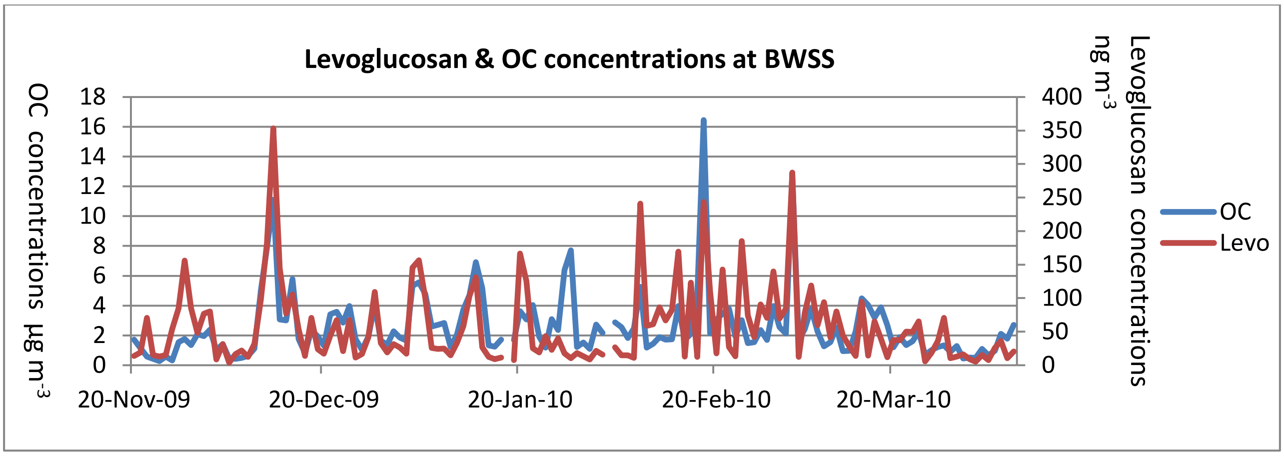
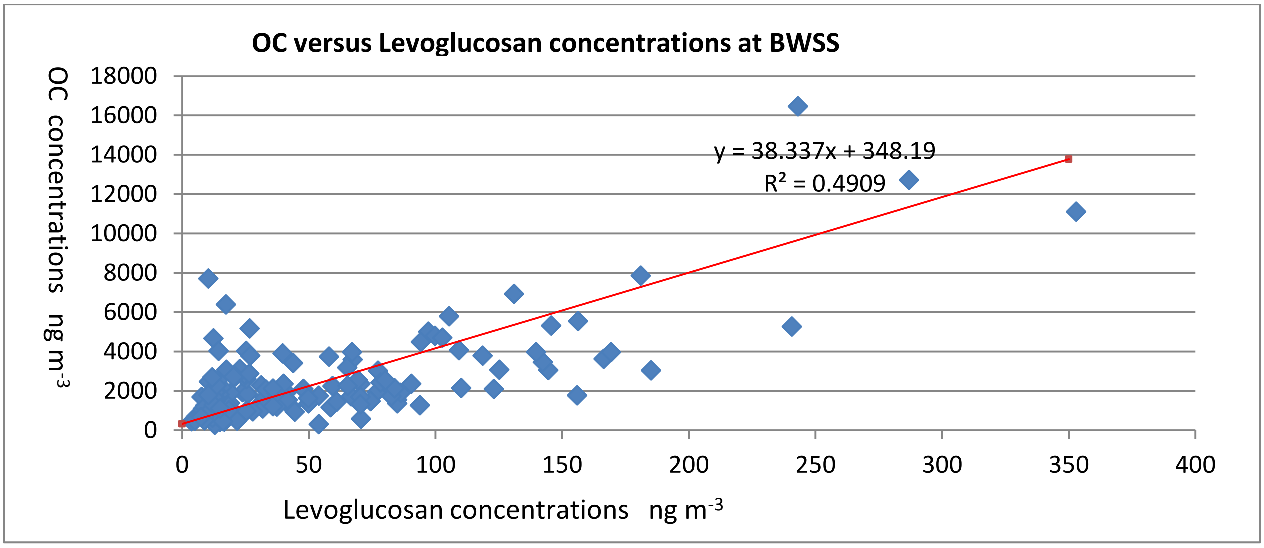
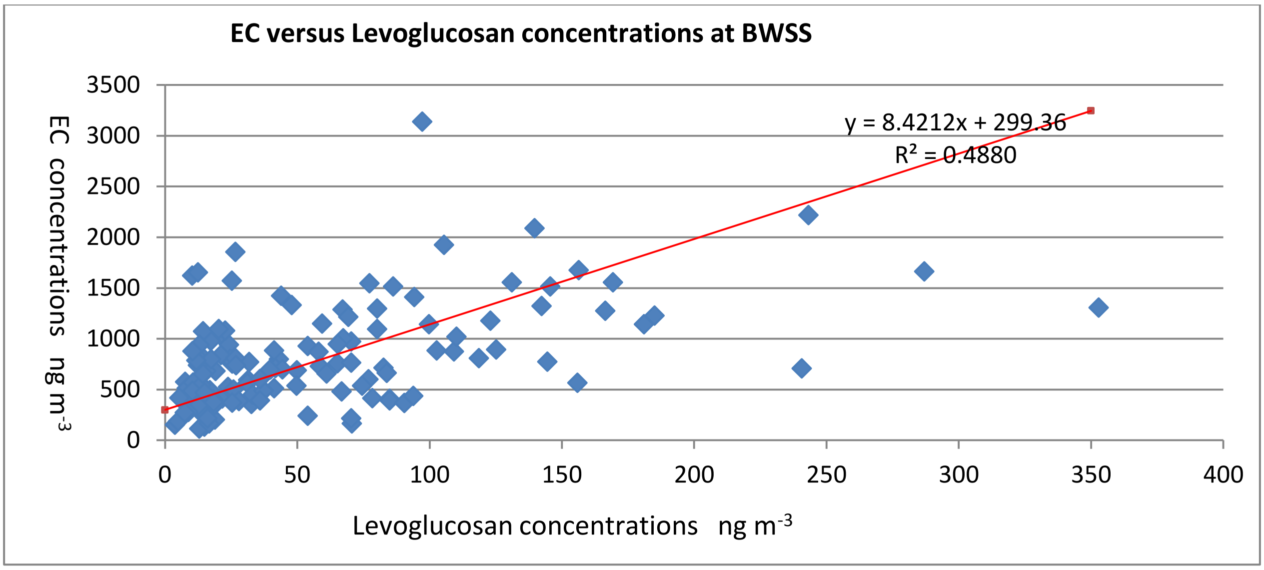


Figure 4.3 Levoglucosan & OC concentrations at BWSS

Figure 4.3 presents the levoglucosan and OC concentrations from 20th November 2009 to 08th April 2010 at BWSS. The BWSS and EROS locations and methodologies were presented in Chapter 2. At BWSS, the levoglucosan concentration ranged from 5ng m^{-3} to 353ng m^{-3} and the OC concentration ranged from 0.27µg m^{-3} to 16.5µg m^{-3} during the sampling periods. The highest levoglucosan concentrations were detected in December 2009 and February 2010. Therefore if winter is defined as November, December, January and February and spring defined as March and April, the majority wood burning activities in these sampling areas happened in winter.

Figure 4.4 shows the scatter gram ratio between the levoglucosan and OC, EC, TC concentrations. Figure 4.5 is the OC versus EC and OC/levoglucosan ratios at BWSS. The levoglucosan results are well correlated with OC concentrations (R^2=0.4909) and EC concentrations (R^2=0.4880). This suggests that wood burning is a significant source of aerosol organic carbon in this sampling area. The levoglucosan to OC ratio has been used to estimate the contribution from wood burning to the aerosol OC (Zdrahal, 2002; Puxbaum, 2007). The highest levoglucosan/OC ratio of 0.18 was measured at the beginning of the sampling period in the end of November 2009. After that, lower ratios ranging from 0.001 to 0.07, with an average of 0.025 were measured during the sampling periods. This ratio and the levoglucosan versus OC correlation ratios indicated that there were great contributions of wood burning to the aerosol organic carbon at BWSS site, and the levoglucosan and OC were from the same burning source during the low ratio periods. The highest peaks of levoglucosan concentrations were 353ng m^{-3}, 287ng m^{-3} 243ng m^{-3} and 240ng m^{-3}. Apart from those days, the rest of the sample concentrations varied between 5ng m^{-3} and 200ng m^{-3}.





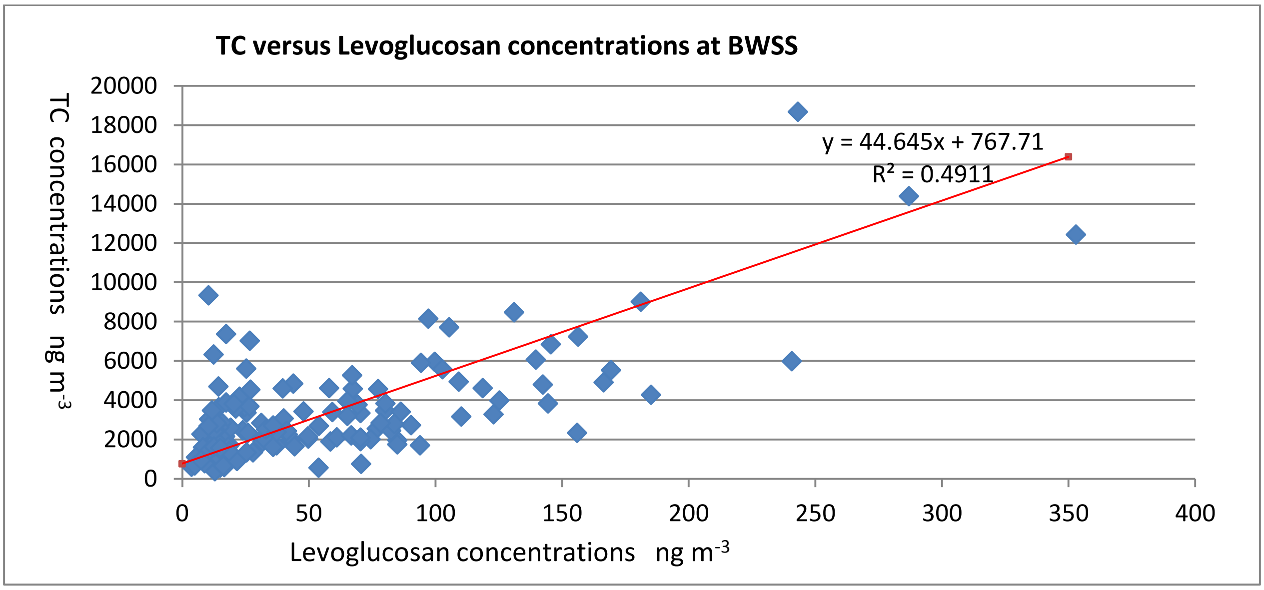
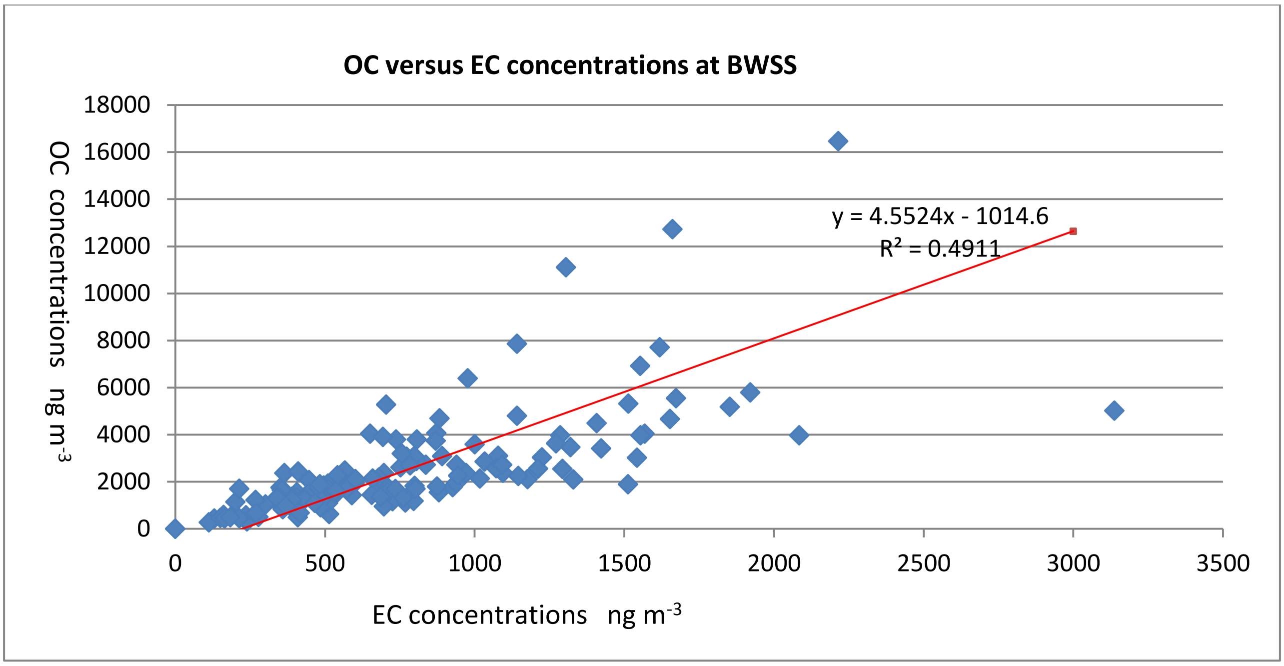
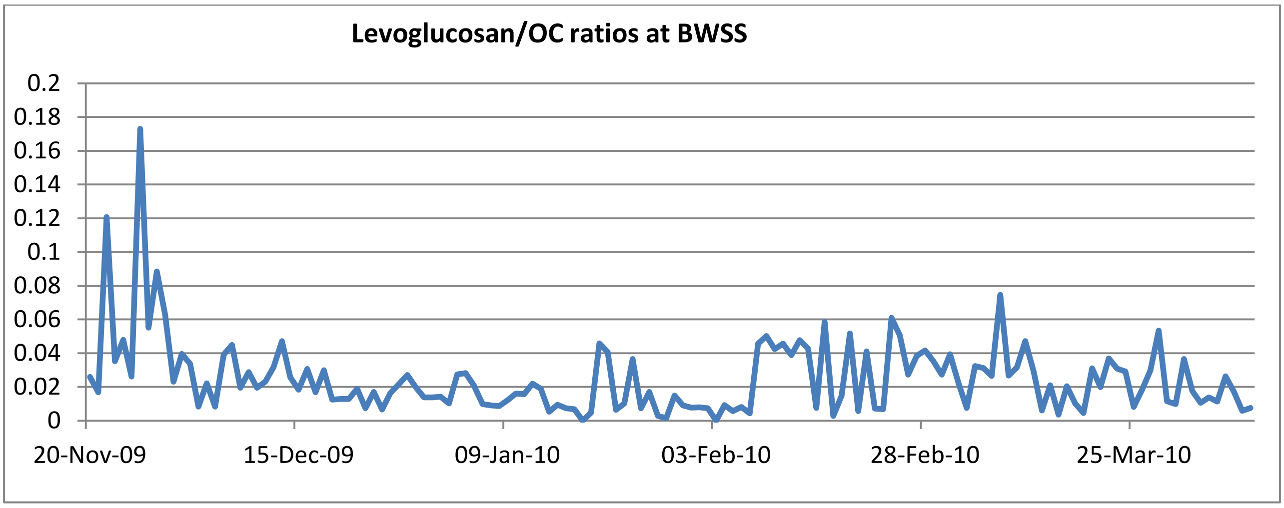


Figure 4.4 Levoglucosan versus OC, EC, TC correlation ratios, red line is the linear regression using RMA technique.



(a)



(b)

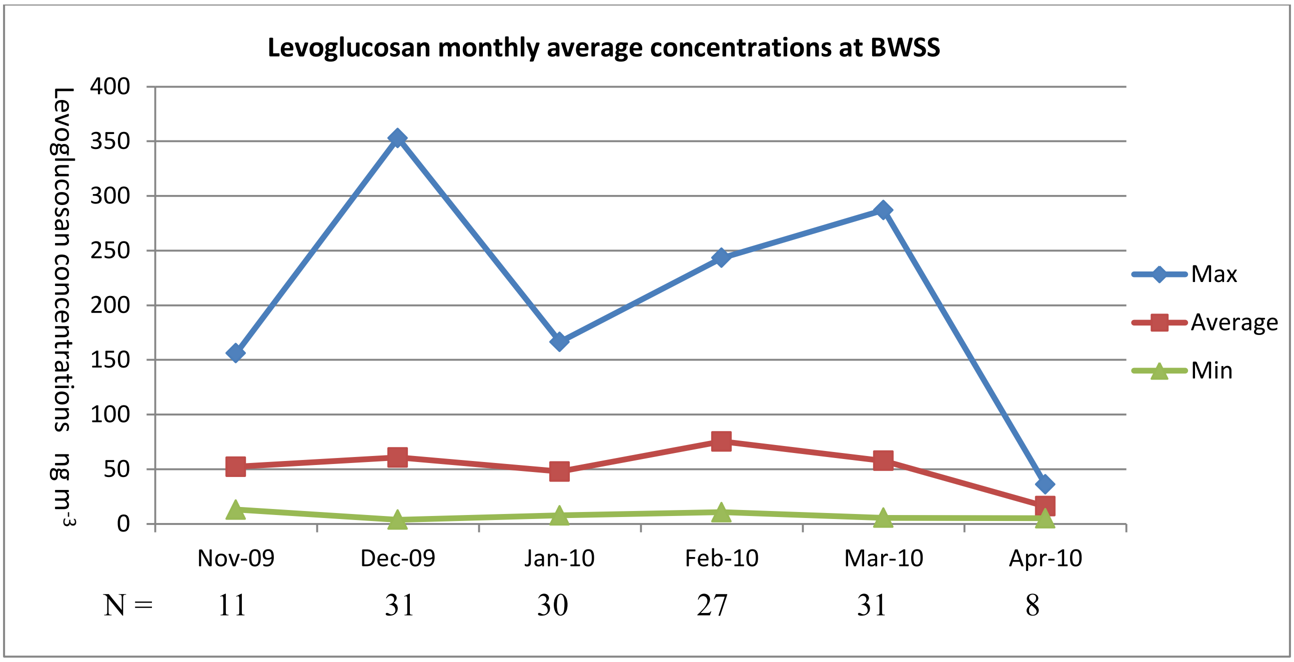
Figure 4.5 (a) OC versus EC correlation ratios, red line is the linear regression using RMA technique. (b) OC/Levoglucosan daily ratios

4.2.2 Levoglucosan seasonal variation

As a wood fuel smoke marker, levoglucosan shows great seasonal variations (Figure 4.6). At BWSS, the local wood smoke activities played a dominant role in this sampling campaign. The main wood burning sources were nearby wood burning based houses for heating and cooking which caused the levoglucosan concentrations much higher in winter than that in spring. Also there was an open fire source burning waste wood fuel for 5 to 8 hours at daytime weekly in winter which cause extremely high levoglucosan concentration on that day. The highest peak of levoglucosan concentrations was 353ng m^{-3}, measured on 12th December 2009, followed by 287ng m^{-3} on 4th March 2010, then 243ng m^{-3} on 18th February 2010 and 240ng m^{-3} on 8th February 2010. The OC concentrations were 11.1µg m^{-3}, 12.7µg m^{-3}, 16.5µg m^{-3} and 5.3µg m^{-3} on 12th December 2009, 4th March 2010, 18th February 2010 and 8th February 2010, respectively. The OC concentration peaks and levoglucosan concentration peaks appeared on the same day (Figure 4.3), therefore the dominant source of OC at BWSS was also wood smoke particles. Besides the peak day from November 2009 to April 2010, the levoglucosan concentrations at BWSS ranged from 13ng m^{-3} to 200ng m^{-3} in winter and from 5ng m^{-3} to 100ng m^{-3} in spring.

At EROS there was significantly seasonal effect during sampling periods. The warm periods (May, June, July, August, September and October), which was characterized by a low burning activities, had much lower concentrations than in cold periods (November, December, January, February, March and April).At EROS, mean concentrations in warm periods was 10ng m^{-3}, with the highest value of 29ng m^{-3}, while in cold periods, these values were 40ng m^{-3} and 98ng m^{-3}, respectively.

In this study levoglucosan concentrations in summer time was considered as background concentrations, and exist all year round. As wood burning is the only source for levoglucosan, this all year round levoglucosan background concentration may be explained by wood fuel and agriculture waste combustion in rural areas and the houses which only install wood fuel heating systems. As a traditional way of heating and cooking in the countryside, wood fuel combustion is continuous and has an impact on the regional air quality. The importance of this kind of biomass burning emissions has also been reported for India, China, U.S. and other developing and developed countries in the world (Venkataraman, 2005; Zhang et al., 2008; Jimenez et al., 2006; James et al., 2008; Engling et al., 2009).



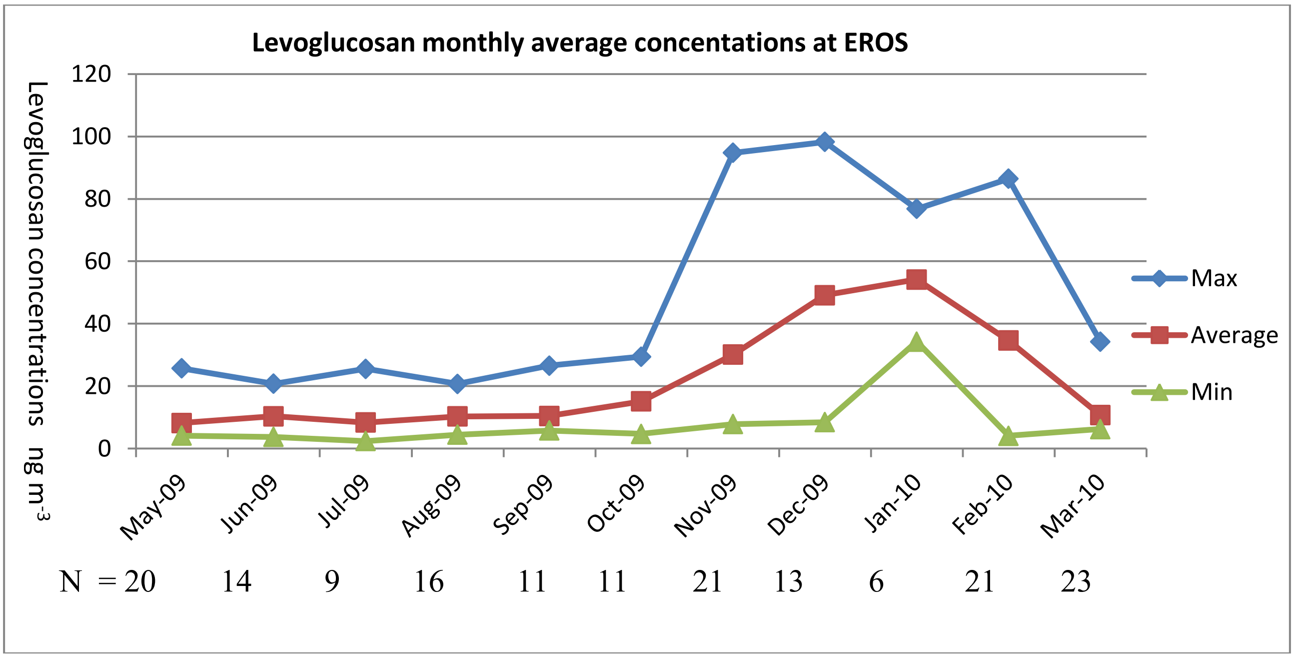


Figure 4.6 Levoglucosan monthly average concentrations at EROS & BWSS

Chapter 5
Multi-wavelength Aethalometer measurement and result analysis

5.1 Introduction

Using the multi-wavelength Aethalometer for the quantification of wood smoke aerosol in the atmosphere is a new technology for atmosphere science. Recent studies (Jeong et al., 2004; Hand et al., 2005; Park et al., 2006) showed that organic compounds in wood smoke aerosols could result in a strong UV absorption as measured at the 370-nm wavelength. Therefore those scientists introduced a dual wavelength Aethalometer (UV- and near-infrared (IR) wavelengths of 370 nm and 880 nm, respectively) to measure the light absorption from sampled filters in order to obtain different wavelengths absorption ratios. They also found that traffic dominant aerosol conditions would cause a lower ratio of the aerosol light absorption at 370 nm compared to that at 880nm (Kirchstetter et al., 2004). In 2008, Sandradewi's study was published (Sandradewi et al., 2008a; Sandradewi et al., 2008b). These two studies used a multi-wavelength Aethalometer (λ = 370, 470, 520, 590, 660, 880 and 950 nm) to measure the 7 different wavelength absorption ratios simultaneously in order to quantify the wood smoke aerosol and the traffic aerosol respectively. This equipment was deployed in the traffic and wood smoke predominantly area to obtain traffic and wood smoke aerosols only.

In this chapter, the study mainly used a multi-wavelength Aethalometer results to demonstrate the local wood smoke and traffic aerosol levels. The Aethalometer was only deployed at BWSS because this site was a small village with many homes burning wood for home heating and cooking. The heating systems in this village were different from that in urban areas. The houses in this village mainly use wood fuel for the central heating system and cooking system. The only fossil fuel usage was for vehicles. The nearest traffic was M40, 3km south of the site and the A46, 1.5km east of the site. This was an excellent sampling location to measure the wood smoke aerosols and traffic aerosols.

To convert the datasets from Aethalometer to PM wood smoke and PM traffic was very complicated. Dr. David Beddows had used Sandradewi's findings (Sandradewi et al., 2008a; Sandradewi et al., 2008b) and developed useful equations based on R-Cran software (R Development Core Team, 2008) to deal with those sophisticate calculations, so that the wood smoke PM concentrations, traffic PM concentrations and those PM relative parameters can be easily analysed in this study.

5.2 Multi-wavelength Aethalometer wood smoke and traffic aerosol results

5.2.1 Multi-wavelength Aethalometer result analytical process discussions

The Multi-wavelength Aethalometer working principles and calculation methods were discussed in chapter 2. The sampling periods were from 19th November 2009 to 20th April 2010. The sampler was stopped during 25th December to 17th January 2010. The sampling result discussion is separated into 4 sections: from 19th November to 31st January 2010 – winter seasons; from 1st Febuary 2010 to 28th Febuary 2010 – end winter season; from 1st March 2010 to 31st March 2010 – early spring season; from 1st April 2010 to 20th April 2010 – spring season.

One important task in this study is to differentiate between wood smoke emissions and road traffic emissions. Therefore the Ångström Exponent **α** was utilised to separate the wood smoke particles and traffic particles. From the equation 2.6 in chapter 2:

$$b_{abs} \propto \lambda^{-\alpha} \qquad 2.6$$

This equation shows that the Ångström Exponent **α** is related with wavelength and absorption coefficient. The value of **α** is used in the sample aerosols analysis to distinguish the wood smoke PM and traffic PM.

The absorption exponents **α** can be compared with literature value in Table 5.1a. The literature (Table 5.1b) also reported a range of **α** value between 0.9 and 2.2 depending on the type of wood burnt. But in this study the sampling location was not changed during sampling periods, thus the type of wood burnt was not taken into consideration here. In this study, the highest absorption exponent of 1.6 was obtained from November 2009 to February 2010, when the effect of wood burning was expected in this period of time. After that, the Ångström Exponent **α** had dropped to 1.58 in March 2010 and 1.27 in April 2010, due to less wood burning activities in that period. But the Ångström Exponent **α** result was all higher than that for the traffic dominated area.

The absorption coefficient b_{abs} is also a very important factor because it is utilized to calculate the final wood smoke PM and traffic PM results. The result of Ångström Exponent **α** and absorption coefficient b_{abs} are shown in Figure 5.1. According to Sandradewi (Sandradewi et al., 2008a; Sandradewi et al., 2008b), the diurnal cycles should be much stronger in the winter, with high b_{abs} and **α** values during the afternoon and evening hours. However these diurnal cycles exist only if the wood fuel for house heating is the sole source in the local areas. The b_{abs} and **α** value will be lower during the night when wood burning activities is getting less. But in this study there were only a few diurnal cycles measured from the end of March 2010 to the early April 2010, and also in the middle of winter periods. This is because besides wood fuel house heating source, there was another wood smoke source existed in this local area. The local people burn waste wood fuels in public area for outdoor activities in cold periods. Therefore in this study the diurnal cycles were not obvious during cold periods but a huge b_{abs} and **α** value peaks were detected during cold periods. Those huge peaks proved that a large amount of wood fuels had been burned during those periods. After middle of March 2010, as the local temperature was higher, the open fire activities for waste wood fuels burning were reduced. The b_{abs} and **α** value diurnal cycles were observed in the late March 2010 and early April 2010 periods. It showed that local people still burn wood for house heating and cooking. After that, the temperature went up and house heating activities stopped, therefore the diurnal cycles disappeared again.

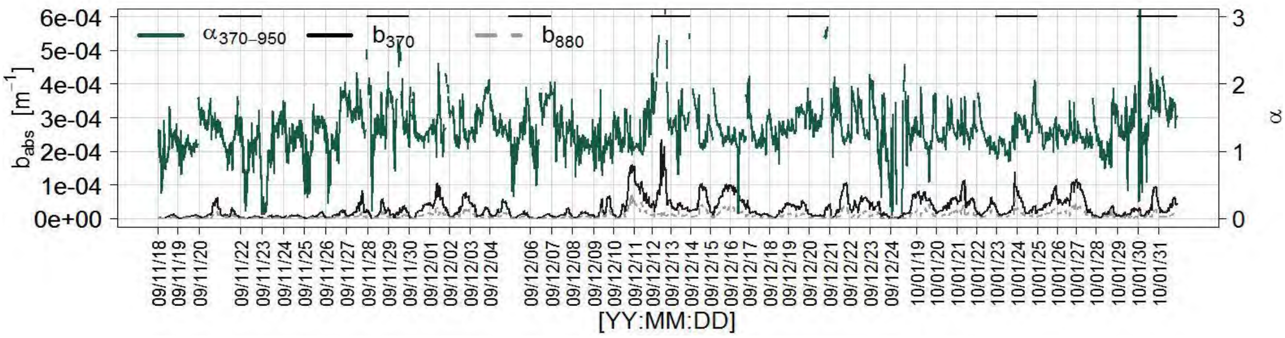
Table 5.1a literature values Ångström (Absorption) exponent for different emission sources (Sandradewi et al., 2008a; Sandradewi et al., 2008b).

Spectra	$\alpha_{370\text{-}950nm}$	$\alpha_{370\text{-}530nm}$	$\alpha_{660\text{-}950nm}$
□ Wood smoke	2.8	3.6	2.1
◇ Winter	2.2	3.7	1.1
△ Summer	1.2	1.2	1.0

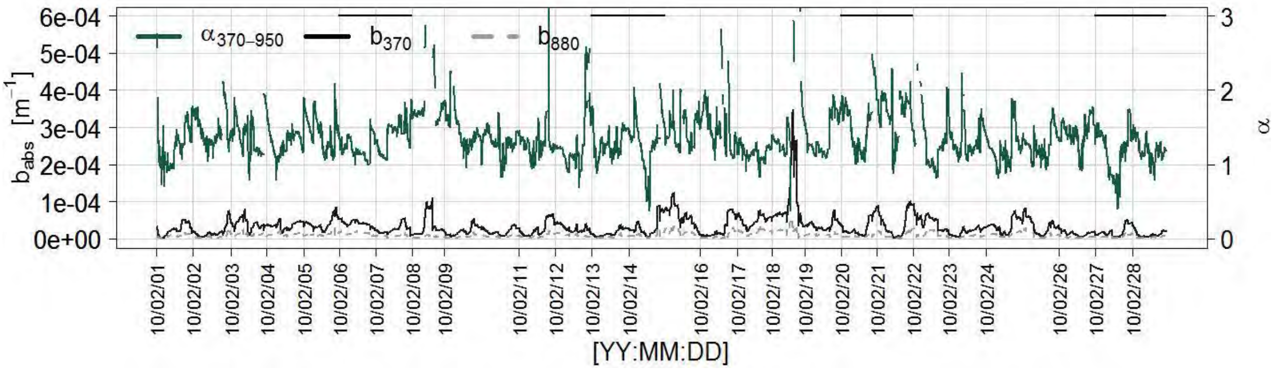
Table 5. 1b Literature values reported for the Ångström (Absorption) exponent

Description	Ångsröm exponent α,	Research Group
High Alpine Station, Saharan dust storm	1.5	Collaud Coen et al (2004)
Azores archipelago, Saharan dust storm	1.0 ± 0.2	Fialho et al (2006)
Wood burning	2.2	Kirchstetter et al (2004)
Savanna fire	1.8	Kirchstetter et al (2004)
Traffic dominated	0.8-1.1	Kirchstetter et al (2004)
Uncoated diesel	1.1	Schnaiter et al (2003, 2005)
Spark generated soot	2.1	Schnaiter et al (2003, 2005)
7 fresh forest wood smoke types	0.9 & 2.2	Day et al (2006)
Water-soluble HULIS	6.0-7.0	Hoffer et al (2006)
18Nov2009 – 31Jan2010	1.62	This study
01Feb2010 – 28Feb2010	1.62	This study
01Mar2010 – 31Mar2010	1.59	This study
01Apr2010 – 20Apr2010	1.28	This study

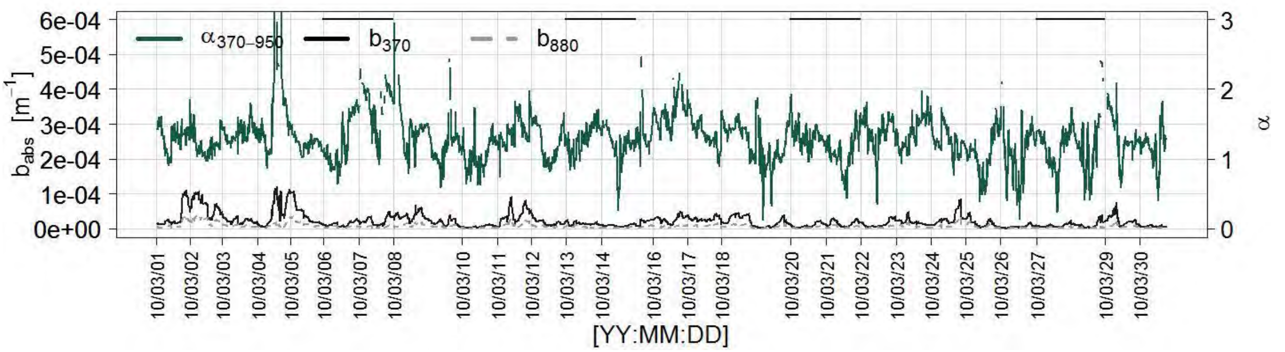
b_{abs} from 18th Nov 2009 – 31st Jan 2010



b_{abs} from 01st Feb 2010 – 28th Feb 2010



b_{abs} from 01st Mar 2010 – 31st Mar 2010



b_{abs} from 01st Apr 2010 – 20th Apr 2010

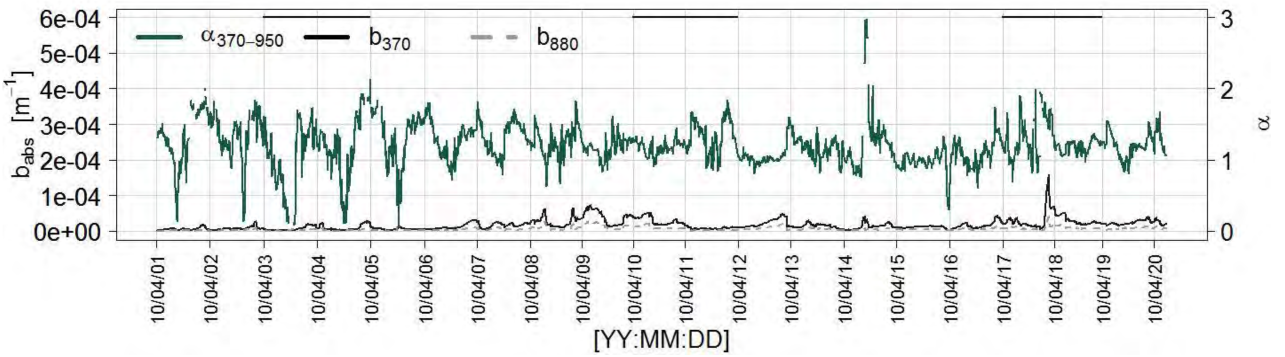
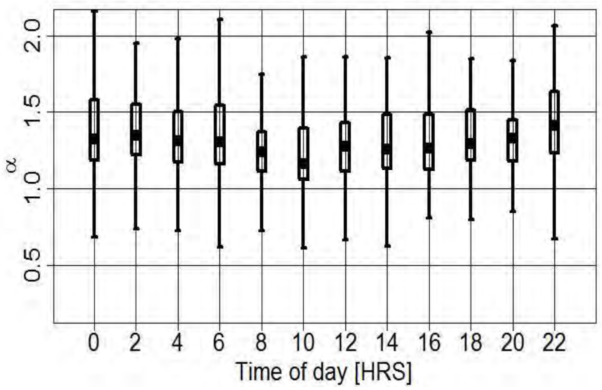
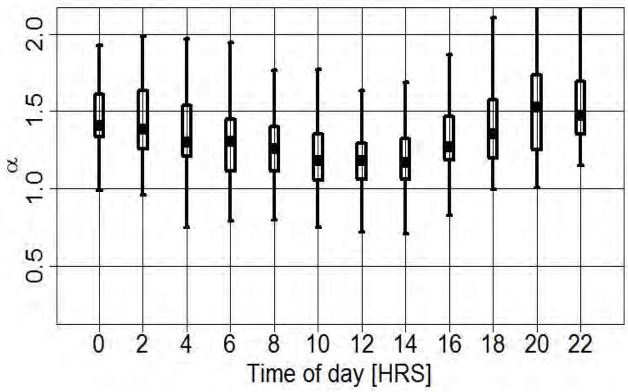


Figure 5.1 Time series (5 minutes per measurement) of the absorption coefficients b_{abs} (370 nm), b_{abs} (880 nm) and the absorption exponent (green line) at BWSS.

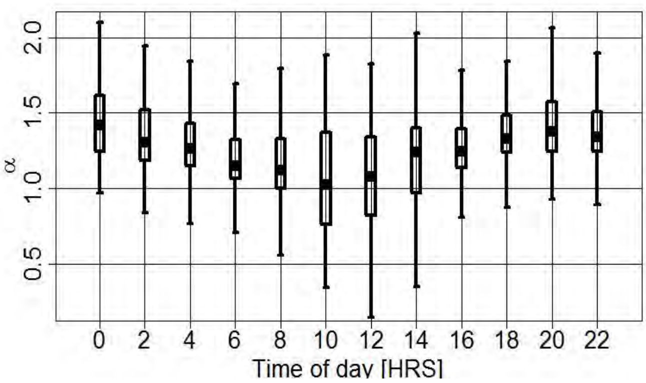
α from 18th Nov 2009 – 31st Jan 2010



α from 01st Feb 2010 – 28th Feb 2010



α from 01st Mar 2010 – 31st Mar 2010



α from 01st Apr 2010 – 20th Apr 2010

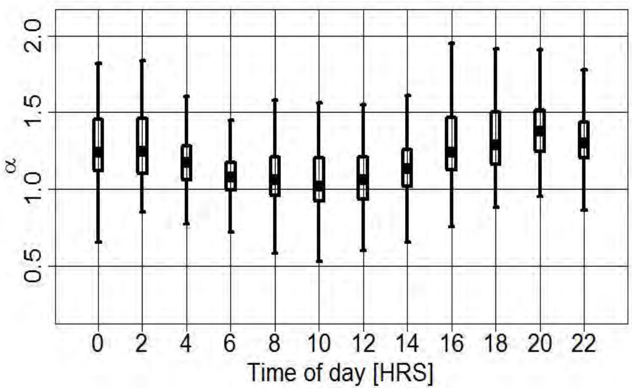


Figure 5.2 Box plot of daily variation for absorption exponent α in different time periods at BWSS. The horizontal thick bars represent the group medians. The vertical hinges represent data points from the lower to the upper quartile (I.e. 25th- and 75-percentiles). The whiskers represent data points from the 5th- to 96th-percentiles

The immediate differences between the median-day $\alpha_{370-950}$ values for BWSS site are in Figure 5.2. The values were generally higher in November 2009 to February 2010, and then followed by less wood burning activity in March and April 2010, the values were starting to decrease. The daily peak characteristic emission pattern of wood burning area was observed in February 2010 to April 2010: lower peak during the daytime and higher peaks during 18:00-22:00 when people started to cook and heat the house at night, then slightly dropped after 22:00 when people went to sleep.

Although the $\alpha_{370-950}$ values provided a general representation of the measured absorption coefficients, an improved representation was obtained by fitting the two halves of the absorption coefficient spectrum together (Figure 5.3). By plotting the absorption coefficient for the low (370-520 nm) and high (660-950 nm) wavelengths, an improved absorption-exponent representation of wood burning and traffic emission was derived (Figure 5.4). From all the sampling periods the difference between the two absorption-exponents fluctuates between a minimum value during the day and a maximum value during the night, this is also an obviously characteristic emission pattern of a wood fuel burning area.

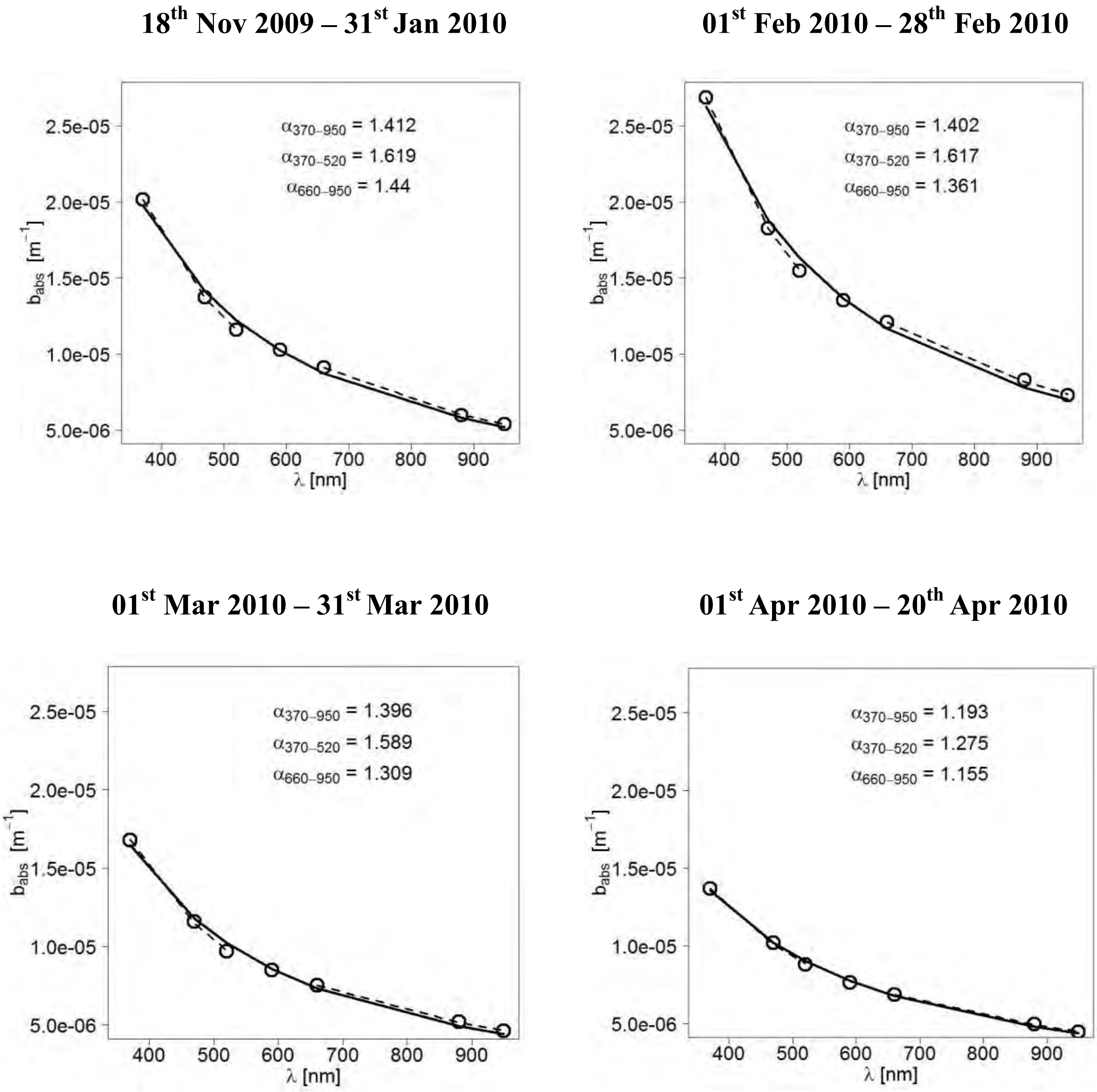
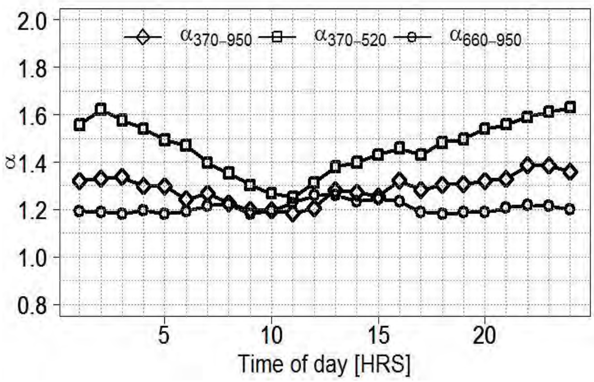
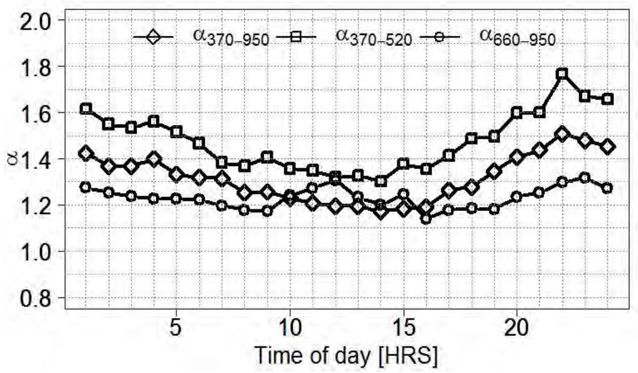


Figure 5.3 Median absorption coefficients for different time periods fitting the equation (2.6) at BWSS. The solid lines were generated by fitting the absorption coefficients b_{abs} over all seven wavelengths. The dashed lines correspond to the power law fits of b_{abs} over 370-520 or 660-950 nm.

18th Nov 2009 – 31st Jan 2010



01st Feb 2010 – 28th Feb 2010



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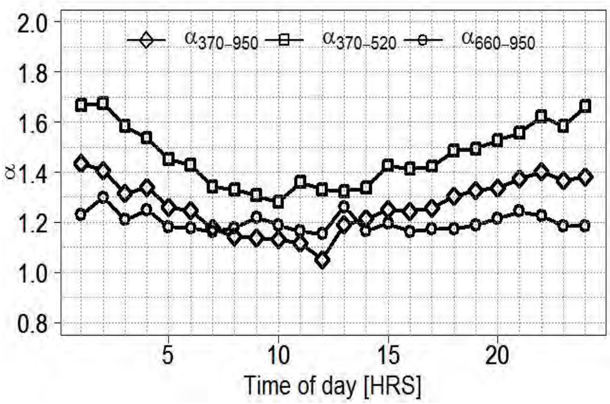

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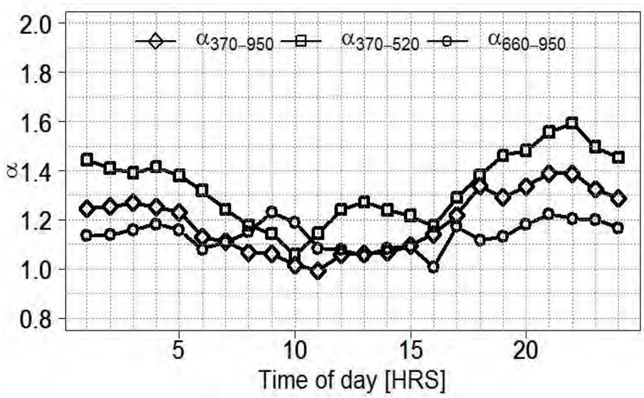
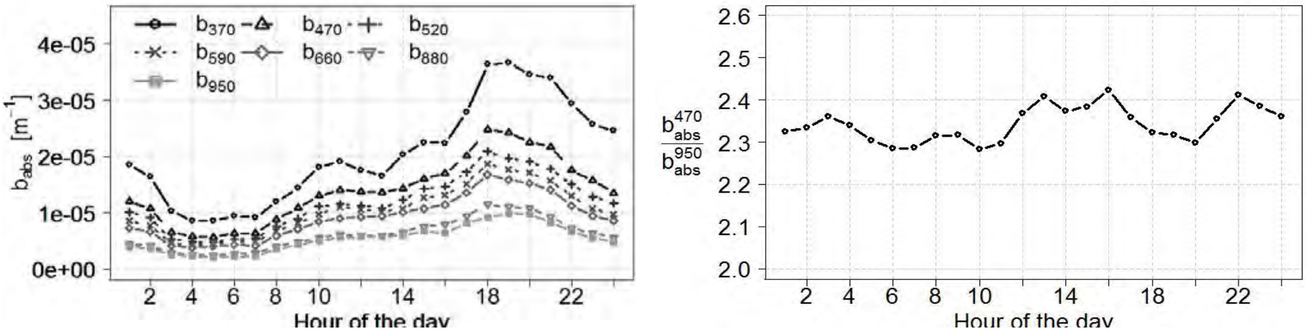


Figure 5.4 Daily variations of median $\alpha_{370\text{-}950nm}$, $\alpha_{370\text{-}520nm}$ and $\alpha_{360\text{-}950nm}$ values at BWSS.

Seven absorption coefficients b_{abs} of general overall diurnal patterns observed by taking the median hourly values derived at sampling area are presented in Figure 5.5. The lowest peak from November 2009 to January 2010 appeared at 5:00am in the morning when people awake from sleep. But from February 2010 to March 2010 this low peak area were changed to day time from 7:00am to14:00pm, especially in March 2010, a lower peak was measured during 10:00am to 14:00pm. This pattern shows a lower wood burning activities during this periods at the sampling area. The highest peak were measured during 16:00pm to 22:00pm in November 2009 to March 2010, when people started to cook and heat the houses. This was the characteristic expected at the wood burning site, which was also reflected in the ratio b_{abs}(470 nm) to b_{abs}(950 nm) - the values of which, were used to derive the PM_{wb} and PM_{traf} contributions. All the time values are based on GMT time.

18th Nov 2009 – 31st Jan 2010



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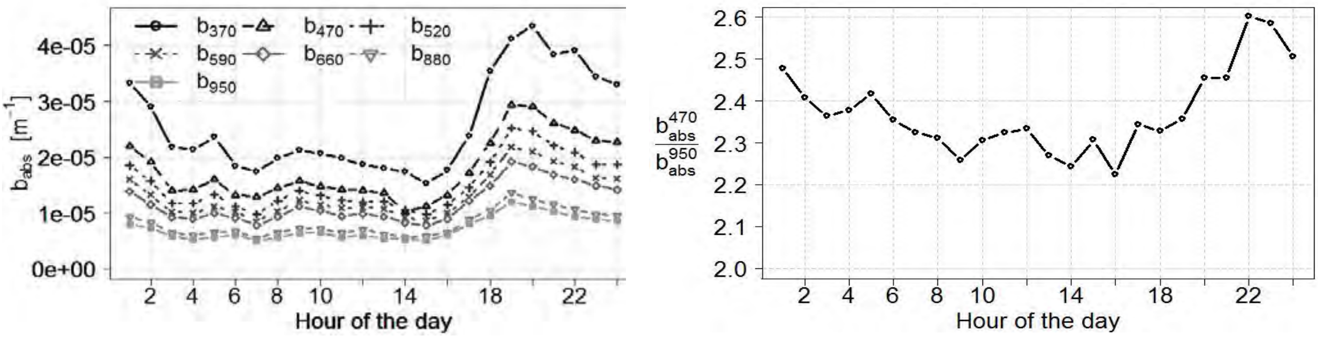

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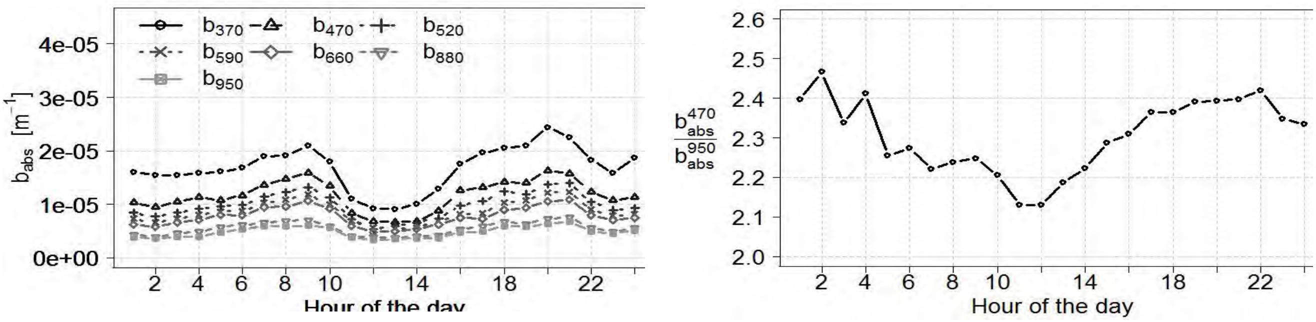

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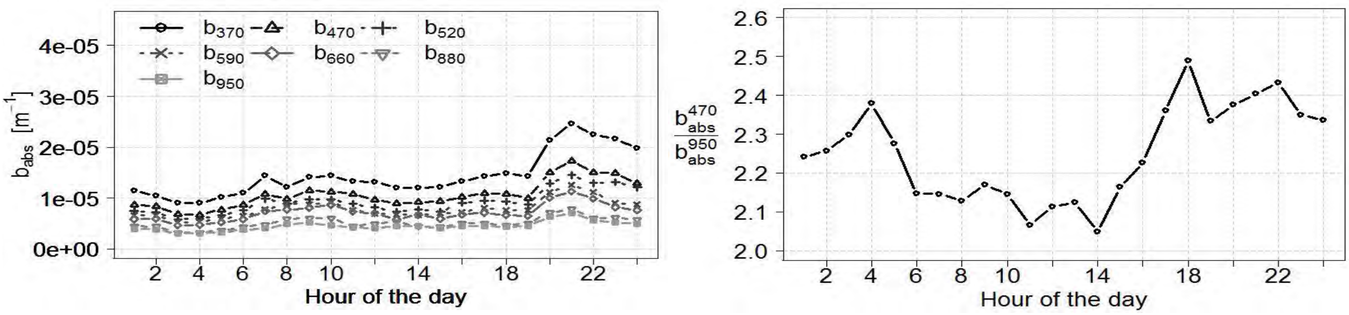


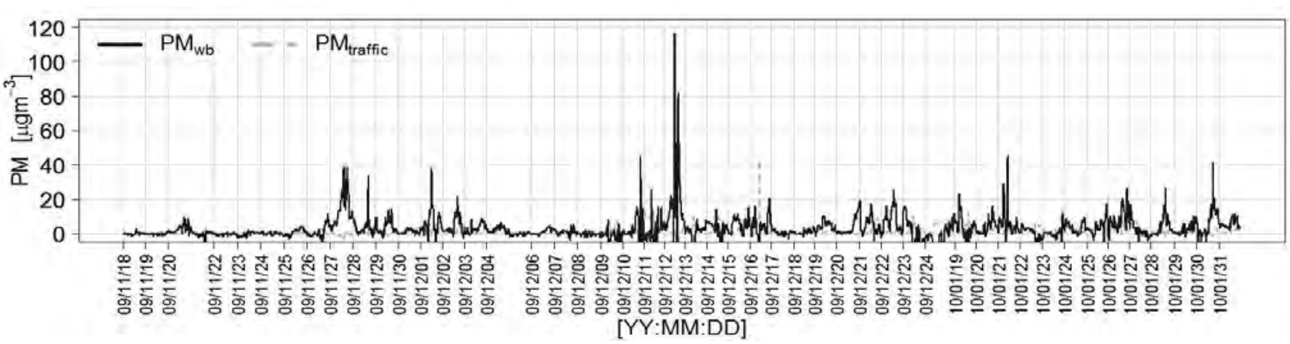
Figure 5.5 The b_{abs} daily variation for different time periods at BWSS. The left are seven wavelength variation during the day. The Right is the b_{abs}(470nm) and b_{abs}(950nm) ratio variation.

5.2.2 Wood smoke PM mass and traffic PM mass concentration results

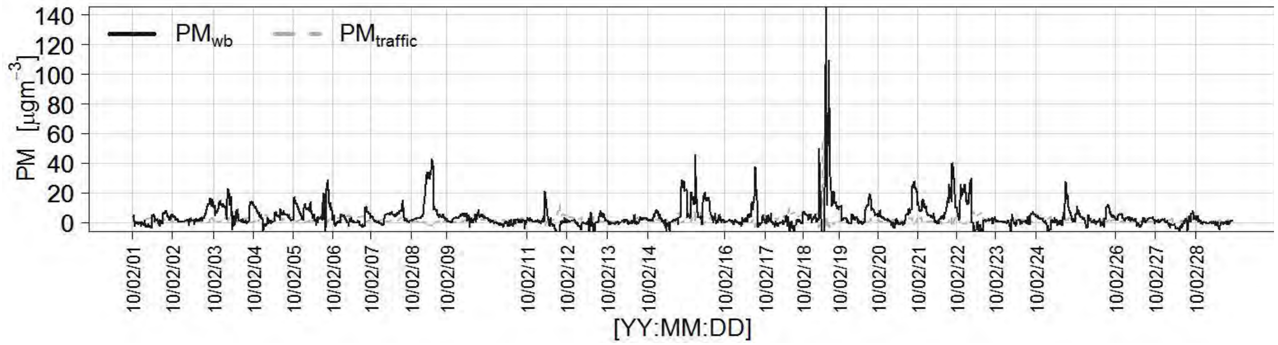
The improved absorption coefficients can be used to calculate the wood smoke PM mass and traffic PM mass. The BWSS site was wood burning dominant site therefore from November 2009 to March 2010 the wood burning PM mass value contribution was more than that of traffic PM mass (Figure 5.6). In this period the PM mass from wood burning varied between 0 and 40μg m^{-3}, with the highest concentrations of 120μg m^{-3} and 140μg m^{-3} on 12th December 2009 and 18th February 2010 respectively. The traffic PM mass varied between 0 and 10μg m^{-3}, with the maximum of 40μg m^{-3} on 16th December 2009. In April 2010 there were less wood burning activities and the wood burning PM masses were all below 10μg m^{-3} except one day on 17th April 2010 when the wood burning PM mass reached to 75μg m^{-3}. Therefore it can be assumed that the local people have burned the waste wood fuel on that day. The traffic PM mass was still between 0 and 10μg m^{-3} in April 2010. The hourly average traffic PM mass was 0.819μg m^{-3} in November 2009, 2.28μg m^{-3} in December 2009, 2.52μg m^{-3} in January 2010, 1.92μg m^{-3} in February 2010, 1.34μg m^{-3} in March 2010 and 1.37μg m^{-3} in April 2010. This fluctuation of traffic PM mass concentration was lower compared with that of wood smoke PM mass during the entire winter period.

The daily variation of median wood smoke PM mass and traffic PM mass can be found in Figure 5.7 where weekdays and weekends are presented separately. From November 2009 to January 2010 the wood burning PM mass and traffic PM mass were below 3μg m^{-3}. The wood burning PM mass reached to 3.5μg m^{-3} in the evening but only 0.5μg m^{-3} in the morning during the weekends. On weekdays the PM mass has not shown significant daily change. In February 2010 the clear wood burning contribution (10μg m^{-3}) was obtained at 22:00pm at night during the weekends, but it was only 4.5μg m^{-3} at the same time on weekdays. In March and April 2010 there were almost no wood burning contributions at day time from 10:00am to 15:00pm, but only 2.5μg m^{-3} at the evening hours. The traffic PM mass contribution was always 1μg m^{-3} on weekdays but had two small peaks of 3μg m^{-3} in the morning during the weekend in March and April 2010.

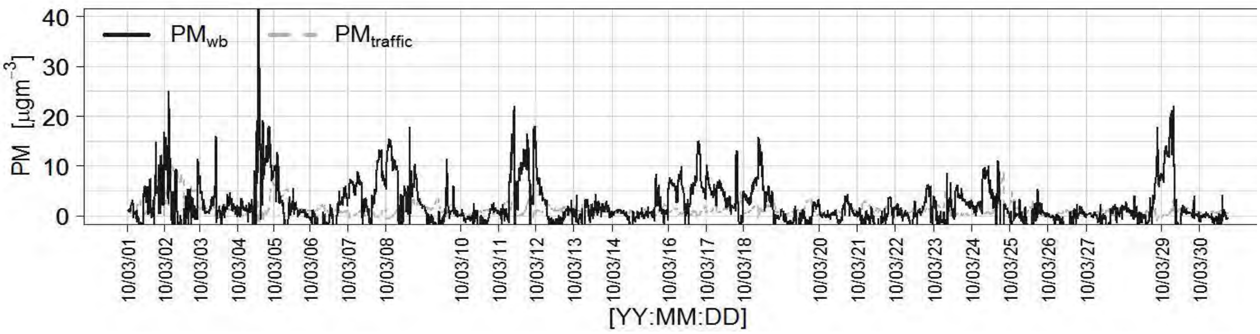
18^{th} Nov 2009 – 31^{th} Jan 2010



01^{st} Feb 2010 – 28^{th} Feb 2010



01^{st} Mar 2010 – 31^{th} Mar 2010



From 01^{st} Apr 2010 – 20^{th} Apr 2010

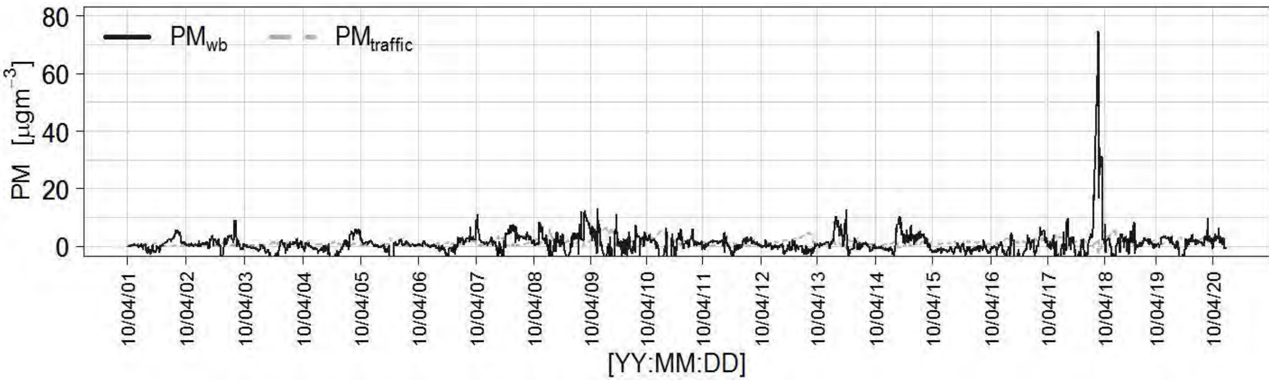


Figure 5.6 Time series (5 minutes per measurement) PM_{wb} & $PM_{traffic}$ from 18^{th} Nov 2009 – 20^{th} Apr 2010 for the duration of the BWSS site measurement.

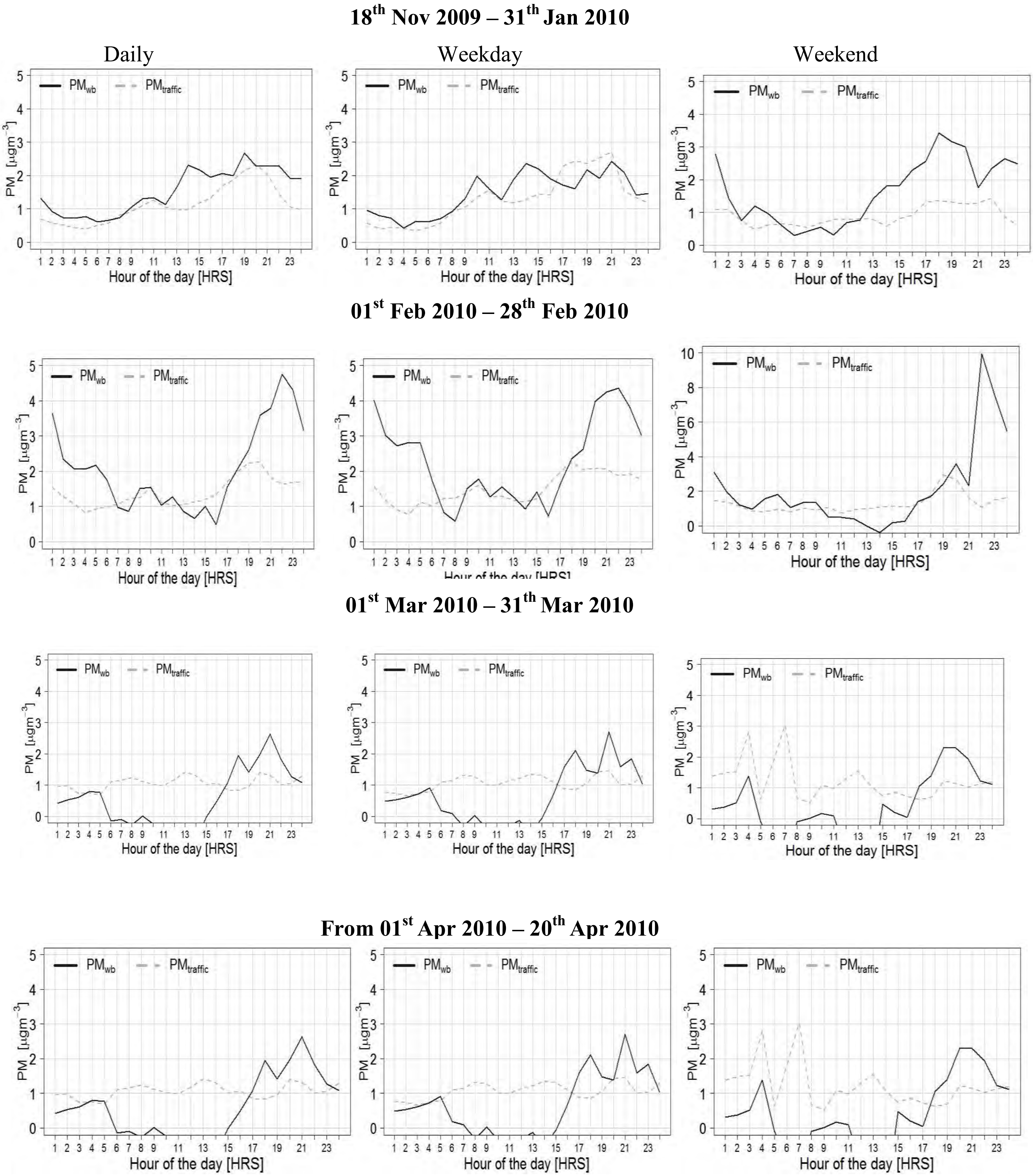
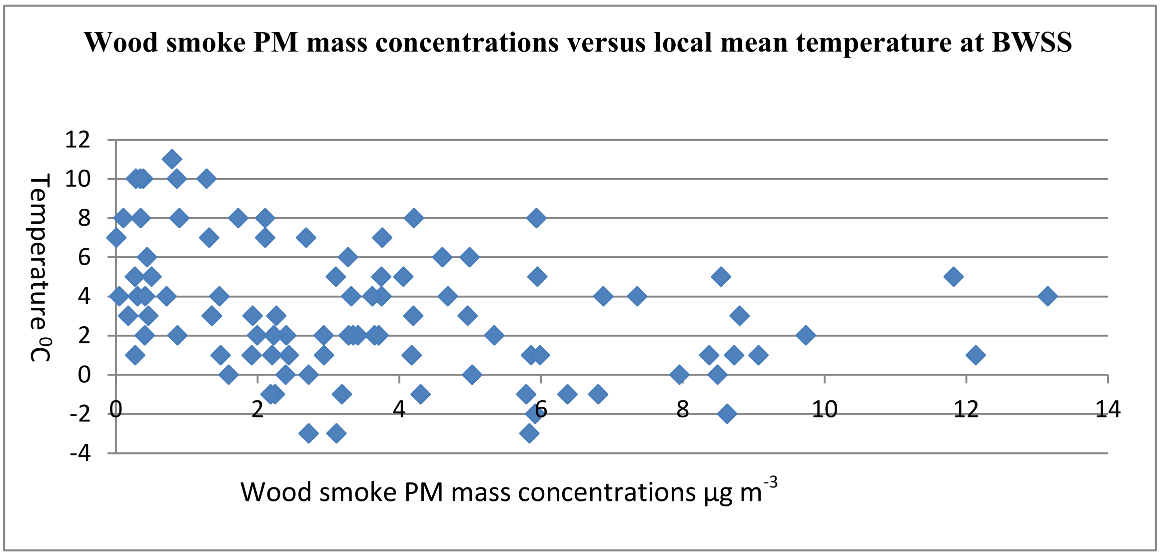


Figure 5.7 Daily variation of median PM_{wb} & $PM_{traffic}$ values at BWSS, the left figures are the average median value for the given period, the middle figures are the median value for weekdays and the right figures are the median value for weekends.



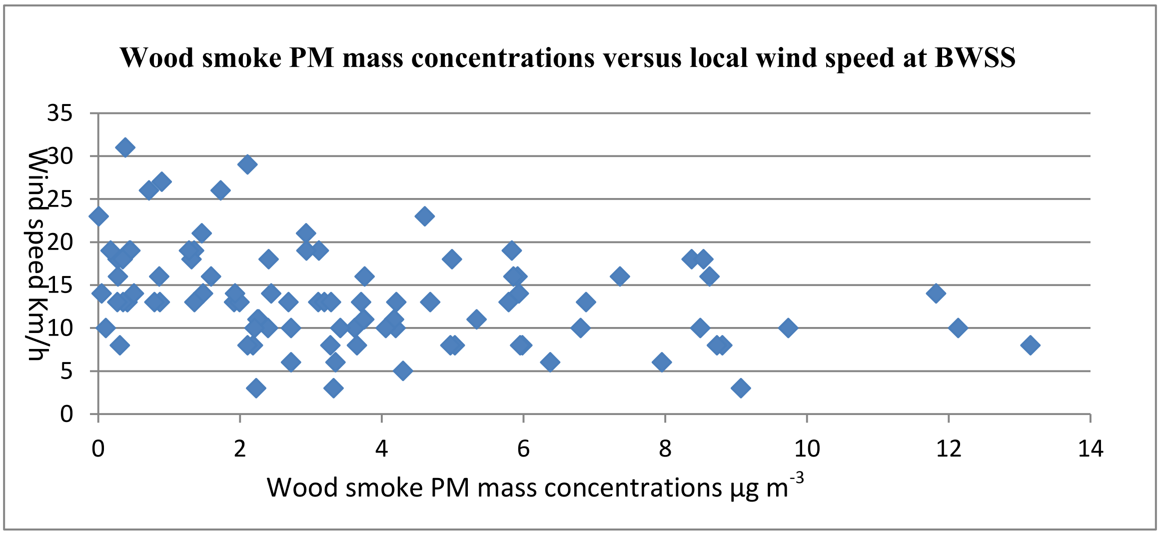
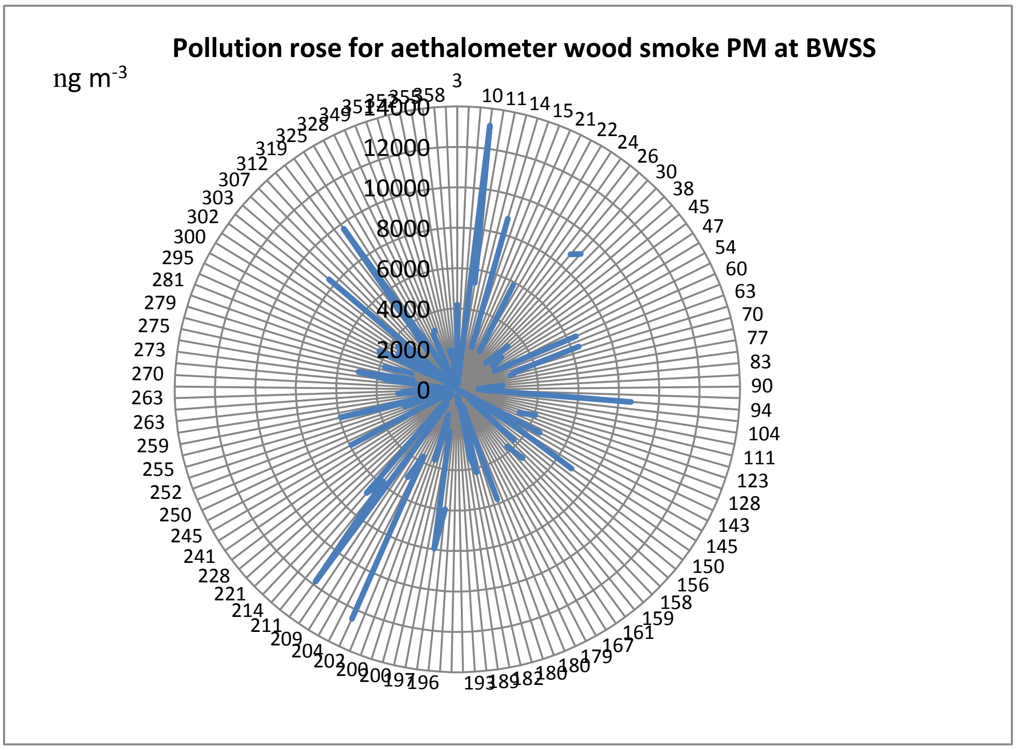


Figure 5.8 Wood smoke PM mass concentrations versus local temperature and wind speed at BWSS

Figure 5.8 shows the scatter gram of wood smoke PM mass concentrations from BWSS against local temperature and wind speed. The pattern shows that there was a negative correlation between the wood smoke PM mass concentration and temperature. This indicates that the wood smoke PM mass was mainly collected during cold periods. This characteristics agrees with the emission pattern of wood fuel burning for local heating and warming. The wood smoke PM mass concentrations have a negative exponential correlation with wind speed. This correlation is following the study (Jones et al., 2010) on primary pollutant concentration versus the wind speed. It seems the wind with higher speed will blow away the wood smoke mass therefore the higher wind speed will result a much lower concentrations.



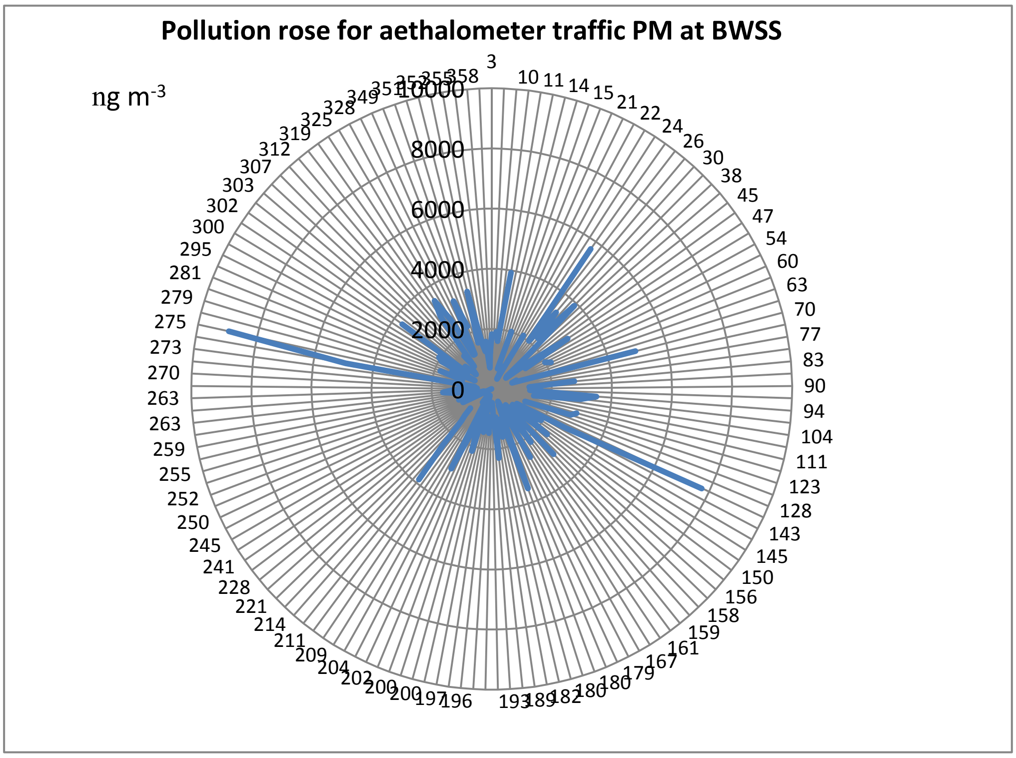


Figure 5.9 Pollution roses for aethalometer wood smoke and traffic PM concentrations at BWSS

Figure 5.9 shows the pollution roses for aethalometer wood smoke PM concentrations and traffic PM concentrations at BWSS. The main wood smoke sources for this locations are from southwest and the north. The peaks from the north was expected because it has an open fire source burning waste wood from that area. But the surprise is there were two peaks coming from the southwest, it is an unknown source for this location. It might be the other farms burning waste wood too because there are approximately six woodcutter and Sawmills which might doing the same thing. The traffic sources are evenly distributed except two higher peaks were measured. Because they were from west and southeast so it can be assumed that the higher peaks were from M40 from the west and Warwick town centre from the east.

Chapter 6
Inter-comparison of three methods for identifying and quantifying the wood smoke concentrations in Birmingham

6.1 Introduction

Many studies discussed the influence of wood smoke emission on atmosphere quality. The methods used included use the levoglucosan and potassium as the tracers to estimate the wood smoke pollutants; measure the fine and coarse potassium then evaluate the wood smoke potassium from fine potassium; measure the fine potassium then deduct the potassium from other sources; directly measure the carbonaceous aerosol then distinguish the wood smoke brown carbon from other sources by the special techniques. But the individual result of those methods might have variations making it hard to decide on the reliability of each one. In this study, it is important to choose the best method to quantify the wood smoke emissions. Also the conversion factor to change the wood smoke tracer to wood smoke concentrations is crucial when quantify the wood smoke atmospheric concentrations. The discussion on this factor is also necessary.

This chapter will compare the three wood smoke measurement methods to find out the most accurate methodology to quantify the wood smoke atmospheric concentrations, and then discuss the conversion factor for the wood smoke tracers potassium, levoglucosan and Aethalometer wood smoke concentrations to $PM_{2.5}$ atmosphere wood smoke concentrations. As the BWSS site is the only site which has all three measurement methods, the discussion will mainly based on BWSS dataset.

6.2 Inter-comparison for wood smoke quantification methods

6.2.1 Advantage and disadvantage of three methodologies to measure wood smoke

Three methods to identify and quantify the local wood smoke combustion level have been introduced in Chapter 3, 4 and 5. The wood smoke potassium in chapter 3, being deducted from sea-salt and soil can be considered as tracer element for local wood smoke qualitative identification marker. However, the emission of this tracer element is highly variable for the combustion conditions, also different wood type might be determined by local situation. Research (Muller-Hagedorn, 2003) showed that the pyrolysis process would influence inorganic salts, including potassium. Also, it will influence product distributions. Therefore the result of potassium will have great uncertainty.

Levoglucosan, introduced in Chapter 4, is a very unique tracer for wood smoke. This compound can only be detected in biomass burning combustion process, and the local amount released from biomass burning is suitable for laboratory measurement. Another advantage of levoglucosan is it is not detectable in smoke from burning of lignite and semibituminous coals (Simoneit, 1999), therefore this characteristic can be used to distinguish the combustion materials between wood fuel and coals. However, the extraction and the laboratory analytical process for levoglucosan are much more complicated than the other two methods, also levoglucosan needs to be derivatizated in order to be analyzed by GC/MS. This process needs to be extremely cautious as any changes of the derivatization condition (derivatizad time, temperature and waiting time for the GC/MS analysis) will influence the results.

Multi-wavelength Aethalometer is a new technique to measure the wood smoke emission, it used different laser absorption levels to distinguish the aerosol from local traffic and local wood smoke. It is very easy for equipment installation and dataset collection. It doesn't need any laboratory works but only some statistical calculation in the computer. But in this stage of research a few works have been done for this wood smoke combustion measurement, thus it seems that the Aethalometer can only measure the wood smoke and traffic aerosol when there are only traffic and wood smoke as local sources. There is still no any evidence showing that the Aethalometer will be still functional if other unknown brown carbon source present in the sampling area. Therefore using the Aethalometer to measure the wood smoke and traffic aerosol is still immature.

6.2.2 Inter-comparison for wood smoke quantification methods

6.2.2.1 BWSS site

Figure 6.1 shows wood smoke potassium concentrations, levoglucosan concentrations and Aethalometer wood smoke particles concentrations versus organic carbon concentrations correlation ratios. The RMA linear regressions for those ratios fitting the measured dataset have the forms:

[Kws] = 0.0354[OC] – 15.503 R^2 = 0.3421

[Levo]= 0.0261[OC] – 9.0823 R^2 = 0.4690

[Aeth]= 1.5559[OC] – 530.47 R^2 = 0.2531

Levoglucosan concentrations versus OC concentrations have the best correlation coefficient than other two methods (R^2 = 0.4690), followed by R^2 = 0.3421 for wood smoke potassium (R^2 = 0.3421) and Aethalometer (R^2 = 0.2531). The [Kws]/[OC] ratios and [Levo]/[OC] ratio are nearly the same (0.0354 and 0.0261), but [Aeth]/[OC] have the huge ratio of 1.5559, which is 44 and 60 times higher than [Kws]/[OC] and [Levo]/[OC] ratios, respectively. Different kinds of combustion condition will result in wide range of correlation ratios. The levoglucosan and OC are highly correlated for branches, straw, needles, and leaves, with branches generally having the highest average ratios (Sullivan et al., 2008). However, for duffs and grasses the levoglucosan is poorly correlated with the OC.

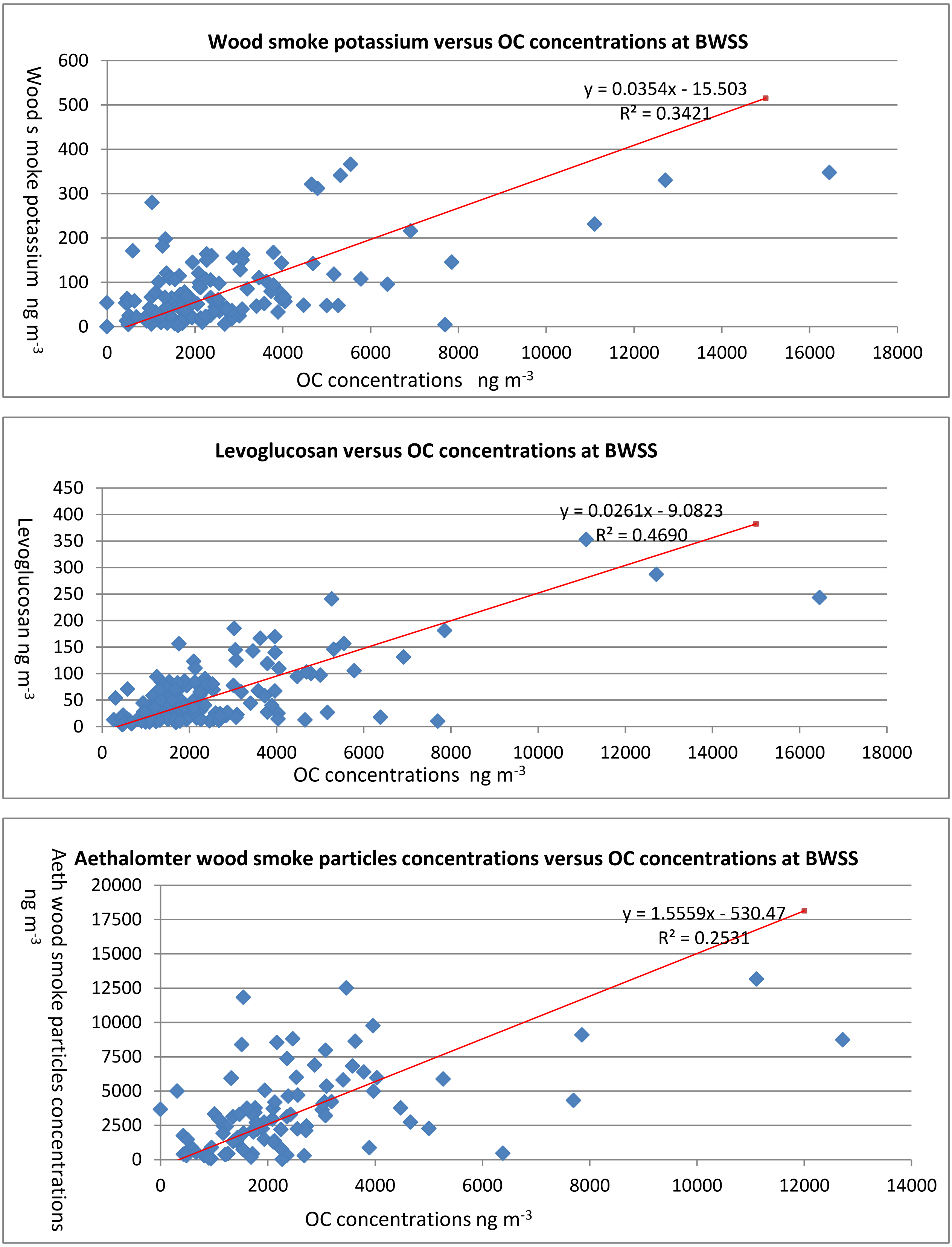


Figure 6.1 Correlation ratios of wood smoke potassium concentrations, levoglucosan concentrations and particles concentrations from Aethalometer versus organic carbon concentrations in RMA regression.

The levoglucosan versus OC ratios can also be compared to literature values in Table 6.1. But some of the literatures did not specify the type of tree burned.

Table 6.1 levoglucosan/OC literature ratios. * means the ratios are based on the laboratory results.

Burning conditions	Levoglucosan/OC ratios(μg/μg)	Literature
Fireplace	0.259	Fine et al., 2004
Fireplace	0.072	Fine et al., 2004
Burn enclosure	0.043	Hays et al., 2002
Sticks	0.045±0.069	Mazzoleni et al., 2007
Needls	0.043±0.034	Mazzoleni et al., 2007
Kudzo*	0.025	Sullivan et al., 2008
Fir, dired*	0.027	Sullivan et al., 2008
Wood fuel	0.026(ng/ng)	This study

The levoglucosan/OC ratios are varying depend on the burning conditions. Sullivan (Sullivan et al., 2008) has done some experiments measuring the levoglucosan/OC ratios from specific tree types and obtained wide ranges of ratios from 0.011 to 0.187(μg/μg) with an average ratio and standard deviation of 0.070 ± 0.038(μg/μg). Two of them have a results of 0.025 and 0.027(μg/μg) which is very close to this study's result 0.026(ng/ng). Compared with the literature results, the result from this study is very low than other residential wood smoke sampling area. But larger range in ratios is generally observed for the residential wood burning. Schauer (Schauer et al., 2001), Fine(Fine et al., 2004) and Hays (Hays et al., 2002) find out the range of ratios for three, ten and six types wood fuels are from 0.135 to 0.518 , 0.01 to 0.334 and 0.036 to 0.056 in U.S.. This wide range of wood fuel levoglucosan versus OC ratios indicate that the local tree types and combustion conditions are extremely important when measuring the residential wood smoke.

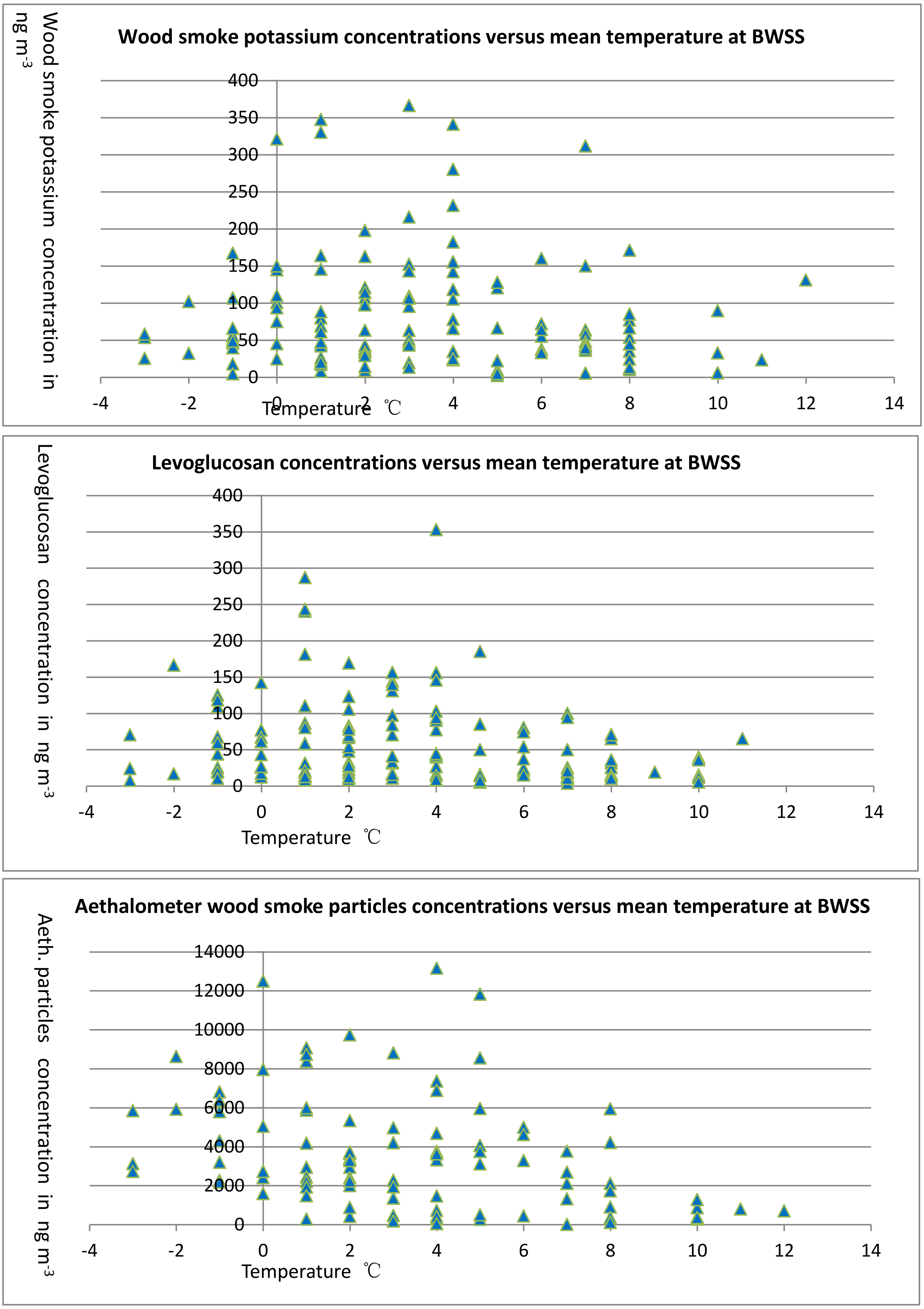


Figure 6.2 Wood smoke potassium, levoglucosan and aethalometer wood smoke particles concentrations versus mean temperature

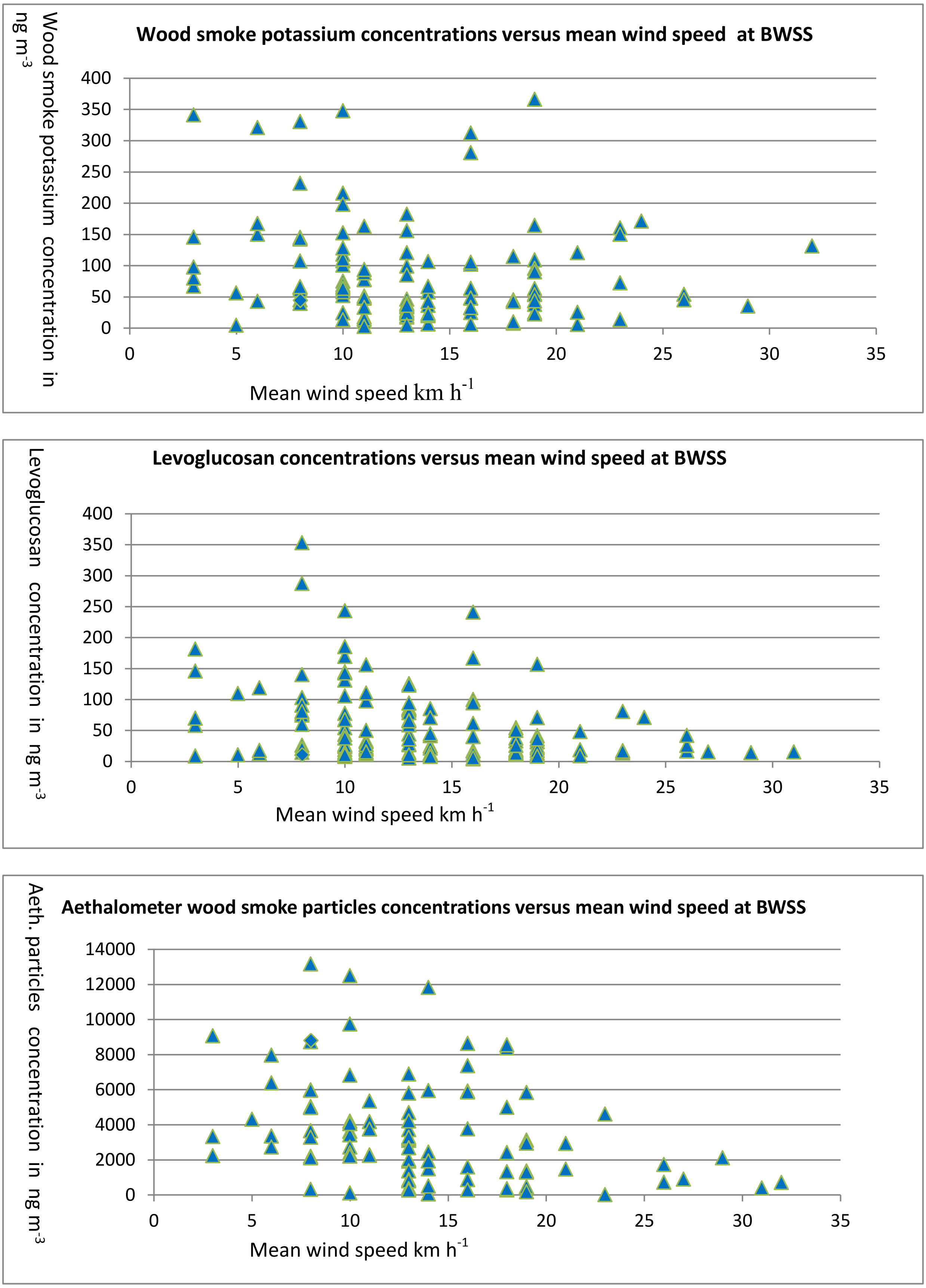
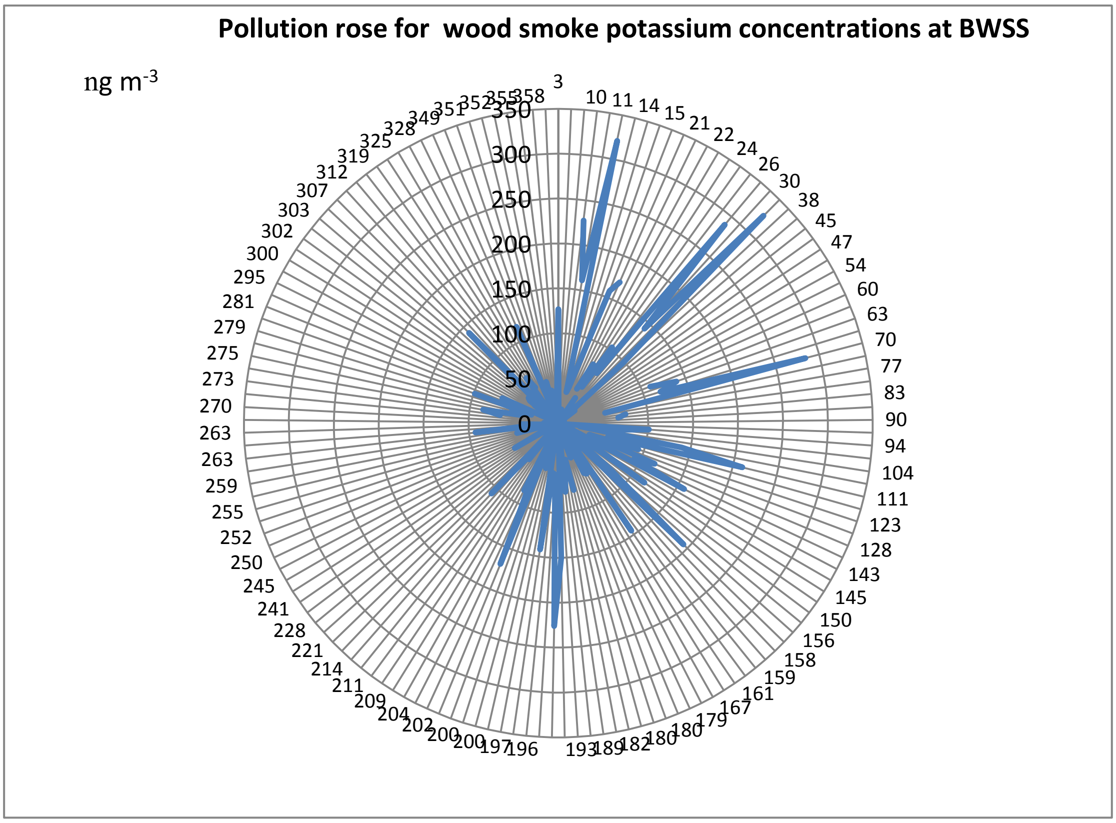


Figure 6.3 Wood smoke potassium, levoglucosan and aethalometer wood smoke particles concentrations versus mean wind speed



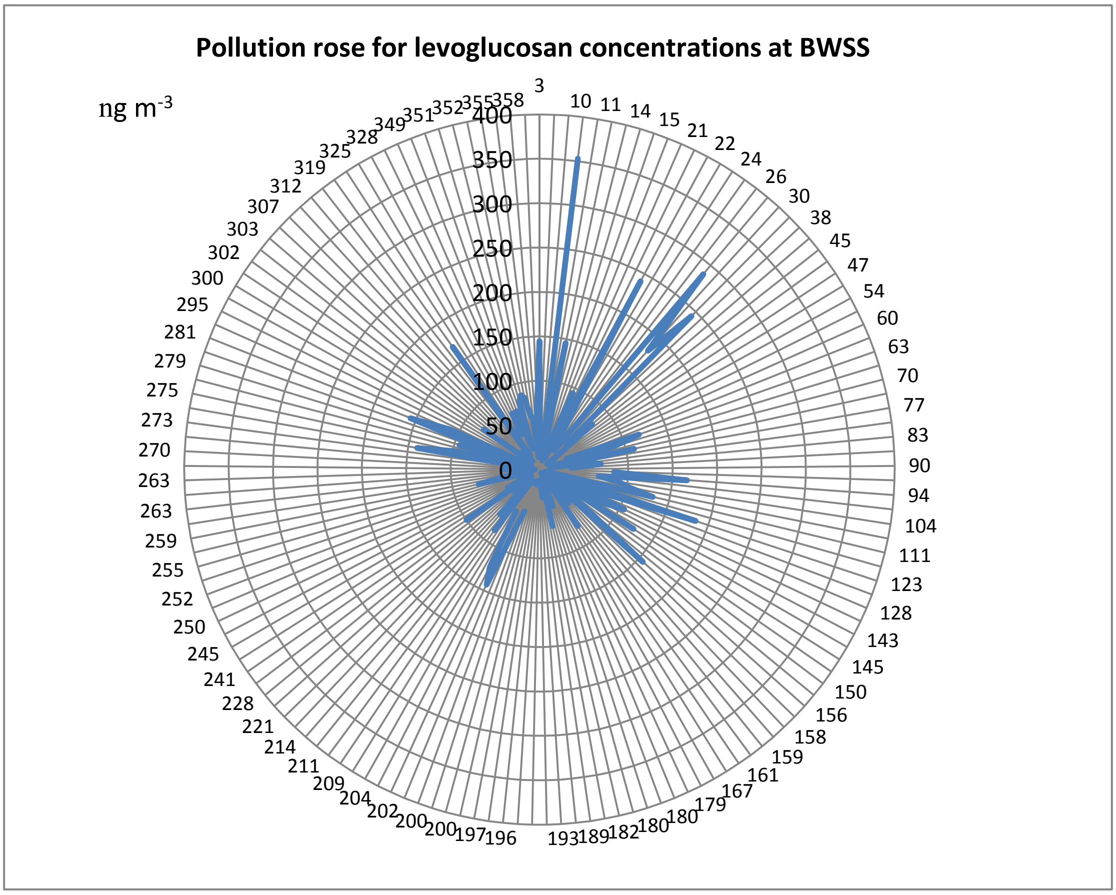


Figure 6.4 Pollution roses for wood smoke potassium and levoglucosan concentrations at BWSS

Figure 6.2 is the wood smoke potassium, levoglucosan and aethalometer wood smoke particles concentrations versus local mean temperature. The higher wood smoke potassium and levoglucosan concentration were measured when the local mean temperature were between 1℃ and 4℃. The higher Aethalometer wood smoke particles concentration were measured when the local mean temperature were between 0℃ and 5℃. This is suggested that the wood smoke have higher concentrations when temperature is getting lower.

Figure 6.3 is wood smoke potassium, Levoglucosan and Aethalometer wood smoke particles concentrations versus local mean wind speed. The wood smoke potassium, Levoglucosan and Aethalometer wood smoke particles concentrations are all inversely proportional to local means wind speed. The higher wood smoke potassium concentrations were measured when the local means wind speed was within 10 km h^{-1}. The higher levoglucosan concentrations were measured when the local means wind speed were between 8 to 16 km h^{-1}. The Aethalometer concentrations were measured when the local means wind speed were between 8 and 14 km h^{-1}.

Based on figure 6.2 and figure 6.3, wood smoke potassium, levoglucosan and aethalometer wood smoke particles concentrations are all in the same range between about 1℃ and 4℃ and 8 to 13 km h^{-1}, which means they have the same source in that sampling area. It is necessary to make sure that the three method are collecting the same source therefore the methods comparison will be much more accurate.

Figure 6.4 is the pollution roses for wood smoke potassium and levoglucosan concentrations at BWSS. It is expected that some huge peaks were measured from the northeast for both wood smoke potassium and levoglucosan concentrations because there were an open fire source located in that direction. But wood smoke potassium also has some peaks from the south which has unknown wood smoke sources. Compare with figure 5.9 at last chapter, the aethalometer also have some unknown source from that direction therefore it might be another wood smoke source in this sampling location which was not expected at the beginning. Because the levoglucosan is more difficult transported than potassium, therefore this location is not very close to the sampling location or it was burning different source than wood fuel so that it release less levoglucosan compare with the open fire source in the northeast of sampling location.

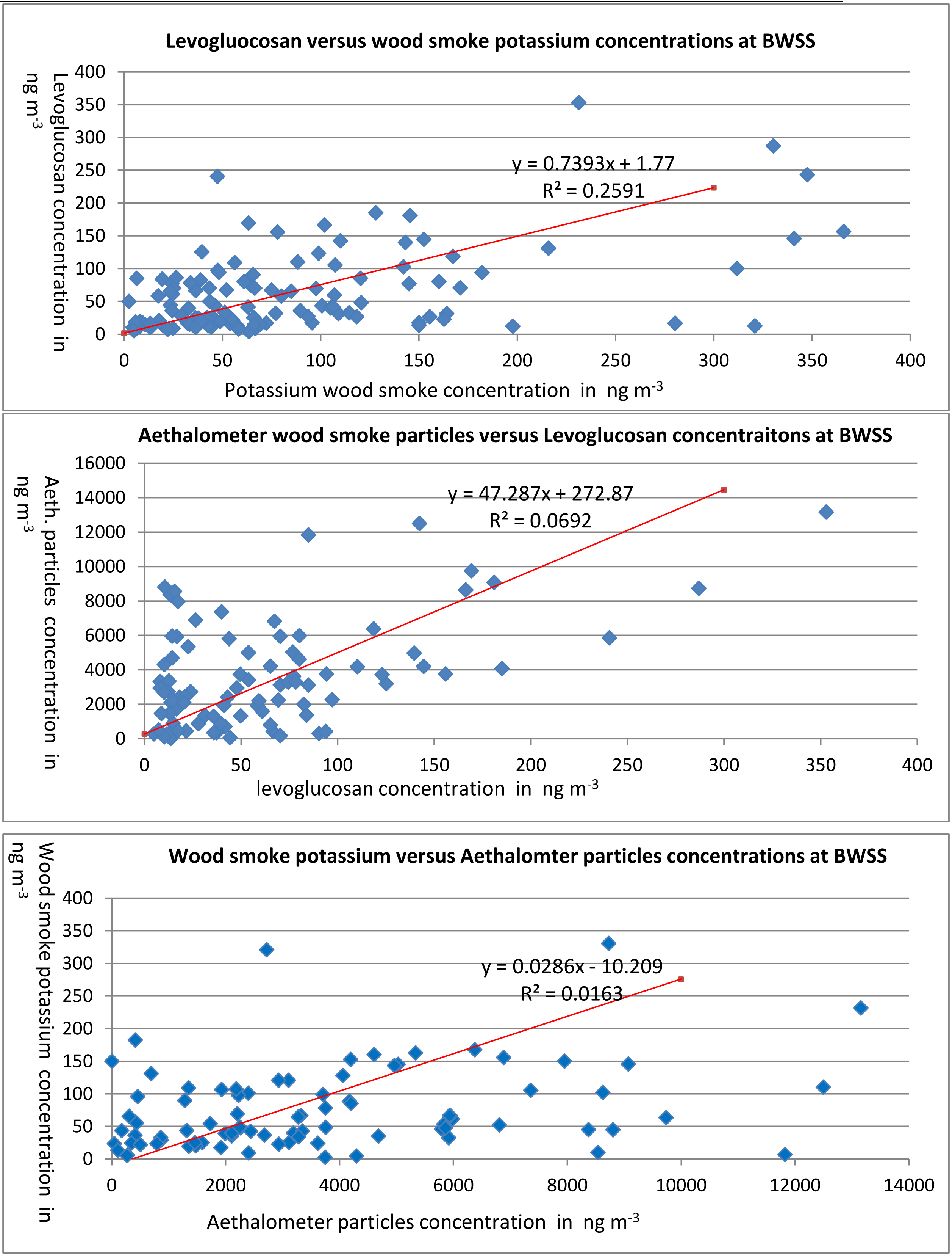
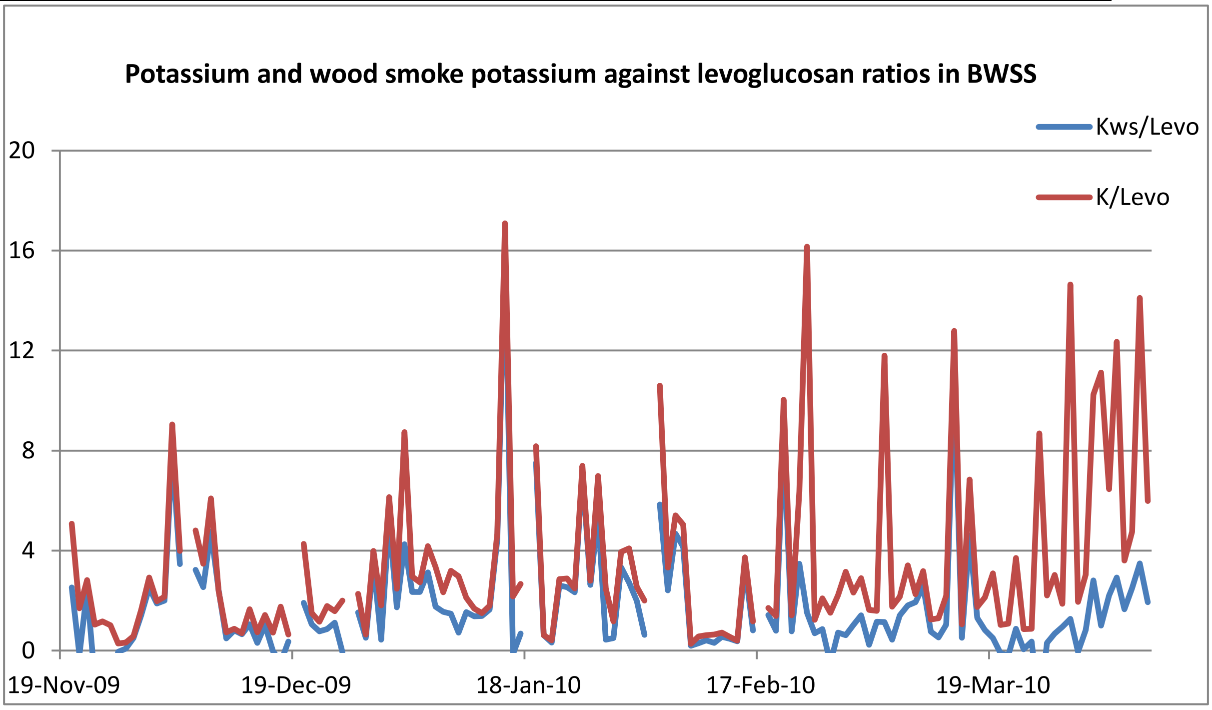


Figure 6.5 Inter-comparison ratios between wood smoke potassium, levoglucosan and Aethalometer wood smoke particles at BWSS site. The red line is the linear regression using the RMA technique.

Figure 6.5 is the inter-comparison ratios among wood smoke potassium, levoglucosan and Aethalometer wood smoke particles. Because all three groups of datasets are uncertain about the true value, the Reduced Major Axis (RMA) regression is introduced to plot those datasets which has uncertainty values. RMA is much more appropriate than normal standard least squares regression to analyze the dataset when the independent variable x is measured with error (Sokal and Biometry, 1981). McArdle (McArdle, 1988) suggested RMA technique should be used to analyze the dataset when error rate in x exceeds one-third of the error rate in y. Wood smoke potassium and levoglucosan have the correlation coefficient of R^2=0.2591. At this study water-soluble wood smoke potassium was found in higher concentrations than levoglucosan. Both wood smoke potassium and levoglucosan have very low correlation coefficient ratio to Aethalometer wood smoke particles (R^2= 0.0692 and R^2= 0.0163). Compared with wood smoke potassium and levoglucosan concentrations, the Aethalometer wood smoke PM mass have very high concentrations. Even by considered the conversion factor of levoglucosan and wood smoke potassium to woods smoke mass as nearly 10 (Schmidl et al., 2008), the Aethalometer wood smoke PM mass were still nearly 4.5 time greater than wood smoke potassium and levoglucosan PM mass.



(a)

BWSS	Kws/Levo			K/Levo		
	Min	Average	Max	Min	Average	Max
Nov-09	0.077	1.576	2.523	0.282	1.686	5.071
Dec-09	0.315	1.996	7.975	0.636	2.508	9.044
Jan-10	0.317	2.922	16.013	0.412	3.752	17.090
Feb-10	0.198	1.837	8.585	0.266	3.263	16.157
Mar-10	0.051	1.461	10.937	0.867	3.495	14.639
Apr-10	0.998	2.313	3.491	3.600	8.574	14.101
average	0.326	2.017	8.254	1.011	3.880	12.684

(b)

Figure 6.6 Potassium and wood smoke potassium versus levoglucosan ratios

Figure 6.6 shows the potassium/levoglucosan and wood smoke potassium/levoglucosan ratios. Those ratios are quite variable from month to month. Potassium/levoglucosan mean ratios varied from 1.60 to 8.57 from winter to spring periods, with a range of 0.267 to 17.09 in winter season and 0.86 to 14.64 in spring periods. Wood smoke potassium/levoglucosan mean ratios varied from 0.50 to 2.81 in sampling periods, with a range of 0.077 to 16.01 in winter periods and 0.051 to 10.94 in spring periods. Because of those wide ranges of potassium and levoglucosan behaviors, different seasons and different wood smoke combustion conditions, wood smoke potassium versus levoglucosan is not necessarily well correlated.

A study (Puxbaum et al., 2007) reported that the different potassium/levoglucosan ratios represent different local combustion types: the ratio below 0.2 represent wood combustion in fire places and oven, 0.2 – 0.5 represent open fires. In other words this ratio below 0.2 indicates the local heating with wood; 0.2 to 0.5 indicates the local open fires.

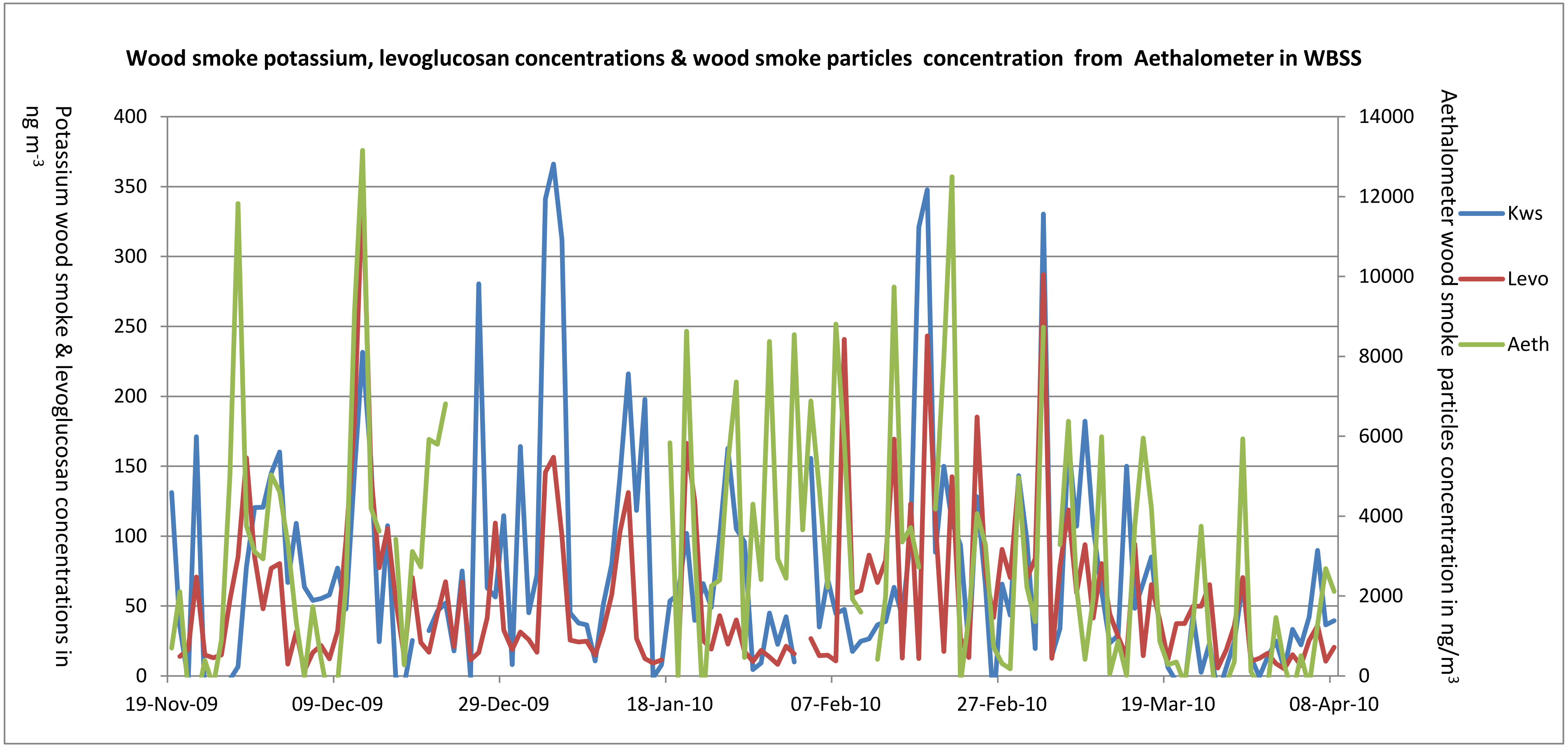


Figure 6.7 Wood smoke potassium, levoglucosan and Aethalometer wood smoke particles concentrations at BWSS

Figure 6.7 represents the wood smoke potassium, levoglucosan, and Aethalometer wood smoke particles concentrations at BWSS. Some of the peaks were measured on the same day which indicates that the local wood smoke was dominant in the sampling area. Especially the open fire sources combusting waste wood has released great amount of wood tracer levoglucosan and potassium, thus all three measurement methods can detect huge peaks. The November, December and January average concentration for wood smoke potassium, levoglucosan and Aethalometer wood smoke particles were 83ng m^{-3}, 54ng m^{-3} and 3363ng m^{-3}, respectively. The February, March and April average concentration for wood smoke potassium, levoglucosan and Aethalometer wood smoke particles were 66ng m^{-3}, 60ng m^{-3} and 2733ng m^{-3}, respectively.

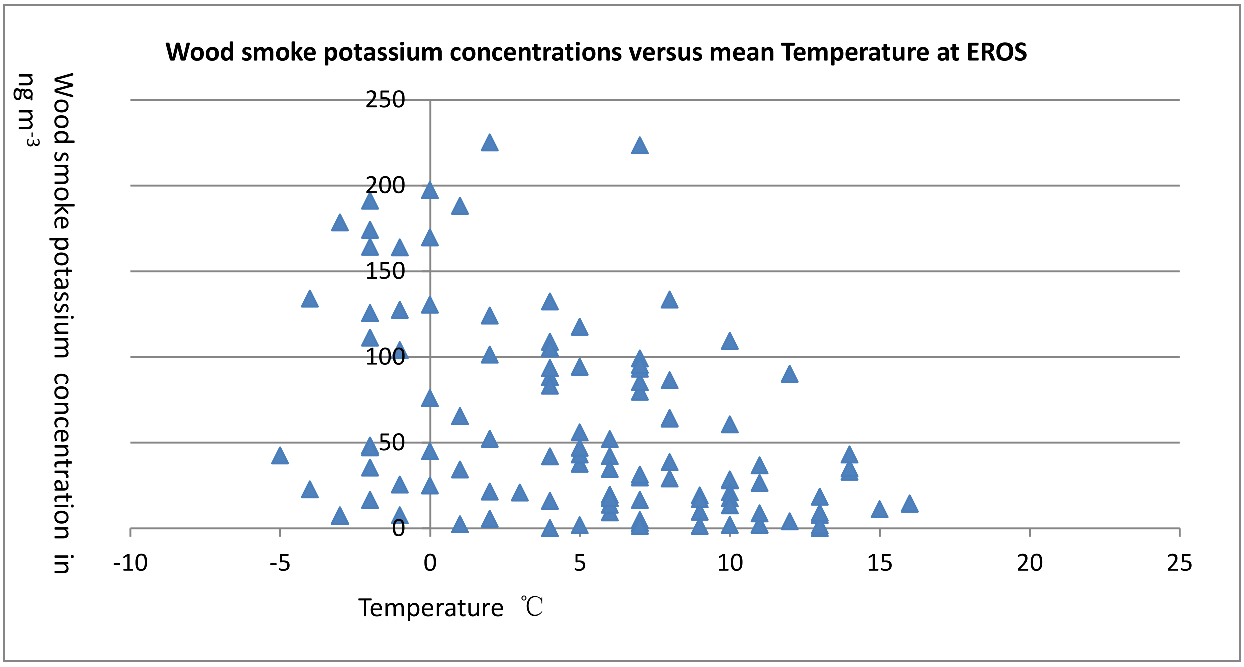
6.2.2.2 EROS site

The atmosphere condition at EROS site was totally different compared with that at BWSS site. The local houses are based on gas heating system therefore they will not release any of the wood smoke tracer potassium and levoglucosan. However, there was a wood fuel burning activity happened once every two month located, at 200 meters from the north of the sampling location. Besides that no regular wood fuel burning activities were detected at EROS.

Figure 6.8 shows wood smoke potassium and levoglucosan versus local temperature at EROS. The higher wood smoke potassium concentrations were measured between -2℃ and 7℃, and the highest peak 225ng m^{-3} and 223ng m^{-3} were measured in 2 ℃ and 7℃. The high levoglucosan concentrations were measured between 0℃ and 4℃, and the highest peak 98ng m^{-3} was measured at 0℃.

Figure 6.9 is the dataset for wood smoke potassium and levoglucosan versus local wind speed. The peak area for wood smoke potassium is between 6 and 14 km h^{-1}, and the highest concentrations of 225ng m^{-3} and 223ng m^{-3} were measured at 11 km h^{-1} together. The higher levoglucosan concentrations were in 10 km h^{-1} to 16 km h^{-1}, and the highest levoglucosan concentration 98ng m^{-3} was measured at 10 km h^{-1}.

Figure 6.10 is the pollution roses for wood smoke potassium and levoglucosan concentrations at EROS. The concentrations peaks are randomly distributed as expected because there were no obvious wood smoke sources in this sampling location, therefore the wood smoke potassium were mainly from long-range transportation, so does levoglucosan concentrations.



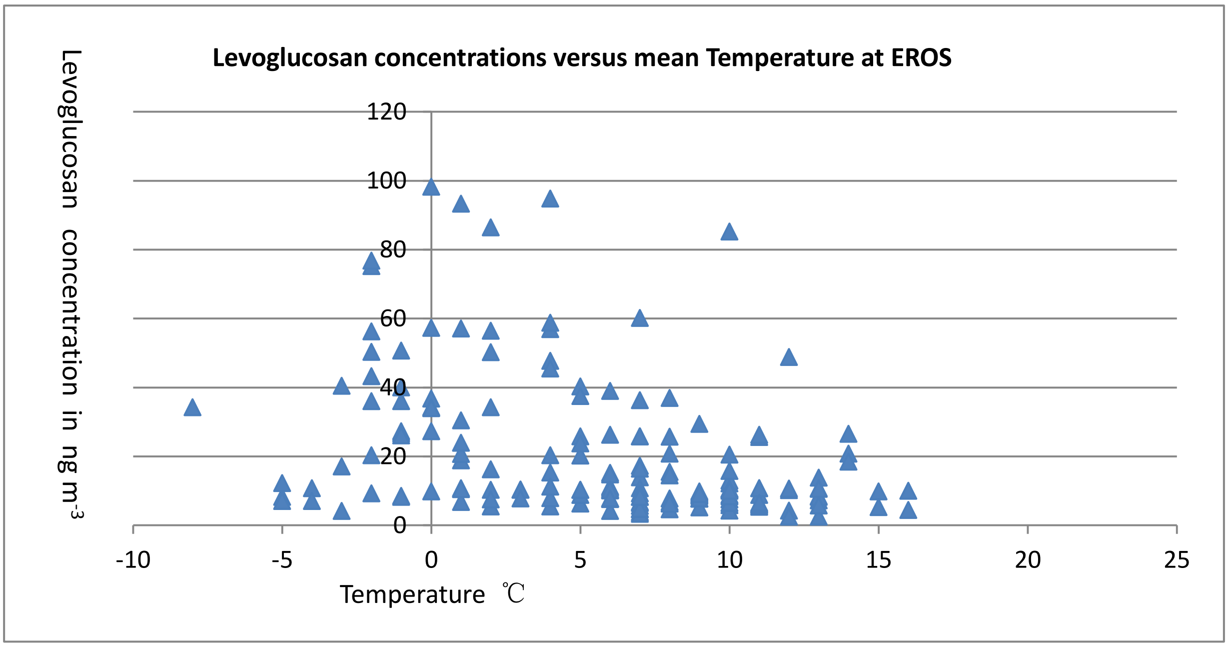
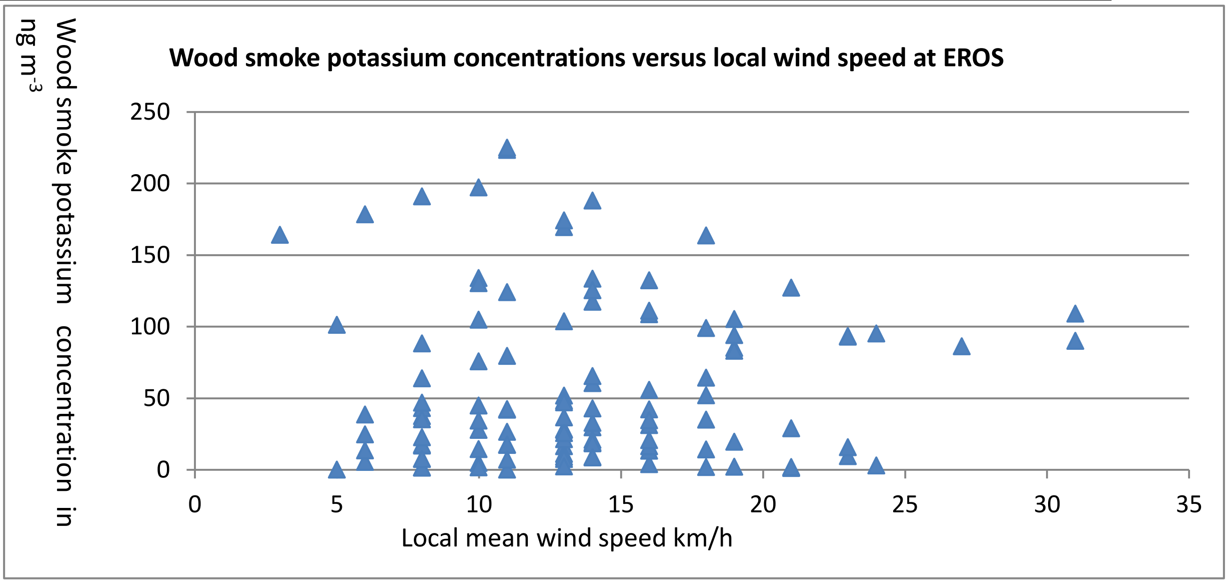


Figure 6.8 Wood smoke potassium & levoglucosan versus local Temperature



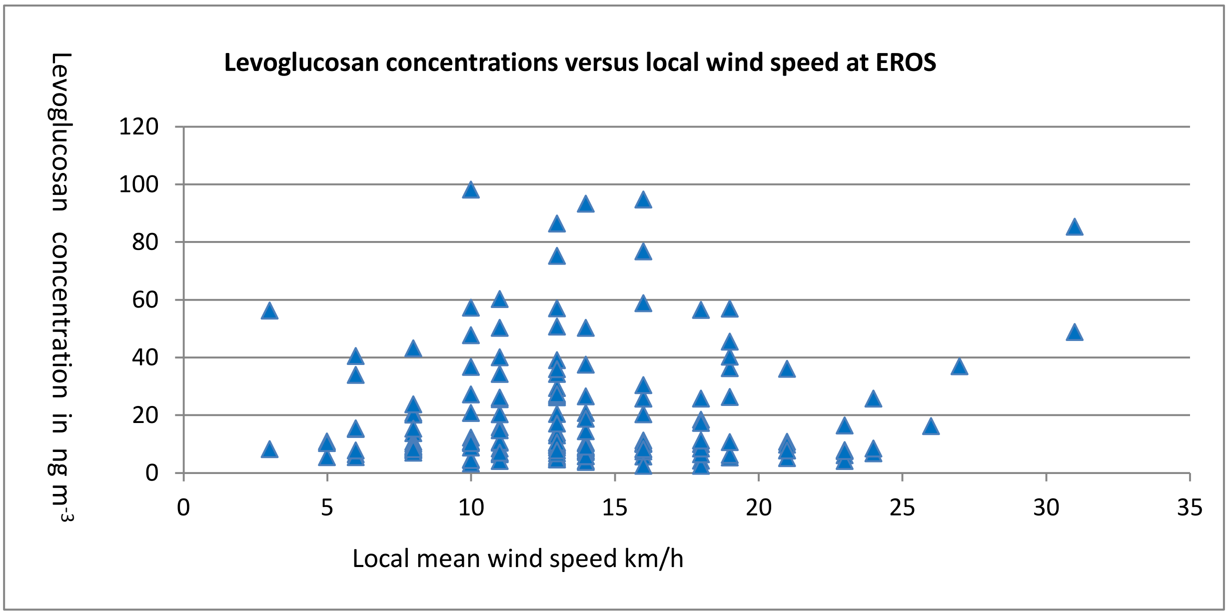
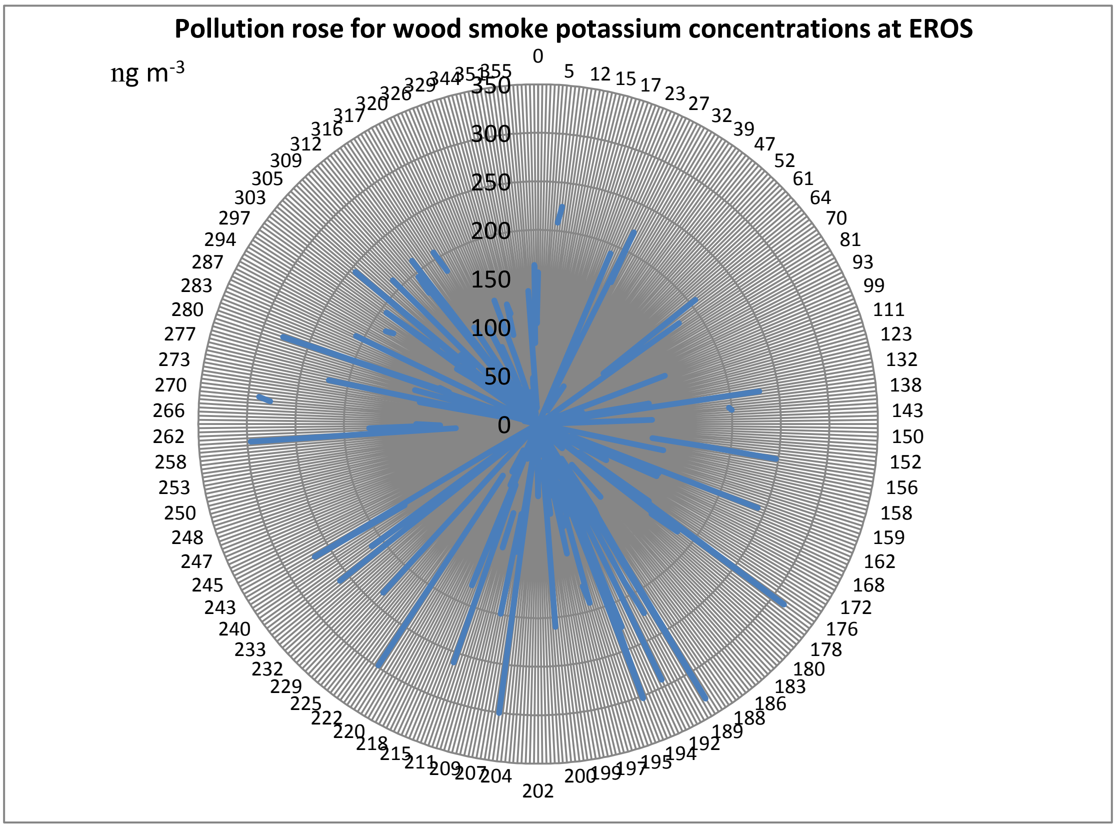


Figure 6.9 Wood smoke potassium & levoglucosan versus local wind speed



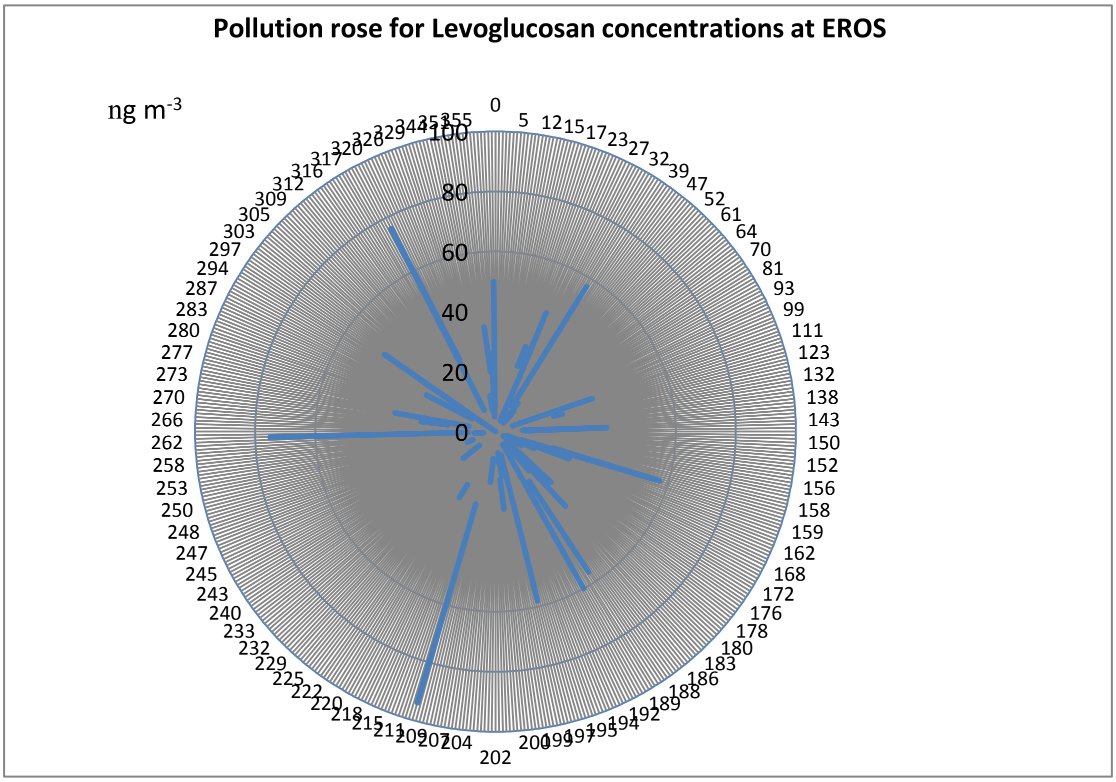
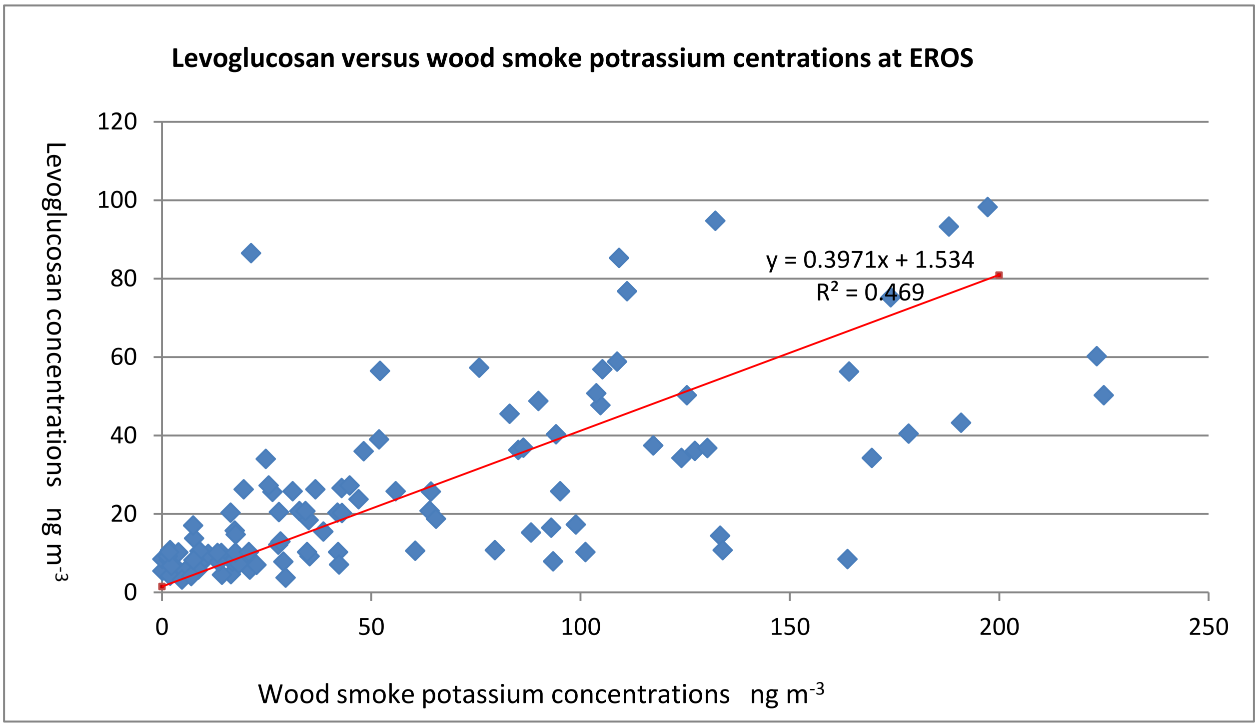
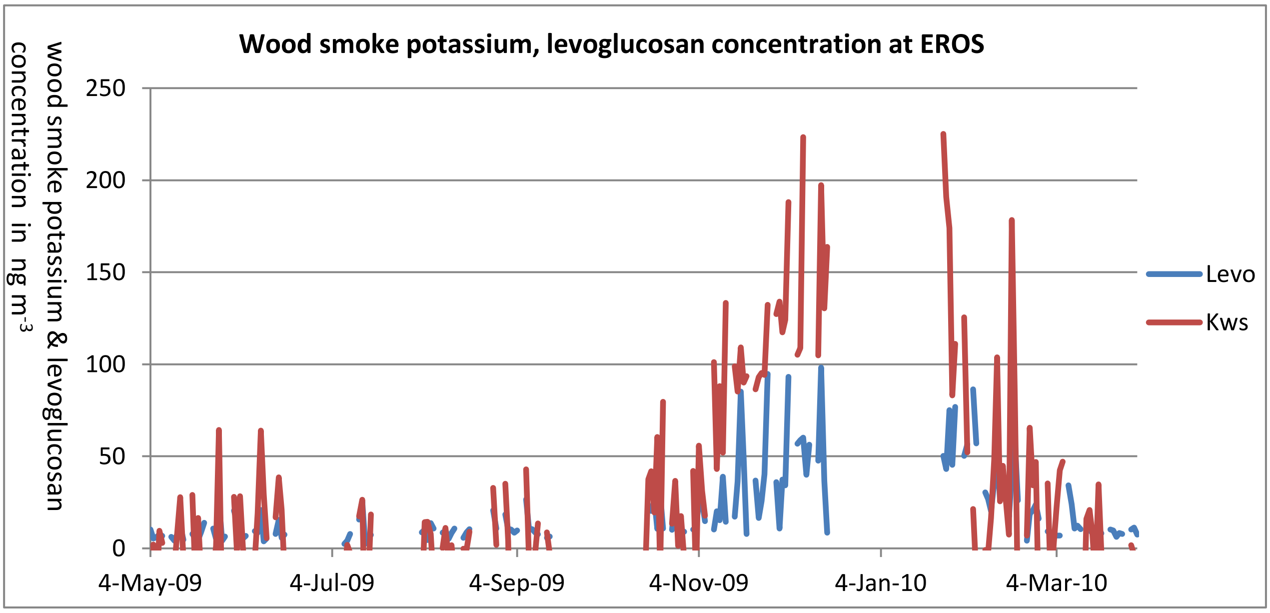


Figure 6.10 Pollution roses for wood smoke potassium and levoglucosan concentrations at EROS



(a)



(b)

Figure 6.11 Wood smoke potassium concentrations versus levoglucosan concentrations results, the red line in figure (a) is the linear regression achieved by RMA technique.

In Figure 6.11, the wood smoke level at EROS was much lower compared with that at BWSS site, the summer (May, June, July, August, September and October) average wood smoke potassium and levoglucosan concentrations were nearly 3ng m^{-3} and 9ng m^{-3}, respectively. The winter (November, December, January, February, March and April) average wood smoke potassium and levoglucosan concentrations were 61ng m^{-3} and 29ng m^{-3}, respectively. These results were much lower than the BWSS winter campaign results, which were 75ng m^{-3} and 57ng m^{-3}, respectively.

The levoglucosan versus wood smoke potassium ratio (0.397) is also lower than that measured at BWSS site (0.739 in Figure 6.5). The local conditions might result in these differentiations: No obvious wood fuel sources at EROS site thus the wood smoke potassium and levoglucosan were mainly from long range transport; the different wood fuels will cause significantly ranges of results, some of the fuels like duff and needle emit very little water soluble potassium and fuel like coal will not release levoglucosan (Sullivan et al., 2008).

6.3 Wood smoke potassium, levoglucosan to wood smoke Conversion factors

One of the main purposes of measuring wood smoke tracer potassium and levoglucosan is to quantify the local wood smoke concentrations. Therefore it is very important to discuss the conversion factors to shift those tracers' concentrations to real atmosphere wood smoke concentrations.

A suitable composite factor can be calculated as follow:

$F_w = 100/\{c_{beech} \times 4.1 + c_{oak} \times 13.3 + c_{spruce} \times 10.7 + c_{larch} \times 15.1 + c_{briquettes} \times 10.1\}$ (Schmidl et al., 2008) 6.1

Where:

F_w represents the conversion factor from levoglucosan to wood smoke concentrations

c represents the relative contribution of wood types

The Fw ranges from 6.6 to 24.4 depending on the tree types.

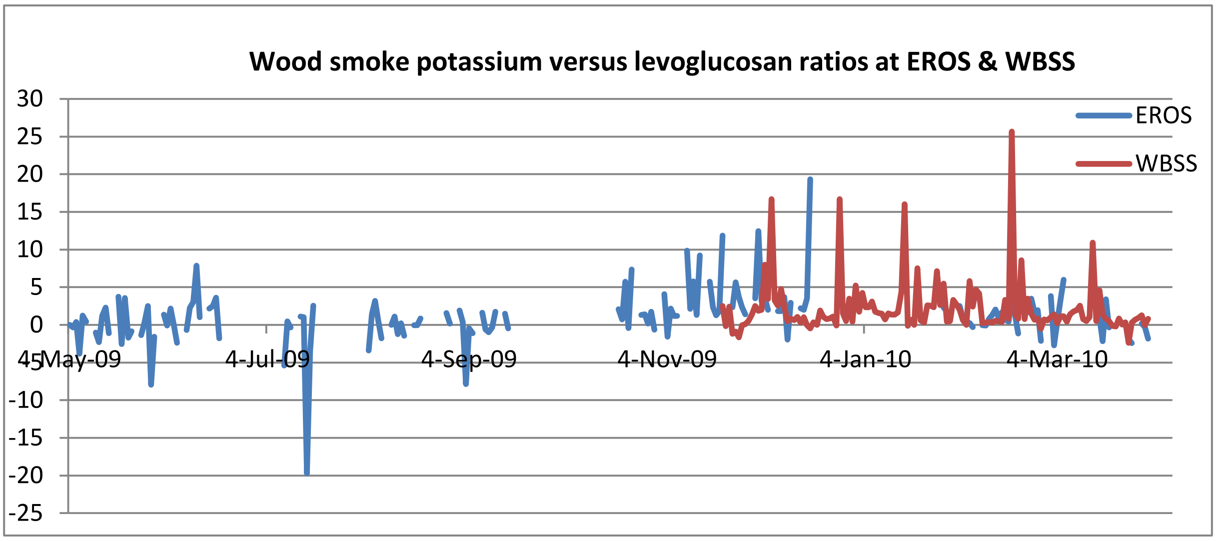
At the BWSS sampling site, the wood fuel is a combination of 60% hardwood and 40% softwood as well as the open fire for waste wood combustion. The wood burnt at BWSS can be integrated to the relative numbers for timber felled in UK trees to each of the softwood and hardwood. Then 10% of the wood burned was assumed in the form of briquettes as softwood. This combination of tree types of beech/oak/spruce/larch/briquette is 30/30/25/5/10%. Applying above equation 6.1, the result for F_w factor is 10.4.

In literature (Schmidl et al., 2008), the sensitivity study also give reasonable European F_w factor results of 10.7 and 11.2 based on the wood fuel type in Austria. This result is also very close to the estimation 10.4. According to the Table 6.1, the levoglucosan/OC ratio in this study was very close to fir combustion levoglucosan/OC ratio in laboratory condition, and fir is close to spruce type. Therefore 10.7 might be eligible as BWSS wood smoke conversion factor.

Based on the above, wood smoke particles concentrations = 10.7 × levoglucosan concentrations can be adopted as the levoglucosan mass to wood smoke mass conversion factor at BWSS local site.

It is very difficult to determine the conversion factor at EROS site because the wood smoke masses were mainly from long range transportation, thus the conversion factor is not eligible in this site. The conversion factor can only be determined if the wood smoke is from local source.

Figure 6.12 compares wood smoke potassium versus levoglucosan ratios and potassium versus levoglucosan ratios. At EROS higher wood smoke potassium versus levoglucosan ratios were observed in cold periods. And at BWSS the ratios in most periods were lower during winter periods. This lower ratio indicates that the wood smoke potassium and levoglucosan were from the same sources at BWSS. Because wood smoke potassium and levoglucosan have different sensitivities to long range transport conditions (wind speed, humidity and transport attitude level), wood smoke potassium and levoglucosan would have different concentrations when wood is not dominant fuel in local area. Therefore, the wood smoke potassium/levoglucosan ratios from EROS site are larger than that of BWSS site. The huge peaks from wood smoke potassium versus levoglucosan ratios at BWSS probably because of the open combustions process. In this process huge potassium and levoglucosan particles were released but levoglucosan might be decomposed during high temperature combustion. Therefore the huge peaks of wood smoke potassium versus levoglucosan ratios were measured several times in winter periods. At EROS site, the combustion conditions are not the same as that at BWSS site. The wood smoke particles were probably from wood burning stoves rather than open combustions, thus the wood smoke potassium versus levoglucosan ratios can mainly be maintained at a lower level.



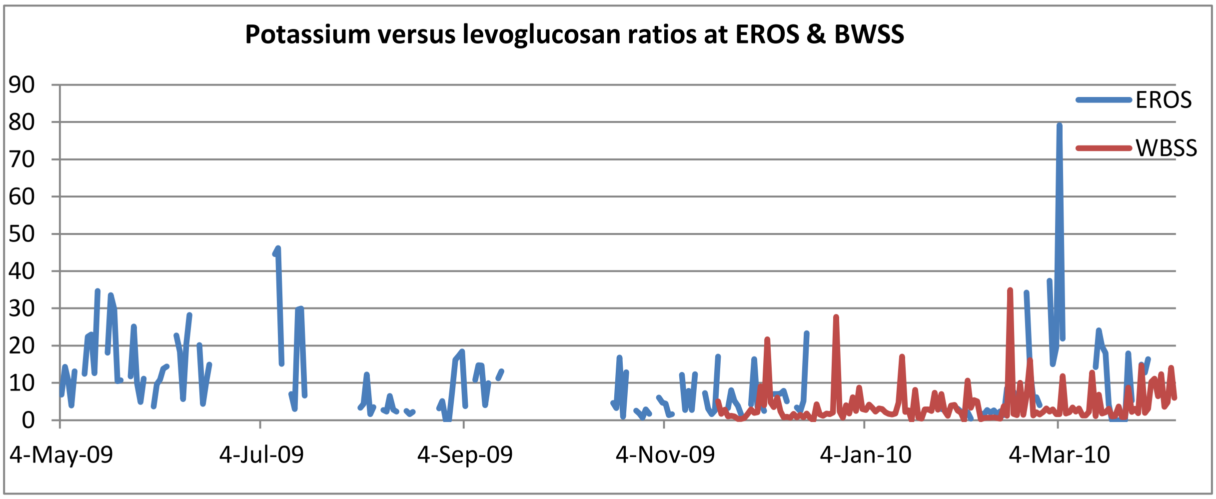
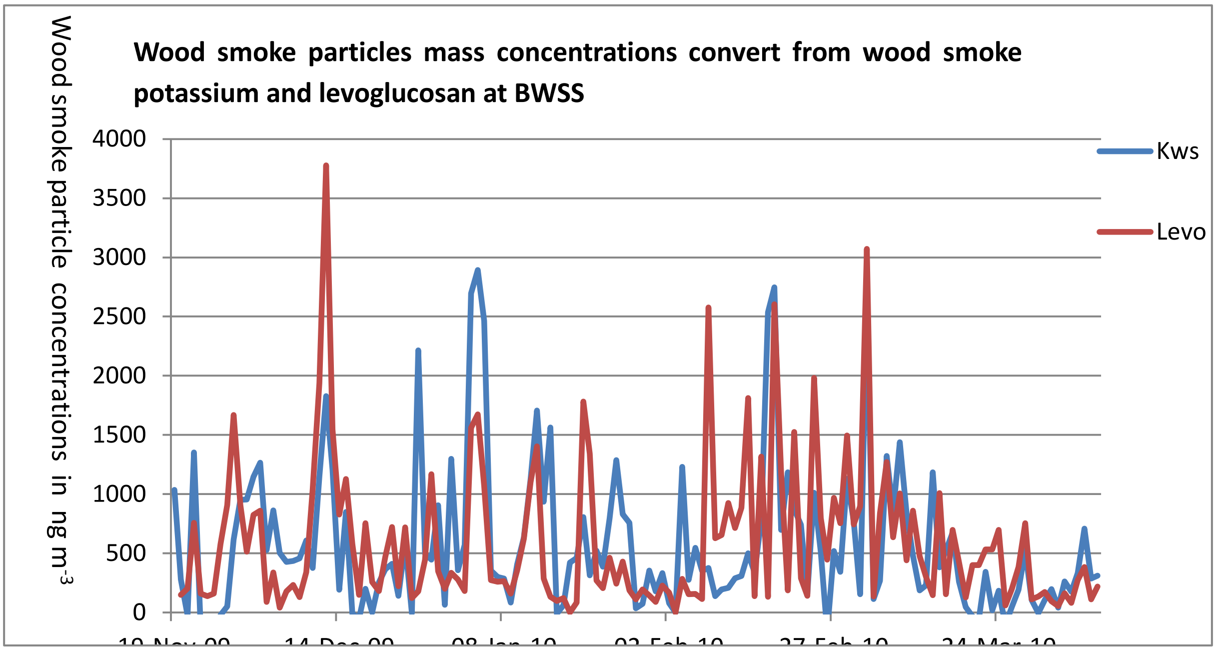


Figure 6.12 Wood smoke potassium versus levoglucosan and potassium versus levoglucosan ratios

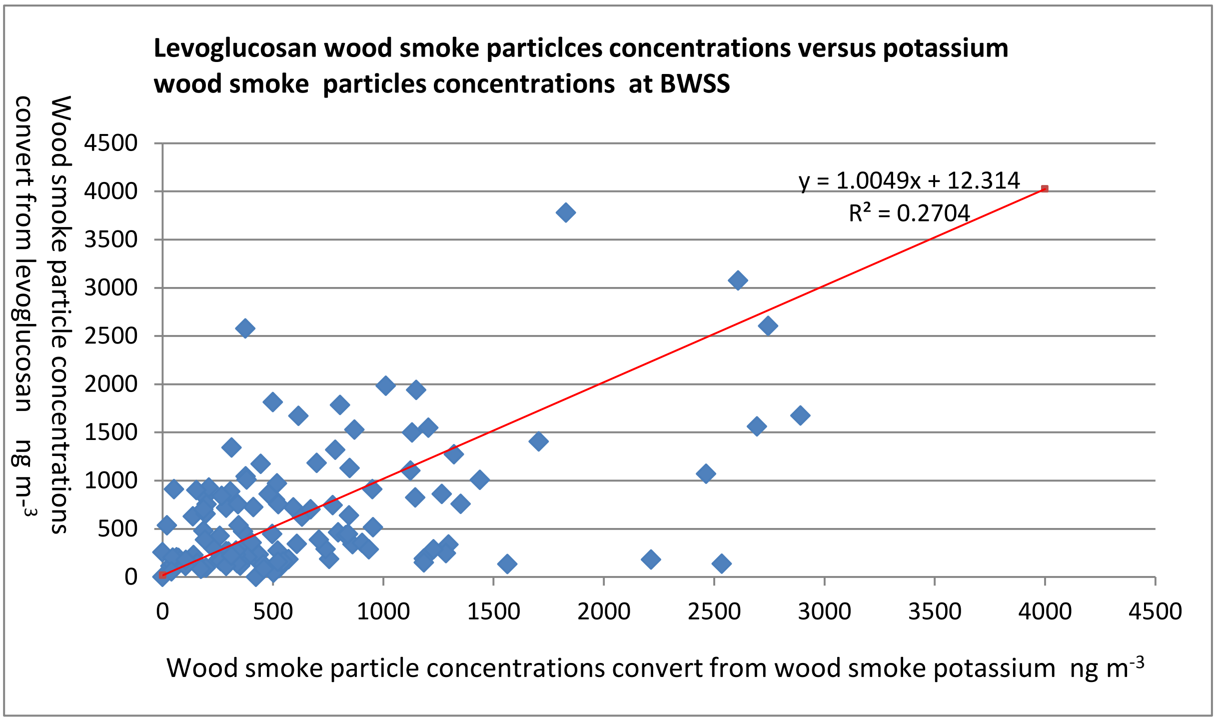
The wood smoke particles concentrations convert from levoglucosan should be equivalent to wood smoke particles concentration converted from wood smoke potassium. The dataset applied was based on BWSS because the sampling results were mainly corresponding to local wood smoke conditions. The long range wood smoke transportation would have limited effect compared with the locally huge amount of wood smoke released. The huge amount of wood smoke potassium with the small amount of levoglucosan indicates that the wood smoke might be transported to EROS from somewhere else. When calculate the conversion factors, the result for EROS site will not as accurate as that for BWSS site.

6.4 Wood smoke mass concentrations at BWSS

When the levoglucosan conversion factor is 10.7, the wood smoke potassium will have a corresponding conversion factor, which in this study is 7.9. This figure is calculated by the RMA method to plot the wood smoke particles from levoglucosan against the wood smoke potassium(Figure 6.13b). Therefore the wood smoke particles concentration from levoglucosan and wood smoke potassium is equal to nearly 1. Figure 6.13 is the dataset presenting both wood smoke particle concentrations convert from levoglucosan and wood smoke potassium in BWSS. The highest wood smoke particles concentration of 3777ng m^{-3} is converted from levoglucosan in December 2009, while the correlated wood smoke concentrations for that day converted from wood smoke potassium is 1828ng m^{-3}. The highest wood smoke concentrations converted from wood smoke potassium is 2893ng m^{-3} in January 2010, while the correlated wood smoke concentration for that day converted from levoglucosan is 1673ng m^{-3}.



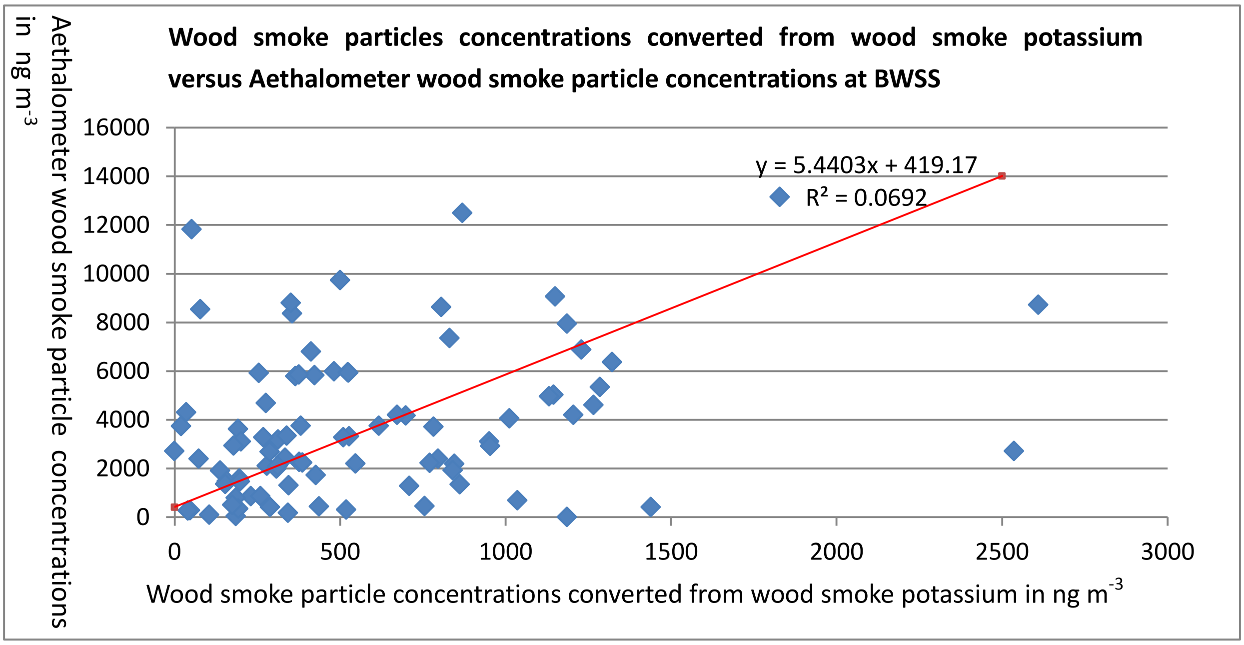
(a)



(b)

Figure 6.13 Wood smoke particles converted from levoglucosan and wood smoke potassium concentrations, the red line in (b) is based on RMA linear regression.

If the aethalometer is also measuring the wood smoke particles concentration, the measurement results for aethalometer wood smoke particles should equal to wood smoke particle concentrations from both levoglucosan and wood smoke potassium measurement methods. But in fact, the aethalometer wood smoke particles have much higher concentrations than wood smoke particles concentrations converted from wood smoke potassium and levoglucosan(Figure 6.14).



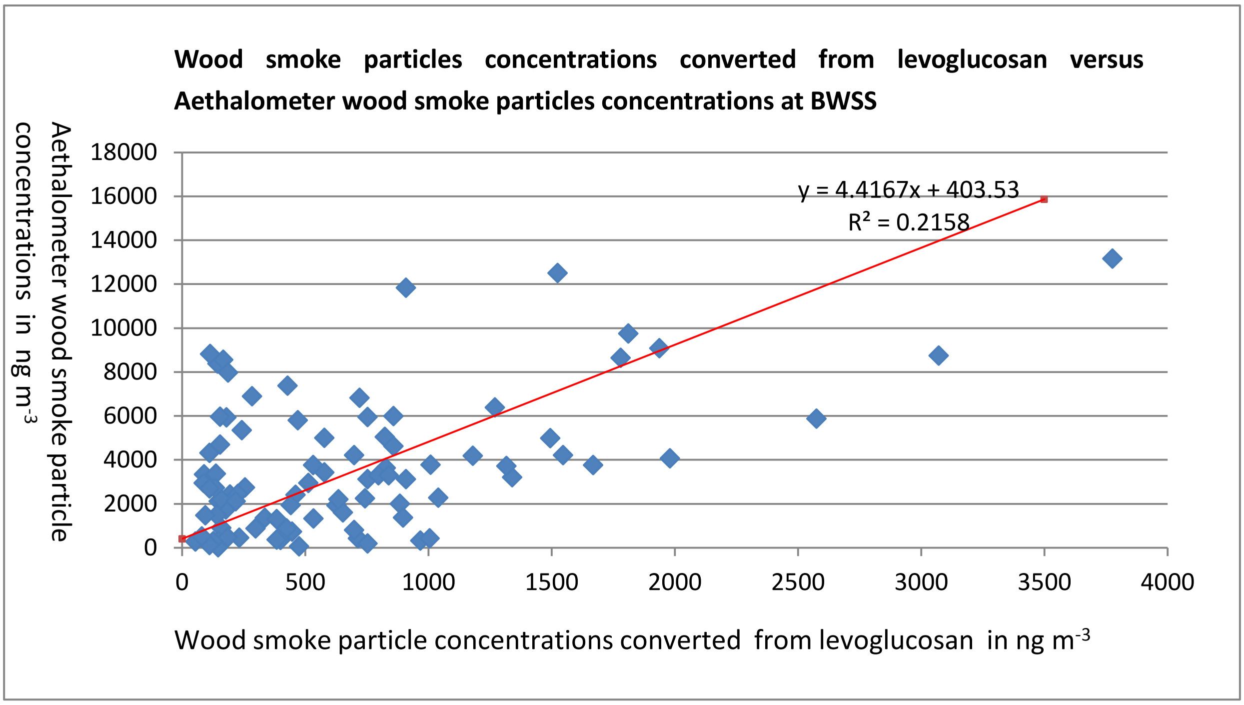


Figure 6.14 Wood smoke particles concentrations converted from wood smoke potassium and levoglucosan versus Aethalometer wood smoke particles concentrations, the red line represents the linear regression using RMA technique.

Figure 6.14 shows that the aethalometer measured 5.4 times and 4.4 times more particles concentration than wood smoke particles concentrations converted from wood smoke potassium. This huge difference might come from both aethalometer measurement method and levoglucosan, wood smoke particles measurement methods. There might be some other carbonaceous sources rather than wood smoke in this sampling area which cause this result. These unknown sources make the aethalometer is not suitable to sampling in this location. The disadvantage of the aethalometer measurement method is it has to be applied in the areas where wood smoke aerosol and traffic aerosol is the only sources. The measurement methods of levoglucosan and wood smoke potassium also have disadvantages: although levoglucosan measurement is well developed in the experiment measurement, but the organic compound quantification process has huge residual than inorganic compound/element quantification process. In this study it is about 5.2% uncertainty of quantifying levoglucosan, this uncertainty is very close to the Kings College's methodology which is about 5%. Also a conversion factor from levoglucosan to wood smoke particles is very difficult to determine because of the various tree types and combustion conditions. The wood smoke potassium has less residual in laboratory measurement, but the determination of the potassium from wood smoke only is very difficult, and the measurement of soil potassium has very huge uncertainty, which contributes about 10% uncertainty to the wood smoke potassium quantification experimental errors. By add the 5.8% uncertainty of measuring $PM_{2.5}$ water soluble potassium, the uncertainty of quantifying the wood smoke potassium is about 11.6%. The conversion factor is also hard to distinguish because of the various tree types and the combustion conditions. In BWSS is estimated to be 10.7 but it is variable depends on the locations. All in all, the levoglucosan can be the best method for local wood smoke measurement because of the mature experimental quantification methodology; Multi-wavelength aethalometer black carbon measurement can be the best methodology only if there are only traffic and wood smoke pollutant in the sampling area, but this condition is very difficult to reach because the long range transport effect sometimes influence the local condition a lot; the wood smoke potassium measurement is less accurate(about 11.6% uncertainty, sometimes even larger if the local condition has changed, the local soil has exposed to the air and no glass or tree can hold the soil so that it can be easy to transport by the wind), but it can still be used to examine and compare with other wood smoke quantification.

Chapter 7
Summary and Conclusions

7.1 Introduction

Daily $PM_{2.5}$ inorganic water soluble samples cations (sodium, ammonia, potassium, magnesium and calcium) and anions (chloride, nitrate and sulphate) were measured over the periods from February 2008 to April 2010 at three rural sites (CPSS, NKMOS and BWSS) and one urban (EROS) site. The inorganic water soluble aerosols concentration datasets observed from above four sites were used to examine the temporal, spatial and seasonal variations. Then the potassium which has been subtracted by sea salt and soil source was considered as a wood smoke tracer to estimate wood smoke contribution to the ambient atmosphere. There were two high volume samplers, collecting organic wood smoke tracer levoglucosan, which were sampled over the periods from May 2009 to April 2010 in one urban (EROS) site and one rural (BWSS) site. This organic wood smoke tracer levoglucosan was the factor to achieve wood smoke contribution to ambient atmosphere too. Multi-wavelength Aethalometer was set up in rural (BWSS) site to measure the carbonaceous aerosol in order to achieve local wood smoke aerosol concentrations and local traffic aerosol concentrations. Finally those methods, which use wood smoke potassium, levoglucosan as tracers and use Aethalometer to measure the local wood smoke concentrations, have been inter-compared with each other in order to obtain the best method of measuring local wood smoke contribution to ambient atmosphere.

7.2 Temporal and seasonal variations in atmospheric inorganic water soluble ions concentrations

Water soluble inorganic ions have been measured during summer 2008 and spring 2010 at four sampling sites: EROS, CPSS, NKMOS and BWSS. The temporal variations were much greater than the spatial variations. The higher sodium, ammonium, potassium, nitrate and sulphate concentrations were measured in the winter periods and lower sodium concentrations were measured in the summer. The magnesium concentration was maintained at a very low level below 0.2µg m^{-3}, except in June 2008 and October 2009, which have two large concentration peaks of 0.34µg m^{-3} and 0.42µg m^{-3}, respectively. Calcium concentrations were also maintained at a very low level, mostly below 0.3µg m^{-3} at EROS, CPSS and NKMOS. However at BWSS, the calcium concentration has very huge peaks of about 0.8µg m^{-3} to 0.9µg m^{-3}, with an average of 0.19µg m^{-3} during November 2009 and April 2010. Chloride has a higher mean value of 1.5µg m^{-3} from October 2008 to February 2009 but lower concentration mean value of 0.72µg m^{-3} at EROS. The average value of chloride at BWSS was 0.47µg m^{-3}. The inorganic water soluble ions concentrations for the whole sampling periods at four sampling sites are summarized in Table 7.1.

Sites	µg m^{-3}	Na	NH4	K	Mg	Ca	Cl	NO3	SO4
EROS	N	436	436	436	436	436	414	407	407
	Max	1.633	5.897	0.558	0.412	0.644	6.68	10.542	12.096
	Average	0.476	1.038	0.124	0.056	0.08	1.129	1.315	2.106
	Min	0.011	0.047	0.006	0.001	0.002	0.036	0.006	0.149
	Std	0.345	0.886	0.09	0.048	0.075	0.95	1.4	1.979
BWSS	N	139	139	139	127	127	112	111	112
	Max	1.148	5.897	0.465	0.095	0.928	2.004	13.192	9.936
	Average	0.293	1.416	0.119	0.024	0.191	0.47	2.319	1.445
	Min	0.012	0.004	0.015	0.0003	0.003	0.043	0.125	0.236
	Std	0.243	1.316	0.098	0.022	0.199	0.364	2.094	1.623
NKMOS	N	113	113	113	113	112	113	104	103
	Max	1.511	6.051	0.406	0.067	0.18	2.137	11.768	14.808
	Mean	0.244	1.076	0.047	0.029	0.021	0.419	1.523	2.148
	Min	0.005	0.017	0.0002	0.0001	0.0004	0.007	0.031	0.015
	Std	0.198	1.143	0.063	0.017	0.026	0.31	1.664	2.528
CPSS	N	23	20	23	23	23	23	20	20
	Max	1.067	0.631	0.081	0.016	0.096	1.739	0.756	1.243
	Average	0.25	0.231	0.025	0.004	0.027	0.405	0.361	0.452
	min	0.019	0.01	0.003	0.0003	0.003	0.036	0.008	0.024
	Std	0.286	0.192	0.021	0.004	0.029	0.466	0.25	0.358

Table 7.1 Water soluble inorganic ions concentrations from EROS, BWSS, NKMOS and CPSS.

The water soluble ions chemical balance for potassium/sodium, magnesium/sodium, calcium/sodium, chloride/sodium+magnesium and ammonium/nitrate+sulphate were also measured at each site. Magnesium and sodium coefficient of determination (R^2) was found very high and the correlation ratios were all close to sea salt ratio at all sampling sites. This indicates that all the magnesium was from sea water. The potassium versus sodium correlation ratio and calcium versus sodium correlation ratio at EROS were clear made up with summer and winter datasets. The higher ratio (0.3095) of potassium versus sodium was found in winter and lower ratio (0.1355) in summer, suggesting that the wood smoke potassium was an important source in winter at EROS. The calcium versus sodium showed a converse Phenomenon: higher correlation ratio (0.2691) in summer and lower ratio (0.1781) in winter. At NKMOS and BWSS site, NKMOS was mostly sampling for summer period and BWSS was all sampling for winter period, and therefore the potassium versus sodium correlation ratio was very low (0.2734) at NKMOWS site and very high (0.4032) at BWSS site.

7.3 Wood smoke particles tracers

It is very important to examine the tracers before quantifying the wood smoke mass. Methyl chloride, levoglucosan, potassium, chloride, OC/EC ratio and ^{14}C have been introduced in this study as wood smoke tracers for different measurements. But only levoglucosan and potassium were utilized as tracers for quantifying wood smoke concentration. Quantification processes for potassium and levoglucosan are very different from each other. Potassium, as used as a wood smoke tracer, is estimated by subtraction of soil and sea salt-derived potassium from the total fine potassium concentration. Therefore the measurement has been focusing on both local soil samples and air samples. The sea salt potassium was derived from the total fine sodium multiple constant sodium to potassium sea water ratio.

Because it is impossible to measure the soil potassium from an individual air sample, the local average soil potassium concentration was used in this study instead of the individual soil potassium concentration, and this will result in a moderate uncertainty of wood smoke potassium concentrations. Levoglucosan method needs complicated extraction and equipment for quantification. The important step is derivatization, because the levoglucosan itself has low sensitivity for GC/MS detection. Therefore the derivatization conditions such as temperature, time and time for being waiting for GC/MS analysis are crucial to control in levoglucosan analysis. Better organization of these steps could result in less experimental error for levoglucosan concentration measurement.

7.4 Wood smoke potassium measurement results

Daily potassium measurements have been carried out by Partisol sampler at four sampling sites: EROS, CPSS, NKMOS and BWSS. The potassium measurement results have been subtracted by the local soil potassium mean values and the sea sale potassium. This result can be represented as wood smoke tracer potassium. The highest wood smoke potassium of 408ng m^{-3} has been measured at NKMOS in February 2009, with an average of 33.69ng m^{-3}. The sampling period at NKMOWS was from February 2009 to August 2009. The second highest result was measured at BWSS in January 2010, with an average of 62.35ng m^{-3}. The sampling periods at BWSS was from November 2009 to April 2010. The maxium result measured at EROS site was 341.25ng m^{-3} in February 2009 too, with an average of 58.66ng m^{-3}. The sampling period was from June 2008 to March 2010. CPSS has the lowest results with an maxium concentration of 23.46 ng m^{-3} in March 2009, but the sampling period was only from February 2009 to March 2009. Wood smoke potassium concentration for the whole sampling periods at four sampling sites are summarised in Table 7.2.

Table 7.2 Wood smoke potassium concentrations from EROS, BWSS, NKMOS and CPSS

ng m^{-3}	EROS	BWSS	NKMOS	CPSS
N	436	139	113	23
Max	341.24	353.8	407.95	23.46
Average	58.66	62.35	33.69	5.96
Min	0.097	1.48	0.018	0.54
Std	85.83	77.52	62.58	7.18

The potassium sources are sea salt, soil and wood smoke only. About 75% of total potassium is from wood smoke in winter period at EROS. This rate is almost the same as BWSS site in winter period. At NKMOS site, wood smoke potassium was about 50% of total potassium in winter- spring period. After that, the soil potassium was dominant in this local area in summer period. Probably 60% of the potassium was from soil at this time, but the total amount of potassium was only 1/3 to 1/4 compared to winter potassium concentration level. At CPSS site, the potassium from wood smoke and soil were almost the same, they took part of 80% of total potassium at this site. But because this is an unused/waste land, less human activities were happened here thus the total amount of potassium concentrations was very low. It was only 20ng m^{-3} and 24ng m^{-3} in February 2009 and March 2009, respectively.

7.5 Levoglucosan measurement results

Levoglucosan, mannosan and galactosan are three monosaccharide anhydrides (MA), they are the unique wood smoke tracers due to the fact that they can only be released from wood fuel combustion. Because levoglucosan takes part of 95% of total MA group, this study was only focusing on levoglucosan measurement and analytical process. The levoglucosan concentrations were measured at EROS and BWSS site. The manual high volume sampler was setup at EROS and the automatic high volume sampler was setup at BWSS. The monthly levoglucosan concentrations are summarized in Table 7.3.

Table 7.3 Levoglucosan monthly concentrations result from EROS and BWSS.

	EROS						BWSS				
ng m^{-3}	Max	Average	Min	Stdev	N	ng m^{-3}	Max	Average	Min	Stdev	N
May-09	25.73	8.22	4.16	4.93	20	May-09					
Jun-09	20.79	10.38	3.77	5.62	14	Jun-09					
Jul-09	25.58	8.36	2.44	7.66	9	Jul-09					
Aug-09	20.75	10.34	4.48	4.32	16	Aug-09					
Sep-09	26.58	10.47	5.79	5.59	11	Sep-09					
Oct-09	29.46	15.16	4.71	8.66	11	Oct-09					
Nov-09	94.76	30.13	7.88	23.15	21	Nov-09	156.00	52.25	13.00	44.89	11
Dec-09	98.24	49.17	8.48	26.47	13	Dec-09	353.00	60.74	3.81	68.99	31
Jan-10	76.79	54.20	34.28	17.67	6	Jan-10	166.47	47.93	7.76	50.05	30
Feb-10	86.46	34.63	4.13	19.14	21	Feb-10	243.26	75.34	10.72	69.17	27
Mar-10	34.26	10.71	6.27	6.22	23	Mar-10	287.12	57.64	5.55	54.48	31
Apr-10						Apr-10	35.99	16.14	5.10	10.56	8

Much higher results were measured at BWSS than EROS, with an average of 58.78ng m^{-3} and 21.98ng m^{-3} at those two sites. The highest concentration value of 353ng m^{-3} was measured at December 2009 at BWSS site. There was no obvious fire source at EROS site so the maximum levoglucosan concentration was only 98ng m^{-3} in December 2009. In summer period the levoglucosan concentrations were maintained at a very reasonable lower level at EROS site. Also according to the April 2010 result at BWSS site, the summer period at BWSS site should also has a lower concentration values.

7.6 Multi-wavelength Aethalometer results

A Multi-wavelength Aethalometer (λ = 370, 470, 520, 590, 660, 880 and 950 nm) was set up at BWSS site from November 2009 to April 2010 to measure the wood smoke particulate matter and traffic particulate matter. Because of the complicated calculation from original Aethalometer dataset to local PM concentrations, R-cran software was utilized as shifting tool to estimate the local wood smoke PM and traffic PM levels. The computer code for R-cran was developed by Dr. David Beddows.

The maximum wood smoke particle mass concentration was measured in February

2009 with the whole sampling period average concentration of 2.5294μg m^{-3}. The Maximum traffic PM was measured in December 2009 with the whole sampling period average concentration of 1.7112μg m^{-3}. The local wood smoke PM and traffic PM observed at BWSS were summarized in Table 7.4.

Table 7.4 Wood smoke PM and traffic PM monthly concentrations at BWSS

BWSS	μg m^{-3}	Max	Average	Min	Std	N
PM Wood smoke	9-Nov	11.83	3.27	-0.66	3.4	9
	9-Dec	13.16	2.54	-7.61	4.37	18
	10-Jan	8.63	3.76	-0.79	3.02	12
	10-Feb	12.5	3.51	-2.59	3.6	25
	10-Mar	8.73	2.07	-0.88	2.54	25
	10-Apr	1.11	1.11	-0.89	1.58	16
PM traffic	9-Nov	3.19	1.59	-0.34	0.85	9
	9-Dec	8.96	2.28	0	2.12	18
	10-Jan	5.71	2.52	0.63	1.45	12
	10-Feb	4.94	1.92	0.38	1.02	25
	10-Mar	4.94	1.34	0.49	0.94	25
	10-Apr	1.37	1.37	0.26	0.76	16

7.7 Three methodologies inter-comparison results

Wood smoke potassium and levoglucosan were utilized as wood smoke tracers for identification and quantification of the local wood smoke concentrations. Multi-wavelength Aethalometer was also used as a local wood smoke mass measurement equipment. Those three methodologies can all measure the wood smoke concentrations in different manners. The advantage of wood smoke potassium measurement is that the experimental analytical procedure is very easy. The atmospheric water soluble potassium concentrations deducted by the local soil potassium concentrations and sea salt potassium represent the potassium from wood smoke only. Because the soil potassium from individual air sample is very difficult to measure, the mean soil potassium value was used as individual potassium concentrations from soil. This can greatly influence the final wood smoke potassium concentrations. The levoglucosan measurement method has a very complicated extraction and experimental measurement process, but the measurement result is much more accurate than wood smoke potassium measurement. The principle of Aethalometer measurement method is that by measuring the light absorption to obtain different carbon aerosol values and then uses these values to distinguish the carbon from wood smoke and traffic source. But there are always some unknown carbon sources rather than wood smoke and traffic aerosols so the result from Aethalometer can only be used as a background reference value for local wood smoke and traffic aerosol guide lines.

BWSS site have all three kind of sampling equipments therefore the wood smoke tracer inter-comparison was mainly focus on the dataset from BWSS site. Slightly higher correlation ratios between levoglucosan and OC concentrations (R^2=0.4690) was measured at BWSS site, follow by wood smoke potassium to OC (R^2=0.3421) and Aethalometer wood smoke particles to OC (R^2=0.2531) correlation ratios. This suggesting the local wood fuel was wood rather than grass or coal. Because higher levoglucosan to OC correlation ratios was found in wood and lower ratios was found in duff, grass and coal burning (Sullivan et al., 2008).

Higher wood smoke potassium and levoglucosan concentrations were also be found in a lower temperature conditions at BWSS. This suggests that the local wood fuel is for house-heating purpose. Also a considerable lower wood smoke potassium and levoglucosan concentrations was found in late spring periods at BWSS. This suggesting that there are wood fuel heating and cooking system at BWSS.

Wood smoke conversion factor was also discussed in this chapter and the levoglucosan factor 10.7 was suggested as levoglucosan to wood smoke conversion factor in Birmingham area. The relative wood smoke potassium to wood smoke conversion factor of 7.9 was also suggested. Because those conversion factors were highly correlated with local conditions like combustion condition, wood fuel types and local locations, the application of those factors needs extreme caution.

7.8 Suggestions for future works

Because the limited time and aims, the improvement to any of the statistical and measurement methodologies are still inadequate. However, the research work respect to inorganic, organic aerosol measurements and aethalometer measurements can still provide a fundamental for possible future works.

To better understand the relationship between water soluble ions and wood smoke potassium, wood smoke potassium and levoglucosan, monitoring of these elements, ions and compounds concentrations at the study site is recommended. Furthermore, the sampling location is extremely important for wood smoke measurement. The sampling locations should be in the domestic wood smoke area and background/unused area near this location, also another non-wood smoke area is necessary to be the sampling locations, these three sampling location will build a very good structure for inter-comparisons. The sampling period will also necessary to expand to a complete year for measuring seasonal variations. If those can be done, a complete spatial and temporal diversion can be analyzed to demonstrate the wood smoke variations.

This study was only focusing on the $PM_{2.5}$ fraction because of the limited time. Actually the $PM_{2.5}$ and $PM_{2.5-10}$ can be sampled simultaneously therefore the $PM_{2.5-10}$ daily values can also be analyzed if there is enough time to do that. This study is also less focusing on spatial difference rather than temporal changes. In order to improve this, it is better to setup a better plan to measure all the sampling locations simultaneously during the sampling periods. Site management will also need to be improved by recruiting experienced person and more frequently visited by academic members.

Thus all three kind of sampling equipments will need to be setup at these three sampling location. These should include a Dichotomous Partisol Sampler for measuring wood smoke potassium concentrations; a High Volume Sampler for measuring levoglucosan and OC/EC concentrations and a Multi-wavelength aethalometer for directly measure wood smoke particle and traffic particle concentrations.

Because of the restriction of the usage of aethalometer, the sampling location for wood smoke mass and traffic mass only area is very difficult to locate. But as long as the aethalometer sensitivity studies on other sources have not been developed, this restriction should still need to be treated very carefully. Therefore one of the future studies it to find out the aethalometer sensitivity of measuring other carbons sources rather than wood smoke and traffic. If this study can be successfully carried out, aethalometer can be the best method to quantify the wood smoke or any other local carbon sources.

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Appendix I: Water soluble ions fine fraction concentrations measured at EROS site

	Cencentration in air (µg m^{-3})							
	Na	NH_4	K	Mg	Ca	Cl	NO_3	SO_4
23-Jun-08	0.547	0.559	0.078	0.018	0.130	0.043	0.335	0.480
24-Jun-08	1.155	0.804	0.156	0.335	0.226	2.680	0.459	0.720
25-Jun-08	0.409	0.516	0.078	0.176	0.090	2.173	0.378	0.480
26-Jun-08	0.283	0.455	0.117	0.018	0.094	0.064	0.205	1.440
27-Jun-08	0.239	0.885	0.078	0.061	0.042	0.050	0.459	0.912
28-Jun-08	0.720	0.599	0.118	0.022	0.142	0.107	0.843	0.768
29-Jun-08	0.497	0.649	0.078	0.233	0.058	1.463	0.564	0.528
30-Jun-08	0.451	0.728	0.078	0.034	0.116	0.163	2.796	3.216
1-Jul-08	0.980	0.410	0.117	0.030	0.146	1.037	0.360	1.200
2-Jul-08	0.676	0.505	0.078	0.010	0.082	0.341	0.229	0.336
3-Jul-08	0.527	0.509	0.078	0.014	0.132	0.298	0.403	1.296
4-Jul-08	0.630	0.876	0.117	0.023	0.092	0.206	0.552	1.008
5-Jul-08	0.547	0.559	0.078	0.018	0.116	0.092	0.837	5.328
6-Jul-08	1.155	0.804	0.156	0.070	0.204	1.977	0.583	3.552
7-Jul-08	0.409	0.220	0.078	0.001	0.140	0.774	0.459	2.592
8-Jul-08	0.283	2.592	0.117	0.234	0.064	1.544	2.189	5.280
9-Jul-08	0.239	0.885	0.078	0.118	0.056	1.076	0.601	2.304
10-Jul-08	0.720	3.823	0.124	0.016	0.164	0.295	3.980	12.096
11-Jul-08	0.497	0.441	0.078	0.002	0.060	0.359	2.933	2.496
12-Jul-08	0.451	0.518	0.078	0.106	0.116	2.648	0.211	3.888
13-Jul-08	0.980	0.410	0.117	0.049	0.190	0.884	0.006	1.440
14-Jul-08	0.676	0.927	0.078	0.018	0.034	0.504	0.012	1.968
15-Jul-08	0.527	2.112	0.078	0.013	0.042	0.586	0.006	7.104
16-Jul-08	0.630	1.931	0.117	0.086	0.142	0.472	0.310	6.288
17-Jul-08								
18-Jul-08								
19-Jul-08								
20-Jul-08								
21-Jul-08								
22-Jul-08								
23-Jul-08								
24-Jul-08								
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2-Aug-08								
3-Aug-08								
4-Aug-08								
5-Aug-08								
6-Aug-08								

7-Aug-08								
8-Aug-08								
9-Aug-08	0.497	1.555	0.089	0.023	0.124	0.351	0.279	2.160
10-Aug-08	0.529	0.381	0.027	0.006	0.018	0.192	0.248	0.480
11-Aug-08	0.777	1.011	0.039	0.094	0.024	0.866	0.589	2.208
12-Aug-08	0.897	0.879	0.039	0.077	0.064	2.034	0.434	0.768
13-Aug-08	0.688	0.684	0.039	0.065	0.034	0.309	0.316	0.816
14-Aug-08	0.651	0.540	0.039	0.103	0.042	0.753	0.273	0.624
15-Aug-08	0.455	0.534	0.027	0.068	0.014	0.217	0.310	1.728
16-Aug-08	1.065	2.631	0.078	0.047	0.060	1.590	6.969	1.392
17-Aug-08	0.522	1.058	0.069	0.050	0.092	1.278	0.310	2.304
21-Aug-08	0.639	0.472	0.020	0.095	0.022	1.409	1.073	1.296
22-Aug-08	0.653	0.455	0.023	0.077	0.020	1.377	1.153	1.104
23-Aug-08	0.474	0.434	0.016	0.083	0.014	1.118	0.868	1.104
24-Aug-08	0.734	0.220	0.039	0.118	0.040	2.318	0.856	1.440
25-Aug-08	0.637	0.375	0.023	0.070	0.024	1.416	0.831	1.152
26-Aug-08	0.697	0.404	0.027	0.084	0.026	1.640	0.527	1.200
27-Aug-08	0.660	0.376	0.027	0.065	0.024	1.079	0.409	1.296
28-Aug-08	0.718	0.390	0.027	0.090	0.024	1.498	0.484	1.200
29-Aug-08	0.501	0.590	0.016	0.060	0.014	1.562	0.763	1.728
30-Aug-08	0.274	0.726	0.016	0.038	0.012	0.430	1.147	1.968
31-Aug-08	0.630	0.667	0.023	0.065	0.018	1.246	1.011	1.728
1-Sep-08	0.557	0.951	0.078	0.065	0.038	0.916	1.048	2.256
2-Sep-08	0.725	1.165	0.078	0.088	0.054	1.285	0.887	3.600
3-Sep-08	0.941	1.879	0.157	0.113	0.198	1.289	3.875	4.752
4-Sep-08	0.760	1.439	0.078	0.108	0.086	1.335	3.869	2.928
5-Sep-08	0.567	1.905	0.117	0.073	0.128	2.016	3.528	2.832
6-Sep-08	0.735	1.226	0.138	0.068	0.172	1.647	3.292	2.016
7-Sep-08	1.182	2.462	0.178	0.118	0.216	1.519	9.424	3.312
8-Sep-08	1.311	3.231	0.108	0.148	0.152	2.826	7.880	5.712
9-Sep-08	0.833	2.748	0.039	0.107	0.040	1.345	5.425	2.640
10-Sep-08	1.626	2.294	0.152	0.046	0.192	2.868	1.686	7.776
11-Sep-08	0.955	1.326	0.078	0.104	0.056	1.622	2.511	2.256
12-Sep-08	1.304	2.617	0.152	0.154	0.214	2.130	2.102	1.968
13-Sep-08	1.323	2.981	0.178	0.103	0.170	1.995	3.522	3.648
14-Sep-08	1.283	1.905	0.128	0.155	0.150	2.116	4.619	1.920
15-Sep-08	1.074	0.491	0.035	0.050	0.038	2.205	0.490	1.536
16-Sep-08	1.587	0.233	0.078	0.064	0.062	2.698	0.378	0.624
17-Sep-08	0.439	0.267	0.039	0.032	0.012	1.377	0.539	0.576
18-Sep-08	1.375	0.253	0.039	0.028	0.050	1.303	0.397	0.576
19-Sep-08	1.546	0.248	0.039	0.056	0.058	2.428	0.192	0.528
20-Sep-08	0.354	0.273	0.027	0.035	0.050	1.356	0.285	0.528
21-Sep-08	1.111	0.400	0.104	0.108	0.140	2.173	0.626	1.104
22-Sep-08	0.363	0.271	0.020	0.024	0.030	1.445	0.539	0.912
23-Sep-08	0.989	0.455	0.078	0.058	0.068	1.264	0.713	1.008
24-Sep-08	0.948	0.430	0.039	0.103	0.052	1.285	0.465	0.768
25-Sep-08	1.226	0.385	0.039	0.058	0.046	1.789	0.484	0.768
26-Sep-08	0.587	0.327	0.078	0.043	0.060	0.848	0.502	0.912

27-Sep-08	0.315	0.284	0.027	0.049	0.044	0.611	0.496	0.960
28-Sep-08	0.812	0.403	0.039	0.083	0.052	1.250	0.763	1.152
30-Sep-08	0.136	0.121	0.020	0.030	0.018	0.508	0.397	0.624
1-Oct-08	0.175	0.194	0.012	0.021	0.022	0.249	0.825	0.384
2-Oct-08	0.239	0.101	0.016	0.029	0.014	0.284	0.291	0.336
4-Oct-08	0.163	0.154	0.016	0.020	0.014	0.135	0.378	0.624
5-Oct-08	0.058	0.320	0.008	0.007	0.002	0.163	2.015	1.008
6-Oct-08	0.067	0.259	0.020	0.008	0.012	0.064	0.992	0.720
7-Oct-08	0.124	0.480	0.016	0.015	0.010	0.809	0.756	1.152
8-Oct-08	0.179	0.126	0.012	0.022	0.016	0.391	2.406	0.576
9-Oct-08	0.173	0.293	0.031	0.021	0.028	0.138	0.490	0.816
10-Oct-08	0.244	0.362	0.031	0.029	0.028	0.696	1.370	1.776
11-Oct-08	0.276	0.710	0.084	0.033	0.086	0.280	1.004	2.208
12-Oct-08	0.136	1.476	0.078	0.016	0.070	0.064	2.616	2.160
13-Oct-08	0.200	0.463	0.020	0.024	0.008	0.192	0.688	1.488
14-Oct-08	0.074	0.884	0.020	0.009		0.131	1.457	1.440
15-Oct-08	0.223	0.149	0.016	0.027	0.030	0.142	0.409	0.816
16-Oct-08	0.136	0.047	0.008	0.016	0.006	0.053	1.649	0.528
17-Oct-08	0.120	0.211	0.035	0.014	0.030	0.036	0.527	1.056
18-Oct-08	0.133	0.316	0.039	0.016	0.018	0.096	0.893	1.488
19-Oct-08	0.492	0.452	0.020	0.059	0.034	0.380	0.527	1.488
20-Oct-08	0.255	0.058	0.020	0.031	0.008	0.312	0.527	0.480
21-Oct-08	0.336	0.150	0.079	0.040	0.138	0.156	0.409	0.816
22-Oct-08	0.416	0.213	0.099	0.050	0.128	0.295	0.508	1.152
23-Oct-08	0.228	0.052	0.036	0.027	0.042	0.217	0.211	0.336
24-Oct-08	0.465	0.203	0.091	0.056	0.116	0.501	0.577	0.912
25-Oct-08	0.246	0.251	0.027	0.030	0.058	0.174	0.570	1.152
28-Oct-08	0.081	0.515	0.060	0.010	0.020	0.905	0.301	1.991
29-Oct-08	0.078	0.400	0.059	0.009	0.021	0.539	0.954	2.208
30-Oct-08	0.126	0.480	0.067	0.015	0.020	1.977	0.252	0.590
31-Oct-08	0.087	0.975	0.021	0.010	0.019	2.584	2.209	4.888
1-Nov-08	1.079	1.066	0.170	0.129	0.020	3.195	5.213	6.936
2-Nov-08	0.534	0.549	0.098	0.064	0.019	1.214	0.109	1.115
3-Nov-08	1.131	1.233	0.147	0.136	0.009	3.046	5.251	5.462
4-Nov-08	0.715	0.548	0.226	0.086	0.016	0.607	0.661	2.712
5-Nov-08	1.139	2.242	0.145	0.137	0.011	3.064	3.685	4.601
6-Nov-08	0.348	0.467	0.198	0.042	0.053	4.278	0.406	1.218
7-Nov-08	0.243	0.660	0.198	0.029	0.078	0.820	2.269	2.537
8-Nov-08	0.784	0.150	0.211	0.094	0.079	2.556	0.233	1.277
9-Nov-08	0.128	1.711	0.202	0.015	0.015	2.780	0.338	11.840
10-Nov-08	0.577	0.340	0.217	0.069	0.039	2.394	0.605	1.198
11-Nov-08	0.087	0.320	0.226	0.010	0.023	1.072	0.379	2.174
12-Nov-08	0.088	0.350	0.221	0.011	0.013	0.391	0.492	1.280
13-Nov-08	0.611	1.108	0.265	0.073	0.018	0.160	0.244	1.229
14-Nov-08	0.057	1.484	0.210	0.007	0.009	0.089	0.849	1.951
15-Nov-08	0.560	0.327	0.285	0.067	0.043	0.353	1.300	1.544
16-Nov-08	0.260	0.436	0.248	0.031	0.060	0.284	1.052	1.382
17-Nov-08	0.302	0.353	0.350	0.036	0.060	1.033	0.935	0.251

18-Nov-08	0.508	1.526	0.249	0.061	0.017	4.104	0.667	4.266
19-Nov-08	0.011	0.052	0.156	0.001	0.037	3.728	0.685	0.230
20-Nov-08	0.607	0.135	0.226	0.073	0.030	2.709	0.710	0.187
21-Nov-08	0.148	1.208	0.201	0.018	0.040	0.373	0.710	1.366
22-Nov-08	0.257	0.554	0.233	0.031	0.038	2.886	0.446	5.723
23-Nov-08	0.243	2.265	0.324	0.029	0.049	1.047	0.902	7.464
24-Nov-08	0.031	0.441	0.155	0.004	0.052	1.690	0.794	0.738
25-Nov-08	0.297	0.625	0.248	0.036	0.074	2.052	1.040	2.173
26-Nov-08	0.101	0.082	0.075	0.012	0.052	2.744	1.207	0.382
27-Nov-08	0.427	0.336	0.207	0.051	0.041	1.846	2.362	0.394
28-Nov-08	0.511	2.250	0.318	0.061	0.041	1.704	3.833	1.659
29-Nov-08	0.406	1.150	0.133	0.049	0.044	0.521	3.257	4.644
30-Nov-08	0.437	1.311	0.151	0.052	0.070	3.064	0.768	0.376
1-Dec-08	0.746	0.236	0.209	0.089	0.016	1.069	1.844	0.303
2-Dec-08	0.151	0.444	0.257	0.018	0.039	1.040	2.562	0.391
3-Dec-08	0.185	0.052	0.308	0.022	0.052	1.022	0.975	0.570
4-Dec-08	0.121	0.385	0.313	0.014	0.032	0.397	2.786	0.335
5-Dec-08	0.095	0.770	0.312	0.011	0.058	2.357	4.391	0.222
6-Dec-08	0.079	1.958	0.222	0.010	0.024	2.396	4.196	5.979
7-Dec-08	0.141	0.546	0.263	0.017	0.057	0.330	2.649	1.116
8-Dec-08	0.446	0.213	0.238	0.053	0.127	0.295	0.508	1.165
9-Dec-08	0.235	0.055	0.215	0.028	0.047	0.217	0.231	0.374
10-Dec-08	0.446	0.183	0.337	0.053	0.163	0.504	0.578	0.978
11-Dec-08	0.274	0.265	0.225	0.033	0.059	0.174	0.574	1.137
12-Dec-08	0.752	0.550	0.247	0.090	0.017	0.641	0.668	2.717
13-Dec-08	1.136	2.277	0.134	0.136	0.016	3.065	3.657	4.656
14-Dec-08	0.673	0.487	0.179	0.081	0.057	4.278	0.405	1.263
15-Dec-08	0.576	0.701	0.180	0.069	0.077	0.876	2.266	2.524
16-Dec-08	0.775	0.159	0.243	0.093	0.078	2.548	0.246	1.274
17-Dec-08	0.923	1.718	0.274	0.111	0.019	2.748	0.355	3.840
18-Dec-08								
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1-Jan-09								
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7-Jan-09								
8-Jan-09	0.115	0.500	0.124	0.014	0.019	0.696	1.927	1.231
9-Jan-09	0.120	1.970	0.213	0.014	0.052	2.698	1.392	7.299
10-Jan-09	0.042	0.985	0.186	0.005	0.052	0.452	1.238	8.294
11-Jan-09	0.249	1.140	0.313	0.030	0.041	2.698	0.015	5.717
12-Jan-09	0.054	1.259	0.198	0.006	0.046	4.274	0.498	2.208
13-Jan-09	0.145	0.940	0.319	0.017	0.043	1.406	0.375	5.274
14-Jan-09	0.162	0.609	0.233	0.019	0.051	0.696	0.045	6.094
15-Jan-09	0.348	1.760	0.172	0.042	0.070	1.392	0.776	0.912
16-Jan-09	0.258	0.680	0.075	0.031	0.076	3.195	0.408	3.882
17-Jan-09	0.482	1.254	0.136	0.058	0.095	4.171	0.728	5.855
18-Jan-09	0.038	0.174	0.105	0.005	0.050	1.477	0.284	1.094
19-Jan-09	0.128	1.290	0.195	0.015	0.036	1.488	0.112	5.780
20-Jan-09	0.609	1.336	0.233	0.073	0.044	2.073	1.619	5.626
21-Jan-09	0.458	0.377	0.251	0.055	0.051	1.051	0.625	1.728
22-Jan-09	0.370	0.337	0.344	0.044	0.067	1.033	0.935	0.251
23-Jan-09	0.556	1.536	0.276	0.067	0.016	4.104	0.667	4.266
24-Jan-09	0.345	0.053	0.157	0.041	0.035	3.728	0.685	0.230
25-Jan-09	0.641	0.127	0.235	0.077	0.035	2.709	0.710	0.187
26-Jan-09	0.474	1.179	0.206	0.057	0.048	0.373	0.710	1.366
27-Jan-09	0.548	0.559	0.267	0.066	0.036	2.886	0.446	5.723
28-Jan-09	0.345	0.961	0.342	0.041	0.043	1.406	0.375	5.274
29-Jan-09	0.366	0.631	0.263	0.044	0.052	0.696	0.045	6.094
30-Jan-09	0.376	1.753	0.172	0.045	0.073	1.392	0.776	0.912
31-Jan-09	0.275	0.703	0.068	0.033	0.078	3.195	0.408	3.882
1-Feb-09	0.673	0.166	0.195	0.081	0.134	1.156	0.409	0.816
2-Feb-09	0.624	0.199	0.094	0.075	0.128	0.895	0.508	1.152
3-Feb-09	0.543	0.056	0.036	0.065	0.044	0.717	0.211	0.336
4-Feb-09	0.775	0.193	0.092	0.093	0.114	0.801	0.577	0.912
5-Feb-09	0.374	0.248	0.025	0.045	0.057	0.674	0.570	1.152
6-Feb-09	0.775	0.555	0.057	0.093	0.052	0.905	0.301	1.991
7-Feb-09	0.775	0.393	0.057	0.093	0.037	1.139	0.954	2.208
8-Feb-09	0.732	0.466	0.064	0.088	0.035	1.977	0.252	0.590
9-Feb-09	0.577	0.991	0.035	0.069	0.026	2.584	2.209	4.888
10-Feb-09	0.246	1.983	0.231	0.030	0.056	2.660	1.344	7.234
11-Feb-09	0.145	0.974	0.157	0.017	0.053	0.435	1.234	6.429
12-Feb-09	0.245	1.121	0.363	0.029	0.046	1.566	0.015	3.672
13-Feb-09	0.054	1.249	0.156	0.007	0.046	2.274	0.453	3.562
14-Feb-09	0.136	0.972	0.353	0.016	0.046	0.906	0.366	4.673
15-Feb-09	0.165	0.594	0.263	0.020	0.055	0.634	0.065	7.452
16-Feb-09	0.365	1.911	0.177	0.046	0.073	1.244	0.764	3.429
17-Feb-09	0.276	0.695	0.074	0.030	0.076	1.420	0.465	5.629
18-Feb-09	0.444	1.265	0.136	0.062	0.098	1.452	0.763	2.569
19-Feb-09	0.036	0.185	0.131	0.049	0.055	0.767	0.233	4.621
20-Feb-09	0.153	1.271	0.066	0.019	0.038	0.935	0.156	4.118
21-Feb-09	0.123	0.532	0.104	0.015	0.013	0.630	1.934	1.431

22-Feb-09	0.123	1.150	0.213	0.012	0.054	2.624	1.139	7.542
23-Feb-09	0.014	0.934	0.136	0.001	0.063	0.555	1.253	2.431
24-Feb-09	0.253	1.154	0.313	0.055	0.045	2.237	0.312	5.342
25-Feb-09	0.054	1.223	0.198	0.081	0.043	2.233	0.444	2.431
26-Feb-09	0.245	0.952	0.119	0.060	0.045	1.403	0.123	5.327
27-Feb-09	0.165	0.654	0.133	0.049	0.052	0.653	0.042	6.341
28-Feb-09	0.354	1.731	0.092	0.042	0.075	1.787	0.744	0.912
1-Mar-09	0.453	0.638	0.075	0.060	0.075	2.312	0.434	3.349
2-Mar-09	0.443	1.413	0.136	0.057	0.095	2.114	0.743	3.449
3-Mar-09	0.035	0.142	0.105	0.066	0.051	1.444	0.213	1.411
4-Mar-09	0.122	1.244	0.095	0.020	0.034	3.449	0.143	5.548
5-Mar-09	0.241	1.133	0.103	0.071	0.042	2.123	1.612	5.126
6-Mar-09	0.542	0.422	0.069	0.076	0.055	1.250	0.753	1.412
7-Mar-09	0.136	0.112	0.025	0.025	0.044	0.505	0.343	0.432
8-Mar-09	0.124	0.142	0.011	0.027	0.027	0.215	0.854	0.431
9-Mar-09	0.212	0.134	0.026	0.045	0.034	0.243	0.349	0.343
10-Mar-09	0.236	0.115	0.013	0.064	0.025	0.145	0.348	0.634
11-Mar-09	0.053	0.334	0.018	0.009	0.004	0.114	1.750	1.201
12-Mar-09	0.064	0.234	0.013	0.005	0.011	0.065	1.239	0.472
13-Mar-09	0.232	0.442	0.035	0.044	0.014	0.852	0.746	1.231
14-Mar-09	0.142	0.143	0.011	0.038	0.015	0.353	1.741	0.544
15-Mar-09	0.134	0.234	0.033	0.028	0.025	0.145	0.434	0.582
16-Mar-09	0.234	0.313	0.034	0.058	0.025	0.642	1.637	1.578
17-Mar-09	0.274	0.743	0.084	0.035	0.087	0.255	1.604	1.342
18-Mar-09	0.114	1.434	0.078	0.021	0.075	0.065	2.652	1.778
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1-May-09								
2-May-09								
3-May-09								
4-May-09	0.293		0.071	0.015	0.088			
5-May-09	0.389		0.076	0.019	0.088			
6-May-09	0.327		0.065	0.004	0.104			
7-May-09	0.316		0.030	0.039	0.024			
8-May-09	0.341		0.089	0.003	0.102			
9-May-09	0.264		0.060	0.001	0.035			
10-May-09	0.231		0.062	0.029	0.086			
11-May-09	0.091		0.078	0.033	0.100			
12-May-09	0.480		0.093	0.042	0.120			
13-May-09	0.219		0.175	0.045	0.200			
14-May-09	0.380		0.153	0.042	0.151			
15-May-09	0.415		0.161	0.021	0.198			
16-May-09	0.512		0.078	0.025	0.108			
17-May-09	0.450		0.166	0.010	0.214			
18-May-09	0.439		0.141	0.044	0.134			
19-May-09	0.463		0.189	0.009	0.242			
20-May-09	0.387		0.138	0.007	0.145			
21-May-09	0.354		0.092	0.034	0.126			
22-May-09	0.213		0.148	0.038	0.191			
23-May-09	0.602		0.094	0.048	0.114			
24-May-09	0.341		0.105	0.050	0.110			
25-May-09	0.503		0.127	0.048	0.168			
26-May-09	0.347	0.435	0.130	0.062	0.153	0.046	0.352	0.454
27-May-09	0.415	0.655	0.256	0.021	0.233	6.680	0.446	0.732
28-May-09	0.251	0.516	0.021	0.035	0.062	2.517	0.343	0.453

29-May-09	0.255	0.545	0.072	0.042	0.097	0.756	0.265	1.434
30-May-09	0.354	0.866	0.098	0.051	0.045	0.550	0.423	0.149
31-May-09	0.220	0.240	0.178	0.031	0.124	0.411	0.865	0.677
1-Jun-09	0.435	0.676	0.075	0.052	0.057	1.525	0.563	0.775
2-Jun-09	0.455	0.765	0.147	0.057	0.176	0.763	1.655	2.622
3-Jun-09	0.580	0.465	0.141	0.071	0.134	1.404	0.336	1.542
4-Jun-09	0.632	0.561	0.076	0.081	0.088	0.741	1.229	0.765
5-Jun-09	0.553	0.562	0.098	0.069	0.133	0.898	0.740	1.343
6-Jun-09	0.353	0.876	0.128	0.049	0.096	0.806	0.535	1.421
7-Jun-09	0.545	0.564	0.165	0.067	0.176	0.492	0.854	5.228
8-Jun-09	0.742	0.862	0.215	0.019	0.263	1.577	0.528	3.626
9-Jun-09	0.454	0.445	0.156	0.062	0.163	0.998	0.454	2.426
10-Jun-09	0.438	1.659	0.117	0.098	0.065	1.254	1.189	5.611
11-Jun-09	0.354	0.839	0.076	0.049	0.056	1.541	0.660	2.443
12-Jun-09	0.520	3.832	0.154	0.069	0.177	0.629	3.498	9.610
13-Jun-09	0.350	0.454	0.077	0.052	0.063	0.436	1.933	2.250
14-Jun-09	0.452	0.422	0.098	0.062	0.132	1.865	1.211	3.629
15-Jun-09	0.542	0.650	0.157	0.072	0.167	0.484	0.506	1.644
16-Jun-09	0.446	0.956	0.068	0.052	0.035	0.604	0.612	1.963
17-Jun-09	0.643	2.651	0.058	0.082	0.042	0.549	0.306	7.621
18-Jun-09	0.645	1.493	0.111	0.082	0.145	0.427	0.663	6.556
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8-Jul-09	0.544	0.436	0.109	0.069	0.143	0.823	0.834	2.333
9-Jul-09	0.645	0.704	0.196	0.019	0.230	1.524	0.548	3.552
10-Jul-09	0.631	0.520	0.118	0.098	0.141	0.568	0.416	2.316
11-Jul-09	0.283	2.292	0.107	0.042	0.065	1.123	2.142	2.513
12-Jul-09	0.543	1.885	0.048	0.078	0.055	1.441	0.641	2.413
13-Jul-09	0.420	3.482	0.111	0.062	0.112	0.333	2.398	7.321
14-Jul-09	0.597	1.441	0.076	0.081	0.058	0.313	2.439	2.415
15-Jul-09	0.351	1.518	0.073	0.049	0.141	1.265	0.511	2.334

16-Jul-09	0.680	1.410	0.194	0.091	0.256	1.388	0.423	1.414
17-Jul-09	0.476	1.927	0.048	0.061	0.034	0.535	0.411	1.543
18-Jul-09	0.327	1.112	0.038	0.041	0.045	0.533	0.543	6.311
19-Jul-09	0.530	1.449	0.127	0.071	0.141	0.447	0.541	6.413
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29-Jul-09								
30-Jul-09								
31-Jul-09	0.454	1.552	0.109	0.057	0.123	0.251	0.275	2.312
1-Aug-09	0.225	0.334	0.023	0.038	0.014	0.144	0.242	0.455
2-Aug-09	0.274	1.052	0.034	0.038	0.025	0.566	0.529	2.212
3-Aug-09	0.459	0.828	0.029	0.058	0.067	1.534	0.443	0.755
4-Aug-09	0.429	0.625	0.044	0.057	0.034	0.871	0.316	0.182
5-Aug-09	0.643	0.564	0.055	0.070	0.046	0.553	0.227	0.624
6-Aug-09	0.346	1.523	0.022	0.042	0.015	0.717	2.331	1.227
7-Aug-09	0.626	2.263	0.038	0.168	0.064	1.336	6.969	1.392
8-Aug-09	0.325	1.035	0.045	0.058	0.094	1.244	0.344	2.304
9-Aug-09	0.652	1.472	0.024	0.079	0.025	1.409	2.073	1.443
10-Aug-09	0.653	1.425	0.023	0.058	0.024	1.138	3.153	1.144
11-Aug-09	0.444	0.524	0.023	0.065	0.012	1.118	0.449	1.541
12-Aug-09	0.645	0.422	0.034	0.079	0.045	2.334	0.856	1.424
13-Aug-09	0.364	0.524	0.023	0.045	0.024	1.342	0.831	1.143
14-Aug-09	0.597	0.234	0.024	0.081	0.044	1.640	0.512	1.522
15-Aug-09	0.360	0.664	0.023	0.055	0.025	1.058	0.453	1.430
16-Aug-09	0.742	0.434	0.024	0.095	0.025	1.442	0.443	1.422
17-Aug-09	0.552	0.526	0.014	0.069	0.014	1.556	0.726	1.234
18-Aug-09	0.227	0.937	0.014	0.038	0.017	0.430	1.421	1.397
19-Aug-09	0.652	1.467	0.023	0.081	0.014	1.242	2.014	2.373
20-Aug-09								
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22-Aug-09								
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25-Aug-09								
26-Aug-09								
27-Aug-09	0.846	1.951	0.065	0.065	0.037	0.916	1.045	2.326
28-Aug-09	0.972	1.137	0.056	0.061	0.060	1.285	0.833	3.436
29-Aug-09	1.094	1.818	0.154	0.055	0.190	1.289	1.239	4.475
30-Aug-09	0.828	1.441	0.038	0.056	0.086	1.335	2.487	3.493
31-Aug-09	0.927	1.341	0.144	0.073	0.129	2.016	1.528	1.548
1-Sep-09	0.927	1.423	0.165	0.058	0.190	1.647	1.343	2.540

2-Sep-09	1.418	2.455	0.178	0.179	0.299	1.519	1.434	3.456
3-Sep-09	1.331	2.231	0.156	0.168	0.186	2.826	2.588	2.571
4-Sep-09	1.383	2.748	0.037	0.175	0.049	1.345	2.543	2.546
5-Sep-09	1.633	2.239	0.152	0.205	0.199	2.868	4.569	3.578
6-Sep-09	0.942	1.313	0.053	0.115	0.059	1.622	1.551	2.543
7-Sep-09	1.130	2.462	0.286	0.146	0.290	2.130	2.541	1.460
8-Sep-09	1.432	1.981	0.158	0.181	0.190	1.995	3.535	1.565
9-Sep-09	1.218	1.943	0.153	0.155	0.190	2.116	1.462	1.549
10-Sep-09	1.374	1.449	0.035	0.168	0.039	2.205	0.545	1.655
11-Sep-09	1.239	1.233	0.076	0.158	0.070	2.698	0.768	1.462
12-Sep-09	1.344	1.343	0.054	0.168	0.019	1.377	0.455	1.226
13-Sep-09	1.138	1.525	0.034	0.146	0.059	1.303	0.640	0.453
14-Sep-09	1.546	1.333	0.065	0.195	0.060	2.428	0.452	0.756
15-Sep-09	1.235	1.513	0.085	0.158	0.099	1.356	0.763	0.648
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15-Oct-09								
16-Oct-09	1.541	0.800	0.104	0.188	0.145	2.457	0.633	1.154
17-Oct-09	0.426	0.771	0.020	0.058	0.032	1.745	0.543	0.945
18-Oct-09	0.240	0.955	0.118	0.027	0.098	1.564	0.754	1.025
19-Oct-09	0.349	1.430	0.094	0.058	0.063	1.659	0.446	0.765

20-Oct-09	1.226	1.385	0.086	0.156	0.075	1.889	0.446	0.768
21-Oct-09	0.287	1.327	0.178	0.379	0.144	0.455	0.542	0.941
22-Oct-09	0.315	1.284	0.027	0.038	0.045	0.811	0.443	0.960
23-Oct-09	0.341	1.443	0.139	0.412	0.075	1.425	0.755	1.215
24-Oct-09	0.124	1.121	0.050	0.016	0.023	0.555	0.354	0.624
25-Oct-09	0.155	1.519	0.032	0.015	0.025	0.562	0.842	0.544
26-Oct-09	0.252	0.910	0.026	0.035	0.014	1.284	0.243	1.234
27-Oct-09	0.116	0.762	0.046	0.148	0.012	0.871	0.352	0.456
28-Oct-09	0.146	0.532	0.006	0.018	0.005	0.616	2.025	1.430
29-Oct-09	0.167	0.533	0.030	0.027	0.015	0.546	0.943	0.547
30-Oct-09	0.154	0.748	0.016	0.020	0.025	0.658	0.428	1.152
31-Oct-09	0.145	0.351	0.032	0.020	0.015	0.764	1.406	0.458
1-Nov-09	0.154	0.763	0.051	0.019	0.023	0.541	0.485	0.816
2-Nov-09	0.224	0.336	0.062	0.027	0.026	0.437	1.544	1.278
3-Nov-09	0.245	0.371	0.052	0.030	0.082	0.543	1.654	2.422
4-Nov-09	0.114	1.476	0.115	0.015	0.075	0.546	1.456	1.452
5-Nov-09	0.254	0.653	0.034	0.037	0.004	0.143	0.643	1.455
6-Nov-09	0.427	0.388	0.023	0.057	0.005	0.154	1.446	1.424
7-Nov-09	0.242	0.153	0.125	0.035	0.037	0.442	0.409	0.458
8-Nov-09	0.142	0.335	0.043	0.018	0.003	0.425	1.642	0.542
9-Nov-09	0.142	0.261	0.125	0.018	0.035	0.545	0.542	1.052
10-Nov-09	0.152	0.335	0.054	0.018	0.015	0.660	0.853	1.674
11-Nov-09	0.360	0.727	0.121	0.047	0.042	0.555	1.235	1.564
12-Nov-09	0.460	0.636	0.105	0.055	0.064	0.243	1.032	1.423
13-Nov-09	0.202	0.553	0.178	0.028	0.061	1.033	0.953	0.433
14-Nov-09	0.508	1.465	0.109	0.068	0.014	1.104	0.647	2.343
15-Nov-09	0.011	0.645	0.107	0.015	0.035	1.728	0.685	0.254
16-Nov-09	0.634	0.835	0.126	0.086	0.035	1.709	0.745	0.155
17-Nov-09	0.311	1.421	0.110	0.037	0.033	0.347	0.742	1.564
18-Nov-09	0.257	0.647	0.133	0.038	0.034	1.886	0.445	3.472
19-Nov-09	0.254	1.763	0.124	0.047	0.044	1.047	0.902	4.546
20-Nov-09	0.133	1.441	0.135	0.017	0.055	1.690	0.755	0.756
21-Nov-09	0.244	1.462	0.248	0.030	0.074	1.052	1.024	2.168
22-Nov-09	0.154	0.682	0.118	0.019	0.055	2.744	1.207	0.644
23-Nov-09	0.427	0.736	0.121	0.052	0.044	1.846	2.544	0.376
24-Nov-09	1.511	1.452	0.132	0.068	0.044	2.704	3.833	1.667
25-Nov-09	1.406	1.575	0.134	0.048	0.045	2.521	3.236	2.868
26-Nov-09	0.437	1.741	0.153	0.052	0.074	3.064	0.755	1.434
27-Nov-09	0.746	1.236	0.141	0.095	0.014	1.069	1.384	1.343
28-Nov-09	0.551	1.444	0.157	0.068	0.035	1.040	1.546	1.234
29-Nov-09	0.685	0.545	0.245	0.086	0.055	1.024	2.497	0.570
30-Nov-09	0.421	0.654	0.151	0.057	0.034	0.352	2.786	0.543
1-Dec-09	0.795	0.658	0.176	0.010	0.055	1.357	2.391	0.652
2-Dec-09	0.566	1.456	0.134	0.066	0.024	1.396	2.542	5.979
3-Dec-09	0.741	0.655	0.166	0.088	0.054	0.553	2.465	2.116
4-Dec-09	0.467	0.444	0.233	0.056	0.063	0.436	1.531	1.542
5-Dec-09	0.375	1.585	0.292	0.045	0.143	0.540	1.270	0.909
6-Dec-09	0.568	0.451	0.264		0.075	0.521	1.876	0.769

7-Dec-09	0.647	0.340	0.399		0.356	0.638	1.428	0.987
8-Dec-09	1.470	0.758	0.413		0.365	0.931	1.876	1.995
9-Dec-09	0.930	1.656	0.427		0.253	0.867	2.451	1.563
10-Dec-09	1.146	1.333	0.317		0.465	0.436	3.459	1.988
11-Dec-09	0.376	1.308	0.285		0.154	0.434	2.145	0.658
12-Dec-09	0.213	2.742	0.244		0.054	1.156	4.451	2.784
13-Dec-09	0.987	1.434	0.138		0.073	1.954	3.454	3.541
14-Dec-09	0.676	0.898	0.164		0.075	1.354	0.658	1.954
15-Dec-09	0.306	1.651	0.235		0.055	0.313	1.625	1.987
16-Dec-09	0.144	1.438	0.188		0.077	0.498	2.544	2.546
17-Dec-09	0.763	1.311	0.198		0.047	0.532	4.653	7.025
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13-Jan-10	0.276	5.897	0.236	0.009	0.088	0.774	10.542	5.293
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23-Jan-10	0.018	3.709	0.206	0.002	0.078	0.278	3.489	2.470

24-Jan-10	0.184	2.834	0.132	0.022	0.035	0.068	4.382	4.173
25-Jan-10	0.270	4.342	0.244	0.040	0.035	0.451	3.540	8.674
26-Jan-10	0.323	3.342	0.212	0.042	0.035	0.694	7.624	5.262
27-Jan-10	0.652	3.543	0.222	0.079	0.065	0.362	1.931	3.638
28-Jan-10	0.234	1.575	0.126	0.031	0.055	0.586	1.294	0.721
29-Jan-10	0.542	1.334	0.143	0.065	0.042	0.173	0.378	0.269
30-Jan-10	0.431	0.453	0.123	0.059	0.025	0.441	1.528	0.622
31-Jan-10	0.124	0.765	0.133	0.016	0.045	0.316	1.215	0.676
1-Feb-10	0.134	0.765	0.154	0.022	0.041	0.413	1.326	0.608
2-Feb-10	0.543	3.111	0.131	0.071	0.096	0.281	3.994	0.852
3-Feb-10								
4-Feb-10	0.443	0.548	0.182	0.052	0.193	0.318	2.450	1.162
5-Feb-10	0.154	1.762	0.023	0.019	0.045	0.108	1.384	0.571
6-Feb-10	0.143	4.451	0.048	0.020	0.043	0.323	1.828	4.475
7-Feb-10	0.123	3.542	0.144	0.022	0.014	0.403	2.880	3.233
8-Feb-10	0.132	1.342	0.053	0.016	0.065	0.437	1.391	1.115
9-Feb-10	0.341	1.550	0.043	0.050	0.052	0.454	2.199	0.854
10-Feb-10	0.324	1.201	0.055	0.035	0.045	0.235	1.705	0.786
11-Feb-10	0.234	3.069	0.073	0.032	0.031	0.439	3.439	1.007
12-Feb-10	0.235	3.429	0.134	0.032	0.042	0.411	1.528	0.931
13-Feb-10	0.173	2.522	0.045	0.026	0.023	0.310	3.594	1.157
14-Feb-10	0.133	1.951	0.065	0.020	0.026	0.146	4.109	1.635
15-Feb-10	0.151	1.310	0.045	0.019	0.025	0.255	2.797	1.381
16-Feb-10	0.162	1.457	0.145	0.020	0.166	0.044	2.343	0.569
17-Feb-10	0.451	1.657	0.344	0.062	0.207	0.415	6.375	1.409
18-Feb-10	0.243	1.523	0.442	0.031	0.445	0.260	2.427	0.915
19-Feb-10	0.289	0.555	0.142	0.035	0.204	0.228	1.379	0.551
20-Feb-10	0.373	0.563	0.174	0.050	0.122	0.281	1.734	0.590
21-Feb-10	0.432	0.234	0.254	0.055	0.252	0.237	1.192	0.405
22-Feb-10	0.243	1.587	0.141	0.031	0.161	0.577	1.031	1.030
23-Feb-10	0.549	1.514	0.254	0.064	0.228	0.341	1.054	0.728
24-Feb-10	0.322	0.674	0.124	0.041	0.108	0.479	1.448	0.533
25-Feb-10	0.235	0.675	0.145	0.031	0.120	0.253	0.749	0.478
26-Feb-10	0.123	0.233	0.065	0.019	0.117	0.481	0.723	0.501
27-Feb-10	0.335	0.654	0.242	0.041	0.130	0.245	1.255	0.835
28-Feb-10	0.457	0.877	0.245	0.065	0.291	0.392	0.512	0.439
1-Mar-10	0.680	0.822	0.345	0.082	0.372	0.300	0.939	0.316
2-Mar-10	0.341	0.754	0.124	0.052	0.173	0.187	1.715	0.522
3-Mar-10	0.547	0.548	0.132	0.066	0.154	0.416	0.785	0.474
4-Mar-10	0.343	5.285	0.558	0.042	0.644	1.012	3.426	1.151
5-Mar-10	0.432	3.750	0.154	0.051	0.135	0.443	1.770	0.840
6-Mar-10	0.231	0.442	0.155	0.032	0.131	0.629	1.757	1.117
7-Mar-10								
8-Mar-10								
9-Mar-10								
10-Mar-10								
11-Mar-10								
12-Mar-10								

13-Mar-10	0.124	1.458	0.054	0.016	0.122	0.145		
14-Mar-10	0.155	4.421	0.135	0.020	0.143	0.445		
15-Mar-10	0.166	1.459	0.146	0.021	0.151	0.134		
16-Mar-10	0.542	2.658	0.199	0.065	0.228	0.392		
17-Mar-10	0.236	3.653	0.154	0.019	0.204	0.300		
18-Mar-10	0.765	1.235	0.185	0.096	0.179	0.187		
19-Mar-10	0.651	0.659	0.034	0.049	0.041	0.416		
20-Mar-10								
21-Mar-10								
22-Mar-10								
23-Mar-10								
24-Mar-10								
25-Mar-10	0.347	0.568	0.148	0.043	0.195	0.326	0.535	0.776
26-Mar-10	0.548	0.674	0.041	0.069	0.068	1.102	0.696	0.718
27-Mar-10	1.049	0.646	0.109	0.126	0.128	0.803	0.821	0.927
28-Mar-10	0.298	0.346	0.132	0.036	0.123	0.228	1.067	0.686
29-Mar-10	1.148	0.674	0.153	0.020	0.176	0.767	0.893	0.961
30-Mar-10	0.143	0.674	0.143	0.019	0.176	0.081	0.125	0.236
31-Mar-10	0.231	0.346	0.123	0.032	0.163	0.377	0.394	0.490

Appendix II: Water soluble ions fine fraction concentrations measured at NKMO site

	Cencentration in air (µg m^{-3})							
	Na	NH4	K	Mg	Ca	Cl	NO3	SO4
01-Feb-09	0.289	0.132	0.406	0.036	0.026	0.556	0.221	0.219
02-Feb-09	0.433	4.361	0.266	0.052	0.026	0.529	6.481	5.752
03-Feb-09	0.492	2.858	0.242	0.060	0.032	0.476	2.169	5.084
04-Feb-09	0.447	0.959	0.138	0.057	0.034	0.317	1.277	1.929
05-Feb-09	0.558	0.614	0.136	0.067	0.049	0.390	0.942	1.007
06-Feb-09	0.375	1.676	0.276	0.052	0.034	0.643	2.163	3.288
07-Feb-09	0.483	2.003	0.151	0.062	0.047	0.704	2.164	2.447
08-Feb-09	0.404	2.357	0.170	0.052	0.051	0.399	3.168	3.899
09-Feb-09	0.315	1.556	0.134	0.042	0.039	0.674	1.363	2.349
10-Feb-09	0.549	0.809	0.071	0.066	0.039	0.568	0.630	1.871
11-Feb-09	0.512	0.816	0.066	0.065	0.051	0.615	0.756	1.055
12-Feb-09	0.332		0.117	0.042	0.015	0.211		
13-Feb-09	0.305	0.035	0.029	0.039	0.015	0.554	0.508	0.523
14-Feb-09	0.394	0.260	0.149	0.052	0.016	0.646	0.442	0.521
15-Feb-09	0.458	1.250	0.055	0.055	0.011	0.705	1.557	1.675
16-Feb-09	0.084	0.470	0.021	0.011	0.013	0.146	0.557	1.007
17-Feb-09	0.144	0.917	0.164	0.021	0.006	0.388	1.303	1.723
18-Feb-09	0.228	0.166	0.099	0.031	0.045	0.253	0.063	0.249
19-Feb-09	0.304	0.165	0.021	0.039	0.011	0.745	0.320	0.201
20-Feb-09	0.340	2.941	0.065	0.041	0.077	0.780	3.093	5.285
21-Feb-09	0.069	1.344	0.078	0.009	0.002	0.318	1.828	2.015
22-Feb-09	0.118	1.328	0.034	0.020	0.011	0.244	2.163	2.351
23-Feb-09	0.342	0.027	0.044	0.042	0.097	0.905	0.031	0.038
24-Feb-09	0.217	0.060	0.028	0.027	0.004	0.439	0.068	0.140
25-Feb-09	0.251	0.057	0.009	0.035	0.007	0.660	0.066	0.091
26-Feb-09	0.375	2.208	0.035	0.051	0.010	0.422	3.223	3.899
27-Feb-09	0.075	1.346	0.060	0.011	0.011	0.317	2.169	2.351
28-Feb-09	0.192		0.021	0.027	0.011	0.554		
01-Mar-09	0.293		0.024	0.036	0.013	0.389		
02-Mar-09	0.084	0.026	0.037	0.012	0.019	0.317	1.172	0.954
03-Mar-09	0.007	1.065	0.049	0.000	0.000	0.039	1.853	1.915
04-Mar-09	0.170	0.017	0.053	0.022	0.024	0.389	0.099	0.907
05-Mar-09	0.111	0.512	0.030	0.016	0.004	0.389	0.621	0.893
06-Mar-09	0.246	0.602	0.028	0.031	0.014	0.671	0.991	1.435
07-Mar-09	0.300	0.037	0.021	0.036	0.005	0.554	0.099	1.055
08-Mar-09	1.055		0.032	0.017	0.030	0.740		
09-Mar-09								
10-Mar-09								
11-Mar-09	0.350		0.029	0.042	0.010	0.554		
12-Mar-09	0.227	0.032	0.047	0.036	0.008	0.213	0.118	
13-Mar-09	1.511		0.062	0.021	0.018	2.137		
14-Mar-09	0.310	0.195	0.053	0.039	0.008	0.550	0.053	0.892
15-Mar-09	0.416	1.498	0.087	0.051	0.024	0.376	2.163	2.495
16-Mar-09	0.215	1.285	0.021	0.027	0.004	0.388	2.417	2.871
17-Mar-09	0.132	6.050	0.106	0.020	0.006	0.038	6.318	14.808
18-Mar-09								
19-Mar-09								

20-Mar-09								
21-Mar-09								
22-Mar-09								
23-Mar-09								
24-Mar-09								
25-Mar-09								
26-Mar-09								
27-Mar-09								
28-Mar-09								
29-Mar-09								
30-Mar-09								
31-Mar-09								
01-Apr-09	0.238	4.404	0.056	0.029	0.027	0.376	1.221	12.907
02-Apr-09	0.175	5.061	0.069	0.027	0.041	0.376	11.768	10.057
03-Apr-09	0.392	3.631	0.047	0.049	0.007	0.780	3.713	9.081
04-Apr-09	0.005			0.001		0.036		
05-Apr-09	0.121	0.548	0.019	0.019	0.018	0.039	0.626	1.210
06-Apr-09	0.044	1.319	0.013	0.006	0.014	0.288	1.952	2.453
07-Apr-09	0.081	5.275	0.017	0.011	0.017	0.036	6.570	12.144
08-Apr-09	0.198		0.038	0.029	0.015	0.660		
09-Apr-09	0.150	1.581	0.029	0.021	0.016	0.037	1.438	2.971
10-Apr-09								
11-Apr-09								
12-Apr-09								
13-Apr-09	0.012	0.073	0.015	0.019	0.008	0.182	0.072	0.015
14-Apr-09	0.132	0.019	0.011	0.019	0.014	0.174		
15-Apr-09								
16-Apr-09								
17-Apr-09	0.032	0.328	0.016	0.001	0.019	0.068	0.371	0.509
18-Apr-09	0.255	0.225	0.011	0.030	0.011	0.433	0.504	0.509
19-Apr-09	0.172	1.269	0.008	0.021	0.020	0.376	2.161	2.495
20-Apr-09	0.275	0.409	0.011	0.035	0.010	0.744	0.623	0.989
21-Apr-09	0.143	0.970	0.006	0.020	0.011	0.387	1.300	1.972
22-Apr-09	0.386	0.165	0.027	0.050	0.016	1.048	0.179	0.391
23-Apr-09	0.005	0.194	0.000	0.000	0.002	0.007	0.322	0.312
24-Apr-09	0.103	0.948	0.007	0.016	0.002	0.324	1.610	2.011
25-Apr-09	0.047	1.339	0.009	0.001	0.021	0.077	2.163	2.207
26-Apr-09	0.089	1.176	0.008	0.012	0.019	0.317	2.294	2.011
27-Apr-09	0.179	0.267	0.019	0.022	0.001	0.039	0.425	0.390
28-Apr-09	0.228	0.598	0.013	0.030	0.005	0.705	0.756	1.430
29-Apr-09	0.304	0.473	0.018	0.037	0.019	0.182	0.623	0.918
30-Apr-09	0.340	0.455	0.030	0.042	0.015	0.078	0.552	1.291
01-May-09	0.069	0.449	0.013	0.001	0.001	0.067	0.627	0.911
02-May-09	0.118	1.534	0.040	0.020	0.068	0.007	2.163	3.903
03-May-09	0.342	2.346	0.028	0.041	0.052	1.264	3.409	4.379
04-May-09	0.257	0.454	0.020	0.031	0.011	1.143	0.623	0.918
05-May-09	0.243	0.351	0.060	0.031	0.130	0.674	0.554	1.007
06-May-09	0.031	0.446	0.029	0.003	0.021	0.564	0.632	1.003
07-May-09	0.297	2.152	0.089	0.039	0.180	0.574	4.275	4.388
08-May-09	0.101	0.457	0.019	0.013	0.010	0.351	0.555	1.433
09-May-09	0.427	0.133	0.020	0.052	0.012	0.071	0.082	0.246

10-May-09	0.511	1.305	0.025	0.062	0.020	0.385	2.461	4.313
11-May-09	0.406	0.328	0.029	0.048	0.020	0.390	3.223	0.988
12-May-09	0.375	0.225	0.039	0.049	0.021	0.319	0.320	0.390
13-May-09	0.380	0.457	0.030	0.049	0.021	0.253	0.624	0.985
14-May-09								
15-May-09								
16-May-09								
17-May-09								
18-May-09								
19-May-09								
20-May-09								
21-May-09								
22-May-09								
23-May-09								
24-May-09								
25-May-09								
26-May-09								
27-May-09								
28-May-09								
29-May-09								
30-May-09								
31-May-09								
01-Jun-09								
02-Jun-09	0.143	1.542	0.009	0.020	0.020	0.673	1.978	2.971
03-Jun-09	0.224	0.452	0.011	0.027	0.009	0.608	0.627	1.001
04-Jun-09	0.344	0.556	0.008	0.041	0.011	0.919	0.973	1.246
05-Jun-09	0.234	0.653	0.010	0.030	0.013	0.671	1.301	1.469
06-Jun-09	0.123	0.359	0.007	0.019	0.002	0.745	0.568	0.968
07-Jun-09	0.254	1.542	0.019	0.031	0.018	0.376	2.783	1.535
08-Jun-09	0.053	0.339	0.009	0.008	0.021	0.056	0.627	0.582
09-Jun-09	0.135	1.653	0.008	0.019	0.019	0.387	3.223	3.115
10-Jun-09	0.145	0.267	0.019	0.018	0.001	0.376	0.099	0.571
11-Jun-09	0.245	0.598	0.013	0.030	0.005	0.643	0.621	1.007
12-Jun-09								
13-Jun-09								
14-Jun-09								
15-Jun-09								
16-Jun-09								
17-Jun-09								
18-Jun-09								
19-Jun-09								
20-Jun-09								
21-Jun-09								
22-Jun-09								
23-Jun-09								
24-Jun-09								
25-Jun-09								
26-Jun-09								
27-Jun-09								
28-Jun-09								
29-Jun-09								

30-Jun-09								
01-Jul-09								
02-Jul-09								
03-Jul-09	0.135	2.269	0.008	0.020	0.020	0.316	4.042	4.296
04-Jul-09	0.135	0.541	0.011	0.020	0.005	0.304	0.621	0.963
05-Jul-09	0.154	1.970	0.006	0.019	0.011	0.567	0.115	0.404
06-Jul-09	0.345	0.565	0.027	0.042	0.016	0.567	0.621	1.007
07-Jul-09	0.014	0.694	0.000	0.002	0.002	0.038	1.295	1.483
08-Jul-09	0.154	0.543	0.007	0.019	0.002	0.038	0.555	1.469
09-Jul-09	0.054	1.423	0.009	0.007	0.021	0.106	2.164	3.115
10-Jul-09	0.135	0.653	0.020	0.019	0.011	0.039	1.258	1.469
11-Jul-09	0.154	0.439	0.007	0.020	0.002	0.357	1.173	1.247
12-Jul-09	0.254	0.542	0.029	0.032	0.013	0.387	1.088	1.071
13-Jul-09								
14-Jul-09								
15-Jul-09								
16-Jul-09								
17-Jul-09								
18-Jul-09								
19-Jul-09								
20-Jul-09								
21-Jul-09								
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25-Jul-09								
26-Jul-09								
27-Jul-09								
28-Jul-09								
29-Jul-09								
30-Jul-09								
31-Jul-09								
01-Aug-09	0.154	0.955	0.006	0.021	0.011	0.070	1.926	2.350
02-Aug-09	0.352	0.765	0.027	0.042	0.016	0.568	1.306	1.641
03-Aug-09	0.123	1.433	0.008	0.020	0.020	0.385	3.409	3.119
04-Aug-09	0.125	0.761	0.011	0.019	0.005	0.046	1.172	1.850
05-Aug-09	0.354	0.970	0.006	0.041	0.011	0.568	1.797	2.011
06-Aug-09	0.245	0.878	0.070	0.031	0.011	0.493	1.177	1.721
07-Aug-09	0.124	0.746	0.029	0.019	0.019	0.184	1.853	1.848
08-Aug-09	0.046	1.152	0.089	0.001	0.101	0.078	2.223	1.449
09-Aug-09	0.054	1.339	0.009	0.001	0.021	0.103	1.339	2.955
10-Aug-09	0.045	1.176	0.008	0.006	0.019	0.110	2.201	2.328
11-Aug-09	0.165	0.948	0.007	0.021	0.002	0.390	1.456	2.011
12-Aug-09	0.145	0.880	0.013	0.021	0.005	0.424	1.950	1.055

Appendix III: Water soluble ions fine fraction concentrations measured at BWSS site

	Cencentration in air (µg m^{-3})							
	Na	NH4	K	Mg	Ca	Cl	NO3	SO4
19-Nov-09	0.367	0.446	0.165	0.085	0.072	1.538	1.205	1.411
20-Nov-09	0.392	0.431	0.071	0.088	0.127	0.317	0.785	0.737
21-Nov-09	0.393	0.345	0.032	0.049	0.120	0.536	0.719	0.830
22-Nov-09	0.781	0.146	0.199	0.083	0.053	1.702	0.226	2.459
23-Nov-09	0.475	0.150	0.016	0.059	0.096	0.781	0.997	0.525
24-Nov-09	0.358	3.986	0.015	0.041	0.080	0.214		9.936
25-Nov-09	0.359	0.072	0.015	0.054	0.146	0.992	0.858	0.466
26-Nov-09	0.220	0.125	0.015	0.018	0.058	0.325	0.445	0.446
27-Nov-09	0.236	0.130	0.028	0.014	0.072	0.111	0.496	0.387
28-Nov-09	0.421	0.236	0.091		0.016			
29-Nov-09	0.445	0.205	0.138		0.043			
30-Nov-09	0.312	1.418	0.140		0.070			
01-Dec-09	0.298	0.748	0.152		0.014			
02-Dec-09	0.274	1.169	0.172		0.044			
03-Dec-09	0.203	0.336	0.076		0.025			
04-Dec-09	0.444	0.282	0.126		0.034			
05-Dec-09	0.489	0.281	0.083		0.034			
06-Dec-09	0.628	0.052	0.080		0.050			
07-Dec-09	0.527		0.076		0.034			
08-Dec-09	0.451	0.091	0.074		0.023			
09-Dec-09	0.011	0.048	0.076		0.003			
10-Dec-09	0.219	0.604	0.072	0.012	0.095	0.366	0.799	0.728
11-Dec-09	0.203	2.202	0.159	0.010	0.057	0.815	2.993	1.366
12-Dec-09	0.208	2.124	0.246	0.012	0.073	1.057	3.486	1.101
13-Dec-09	0.434	2.448	0.240	0.093	0.396	0.417	4.103	1.217
14-Dec-09	0.145	2.556	0.057	0.012	0.145	0.285	4.402	1.386
15-Dec-09	0.118	5.562	0.150	0.004	0.211	0.689	13.192	3.060
16-Dec-09	0.160	1.614	0.039	0.019	0.176	0.364	2.610	1.318
17-Dec-09	0.380	0.564	0.024	0.042	0.099	0.425	0.467	0.556
18-Dec-09	0.222	1.529	0.045	0.012	0.070	0.064	2.654	1.075
19-Dec-09								
20-Dec-09	0.346	3.279	0.072	0.035	0.154	0.740	1.336	7.839
21-Dec-09	0.134	2.003	0.066	0.010	0.085	0.194	3.157	0.954
22-Dec-09	0.243	2.349	0.078	0.008	0.101	0.570	4.519	1.101
23-Dec-09	0.205	1.443	0.037	0.004	0.070	0.115	2.854	0.709
24-Dec-09	0.140	2.291	0.106	0.004	0.142	0.151	3.898	1.084
25-Dec-09	0.148	0.684	0.023	0.012	0.097	0.102	1.672	0.754
26-Dec-09	0.851	1.009	0.465	0.095	0.838	2.004	0.646	0.926
27-Dec-09	0.316	0.565	0.094	0.018	0.117	0.266	1.511	0.429
28-Dec-09	0.138	2.754	0.070	0.005	0.054	0.304	4.475	1.129
29-Dec-09	0.133	1.751	0.130	0.006	0.075	0.342	2.369	1.194
30-Dec-09	0.456	0.944	0.034	0.050	0.066	0.474	1.091	1.361
31-Dec-09	0.368	1.085	0.192	0.046	0.110	0.340	1.770	0.943
01-Jan-10	0.183	1.051	0.064		0.076	0.121	1.989	0.875
02-Jan-10	0.631	0.340	0.149		0.301	0.375	1.048	0.657
03-Jan-10	1.099	1.076	0.431		0.341	0.908	1.770	0.995
04-Jan-10	0.930	1.173	0.427		0.218	0.863	3.071	1.350

05-Jan-10	1.100	1.051	0.417		0.409	0.460	2.907	1.078
06-Jan-10	0.381	2.084	0.085	0.024	0.154	0.445	4.147	0.836
07-Jan-10	0.213	2.742	0.057	0.009	0.069	1.125	5.139	1.784
08-Jan-10	0.987	2.442	0.079	0.095	0.077	1.951	3.541	3.142
09-Jan-10	0.688	0.934	0.044	0.076	0.072	1.353	0.752	0.954
10-Jan-10	0.306	1.339	0.070	0.021	0.058	0.315	1.467	1.047
11-Jan-10	0.169	3.807	0.098	0.008	0.074	0.498	6.443	2.648
12-Jan-10	0.233	5.085	0.154	0.006	0.045	0.532	8.268	5.025
13-Jan-10	0.276	5.897	0.236	0.009	0.088	0.774	10.542	5.293
14-Jan-10	0.116	3.117	0.125	0.004	0.032	0.523	4.096	2.439
15-Jan-10	0.203	1.745	0.211	0.009	0.064	0.334	1.891	1.442
16-Jan-10	0.249	0.511	0.020	0.011	0.071	0.043	0.818	0.663
17-Jan-10	0.384	0.683	0.030	0.035	0.059	0.587	1.756	0.813
18-Jan-10	0.122	1.540	0.062	0.014	0.032	0.257	2.451	0.951
19-Jan-10	0.077	3.385	0.063	0.007	0.023	0.297	5.108	2.642
20-Jan-10	0.036	3.646	0.104	0.001	0.017	0.338	5.807	2.277
21-Jan-10	0.109	2.839	0.052	0.014	0.049	0.392	3.367	2.639
22-Jan-10	0.095	3.245	0.072	0.009	0.027	0.470	3.763	3.284
23-Jan-10	0.080	2.709	0.056	0.007	0.028	0.278	3.489	2.470
24-Jan-10	0.084	2.805	0.107	0.008	0.033	0.068	4.382	4.173
25-Jan-10	0.127	5.166	0.168	0.009	0.031	0.451	3.540	8.674
26-Jan-10	0.120	5.203	0.112	0.008	0.031	0.694	7.624	5.262
27-Jan-10	0.560	1.970	0.122		0.064	0.362	1.931	3.638
28-Jan-10	0.347	0.575	0.026	0.043	0.058	0.586	1.294	0.721
29-Jan-10	0.146	0.334	0.021	0.020	0.041	0.173	0.378	0.269
30-Jan-10	0.139	0.957	0.053	0.017	0.028	0.441	1.528	0.622
31-Jan-10	0.083	0.779	0.034	0.012	0.048	0.316	1.215	0.676
01-Feb-10	0.164	0.703	0.054	0.021	0.041	0.413	1.326	0.608
02-Feb-10	0.094	2.111	0.031	0.013	0.096	0.281	3.994	0.852
03-Feb-10								
04-Feb-10	0.432	0.844	0.282	0.025	0.593	0.318	2.450	1.162
05-Feb-10	0.165	1.122	0.048	0.021	0.047	0.108	1.384	0.571
06-Feb-10	0.110	3.079	0.080	0.011	0.047	0.323	1.828	4.475
07-Feb-10	0.062	3.054	0.054	0.006	0.044	0.403	2.880	3.233
08-Feb-10	0.139	1.303	0.064	0.019	0.069	0.437	1.391	1.115
09-Feb-10	0.206	1.016	0.033	0.029	0.052	0.424	2.199	0.854
10-Feb-10	0.153	1.015	0.038	0.021	0.047	0.382	1.705	0.786
11-Feb-10	0.118	2.069	0.055	0.015	0.131	0.439	3.439	1.007
12-Feb-10	0.144	0.875	0.048	0.020	0.042	0.411	1.528	0.931
13-Feb-10	0.073	2.206	0.046	0.008	0.029	0.310	3.594	1.157
14-Feb-10	0.033	2.951	0.068	0.001	0.026	0.146	4.109	1.635
15-Feb-10	0.051	2.041	0.048	0.005	0.024	0.255	2.797	1.381
16-Feb-10	0.062	1.703	0.143	0.008	0.225	0.044	2.343	0.569
17-Feb-10	0.451	1.726	0.437	0.014	0.557	0.415	6.375	1.409
18-Feb-10	0.233	1.488	0.414	0.005	0.346	0.260	2.427	0.915
19-Feb-10	0.189	0.593	0.152	0.002	0.304	0.228	1.379	0.551
20-Feb-10	0.173	0.665	0.175	0.000	0.122	0.281	1.734	0.590
21-Feb-10	0.156	0.721	0.202	0.008	0.452	0.237	1.192	0.405
22-Feb-10	0.302	0.587	0.172	0.028	0.361	0.577	1.031	1.030
23-Feb-10	0.294	0.514	0.213	0.021	0.928	0.341	1.054	0.728
24-Feb-10	0.090	0.396	0.229	0.013	0.508	0.479	1.448	0.533

25-Feb-10	0.299	0.463	0.155	0.015	0.420	0.253	0.749	0.478
26-Feb-10	0.020	0.035	0.063	0.019	0.417	0.481	0.723	0.501
27-Feb-10	0.370	0.444	0.200	0.013	0.630	0.245	1.255	0.835
28-Feb-10	0.773	0.267	0.222	0.059	0.791	0.392	0.512	0.439
01-Mar-10	0.380	0.822	0.325	0.026	0.872	0.300	0.939	0.316
02-Mar-10	0.415	0.776	0.201	0.021	0.473	0.187	1.715	0.522
03-Mar-10	0.367	0.179	0.137	0.033	0.539	0.416	0.785	0.474
04-Mar-10	0.328	1.285	0.458	0.022	0.635	1.012	3.426	1.151
05-Mar-10	0.259	0.750	0.148	0.025	0.635	0.443	1.770	0.840
06-Mar-10	0.113	0.442	0.138	0.024	0.510	0.629	1.757	1.117
07-Mar-10	0.268	0.763	0.255	0.010	0.424	0.356	1.402	0.442
08-Mar-10	0.196	1.113	0.203	0.016	0.464	0.784	2.440	1.039
09-Mar-10	0.031	3.962	0.212		0.166			
10-Mar-10	0.040	3.888	0.131		0.132			
11-Mar-10	0.031	1.894	0.100	0.005	0.196			
12-Mar-10	0.039	1.423	0.058	0.005	0.168			
13-Mar-10	0.051	1.846	0.062	0.005	0.158			
14-Mar-10	0.119	3.125	0.175	0.013	0.130			
15-Mar-10	0.066	0.862	0.099	0.010	0.251			
16-Mar-10	0.105	2.761	0.099	0.014	0.156			
17-Mar-10	0.162	3.411	0.114	0.020	0.134			
18-Mar-10	0.480	1.908	0.085	0.068	0.195			
19-Mar-10	0.310	0.921	0.037	0.053	0.110			
20-Mar-10	0.129	2.301	0.038	0.021	0.194			
21-Mar-10	0.296	1.070	0.040	0.053	0.195			
22-Mar-10	0.696	0.210	0.185		0.614	0.957	1.028	0.723
23-Mar-10	0.077	2.087	0.043	0.013	0.193			
24-Mar-10	0.050	2.106	0.057	0.015	0.164			
25-Mar-10	0.071	0.057	0.048	0.025	0.295	0.326	0.535	0.776
26-Mar-10	0.479	0.007	0.041	0.033	0.108	1.102	0.696	0.718
27-Mar-10	1.049	0.060	0.109	0.032	0.278	0.803	0.821	0.927
28-Mar-10	0.298	0.081	0.132	0.013	0.294	0.228	1.067	0.686
29-Mar-10	1.148	0.120	0.153	0.033	0.538	0.767	0.893	0.961
30-Mar-10	0.143	0.004	0.025	0.011	0.106	0.081	0.125	0.236
31-Mar-10	0.131	0.008	0.049	0.031	0.163	0.377	0.394	0.490
01-Apr-10	0.111	0.023	0.091	0.070	0.319	0.124	0.227	0.455
02-Apr-10	0.694	0.028	0.057	0.010	0.160	0.226	0.240	0.323
03-Apr-10	0.337	0.061	0.098	0.028	0.278	0.219	0.880	0.750
04-Apr-10	0.287	0.018	0.094	0.030	0.319	0.349	0.371	0.714
05-Apr-10	0.163	0.011	0.092	0.048	0.230	0.334	0.637	0.716
06-Apr-10	0.598	0.317	0.171	0.024	0.333	0.119	0.995	0.643
07-Apr-10	0.685	0.100	0.147	0.047	0.462	0.181	0.483	0.526
08-Apr-10	0.315	0.261	0.122	0.023	0.375	0.520	1.629	0.755

Appendix IV: Water soluble ions fine fraction concentrations measured at CPSS site

	Cencentration in air (µg m^{-3})							
	Na	NH4	K	Mg	Ca	Cl	NO3	SO4
22-Feb-09	0.098	0.010	0.009	0.001	0.003	0.174	0.008	0.023
23-Feb-09	0.026	0.018	0.004	0.000	0.011	0.036	0.032	0.029
24-Feb-09	0.053	0.356	0.030	0.001	0.036	0.073	0.527	0.730
25-Feb-09	0.031	0.631	0.005	0.000	0.007	0.037	0.756	1.243
26-Feb-09	0.081	0.210	0.021	0.001	0.024	0.137	0.322	0.329
27-Feb-09	0.248	0.387	0.038	0.003	0.045	0.411	0.632	0.764
28-Feb-09	0.210	0.368	0.032	0.003	0.046	0.344	0.657	0.489
01-Mar-09	0.049	0.137	0.003	0.001	0.008	0.092	0.220	0.311
02-Mar-09	0.102	0.547	0.058	0.002	0.091	0.174	0.756	0.953
03-Mar-09	0.092	0.168	0.028	0.001	0.039	0.142	0.196	0.473
04-Mar-09	0.256	0.021	0.012	0.003	0.011	0.361	0.341	0.382
05-Mar-09	0.114	0.103	0.015	0.001	0.005	0.185	0.216	0.235
06-Mar-09	0.060	0.167	0.012	0.001	0.004	0.106	0.216	0.235
07-Mar-09	0.126	0.062	0.019	0.002	0.005	0.213	0.097	0.097
08-Mar-09	0.229	0.080	0.020	0.003	0.025	0.411	0.131	0.153
09-Mar-09	0.478	0.076	0.081	0.006	0.096	0.742	0.136	0.191
10-Mar-09	0.353	0.195	0.019	0.004	0.022	0.674	0.322	0.342
11-Mar-09	0.650		0.032	0.008	0.013	1.060		
12-Mar-09	0.106		0.013	0.002	0.023	0.174		
13-Mar-09	0.019		0.017	0.003	0.032	0.036		
14-Mar-09	0.346	0.150	0.014	0.004	0.003	0.432	0.216	0.250
15-Mar-09	0.144	0.151	0.007	0.002	0.003	0.218	0.403	0.260
16-Mar-09	1.067	0.387	0.040	0.016	0.006	1.739	0.632	0.766

Appendix V: Levoglucosan concentrations measurement dataset at EROS and BWSS sites

	Concentrations(ng m^{-3})	
	EROS	WBSS
4-May-09	10.345	
5-May-09	5.345	
6-May-09	6.145	
7-May-09	7.675	
8-May-09	6.763	
9-May-09		
10-May-09		
11-May-09	6.265	
12-May-09	4.161	
13-May-09	7.620	
14-May-09	12.165	
15-May-09	4.654	
16-May-09		
17-May-09		
18-May-09	7.782	
19-May-09	5.653	
20-May-09	4.634	
21-May-09	8.785	
22-May-09	13.873	
23-May-09		
24-May-09		
25-May-09	10.876	
26-May-09	5.165	
27-May-09	25.727	
28-May-09	4.246	
29-May-09	6.456	
30-May-09		
31-May-09		
1-Jun-09	20.456	
2-Jun-09	15.167	
3-Jun-09	12.975	
4-Jun-09	5.476	
5-Jun-09	6.788	
6-Jun-09		
7-Jun-09		
8-Jun-09	9.476	
9-Jun-09	8.475	
10-Jun-09	20.789	
11-Jun-09	3.770	
12-Jun-09	5.457	
13-Jun-09		
14-Jun-09		
15-Jun-09	7.786	
16-Jun-09	15.475	
17-Jun-09	5.787	
18-Jun-09	7.452	
19-Jun-09		

20-Jun-09	
21-Jun-09	
22-Jun-09	
23-Jun-09	
24-Jun-09	
25-Jun-09	
26-Jun-09	
27-Jun-09	
28-Jun-09	
29-Jun-09	
30-Jun-09	
1-Jul-09	
2-Jul-09	
3-Jul-09	
4-Jul-09	
5-Jul-09	
6-Jul-09	
7-Jul-09	
8-Jul-09	2.442
9-Jul-09	4.242
10-Jul-09	7.790
11-Jul-09	
12-Jul-09	
13-Jul-09	15.745
14-Jul-09	25.577
15-Jul-09	2.453
16-Jul-09	6.475
17-Jul-09	7.246
18-Jul-09	
19-Jul-09	
20-Jul-09	
21-Jul-09	
22-Jul-09	
23-Jul-09	
24-Jul-09	
25-Jul-09	
26-Jul-09	
27-Jul-09	
28-Jul-09	
29-Jul-09	
30-Jul-09	
31-Jul-09	3.275
1-Aug-09	
2-Aug-09	
3-Aug-09	8.779
4-Aug-09	10.046
5-Aug-09	4.479
6-Aug-09	13.790
7-Aug-09	10.789
8-Aug-09	
9-Aug-09	

10-Aug-09	8.457
11-Aug-09	9.788
12-Aug-09	5.257
13-Aug-09	8.275
14-Aug-09	10.787
15-Aug-09	
16-Aug-09	
17-Aug-09	5.747
18-Aug-09	8.787
19-Aug-09	10.525
20-Aug-09	
21-Aug-09	
22-Aug-09	
23-Aug-09	
24-Aug-09	
25-Aug-09	
26-Aug-09	
27-Aug-09	20.747
28-Aug-09	10.790
29-Aug-09	
30-Aug-09	
31-Aug-09	18.425
1-Sep-09	10.215
2-Sep-09	10.247
3-Sep-09	8.458
4-Sep-09	9.790
5-Sep-09	
6-Sep-09	
7-Sep-09	26.575
8-Sep-09	10.687
9-Sep-09	10.456
10-Sep-09	8.790
11-Sep-09	7.723
12-Sep-09	
13-Sep-09	
14-Sep-09	5.787
15-Sep-09	6.456
16-Sep-09	
17-Sep-09	
18-Sep-09	
19-Sep-09	
20-Sep-09	
21-Sep-09	
22-Sep-09	
23-Sep-09	
24-Sep-09	
25-Sep-09	
26-Sep-09	
27-Sep-09	
28-Sep-09	
29-Sep-09	

30-Sep-09	
1-Oct-09	
2-Oct-09	
3-Oct-09	
4-Oct-09	
5-Oct-09	
6-Oct-09	
7-Oct-09	
8-Oct-09	
9-Oct-09	
10-Oct-09	
11-Oct-09	
12-Oct-09	
13-Oct-09	
14-Oct-09	
15-Oct-09	
16-Oct-09	4.712
17-Oct-09	
18-Oct-09	
19-Oct-09	20.280
20-Oct-09	26.278
21-Oct-09	10.577
22-Oct-09	29.457
23-Oct-09	10.790
24-Oct-09	
25-Oct-09	
26-Oct-09	10.025
27-Oct-09	26.242
28-Oct-09	9.218
29-Oct-09	10.079
30-Oct-09	9.078
31-Oct-09	
1-Nov-09	
2-Nov-09	10.279
3-Nov-09	11.245
4-Nov-09	25.782
5-Nov-09	25.789
6-Nov-09	14.731
7-Nov-09	
8-Nov-09	
9-Nov-09	10.279
10-Nov-09	20.205
11-Nov-09	15.275
12-Nov-09	39.027
13-Nov-09	14.457
14-Nov-09	
15-Nov-09	
16-Nov-09	17.279
17-Nov-09	36.275
18-Nov-09	85.279
19-Nov-09	48.787

20-Nov-09	7.877	14.000
21-Nov-09		19.000
22-Nov-09		70.700
23-Nov-09	36.899	15.000
24-Nov-09	16.457	13.000
25-Nov-09	25.749	15.000
26-Nov-09	40.276	54.000
27-Nov-09	94.757	85.000
28-Nov-09		156.000
29-Nov-09		85.000
30-Nov-09	36.046	48.000
1-Dec-09	10.746	77.000
2-Dec-09	37.479	80.287
3-Dec-09	34.279	8.376
4-Dec-09	93.279	31.531
5-Dec-09		3.811
6-Dec-09		16.726
7-Dec-09	56.897	21.761
8-Dec-09	58.782	12.138
9-Dec-09	60.200	31.900
10-Dec-09	40.046	97.300
11-Dec-09	56.275	181.200
12-Dec-09		353.000
13-Dec-09		144.600
14-Dec-09	47.721	77.400
15-Dec-09	98.243	105.500
16-Dec-09	36.767	54.057
17-Dec-09	8.478	13.834
18-Dec-09		70.460
19-Dec-09		23.962
20-Dec-09		16.896
21-Dec-09		43.981
22-Dec-09		67.431
23-Dec-09		20.868
24-Dec-09		67.157
25-Dec-09		11.459
26-Dec-09		16.782
27-Dec-09		41.379
28-Dec-09		109.325
29-Dec-09		32.724
30-Dec-09		18.847
31-Dec-09		31.332
1-Jan-10		26.016
2-Jan-10		17.012
3-Jan-10		145.744
4-Jan-10		156.422
5-Jan-10		99.865
6-Jan-10		25.519
7-Jan-10		24.331
8-Jan-10		24.770
9-Jan-10		14.869

10-Jan-10		33.178
11-Jan-10		58.138
12-Jan-10		102.831
13-Jan-10	34.279	131.142
14-Jan-10		26.737
15-Jan-10		12.361
16-Jan-10		9.207
17-Jan-10		11.418
18-Jan-10		
19-Jan-10		7.765
20-Jan-10		166.472
21-Jan-10		125.321
22-Jan-10		25.354
23-Jan-10		19.247
24-Jan-10		43.157
25-Jan-10	50.215	22.790
26-Jan-10	43.216	40.140
27-Jan-10	75.205	17.446
28-Jan-10	45.477	10.430
29-Jan-10	76.789	18.306
30-Jan-10		13.514
31-Jan-10		8.317
1-Feb-10	50.279	21.235
2-Feb-10	56.478	15.743
3-Feb-10		
4-Feb-10	86.457	26.643
5-Feb-10	57.055	14.501
6-Feb-10		14.794
7-Feb-10		10.717
8-Feb-10	30.457	240.784
9-Feb-10	26.721	58.657
10-Feb-10	20.278	61.111
11-Feb-10	35.979	86.373
12-Feb-10	50.721	66.803
13-Feb-10	27.248	82.679
14-Feb-10	27.241	169.412
15-Feb-10	34.013	12.859
16-Feb-10	17.045	123.123
17-Feb-10	40.454	12.500
18-Feb-10	57.246	243.260
19-Feb-10	26.057	110.330
20-Feb-10		17.485
21-Feb-10		142.498
22-Feb-10	4.127	26.985
23-Feb-10	18.789	13.212
24-Feb-10	20.724	185.189
25-Feb-10	23.749	74.544
26-Feb-10	16.218	41.833
27-Feb-10		90.517
28-Feb-10		70.457
1-Mar-10	9.222	139.797

2-Mar-10	8.213	69.414
3-Mar-10	6.782	83.956
4-Mar-10	7.045	287.119
5-Mar-10	7.048	12.570
6-Mar-10		78.433
7-Mar-10		118.738
8-Mar-10	34.264	59.418
9-Mar-10	23.975	93.946
10-Mar-10	10.782	41.340
11-Mar-10	12.276	80.331
12-Mar-10	10.467	44.495
13-Mar-10		27.988
14-Mar-10		13.723
15-Mar-10	10.245	94.321
16-Mar-10	8.240	14.432
17-Mar-10	7.787	65.342
18-Mar-10	10.245	39.741
19-Mar-10	8.248	11.891
20-Mar-10		37.421
21-Mar-10		37.399
22-Mar-10	10.249	49.939
23-Mar-10	9.790	49.805
24-Mar-10	6.275	65.351
25-Mar-10	8.275	5.547
26-Mar-10	7.787	18.522
27-Mar-10		36.014
28-Mar-10		70.459
29-Mar-10	10.279	10.456
30-Mar-10	11.231	12.634
31-Mar-10	7.543	16.237
1-Apr-10		8.926
2-Apr-10		5.099
3-Apr-10		15.148
4-Apr-10		7.579
5-Apr-10		25.486
6-Apr-10		35.987
7-Apr-10		10.457
8-Apr-10		20.456

Appendix V: Multi-wavelength Aethalometer measurement raw dataset obtained at BWSS sites. The dataset is too much for the list so a disk is attached with this thesis. Also the R-cran computer codes will be in the disk too.

Disk space = 1.013776E+09 bytes free: One entry at every 5 minutes.
There is space for 215514 hours (8980 days) more data

18-jan-10 13:33:29 Tape feeder mechanism advancing for 1 spot(s).

18-jan-10 13:35:37
==
Automatic re-start
==

MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

18-jan-10 13:39:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.990 ref(beam) = 2.616
. Lamp 2 (470 nm): sen(beam) = 2.951 ref(beam) = 2.925
. Lamp 3 (520 nm): sen(beam) = 2.400 ref(beam) = 2.905
. Lamp 4 (590 nm): sen(beam) = 2.497 ref(beam) = 3.714
. Lamp 5 (660 nm): sen(beam) = 2.094 ref(beam) = 2.545
. Lamp 6 (880 nm): sen(beam) = 3.269 ref(beam) = 3.567
. Lamp 7 (950 nm): sen(beam) = 2.074 ref(beam) = 2.384

18-jan-10 19:25:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 5.75 hours
. Total airflow this filter = 1.37 cubic meters
. Mean BC concentration of all lamps = 1616 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.646 sen(zero) = 0.021
. ref(beam) = 2.637 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2454 ng
Mean aerosol black carbon concentration = 1816 ng/m3

The reference beam showed lamp intensity fluctuations of 306 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.918 sen(zero) = 0.021
. ref(beam) = 2.935 ref(zero) = 0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2236 ng
Mean aerosol black carbon concentration = 1654 ng/m3

The reference beam showed lamp intensity fluctuations of 122 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.651 sen(zero) = 0.021
. ref(beam) = 2.907 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2137 ng
Mean aerosol black carbon concentration = 1581 ng/m3

The reference beam showed lamp intensity fluctuations of 152 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.832 sen(zero) = 0.021
. ref(beam) = 3.797 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2161 ng
Mean aerosol black carbon concentration = 1599 ng/m3

The reference beam showed lamp intensity fluctuations of 709 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.547 sen(zero) = 0.021
. ref(beam) = 2.537 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2173 ng
Mean aerosol black carbon concentration = 1608 ng/m3

The reference beam showed lamp intensity fluctuations of 364 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.630 sen(zero) = 0.021
. ref(beam) = 3.565 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2093 ng
Mean aerosol black carbon concentration = 1549 ng/m3

The reference beam showed lamp intensity fluctuations of 368 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.709 sen(zero) = 0.021
. ref(beam) = 2.387 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2038 ng
Mean aerosol black carbon concentration = 1508 ng/m3

The reference beam showed lamp intensity fluctuations of 466 ppm.

Disk space = 1.013776E+09 bytes free: One entry at every 5 minutes.
There is space for 215514 hours (8980 days) more data

18-jan-10 19:25:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

18-jan-10 19:34:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.918 ref(beam) =   2.602
. Lamp 2 (470 nm): sen(beam) =   2.941 ref(beam) =   2.938
. Lamp 3 (520 nm): sen(beam) =   2.355 ref(beam) =   2.922
. Lamp 4 (590 nm): sen(beam) =   2.437 ref(beam) =   3.711
. Lamp 5 (660 nm): sen(beam) =   2.083 ref(beam) =   2.539
. Lamp 6 (880 nm): sen(beam) =   3.219 ref(beam) =   3.571
. Lamp 7 (950 nm): sen(beam) =   2.079 ref(beam) =   2.381

18-jan-10 22:35:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 2.99 hours
.   Total airflow this filter = .71 cubic meters
.   Mean BC concentration of all lamps = 2988 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.537 sen(zero) =   0.021
.   ref(beam) =   2.602 ref(zero) =   0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2483 ng
Mean aerosol black carbon concentration = 3569 ng/m3

The reference beam showed lamp intensity fluctuations of 231 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.897 sen(zero) =   0.021
.   ref(beam) =   2.929 ref(zero) =   0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2155 ng
Mean aerosol black carbon concentration = 3097 ng/m3

The reference beam showed lamp intensity fluctuations of 170 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.620 sen(zero) =   0.021
.   ref(beam) =   2.908 ref(zero) =   0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2036 ng
Mean aerosol black carbon concentration = 2926 ng/m3

The reference beam showed lamp intensity fluctuations of 152 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.783 sen(zero) =   0.021
.   ref(beam) =   3.754 ref(zero) =   0.021
. Optical attenuation of filter deposit = 31

. Total aerosol black carbon on filter = 2039 ng
Mean aerosol black carbon concentration = 2931 ng/m3

The reference beam showed lamp intensity fluctuations of 642 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.551 sen(zero) = 0.021
. ref(beam) = 2.522 ref(zero) = 0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 2026 ng
Mean aerosol black carbon concentration = 2912 ng/m3

The reference beam showed lamp intensity fluctuations of 323 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.598 sen(zero) = 0.021
. ref(beam) = 3.547 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 1944 ng
Mean aerosol black carbon concentration = 2794 ng/m3

The reference beam showed lamp intensity fluctuations of 355 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.719 sen(zero) = 0.021
. ref(beam) = 2.366 ref(zero) = 0.021
. Optical attenuation of filter deposit = 17
. Total aerosol black carbon on filter = 1869 ng
Mean aerosol black carbon concentration = 2687 ng/m3

The reference beam showed lamp intensity fluctuations of 435 ppm.

Disk space = 1.013727E+09 bytes free: One entry at every 5 minutes.
There is space for 215503 hours (8979 days) more data

18-jan-10 22:35:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

18-jan-10 22:44:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.887 ref(beam) = 2.519
. Lamp 2 (470 nm): sen(beam) = 2.907 ref(beam) = 2.864
. Lamp 3 (520 nm): sen(beam) = 2.358 ref(beam) = 2.866
. Lamp 4 (590 nm): sen(beam) = 2.405 ref(beam) = 3.598
. Lamp 5 (660 nm): sen(beam) = 2.038 ref(beam) = 2.467
. Lamp 6 (880 nm): sen(beam) = 3.192 ref(beam) = 3.483

. Lamp 7 (950 nm): sen(beam) = 2.030 ref(beam) = 2.314

19-jan-10 01:45:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 2.99 hours
. Total airflow this filter = .71 cubic meters
. Mean BC concentration of all lamps = 3054 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.555 sen(zero) = 0.021
. ref(beam) = 2.537 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2468 ng
Mean aerosol black carbon concentration = 3548 ng/m3

The reference beam showed lamp intensity fluctuations of 45 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.877 sen(zero) = 0.021
. ref(beam) = 2.865 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2199 ng
Mean aerosol black carbon concentration = 3161 ng/m3

The reference beam showed lamp intensity fluctuations of 54 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.621 sen(zero) = 0.021
. ref(beam) = 2.864 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2088 ng
Mean aerosol black carbon concentration = 3002 ng/m3

The reference beam showed lamp intensity fluctuations of 45 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.783 sen(zero) = 0.021
. ref(beam) = 3.704 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2095 ng
Mean aerosol black carbon concentration = 3012 ng/m3

The reference beam showed lamp intensity fluctuations of 97 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.525 sen(zero) = 0.021
. ref(beam) = 2.473 ref(zero) = 0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 2078 ng
Mean aerosol black carbon concentration = 2987 ng/m3

The reference beam showed lamp intensity fluctuations of 40 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) =   2.592 sen(zero) =   0.021
.   ref(beam) =   3.496 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2010 ng
Mean aerosol black carbon concentration = 2890 ng/m3

The reference beam showed lamp intensity fluctuations of 47 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.691 sen(zero) =   0.021
.   ref(beam) =   2.327 ref(zero) =   0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1935 ng
Mean aerosol black carbon concentration = 2782 ng/m3

The reference beam showed lamp intensity fluctuations of 72 ppm.

Disk space = 1.013711E+09 bytes free: One entry at every 5 minutes.
There is space for 215500 hours (8979 days) more data

19-jan-10 01:45:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

19-jan-10 01:54:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.817 ref(beam) =   2.495
. Lamp 2 (470 nm): sen(beam) =   2.846 ref(beam) =   2.861
. Lamp 3 (520 nm): sen(beam) =   2.316 ref(beam) =   2.847
. Lamp 4 (590 nm): sen(beam) =   2.359 ref(beam) =   3.574
. Lamp 5 (660 nm): sen(beam) =   1.996 ref(beam) =   2.461
. Lamp 6 (880 nm): sen(beam) =   3.139 ref(beam) =   3.475
. Lamp 7 (950 nm): sen(beam) =   1.994 ref(beam) =   2.307

19-jan-10 04:50:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 2.91 hours
.   Total airflow this filter = .69 cubic meters
.   Mean BC concentration of all lamps = 3165 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.518 sen(zero) =   0.021
.   ref(beam) =   2.519 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2444 ng

Mean aerosol black carbon concentration = 3617 ng/m3

The reference beam showed lamp intensity fluctuations of 80 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.823 sen(zero) = 0.021
. ref(beam) = 2.865 ref(zero) = 0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2216 ng
Mean aerosol black carbon concentration = 3279 ng/m3

The reference beam showed lamp intensity fluctuations of 48 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.584 sen(zero) = 0.021
. ref(beam) = 2.848 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2096 ng
Mean aerosol black carbon concentration = 3101 ng/m3

The reference beam showed lamp intensity fluctuations of 43 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.749 sen(zero) = 0.021
. ref(beam) = 3.699 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2106 ng
Mean aerosol black carbon concentration = 3116 ng/m3

The reference beam showed lamp intensity fluctuations of 190 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.487 sen(zero) = 0.021
. ref(beam) = 2.473 ref(zero) = 0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 2106 ng
Mean aerosol black carbon concentration = 3116 ng/m3

The reference beam showed lamp intensity fluctuations of 95 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.546 sen(zero) = 0.021
. ref(beam) = 3.500 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2033 ng
Mean aerosol black carbon concentration = 3008 ng/m3

The reference beam showed lamp intensity fluctuations of 132 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.658 sen(zero) = 0.021
. ref(beam) = 2.328 ref(zero) = 0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1972 ng

Mean aerosol black carbon concentration = 2918 ng/m3

The reference beam showed lamp intensity fluctuations of 188 ppm.

Disk space = 1.013678E+09 bytes free: One entry at every 5 minutes.
There is space for 215493 hours (8979 days) more data

19-jan-10 04:50:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

19-jan-10 04:59:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.822 ref(beam) =   2.471
. Lamp 2 (470 nm): sen(beam) =   2.847 ref(beam) =   2.815
. Lamp 3 (520 nm): sen(beam) =   2.315 ref(beam) =   2.814
. Lamp 4 (590 nm): sen(beam) =   2.363 ref(beam) =   3.547
. Lamp 5 (660 nm): sen(beam) =   1.998 ref(beam) =   2.422
. Lamp 6 (880 nm): sen(beam) =   3.127 ref(beam) =   3.439
. Lamp 7 (950 nm): sen(beam) =   1.998 ref(beam) =   2.272

19-jan-10 09:05:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 4.08 hours
.   Total airflow this filter = .97 cubic meters
.   Mean BC concentration of all lamps = 2361 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.502 sen(zero) =   0.021
.   ref(beam) =   2.486 ref(zero) =   0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2505 ng
Mean aerosol black carbon concentration = 2625 ng/m3

The reference beam showed lamp intensity fluctuations of 69 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.792 sen(zero) =   0.021
.   ref(beam) =   2.814 ref(zero) =   0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2323 ng
Mean aerosol black carbon concentration = 2434 ng/m3

The reference beam showed lamp intensity fluctuations of 65 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.558 sen(zero) = 0.021
. ref(beam) = 2.810 ref(zero) = 0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2199 ng
Mean aerosol black carbon concentration = 2305 ng/m3

The reference beam showed lamp intensity fluctuations of 59 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.710 sen(zero) = 0.021
. ref(beam) = 3.639 ref(zero) = 0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2222 ng
Mean aerosol black carbon concentration = 2329 ng/m3

The reference beam showed lamp intensity fluctuations of 141 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.459 sen(zero) = 0.021
. ref(beam) = 2.423 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2240 ng
Mean aerosol black carbon concentration = 2347 ng/m3

The reference beam showed lamp intensity fluctuations of 71 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.492 sen(zero) = 0.021
. ref(beam) = 3.445 ref(zero) = 0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2166 ng
Mean aerosol black carbon concentration = 2270 ng/m3

The reference beam showed lamp intensity fluctuations of 75 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.631 sen(zero) = 0.021
. ref(beam) = 2.279 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2117 ng
Mean aerosol black carbon concentration = 2218 ng/m3

The reference beam showed lamp intensity fluctuations of 102 ppm.

Disk space = 1.013662E+09 bytes free: One entry at every 5 minutes.
There is space for 215489 hours (8979 days) more data

19-jan-10 09:05:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

19-jan-10 09:14:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.755 ref(beam) =   2.492
. Lamp 2 (470 nm): sen(beam) =   2.721 ref(beam) =   2.850
. Lamp 3 (520 nm): sen(beam) =   2.260 ref(beam) =   2.889
. Lamp 4 (590 nm): sen(beam) =   2.303 ref(beam) =   3.647
. Lamp 5 (660 nm): sen(beam) =   1.898 ref(beam) =   2.442
. Lamp 6 (880 nm): sen(beam) =   3.068 ref(beam) =   3.553
. Lamp 7 (950 nm): sen(beam) =   1.899 ref(beam) =   2.301

19-jan-10 12:10:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 2.91 hours
.   Total airflow this filter = .69 cubic meters
.   Mean BC concentration of all lamps = 3381 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.478 sen(zero) =   0.021
.   ref(beam) =   2.494 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2442 ng
Mean aerosol black carbon concentration = 3613 ng/m3

The reference beam showed lamp intensity fluctuations of 209 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.698 sen(zero) =   0.021
.   ref(beam) =   2.844 ref(zero) =   0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2344 ng
Mean aerosol black carbon concentration = 3468 ng/m3

The reference beam showed lamp intensity fluctuations of 146 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.503 sen(zero) =   0.021
.   ref(beam) =   2.880 ref(zero) =   0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2239 ng
Mean aerosol black carbon concentration = 3313 ng/m3

The reference beam showed lamp intensity fluctuations of 119 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.633 sen(zero) =   0.021
.   ref(beam) =   3.699 ref(zero) =   0.021
. Optical attenuation of filter deposit = 35

. Total aerosol black carbon on filter = 2267 ng
Mean aerosol black carbon concentration = 3355 ng/m3

The reference beam showed lamp intensity fluctuations of 357 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.366 sen(zero) = 0.021
. ref(beam) = 2.431 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2287 ng
Mean aerosol black carbon concentration = 3385 ng/m3

The reference beam showed lamp intensity fluctuations of 233 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.409 sen(zero) = 0.021
. ref(beam) = 3.536 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2230 ng
Mean aerosol black carbon concentration = 3299 ng/m3

The reference beam showed lamp intensity fluctuations of 250 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.527 sen(zero) = 0.021
. ref(beam) = 2.290 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2183 ng
Mean aerosol black carbon concentration = 3230 ng/m3

The reference beam showed lamp intensity fluctuations of 255 ppm.

Disk space = 1.013645E+09 bytes free: One entry at every 5 minutes.
There is space for 215486 hours (8979 days) more data

19-jan-10 12:10:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

19-jan-10 12:19:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.722 ref(beam) = 2.506
. Lamp 2 (470 nm): sen(beam) = 2.686 ref(beam) = 2.885
. Lamp 3 (520 nm): sen(beam) = 2.237 ref(beam) = 2.918
. Lamp 4 (590 nm): sen(beam) = 2.244 ref(beam) = 3.637
. Lamp 5 (660 nm): sen(beam) = 1.858 ref(beam) = 2.466
. Lamp 6 (880 nm): sen(beam) = 3.012 ref(beam) = 3.568

. Lamp 7 (950 nm): sen(beam) = 1.857 ref(beam) = 2.312

19-jan-10 16:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 3.66 hours
. Total airflow this filter = .87 cubic meters
. Mean BC concentration of all lamps = 2907 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.449 sen(zero) = 0.021
. ref(beam) = 2.523 ref(zero) = 0.021
. Optical attenuation of filter deposit = 62
. Total aerosol black carbon on filter = 2521 ng
Mean aerosol black carbon concentration = 2950 ng/m3

The reference beam showed lamp intensity fluctuations of 166 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.619 sen(zero) = 0.021
. ref(beam) = 2.891 ref(zero) = 0.021
. Optical attenuation of filter deposit = 49
. Total aerosol black carbon on filter = 2565 ng
Mean aerosol black carbon concentration = 3001 ng/m3

The reference beam showed lamp intensity fluctuations of 118 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.466 sen(zero) = 0.021
. ref(beam) = 2.921 ref(zero) = 0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2374 ng
Mean aerosol black carbon concentration = 2777 ng/m3

The reference beam showed lamp intensity fluctuations of 113 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.590 sen(zero) = 0.021
. ref(beam) = 3.765 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2426 ng
Mean aerosol black carbon concentration = 2839 ng/m3

The reference beam showed lamp intensity fluctuations of 267 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.294 sen(zero) = 0.021
. ref(beam) = 2.478 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2619 ng
Mean aerosol black carbon concentration = 3064 ng/m3

The reference beam showed lamp intensity fluctuations of 180 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.336 sen(zero) = 0.021
. ref(beam) = 3.592 ref(zero) = 0.021
. Optical attenuation of filter deposit = 25
. Total aerosol black carbon on filter = 2482 ng
Mean aerosol black carbon concentration = 2905 ng/m3

The reference beam showed lamp intensity fluctuations of 172 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.485 sen(zero) = 0.021
. ref(beam) = 2.333 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2405 ng
Mean aerosol black carbon concentration = 2814 ng/m3

The reference beam showed lamp intensity fluctuations of 264 ppm.

Disk space = 1.013629E+09 bytes free: One entry at every 5 minutes.
There is space for 215482 hours (8978 days) more data

19-jan-10 16:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

19-jan-10 16:09:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.730 ref(beam) = 2.512
. Lamp 2 (470 nm): sen(beam) = 2.686 ref(beam) = 2.885
. Lamp 3 (520 nm): sen(beam) = 2.224 ref(beam) = 2.927
. Lamp 4 (590 nm): sen(beam) = 2.223 ref(beam) = 3.670
. Lamp 5 (660 nm): sen(beam) = 1.823 ref(beam) = 2.471
. Lamp 6 (880 nm): sen(beam) = 3.057 ref(beam) = 3.601
. Lamp 7 (950 nm): sen(beam) = 1.870 ref(beam) = 2.324

19-jan-10 20:40:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 4.49 hours
. Total airflow this filter = 1.07 cubic meters
. Mean BC concentration of all lamps = 2067 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.504 sen(zero) = 0.021
. ref(beam) = 2.563 ref(zero) = 0.021

. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2442 ng
Mean aerosol black carbon concentration = 2318 ng/m3

The reference beam showed lamp intensity fluctuations of 205 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.719 sen(zero) = 0.021
. ref(beam) = 2.901 ref(zero) = 0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2216 ng
Mean aerosol black carbon concentration = 2103 ng/m3

The reference beam showed lamp intensity fluctuations of 51 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.553 sen(zero) = 0.021
. ref(beam) = 2.940 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2133 ng
Mean aerosol black carbon concentration = 2024 ng/m3

The reference beam showed lamp intensity fluctuations of 71 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.731 sen(zero) = 0.021
. ref(beam) = 3.886 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2147 ng
Mean aerosol black carbon concentration = 2038 ng/m3

The reference beam showed lamp intensity fluctuations of 541 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.391 sen(zero) = 0.021
. ref(beam) = 2.511 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2196 ng
Mean aerosol black carbon concentration = 2085 ng/m3

The reference beam showed lamp intensity fluctuations of 242 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.503 sen(zero) = 0.021
. ref(beam) = 3.671 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2082 ng
Mean aerosol black carbon concentration = 1977 ng/m3

The reference beam showed lamp intensity fluctuations of 280 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.572 sen(zero) = 0.021
. ref(beam) = 2.383 ref(zero) = 0.021

. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2026 ng
Mean aerosol black carbon concentration = 1923 ng/m3

The reference beam showed lamp intensity fluctuations of 362 ppm.

Disk space = 1.013596E+09 bytes free: One entry at every 5 minutes.
There is space for 215475 hours (8978 days) more data

19-jan-10 20:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

19-jan-10 20:49:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.803 ref(beam) =   2.544
. Lamp 2 (470 nm): sen(beam) =   2.741 ref(beam) =   2.915
. Lamp 3 (520 nm): sen(beam) =   2.279 ref(beam) =   2.922
. Lamp 4 (590 nm): sen(beam) =   2.366 ref(beam) =   3.750
. Lamp 5 (660 nm): sen(beam) =   1.925 ref(beam) =   2.520
. Lamp 6 (880 nm): sen(beam) =   3.120 ref(beam) =   3.637
. Lamp 7 (950 nm): sen(beam) =   1.949 ref(beam) =   2.376

20-jan-10 06:35:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 9.74 hours
. Total airflow this filter = 2.32 cubic meters
. Mean BC concentration of all lamps = 926 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.538 sen(zero) = 0.021
. ref(beam) = 2.583 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2431 ng
Mean aerosol black carbon concentration = 1054 ng/m3

The reference beam showed lamp intensity fluctuations of 64 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.783 sen(zero) = 0.021
. ref(beam) = 2.927 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2202 ng
Mean aerosol black carbon concentration = 955 ng/m3

The reference beam showed lamp intensity fluctuations of 34 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.578 sen(zero) = 0.021
. ref(beam) = 2.929 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2084 ng
Mean aerosol black carbon concentration = 903 ng/m3

The reference beam showed lamp intensity fluctuations of 47 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.783 sen(zero) = 0.021
. ref(beam) = 3.915 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2097 ng
Mean aerosol black carbon concentration = 909 ng/m3

The reference beam showed lamp intensity fluctuations of 144 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.448 sen(zero) = 0.021
. ref(beam) = 2.544 ref(zero) = 0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 2110 ng
Mean aerosol black carbon concentration = 915 ng/m3

The reference beam showed lamp intensity fluctuations of 71 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.552 sen(zero) = 0.021
. ref(beam) = 3.681 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2043 ng
Mean aerosol black carbon concentration = 885 ng/m3

The reference beam showed lamp intensity fluctuations of 88 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.635 sen(zero) = 0.021
. ref(beam) = 2.415 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 1990 ng
Mean aerosol black carbon concentration = 862 ng/m3

The reference beam showed lamp intensity fluctuations of 100 ppm.

Disk space = 1.01358E+09 bytes free: One entry at every 5 minutes.
There is space for 215472 hours (8978 days) more data

20-jan-10 06:35:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

20-jan-10 06:44:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.822 ref(beam) = 2.596
. Lamp 2 (470 nm): sen(beam) = 2.751 ref(beam) = 2.957
. Lamp 3 (520 nm): sen(beam) = 2.293 ref(beam) = 2.963
. Lamp 4 (590 nm): sen(beam) = 2.401 ref(beam) = 3.845
. Lamp 5 (660 nm): sen(beam) = 1.940 ref(beam) = 2.559
. Lamp 6 (880 nm): sen(beam) = 3.153 ref(beam) = 3.707
. Lamp 7 (950 nm): sen(beam) = 1.967 ref(beam) = 2.420

20-jan-10 12:05:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 5.33 hours
. Total airflow this filter = 1.27 cubic meters
. Mean BC concentration of all lamps = 1593 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.549 sen(zero) = 0.021
. ref(beam) = 2.619 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2460 ng

Mean aerosol black carbon concentration = 1964 ng/m3

The reference beam showed lamp intensity fluctuations of 92 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.838 sen(zero) = 0.021
. ref(beam) = 2.961 ref(zero) = 0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2076 ng
Mean aerosol black carbon concentration = 1658 ng/m3

The reference beam showed lamp intensity fluctuations of 52 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.627 sen(zero) = 0.021
. ref(beam) = 2.963 ref(zero) = 0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 1949 ng
Mean aerosol black carbon concentration = 1556 ng/m3

The reference beam showed lamp intensity fluctuations of 62 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.843 sen(zero) = 0.021
. ref(beam) = 3.976 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 1936 ng
Mean aerosol black carbon concentration = 1546 ng/m3

The reference beam showed lamp intensity fluctuations of 209 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.496 sen(zero) = 0.021
. ref(beam) = 2.572 ref(zero) = 0.021
. Optical attenuation of filter deposit = 26
. Total aerosol black carbon on filter = 1911 ng
Mean aerosol black carbon concentration = 1525 ng/m3

The reference beam showed lamp intensity fluctuations of 116 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.618 sen(zero) = 0.021
. ref(beam) = 3.732 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 1853 ng
Mean aerosol black carbon concentration = 1479 ng/m3

The reference beam showed lamp intensity fluctuations of 127 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.673 sen(zero) = 0.021
. ref(beam) = 2.443 ref(zero) = 0.021
. Optical attenuation of filter deposit = 17
. Total aerosol black carbon on filter = 1784 ng

Mean aerosol black carbon concentration = 1425 ng/m3

The reference beam showed lamp intensity fluctuations of 151 ppm.

Disk space = 1.013514E+09 bytes free: One entry at every 5 minutes.
There is space for 215458 hours (8977 days) more data

20-jan-10 12:05:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

20-jan-10 12:14:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.826 ref(beam) = 2.585
. Lamp 2 (470 nm): sen(beam) = 2.768 ref(beam) = 2.925
. Lamp 3 (520 nm): sen(beam) = 2.290 ref(beam) = 2.944
. Lamp 4 (590 nm): sen(beam) = 2.402 ref(beam) = 3.824
. Lamp 5 (660 nm): sen(beam) = 1.953 ref(beam) = 2.526
. Lamp 6 (880 nm): sen(beam) = 3.147 ref(beam) = 3.665
. Lamp 7 (950 nm): sen(beam) = 1.985 ref(beam) = 2.394

20-jan-10 17:20:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 5.08 hours
. Total airflow this filter = 1.21 cubic meters
. Mean BC concentration of all lamps = 1788 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.535 sen(zero) = 0.021
. ref(beam) = 2.600 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2467 ng
Mean aerosol black carbon concentration = 2068 ng/m3

The reference beam showed lamp intensity fluctuations of 57 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.793 sen(zero) = 0.021
. ref(beam) = 2.925 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2209 ng
Mean aerosol black carbon concentration = 1852 ng/m3

The reference beam showed lamp intensity fluctuations of 51 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.582 sen(zero) =   0.021
.   ref(beam) =   2.941 ref(zero) =   0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2080 ng
Mean aerosol black carbon concentration = 1743 ng/m3

The reference beam showed lamp intensity fluctuations of 45 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.784 sen(zero) =   0.021
.   ref(beam) =   3.926 ref(zero) =   0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2089 ng
Mean aerosol black carbon concentration = 1751 ng/m3

The reference beam showed lamp intensity fluctuations of 103 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.460 sen(zero) =   0.021
.   ref(beam) =   2.529 ref(zero) =   0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 2096 ng
Mean aerosol black carbon concentration = 1757 ng/m3

The reference beam showed lamp intensity fluctuations of 77 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.555 sen(zero) =   0.021
.   ref(beam) =   3.675 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2019 ng
Mean aerosol black carbon concentration = 1693 ng/m3

The reference beam showed lamp intensity fluctuations of 90 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.648 sen(zero) =   0.021
.   ref(beam) =   2.403 ref(zero) =   0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1973 ng
Mean aerosol black carbon concentration = 1654 ng/m3

The reference beam showed lamp intensity fluctuations of 89 ppm.

Disk space = 1.013481E+09 bytes free: One entry at every 5 minutes.
There is space for 215451 hours (8977 days) more data

20-jan-10 17:20:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

20-jan-10 17:29:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.834 ref(beam) = 2.523
. Lamp 2 (470 nm): sen(beam) = 2.760 ref(beam) = 2.896
. Lamp 3 (520 nm): sen(beam) = 2.294 ref(beam) = 2.936
. Lamp 4 (590 nm): sen(beam) = 2.412 ref(beam) = 3.828
. Lamp 5 (660 nm): sen(beam) = 1.946 ref(beam) = 2.509
. Lamp 6 (880 nm): sen(beam) = 3.159 ref(beam) = 3.681
. Lamp 7 (950 nm): sen(beam) = 1.981 ref(beam) = 2.393

20-jan-10 21:30:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 3.99 hours
. Total airflow this filter = .95 cubic meters
. Mean BC concentration of all lamps = 2251 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.541 sen(zero) = 0.021
. ref(beam) = 2.534 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2437 ng
Mean aerosol black carbon concentration = 2608 ng/m3

The reference beam showed lamp intensity fluctuations of 78 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.790 sen(zero) = 0.021
. ref(beam) = 2.894 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2185 ng
Mean aerosol black carbon concentration = 2338 ng/m3

The reference beam showed lamp intensity fluctuations of 67 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.586 sen(zero) = 0.021
. ref(beam) = 2.931 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2056 ng
Mean aerosol black carbon concentration = 2201 ng/m3

The reference beam showed lamp intensity fluctuations of 56 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.787 sen(zero) = 0.021
. ref(beam) = 3.914 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31

. Total aerosol black carbon on filter = 2062 ng
Mean aerosol black carbon concentration = 2207 ng/m3

The reference beam showed lamp intensity fluctuations of 178 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.455 sen(zero) =   0.021
.   ref(beam) =   2.508 ref(zero) =   0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 2067 ng
Mean aerosol black carbon concentration = 2212 ng/m3

The reference beam showed lamp intensity fluctuations of 101 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.565 sen(zero) =   0.021
.   ref(beam) =   3.682 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 1984 ng
Mean aerosol black carbon concentration = 2123 ng/m3

The reference beam showed lamp intensity fluctuations of 110 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.645 sen(zero) =   0.021
.   ref(beam) =   2.396 ref(zero) =   0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1930 ng
Mean aerosol black carbon concentration = 2065 ng/m3

The reference beam showed lamp intensity fluctuations of 134 ppm.

Disk space = 1.013449E+09 bytes free: One entry at every 5 minutes.
There is space for 215444 hours (8977 days) more data

20-jan-10 21:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

20-jan-10 21:39:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.796 ref(beam) =   2.611
. Lamp 2 (470 nm): sen(beam) =   2.697 ref(beam) =   2.939
. Lamp 3 (520 nm): sen(beam) =   2.270 ref(beam) =   2.996
. Lamp 4 (590 nm): sen(beam) =   2.373 ref(beam) =   3.882
. Lamp 5 (660 nm): sen(beam) =   1.888 ref(beam) =   2.539
. Lamp 6 (880 nm): sen(beam) =   3.114 ref(beam) =   3.730

. Lamp 7 (950 nm): sen(beam) =   1.920 ref(beam) =   2.409

21-jan-10 01:10:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 3.49 hours
.   Total airflow this filter = .83 cubic meters
.   Mean BC concentration of all lamps = 2646 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.517 sen(zero) =   0.021
.   ref(beam) =   2.626 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2440 ng
Mean aerosol black carbon concentration = 2993 ng/m3

The reference beam showed lamp intensity fluctuations of 49 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.729 sen(zero) =   0.021
.   ref(beam) =   2.939 ref(zero) =   0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2237 ng
Mean aerosol black carbon concentration = 2744 ng/m3

The reference beam showed lamp intensity fluctuations of 52 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.552 sen(zero) =   0.021
.   ref(beam) =   2.993 ref(zero) =   0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2119 ng
Mean aerosol black carbon concentration = 2601 ng/m3

The reference beam showed lamp intensity fluctuations of 49 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.746 sen(zero) =   0.021
.   ref(beam) =   3.990 ref(zero) =   0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2133 ng
Mean aerosol black carbon concentration = 2617 ng/m3

The reference beam showed lamp intensity fluctuations of 87 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.401 sen(zero) =   0.021
.   ref(beam) =   2.544 ref(zero) =   0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 2132 ng
Mean aerosol black carbon concentration = 2616 ng/m3

The reference beam showed lamp intensity fluctuations of 62 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.517 sen(zero) = 0.021
. ref(beam) = 3.742 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2049 ng
Mean aerosol black carbon concentration = 2514 ng/m3

The reference beam showed lamp intensity fluctuations of 58 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.590 sen(zero) = 0.021
. ref(beam) = 2.420 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 1985 ng
Mean aerosol black carbon concentration = 2436 ng/m3

The reference beam showed lamp intensity fluctuations of 80 ppm.

Disk space = 1.013432E+09 bytes free: One entry at every 5 minutes.
There is space for 215441 hours (8977 days) more data

21-jan-10 01:10:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

21-jan-10 01:19:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.724 ref(beam) = 2.609
. Lamp 2 (470 nm): sen(beam) = 2.702 ref(beam) = 2.936
. Lamp 3 (520 nm): sen(beam) = 2.278 ref(beam) = 2.970
. Lamp 4 (590 nm): sen(beam) = 2.377 ref(beam) = 3.842
. Lamp 5 (660 nm): sen(beam) = 1.895 ref(beam) = 2.531
. Lamp 6 (880 nm): sen(beam) = 3.130 ref(beam) = 3.699
. Lamp 7 (950 nm): sen(beam) = 1.928 ref(beam) = 2.399

21-jan-10 05:25:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 4.08 hours
. Total airflow this filter = .97 cubic meters
. Mean BC concentration of all lamps = 2287 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.498 sen(zero) = 0.021
. ref(beam) = 2.651 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2432 ng

Mean aerosol black carbon concentration = 2548 ng/m3

The reference beam showed lamp intensity fluctuations of 142 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.729 sen(zero) = 0.021
. ref(beam) = 2.950 ref(zero) = 0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2279 ng
Mean aerosol black carbon concentration = 2389 ng/m3

The reference beam showed lamp intensity fluctuations of 71 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.561 sen(zero) = 0.021
. ref(beam) = 2.981 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2139 ng
Mean aerosol black carbon concentration = 2241 ng/m3

The reference beam showed lamp intensity fluctuations of 75 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.790 sen(zero) = 0.021
. ref(beam) = 4.048 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2152 ng
Mean aerosol black carbon concentration = 2255 ng/m3

The reference beam showed lamp intensity fluctuations of 444 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.417 sen(zero) = 0.021
. ref(beam) = 2.568 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2180 ng
Mean aerosol black carbon concentration = 2284 ng/m3

The reference beam showed lamp intensity fluctuations of 176 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.564 sen(zero) = 0.021
. ref(beam) = 3.765 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2065 ng
Mean aerosol black carbon concentration = 2164 ng/m3

The reference beam showed lamp intensity fluctuations of 218 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.620 sen(zero) = 0.021
. ref(beam) = 2.455 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2030 ng

Mean aerosol black carbon concentration = 2128 ng/m3

The reference beam showed lamp intensity fluctuations of 306 ppm.

Disk space = 1.0134E+09 bytes free: One entry at every 5 minutes.
There is space for 215434 hours (8976 days) more data

21-jan-10 05:25:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

21-jan-10 05:34:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.907 ref(beam) = 2.669
. Lamp 2 (470 nm): sen(beam) = 2.787 ref(beam) = 2.958
. Lamp 3 (520 nm): sen(beam) = 2.342 ref(beam) = 3.019
. Lamp 4 (590 nm): sen(beam) = 2.507 ref(beam) = 3.983
. Lamp 5 (660 nm): sen(beam) = 1.974 ref(beam) = 2.573
. Lamp 6 (880 nm): sen(beam) = 3.258 ref(beam) = 3.782
. Lamp 7 (950 nm): sen(beam) = 2.019 ref(beam) = 2.457

21-jan-10 08:30:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 2.91 hours
. Total airflow this filter = .69 cubic meters
. Mean BC concentration of all lamps = 3201 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.576 sen(zero) = 0.021
. ref(beam) = 2.694 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2432 ng
Mean aerosol black carbon concentration = 3597 ng/m3

The reference beam showed lamp intensity fluctuations of 156 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.776 sen(zero) = 0.021
. ref(beam) = 2.964 ref(zero) = 0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2256 ng
Mean aerosol black carbon concentration = 3336 ng/m3

The reference beam showed lamp intensity fluctuations of 72 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.597 sen(zero) = 0.021
. ref(beam) = 3.022 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2121 ng
Mean aerosol black carbon concentration = 3138 ng/m3

The reference beam showed lamp intensity fluctuations of 87 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.859 sen(zero) = 0.021
. ref(beam) = 4.139 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2134 ng
Mean aerosol black carbon concentration = 3157 ng/m3

The reference beam showed lamp intensity fluctuations of 385 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.466 sen(zero) = 0.021
. ref(beam) = 2.593 ref(zero) = 0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 2154 ng
Mean aerosol black carbon concentration = 3186 ng/m3

The reference beam showed lamp intensity fluctuations of 194 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.646 sen(zero) = 0.021
. ref(beam) = 3.818 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2049 ng
Mean aerosol black carbon concentration = 3031 ng/m3

The reference beam showed lamp intensity fluctuations of 223 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.681 sen(zero) = 0.021
. ref(beam) = 2.490 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2005 ng
Mean aerosol black carbon concentration = 2966 ng/m3

The reference beam showed lamp intensity fluctuations of 272 ppm.

Disk space = 1.013383E+09 bytes free: One entry at every 5 minutes.
There is space for 215430 hours (8976 days) more data

21-jan-10 08:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

21-jan-10 08:39:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.871 ref(beam) =   2.692
. Lamp 2 (470 nm): sen(beam) =   2.719 ref(beam) =   2.979
. Lamp 3 (520 nm): sen(beam) =   2.308 ref(beam) =   3.040
. Lamp 4 (590 nm): sen(beam) =   2.489 ref(beam) =   4.060
. Lamp 5 (660 nm): sen(beam) =   1.928 ref(beam) =   2.602
. Lamp 6 (880 nm): sen(beam) =   3.221 ref(beam) =   3.839
. Lamp 7 (950 nm): sen(beam) =   1.981 ref(beam) =   2.495

21-jan-10 10:30:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 1.83 hours
.   Total airflow this filter = .43 cubic meters
.   Mean BC concentration of all lamps = 5773 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.508 sen(zero) =   0.021
.   ref(beam) =   2.688 ref(zero) =   0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2488 ng
Mean aerosol black carbon concentration = 5959 ng/m3

The reference beam showed lamp intensity fluctuations of 242 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.655 sen(zero) =   0.021
.   ref(beam) =   2.970 ref(zero) =   0.021
. Optical attenuation of filter deposit = 47
. Total aerosol black carbon on filter = 2443 ng
Mean aerosol black carbon concentration = 5852 ng/m3

The reference beam showed lamp intensity fluctuations of 268 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.497 sen(zero) =   0.021
.   ref(beam) =   3.026 ref(zero) =   0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2357 ng
Mean aerosol black carbon concentration = 5645 ng/m3

The reference beam showed lamp intensity fluctuations of 219 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.714 sen(zero) =   0.021
.   ref(beam) =   4.099 ref(zero) =   0.021
. Optical attenuation of filter deposit = 37

. Total aerosol black carbon on filter = 2409 ng
Mean aerosol black carbon concentration = 5770 ng/m3

The reference beam showed lamp intensity fluctuations of 707 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.353 sen(zero) = 0.021
. ref(beam) = 2.584 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2443 ng
Mean aerosol black carbon concentration = 5851 ng/m3

The reference beam showed lamp intensity fluctuations of 353 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.478 sen(zero) = 0.021
. ref(beam) = 3.811 ref(zero) = 0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 2393 ng
Mean aerosol black carbon concentration = 5731 ng/m3

The reference beam showed lamp intensity fluctuations of 428 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.563 sen(zero) = 0.021
. ref(beam) = 2.475 ref(zero) = 0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2338 ng
Mean aerosol black carbon concentration = 5601 ng/m3

The reference beam showed lamp intensity fluctuations of 475 ppm.

Disk space = 1.013367E+09 bytes free: One entry at every 5 minutes.
There is space for 215427 hours (8976 days) more data

21-jan-10 10:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

21-jan-10 10:39:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.815 ref(beam) = 2.660
. Lamp 2 (470 nm): sen(beam) = 2.699 ref(beam) = 2.973
. Lamp 3 (520 nm): sen(beam) = 2.270 ref(beam) = 3.012
. Lamp 4 (590 nm): sen(beam) = 2.411 ref(beam) = 3.942
. Lamp 5 (660 nm): sen(beam) = 1.914 ref(beam) = 2.575
. Lamp 6 (880 nm): sen(beam) = 3.160 ref(beam) = 3.760

. Lamp 7 (950 nm): sen(beam) =   1.967 ref(beam) =   2.449

21-jan-10 15:30:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 4.83 hours
.   Total airflow this filter = 1.15 cubic meters
.   Mean BC concentration of all lamps = 2079 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.454 sen(zero) =   0.021
.   ref(beam) =   2.629 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2445 ng
Mean aerosol black carbon concentration = 2158 ng/m3

The reference beam showed lamp intensity fluctuations of 316 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.634 sen(zero) =   0.021
.   ref(beam) =   2.951 ref(zero) =   0.021
. Optical attenuation of filter deposit = 46
. Total aerosol black carbon on filter = 2378 ng
Mean aerosol black carbon concentration = 2099 ng/m3

The reference beam showed lamp intensity fluctuations of 170 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.461 sen(zero) =   0.021
.   ref(beam) =   2.986 ref(zero) =   0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2315 ng
Mean aerosol black carbon concentration = 2043 ng/m3

The reference beam showed lamp intensity fluctuations of 169 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.609 sen(zero) =   0.021
.   ref(beam) =   3.873 ref(zero) =   0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2371 ng
Mean aerosol black carbon concentration = 2093 ng/m3

The reference beam showed lamp intensity fluctuations of 615 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.328 sen(zero) =   0.021
.   ref(beam) =   2.523 ref(zero) =   0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2371 ng
Mean aerosol black carbon concentration = 2093 ng/m3

The reference beam showed lamp intensity fluctuations of 333 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.393 sen(zero) = 0.021
. ref(beam) = 3.677 ref(zero) = 0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 2345 ng
Mean aerosol black carbon concentration = 2069 ng/m3

The reference beam showed lamp intensity fluctuations of 398 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.527 sen(zero) = 0.021
. ref(beam) = 2.384 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2261 ng
Mean aerosol black carbon concentration = 1995 ng/m3

The reference beam showed lamp intensity fluctuations of 484 ppm.

Disk space = 1.013367E+09 bytes free: One entry at every 5 minutes.
There is space for 215427 hours (8976 days) more data

21-jan-10 15:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

21-jan-10 15:39:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.894 ref(beam) = 2.596
. Lamp 2 (470 nm): sen(beam) = 2.795 ref(beam) = 2.929
. Lamp 3 (520 nm): sen(beam) = 2.331 ref(beam) = 2.993
. Lamp 4 (590 nm): sen(beam) = 2.373 ref(beam) = 3.778
. Lamp 5 (660 nm): sen(beam) = 1.937 ref(beam) = 2.499
. Lamp 6 (880 nm): sen(beam) = 3.154 ref(beam) = 3.678
. Lamp 7 (950 nm): sen(beam) = 1.957 ref(beam) = 2.364

21-jan-10 19:40:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 3.99 hours
. Total airflow this filter = .95 cubic meters
. Mean BC concentration of all lamps = 2350 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.603 sen(zero) = 0.021
. ref(beam) = 2.643 ref(zero) = 0.021

. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2440 ng
Mean aerosol black carbon concentration = 2612 ng/m3

The reference beam showed lamp intensity fluctuations of 123 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.801 sen(zero) = 0.021
. ref(beam) = 2.943 ref(zero) = 0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2264 ng
Mean aerosol black carbon concentration = 2424 ng/m3

The reference beam showed lamp intensity fluctuations of 38 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.595 sen(zero) = 0.021
. ref(beam) = 3.002 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2162 ng
Mean aerosol black carbon concentration = 2314 ng/m3

The reference beam showed lamp intensity fluctuations of 49 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.786 sen(zero) = 0.021
. ref(beam) = 3.986 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2179 ng
Mean aerosol black carbon concentration = 2332 ng/m3

The reference beam showed lamp intensity fluctuations of 364 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.453 sen(zero) = 0.021
. ref(beam) = 2.536 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2172 ng
Mean aerosol black carbon concentration = 2324 ng/m3

The reference beam showed lamp intensity fluctuations of 191 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.572 sen(zero) = 0.021
. ref(beam) = 3.741 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2114 ng
Mean aerosol black carbon concentration = 2262 ng/m3

The reference beam showed lamp intensity fluctuations of 169 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.645 sen(zero) = 0.021
. ref(beam) = 2.418 ref(zero) = 0.021

. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2039 ng
Mean aerosol black carbon concentration = 2183 ng/m3

The reference beam showed lamp intensity fluctuations of 266 ppm.

Disk space = 1.013318E+09 bytes free: One entry at every 5 minutes.
There is space for 215416 hours (8976 days) more data

21-jan-10 19:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

21-jan-10 19:49:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.888 ref(beam) =   2.649
. Lamp 2 (470 nm): sen(beam) =   2.764 ref(beam) =   2.991
. Lamp 3 (520 nm): sen(beam) =   2.320 ref(beam) =   3.014
. Lamp 4 (590 nm): sen(beam) =   2.417 ref(beam) =   3.887
. Lamp 5 (660 nm): sen(beam) =   1.934 ref(beam) =   2.579
. Lamp 6 (880 nm): sen(beam) =   3.178 ref(beam) =   3.747
. Lamp 7 (950 nm): sen(beam) =   1.966 ref(beam) =   2.443

22-jan-10 02:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 6.16 hours
. Total airflow this filter = 1.47 cubic meters
. Mean BC concentration of all lamps = 1439 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.569 sen(zero) = 0.021
. ref(beam) = 2.670 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2437 ng
Mean aerosol black carbon concentration = 1679 ng/m3

The reference beam showed lamp intensity fluctuations of 64 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.802 sen(zero) = 0.021
. ref(beam) = 2.992 ref(zero) = 0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2155 ng
Mean aerosol black carbon concentration = 1485 ng/m3

The reference beam showed lamp intensity fluctuations of 40 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.609 sen(zero) = 0.021
. ref(beam) = 3.011 ref(zero) = 0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2041 ng
Mean aerosol black carbon concentration = 1406 ng/m3

The reference beam showed lamp intensity fluctuations of 34 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.806 sen(zero) = 0.021
. ref(beam) = 4.005 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2055 ng
Mean aerosol black carbon concentration = 1416 ng/m3

The reference beam showed lamp intensity fluctuations of 135 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.454 sen(zero) = 0.021
. ref(beam) = 2.586 ref(zero) = 0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 2049 ng
Mean aerosol black carbon concentration = 1411 ng/m3

The reference beam showed lamp intensity fluctuations of 80 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) =   2.591 sen(zero) =   0.021
.   ref(beam) =   3.762 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 1978 ng
Mean aerosol black carbon concentration = 1363 ng/m3

The reference beam showed lamp intensity fluctuations of 89 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.643 sen(zero) =   0.021
.   ref(beam) =   2.458 ref(zero) =   0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1910 ng
Mean aerosol black carbon concentration = 1316 ng/m3

The reference beam showed lamp intensity fluctuations of 100 ppm.

Disk space = 1.013301E+09 bytes free: One entry at every 5 minutes.
There is space for 215413 hours (8976 days) more data

22-jan-10 02:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

22-jan-10 02:09:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.898 ref(beam) =   2.616
. Lamp 2 (470 nm): sen(beam) =   2.779 ref(beam) =   2.949
. Lamp 3 (520 nm): sen(beam) =   2.341 ref(beam) =   3.001
. Lamp 4 (590 nm): sen(beam) =   2.439 ref(beam) =   3.872
. Lamp 5 (660 nm): sen(beam) =   1.942 ref(beam) =   2.537
. Lamp 6 (880 nm): sen(beam) =   3.199 ref(beam) =   3.724
. Lamp 7 (950 nm): sen(beam) =   1.974 ref(beam) =   2.407

22-jan-10 15:30:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 13.33 hours
.   Total airflow this filter = 3.18 cubic meters
.   Mean BC concentration of all lamps = 743 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.561 sen(zero) =   0.021
.   ref(beam) =   2.577 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2438 ng

Mean aerosol black carbon concentration = 771 ng/m3

The reference beam showed lamp intensity fluctuations of 118 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.734 sen(zero) = 0.021
. ref(beam) = 2.922 ref(zero) = 0.021
. Optical attenuation of filter deposit = 46
. Total aerosol black carbon on filter = 2376 ng
Mean aerosol black carbon concentration = 751 ng/m3

The reference beam showed lamp intensity fluctuations of 63 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.546 sen(zero) = 0.021
. ref(beam) = 2.969 ref(zero) = 0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2305 ng
Mean aerosol black carbon concentration = 729 ng/m3

The reference beam showed lamp intensity fluctuations of 58 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.653 sen(zero) = 0.021
. ref(beam) = 3.769 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2358 ng
Mean aerosol black carbon concentration = 746 ng/m3

The reference beam showed lamp intensity fluctuations of 276 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.364 sen(zero) = 0.021
. ref(beam) = 2.472 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2373 ng
Mean aerosol black carbon concentration = 750 ng/m3

The reference beam showed lamp intensity fluctuations of 159 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.443 sen(zero) = 0.021
. ref(beam) = 3.619 ref(zero) = 0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 2331 ng
Mean aerosol black carbon concentration = 737 ng/m3

The reference beam showed lamp intensity fluctuations of 171 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.537 sen(zero) = 0.021
. ref(beam) = 2.327 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2265 ng

Mean aerosol black carbon concentration = 716 ng/m3

The reference beam showed lamp intensity fluctuations of 208 ppm.

Disk space = 1.013252E+09 bytes free: One entry at every 5 minutes.
There is space for 215402 hours (8975 days) more data

22-jan-10 15:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

22-jan-10 15:39:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.823 ref(beam) = 2.524
. Lamp 2 (470 nm): sen(beam) = 2.744 ref(beam) = 2.899
. Lamp 3 (520 nm): sen(beam) = 2.293 ref(beam) = 2.928
. Lamp 4 (590 nm): sen(beam) = 2.277 ref(beam) = 3.610
. Lamp 5 (660 nm): sen(beam) = 1.876 ref(beam) = 2.455
. Lamp 6 (880 nm): sen(beam) = 3.064 ref(beam) = 3.559
. Lamp 7 (950 nm): sen(beam) = 1.886 ref(beam) = 2.301

22-jan-10 20:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 4.33 hours
. Total airflow this filter = 1.03 cubic meters
. Mean BC concentration of all lamps = 2412 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.566 sen(zero) = 0.021
. ref(beam) = 2.601 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2461 ng
Mean aerosol black carbon concentration = 2428 ng/m3

The reference beam showed lamp intensity fluctuations of 408 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.698 sen(zero) = 0.021
. ref(beam) = 2.927 ref(zero) = 0.021
. Optical attenuation of filter deposit = 48
. Total aerosol black carbon on filter = 2476 ng
Mean aerosol black carbon concentration = 2443 ng/m3

The reference beam showed lamp intensity fluctuations of 117 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.510 sen(zero) = 0.021
. ref(beam) = 2.948 ref(zero) = 0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2385 ng
Mean aerosol black carbon concentration = 2353 ng/m3

The reference beam showed lamp intensity fluctuations of 109 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.687 sen(zero) = 0.021
. ref(beam) = 3.912 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2437 ng
Mean aerosol black carbon concentration = 2404 ng/m3

The reference beam showed lamp intensity fluctuations of 966 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.362 sen(zero) = 0.021
. ref(beam) = 2.525 ref(zero) = 0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2493 ng
Mean aerosol black carbon concentration = 2459 ng/m3

The reference beam showed lamp intensity fluctuations of 467 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.446 sen(zero) = 0.021
. ref(beam) = 3.672 ref(zero) = 0.021
. Optical attenuation of filter deposit = 25
. Total aerosol black carbon on filter = 2448 ng
Mean aerosol black carbon concentration = 2414 ng/m3

The reference beam showed lamp intensity fluctuations of 510 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.558 sen(zero) = 0.021
. ref(beam) = 2.398 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2416 ng
Mean aerosol black carbon concentration = 2384 ng/m3

The reference beam showed lamp intensity fluctuations of 679 ppm.

Disk space = 1.013187E+09 bytes free: One entry at every 5 minutes.
There is space for 215388 hours (8974 days) more data

22-jan-10 20:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

22-jan-10 20:09:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.830 ref(beam) =   2.637
. Lamp 2 (470 nm): sen(beam) =   2.713 ref(beam) =   2.957
. Lamp 3 (520 nm): sen(beam) =   2.299 ref(beam) =   3.005
. Lamp 4 (590 nm): sen(beam) =   2.393 ref(beam) =   3.876
. Lamp 5 (660 nm): sen(beam) =   1.891 ref(beam) =   2.542
. Lamp 6 (880 nm): sen(beam) =   3.143 ref(beam) =   3.737
. Lamp 7 (950 nm): sen(beam) =   1.930 ref(beam) =   2.414

23-jan-10 02:20:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 6.16 hours
.   Total airflow this filter = 1.47 cubic meters
.   Mean BC concentration of all lamps = 1624 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.562 sen(zero) =   0.021
.   ref(beam) =   2.684 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2439 ng
Mean aerosol black carbon concentration = 1680 ng/m3

The reference beam showed lamp intensity fluctuations of 89 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.707 sen(zero) =   0.021
.   ref(beam) =   2.973 ref(zero) =   0.021
. Optical attenuation of filter deposit = 46
. Total aerosol black carbon on filter = 2379 ng
Mean aerosol black carbon concentration = 1640 ng/m3

The reference beam showed lamp intensity fluctuations of 43 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.538 sen(zero) =   0.021
.   ref(beam) =   3.016 ref(zero) =   0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2285 ng
Mean aerosol black carbon concentration = 1574 ng/m3

The reference beam showed lamp intensity fluctuations of 50 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.754 sen(zero) =   0.021
.   ref(beam) =   4.090 ref(zero) =   0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2341 ng
Mean aerosol black carbon concentration = 1613 ng/m3

The reference beam showed lamp intensity fluctuations of 218 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.374 sen(zero) =   0.021
.   ref(beam) =   2.580 ref(zero) =   0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2394 ng
Mean aerosol black carbon concentration = 1650 ng/m3

The reference beam showed lamp intensity fluctuations of 113 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.502 sen(zero) = 0.021
. ref(beam) = 3.803 ref(zero) = 0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 2346 ng
Mean aerosol black carbon concentration = 1616 ng/m3

The reference beam showed lamp intensity fluctuations of 124 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.579 sen(zero) = 0.021
. ref(beam) = 2.471 ref(zero) = 0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2315 ng
Mean aerosol black carbon concentration = 1595 ng/m3

The reference beam showed lamp intensity fluctuations of 165 ppm.

Disk space = 1.01317E+09 bytes free: One entry at every 5 minutes.
There is space for 215385 hours (8974 days) more data

23-jan-10 02:20:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

23-jan-10 02:29:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.865 ref(beam) = 2.690
. Lamp 2 (470 nm): sen(beam) = 2.740 ref(beam) = 2.977
. Lamp 3 (520 nm): sen(beam) = 2.305 ref(beam) = 3.043
. Lamp 4 (590 nm): sen(beam) = 2.451 ref(beam) = 4.004
. Lamp 5 (660 nm): sen(beam) = 1.925 ref(beam) = 2.573
. Lamp 6 (880 nm): sen(beam) = 3.181 ref(beam) = 3.816
. Lamp 7 (950 nm): sen(beam) = 1.968 ref(beam) = 2.459

23-jan-10 17:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 14.49 hours
. Total airflow this filter = 3.45 cubic meters
. Mean BC concentration of all lamps = 713 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.570 sen(zero) = 0.021
. ref(beam) = 2.698 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2450 ng

Mean aerosol black carbon concentration = 712 ng/m3

The reference beam showed lamp intensity fluctuations of 97 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.699 sen(zero) = 0.021
. ref(beam) = 2.973 ref(zero) = 0.021
. Optical attenuation of filter deposit = 47
. Total aerosol black carbon on filter = 2458 ng
Mean aerosol black carbon concentration = 714 ng/m3

The reference beam showed lamp intensity fluctuations of 50 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.515 sen(zero) = 0.021
. ref(beam) = 3.035 ref(zero) = 0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2381 ng
Mean aerosol black carbon concentration = 692 ng/m3

The reference beam showed lamp intensity fluctuations of 56 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.702 sen(zero) = 0.021
. ref(beam) = 4.050 ref(zero) = 0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2456 ng
Mean aerosol black carbon concentration = 714 ng/m3

The reference beam showed lamp intensity fluctuations of 219 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.354 sen(zero) = 0.021
. ref(beam) = 2.557 ref(zero) = 0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2516 ng
Mean aerosol black carbon concentration = 731 ng/m3

The reference beam showed lamp intensity fluctuations of 115 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.448 sen(zero) = 0.021
. ref(beam) = 3.795 ref(zero) = 0.021
. Optical attenuation of filter deposit = 25
. Total aerosol black carbon on filter = 2480 ng
Mean aerosol black carbon concentration = 721 ng/m3

The reference beam showed lamp intensity fluctuations of 141 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.549 sen(zero) = 0.021
. ref(beam) = 2.445 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2447 ng

Mean aerosol black carbon concentration = 711 ng/m3

The reference beam showed lamp intensity fluctuations of 175 ppm.

Disk space = 1.013121E+09 bytes free: One entry at every 5 minutes.
There is space for 215374 hours (8974 days) more data

23-jan-10 17:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

23-jan-10 17:09:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.899 ref(beam) = 2.694
. Lamp 2 (470 nm): sen(beam) = 2.768 ref(beam) = 2.981
. Lamp 3 (520 nm): sen(beam) = 2.335 ref(beam) = 3.035
. Lamp 4 (590 nm): sen(beam) = 2.445 ref(beam) = 3.933
. Lamp 5 (660 nm): sen(beam) = 1.935 ref(beam) = 2.558
. Lamp 6 (880 nm): sen(beam) = 3.203 ref(beam) = 3.777
. Lamp 7 (950 nm): sen(beam) = 1.976 ref(beam) = 2.438

23-jan-10 21:55:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 4.75 hours
. Total airflow this filter = 1.13 cubic meters
. Mean BC concentration of all lamps = 1902 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.596 sen(zero) = 0.021
. ref(beam) = 2.724 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2443 ng
Mean aerosol black carbon concentration = 2194 ng/m3

The reference beam showed lamp intensity fluctuations of 181 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.817 sen(zero) = 0.021
. ref(beam) = 2.989 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2165 ng
Mean aerosol black carbon concentration = 1944 ng/m3

The reference beam showed lamp intensity fluctuations of 79 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.623 sen(zero) =   0.021
.   ref(beam) =   3.039 ref(zero) =   0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2069 ng
Mean aerosol black carbon concentration = 1859 ng/m3

The reference beam showed lamp intensity fluctuations of 81 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.842 sen(zero) =   0.021
.   ref(beam) =   4.092 ref(zero) =   0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2089 ng
Mean aerosol black carbon concentration = 1877 ng/m3

The reference beam showed lamp intensity fluctuations of 479 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.462 sen(zero) =   0.021
.   ref(beam) =   2.579 ref(zero) =   0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 2077 ng
Mean aerosol black carbon concentration = 1866 ng/m3

The reference beam showed lamp intensity fluctuations of 247 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.619 sen(zero) =   0.021
.   ref(beam) =   3.815 ref(zero) =   0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2028 ng
Mean aerosol black carbon concentration = 1822 ng/m3

The reference beam showed lamp intensity fluctuations of 261 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.662 sen(zero) =   0.021
.   ref(beam) =   2.471 ref(zero) =   0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1947 ng
Mean aerosol black carbon concentration = 1749 ng/m3

The reference beam showed lamp intensity fluctuations of 350 ppm.

Disk space = 1.013055E+09 bytes free: One entry at every 5 minutes.
There is space for 215360 hours (8973 days) more data

23-jan-10 21:55:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

23-jan-10 22:04:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.888 ref(beam) =   2.730
. Lamp 2 (470 nm): sen(beam) =   2.746 ref(beam) =   3.024
. Lamp 3 (520 nm): sen(beam) =   2.316 ref(beam) =   3.073
. Lamp 4 (590 nm): sen(beam) =   2.445 ref(beam) =   4.010
. Lamp 5 (660 nm): sen(beam) =   1.928 ref(beam) =   2.606
. Lamp 6 (880 nm): sen(beam) =   3.196 ref(beam) =   3.833
. Lamp 7 (950 nm): sen(beam) =   1.973 ref(beam) =   2.488

24-jan-10 00:40:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 2.58 hours
.   Total airflow this filter = .61 cubic meters
.   Mean BC concentration of all lamps = 3433 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.541 sen(zero) =   0.021
.   ref(beam) =   2.743 ref(zero) =   0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2477 ng
Mean aerosol black carbon concentration = 4154 ng/m3

The reference beam showed lamp intensity fluctuations of 138 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.809 sen(zero) =   0.021
.   ref(beam) =   3.023 ref(zero) =   0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2088 ng
Mean aerosol black carbon concentration = 3501 ng/m3

The reference beam showed lamp intensity fluctuations of 95 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.611 sen(zero) =   0.021
.   ref(beam) =   3.068 ref(zero) =   0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2009 ng
Mean aerosol black carbon concentration = 3368 ng/m3

The reference beam showed lamp intensity fluctuations of 78 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.824 sen(zero) =   0.021
.   ref(beam) =   4.110 ref(zero) =   0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2021 ng
Mean aerosol black carbon concentration = 3388 ng/m3

The reference beam showed lamp intensity fluctuations of 270 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.462 sen(zero) =   0.021
.   ref(beam) =   2.608 ref(zero) =   0.021
. Optical attenuation of filter deposit = 27
. Total aerosol black carbon on filter = 1969 ng
Mean aerosol black carbon concentration = 3301 ng/m3

The reference beam showed lamp intensity fluctuations of 154 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.607 sen(zero) = 0.021
. ref(beam) = 3.838 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 1944 ng
Mean aerosol black carbon concentration = 3259 ng/m3

The reference beam showed lamp intensity fluctuations of 151 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.656 sen(zero) = 0.021
. ref(beam) = 2.495 ref(zero) = 0.021
. Optical attenuation of filter deposit = 17
. Total aerosol black carbon on filter = 1826 ng
Mean aerosol black carbon concentration = 3062 ng/m3

The reference beam showed lamp intensity fluctuations of 169 ppm.

Disk space = 1.013023E+09 bytes free: One entry at every 5 minutes.
There is space for 215353 hours (8973 days) more data

24-jan-10 00:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

24-jan-10 00:49:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.918 ref(beam) = 2.690
. Lamp 2 (470 nm): sen(beam) = 2.789 ref(beam) = 2.987
. Lamp 3 (520 nm): sen(beam) = 2.327 ref(beam) = 3.046
. Lamp 4 (590 nm): sen(beam) = 2.445 ref(beam) = 3.969
. Lamp 5 (660 nm): sen(beam) = 1.956 ref(beam) = 2.570
. Lamp 6 (880 nm): sen(beam) = 3.196 ref(beam) = 3.810
. Lamp 7 (950 nm): sen(beam) = 2.000 ref(beam) = 2.454

24-jan-10 04:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 3.16 hours
. Total airflow this filter = .75 cubic meters
. Mean BC concentration of all lamps = 2772 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.561 sen(zero) = 0.021
. ref(beam) = 2.699 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2469 ng

Mean aerosol black carbon concentration = 3357 ng/m3

The reference beam showed lamp intensity fluctuations of 69 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.831 sen(zero) = 0.021
. ref(beam) = 2.985 ref(zero) = 0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2100 ng
Mean aerosol black carbon concentration = 2855 ng/m3

The reference beam showed lamp intensity fluctuations of 88 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.619 sen(zero) = 0.021
. ref(beam) = 3.041 ref(zero) = 0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2001 ng
Mean aerosol black carbon concentration = 2721 ng/m3

The reference beam showed lamp intensity fluctuations of 67 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.817 sen(zero) = 0.021
. ref(beam) = 4.050 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2013 ng
Mean aerosol black carbon concentration = 2736 ng/m3

The reference beam showed lamp intensity fluctuations of 119 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.479 sen(zero) = 0.021
. ref(beam) = 2.566 ref(zero) = 0.021
. Optical attenuation of filter deposit = 27
. Total aerosol black carbon on filter = 1966 ng
Mean aerosol black carbon concentration = 2673 ng/m3

The reference beam showed lamp intensity fluctuations of 87 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.607 sen(zero) = 0.021
. ref(beam) = 3.808 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 1915 ng
Mean aerosol black carbon concentration = 2604 ng/m3

The reference beam showed lamp intensity fluctuations of 91 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.676 sen(zero) = 0.021
. ref(beam) = 2.454 ref(zero) = 0.021
. Optical attenuation of filter deposit = 17
. Total aerosol black carbon on filter = 1806 ng

Mean aerosol black carbon concentration = 2456 ng/m3

The reference beam showed lamp intensity fluctuations of 84 ppm.

Disk space = 1.01299E+09 bytes free: One entry at every 5 minutes.
There is space for 215347 hours (8973 days) more data

24-jan-10 04:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

24-jan-10 04:09:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.939 ref(beam) = 2.700
. Lamp 2 (470 nm): sen(beam) = 2.796 ref(beam) = 3.027
. Lamp 3 (520 nm): sen(beam) = 2.356 ref(beam) = 3.056
. Lamp 4 (590 nm): sen(beam) = 2.459 ref(beam) = 3.948
. Lamp 5 (660 nm): sen(beam) = 1.955 ref(beam) = 2.597
. Lamp 6 (880 nm): sen(beam) = 3.230 ref(beam) = 3.805
. Lamp 7 (950 nm): sen(beam) = 1.998 ref(beam) = 2.469

24-jan-10 08:05:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 3.91 hours
. Total airflow this filter = .93 cubic meters
. Mean BC concentration of all lamps = 2184 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.608 sen(zero) = 0.021
. ref(beam) = 2.743 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2454 ng
Mean aerosol black carbon concentration = 2684 ng/m3

The reference beam showed lamp intensity fluctuations of 178 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.856 sen(zero) = 0.021
. ref(beam) = 3.042 ref(zero) = 0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2093 ng
Mean aerosol black carbon concentration = 2289 ng/m3

The reference beam showed lamp intensity fluctuations of 64 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.672 sen(zero) = 0.021
. ref(beam) = 3.067 ref(zero) = 0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 1940 ng
Mean aerosol black carbon concentration = 2121 ng/m3

The reference beam showed lamp intensity fluctuations of 66 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.917 sen(zero) = 0.021
. ref(beam) = 4.164 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 1936 ng
Mean aerosol black carbon concentration = 2117 ng/m3

The reference beam showed lamp intensity fluctuations of 469 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.511 sen(zero) = 0.021
. ref(beam) = 2.637 ref(zero) = 0.021
. Optical attenuation of filter deposit = 26
. Total aerosol black carbon on filter = 1945 ng
Mean aerosol black carbon concentration = 2127 ng/m3

The reference beam showed lamp intensity fluctuations of 230 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.712 sen(zero) = 0.021
. ref(beam) = 3.872 ref(zero) = 0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1828 ng
Mean aerosol black carbon concentration = 1999 ng/m3

The reference beam showed lamp intensity fluctuations of 258 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.721 sen(zero) = 0.021
. ref(beam) = 2.527 ref(zero) = 0.021
. Optical attenuation of filter deposit = 17
. Total aerosol black carbon on filter = 1784 ng
Mean aerosol black carbon concentration = 1950 ng/m3

The reference beam showed lamp intensity fluctuations of 340 ppm.

Disk space = 1.012974E+09 bytes free: One entry at every 5 minutes.
There is space for 215343 hours (8973 days) more data

24-jan-10 08:05:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

24-jan-10 08:14:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.928 ref(beam) = 2.699
. Lamp 2 (470 nm): sen(beam) = 2.782 ref(beam) = 3.020
. Lamp 3 (520 nm): sen(beam) = 2.338 ref(beam) = 3.032
. Lamp 4 (590 nm): sen(beam) = 2.489 ref(beam) = 3.997
. Lamp 5 (660 nm): sen(beam) = 1.962 ref(beam) = 2.613
. Lamp 6 (880 nm): sen(beam) = 3.235 ref(beam) = 3.805
. Lamp 7 (950 nm): sen(beam) = 2.013 ref(beam) = 2.492

24-jan-10 17:45:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 9.5 hours
. Total airflow this filter = 2.26 cubic meters
. Mean BC concentration of all lamps = 940 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.579 sen(zero) = 0.021
. ref(beam) = 2.689 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2442 ng
Mean aerosol black carbon concentration = 1087 ng/m3

The reference beam showed lamp intensity fluctuations of 171 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.793 sen(zero) = 0.021
. ref(beam) = 3.006 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2206 ng
Mean aerosol black carbon concentration = 982 ng/m3

The reference beam showed lamp intensity fluctuations of 74 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.611 sen(zero) = 0.021
. ref(beam) = 3.016 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2067 ng
Mean aerosol black carbon concentration = 920 ng/m3

The reference beam showed lamp intensity fluctuations of 80 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.802 sen(zero) = 0.021
. ref(beam) = 3.999 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32

. Total aerosol black carbon on filter = 2084 ng
Mean aerosol black carbon concentration = 927 ng/m3

The reference beam showed lamp intensity fluctuations of 466 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.448 sen(zero) = 0.021
. ref(beam) = 2.582 ref(zero) = 0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 2088 ng
Mean aerosol black carbon concentration = 929 ng/m3

The reference beam showed lamp intensity fluctuations of 229 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.599 sen(zero) = 0.021
. ref(beam) = 3.759 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 1977 ng
Mean aerosol black carbon concentration = 880 ng/m3

The reference beam showed lamp intensity fluctuations of 255 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.649 sen(zero) = 0.021
. ref(beam) = 2.456 ref(zero) = 0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1921 ng
Mean aerosol black carbon concentration = 855 ng/m3

The reference beam showed lamp intensity fluctuations of 324 ppm.

Disk space = 1.012957E+09 bytes free: One entry at every 5 minutes.
There is space for 215340 hours (8972 days) more data

24-jan-10 17:45:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

24-jan-10 17:54:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.909 ref(beam) = 2.641
. Lamp 2 (470 nm): sen(beam) = 2.771 ref(beam) = 2.968
. Lamp 3 (520 nm): sen(beam) = 2.346 ref(beam) = 2.999
. Lamp 4 (590 nm): sen(beam) = 2.442 ref(beam) = 3.867
. Lamp 5 (660 nm): sen(beam) = 1.934 ref(beam) = 2.545
. Lamp 6 (880 nm): sen(beam) = 3.216 ref(beam) = 3.735

. Lamp 7 (950 nm): sen(beam) =   1.973 ref(beam) =   2.421

25-jan-10 02:20:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 8.41 hours
.   Total airflow this filter = 2 cubic meters
.   Mean BC concentration of all lamps = 998 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.612 sen(zero) =   0.021
.   ref(beam) =   2.698 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2451 ng
Mean aerosol black carbon concentration = 1233 ng/m3

The reference beam showed lamp intensity fluctuations of 121 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.856 sen(zero) =   0.021
.   ref(beam) =   2.990 ref(zero) =   0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2080 ng
Mean aerosol black carbon concentration = 1046 ng/m3

The reference beam showed lamp intensity fluctuations of 47 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.672 sen(zero) =   0.021
.   ref(beam) =   3.014 ref(zero) =   0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 1946 ng
Mean aerosol black carbon concentration = 978 ng/m3

The reference beam showed lamp intensity fluctuations of 56 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.936 sen(zero) =   0.021
.   ref(beam) =   4.137 ref(zero) =   0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 1937 ng
Mean aerosol black carbon concentration = 974 ng/m3

The reference beam showed lamp intensity fluctuations of 339 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.515 sen(zero) =   0.021
.   ref(beam) =   2.602 ref(zero) =   0.021
. Optical attenuation of filter deposit = 26
. Total aerosol black carbon on filter = 1917 ng
Mean aerosol black carbon concentration = 964 ng/m3

The reference beam showed lamp intensity fluctuations of 153 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.728 sen(zero) = 0.021
. ref(beam) = 3.830 ref(zero) = 0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1821 ng
Mean aerosol black carbon concentration = 916 ng/m3

The reference beam showed lamp intensity fluctuations of 182 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.725 sen(zero) = 0.021
. ref(beam) = 2.504 ref(zero) = 0.021
. Optical attenuation of filter deposit = 16
. Total aerosol black carbon on filter = 1748 ng
Mean aerosol black carbon concentration = 879 ng/m3

The reference beam showed lamp intensity fluctuations of 246 ppm.

Disk space = 1.012908E+09 bytes free: One entry at every 5 minutes.
There is space for 215329 hours (8972 days) more data

25-jan-10 02:20:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

25-jan-10 02:29:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.933 ref(beam) = 2.661
. Lamp 2 (470 nm): sen(beam) = 2.781 ref(beam) = 2.968
. Lamp 3 (520 nm): sen(beam) = 2.351 ref(beam) = 3.008
. Lamp 4 (590 nm): sen(beam) = 2.536 ref(beam) = 4.007
. Lamp 5 (660 nm): sen(beam) = 1.966 ref(beam) = 2.581
. Lamp 6 (880 nm): sen(beam) = 3.271 ref(beam) = 3.801
. Lamp 7 (950 nm): sen(beam) = 2.030 ref(beam) = 2.478

25-jan-10 09:20:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 6.83 hours
. Total airflow this filter = 1.63 cubic meters
. Mean BC concentration of all lamps = 1410 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.603 sen(zero) = 0.021
. ref(beam) = 2.670 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2446 ng

Mean aerosol black carbon concentration = 1519 ng/m3

The reference beam showed lamp intensity fluctuations of 63 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.773 sen(zero) = 0.021
. ref(beam) = 2.965 ref(zero) = 0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2302 ng
Mean aerosol black carbon concentration = 1429 ng/m3

The reference beam showed lamp intensity fluctuations of 39 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.587 sen(zero) = 0.021
. ref(beam) = 3.002 ref(zero) = 0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2222 ng
Mean aerosol black carbon concentration = 1380 ng/m3

The reference beam showed lamp intensity fluctuations of 44 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.825 sen(zero) = 0.021
. ref(beam) = 4.093 ref(zero) = 0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2270 ng
Mean aerosol black carbon concentration = 1409 ng/m3

The reference beam showed lamp intensity fluctuations of 167 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.432 sen(zero) = 0.021
. ref(beam) = 2.578 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2278 ng
Mean aerosol black carbon concentration = 1414 ng/m3

The reference beam showed lamp intensity fluctuations of 89 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.593 sen(zero) = 0.021
. ref(beam) = 3.800 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2231 ng
Mean aerosol black carbon concentration = 1385 ng/m3

The reference beam showed lamp intensity fluctuations of 99 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.653 sen(zero) = 0.021
. ref(beam) = 2.480 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2152 ng

Mean aerosol black carbon concentration = 1336 ng/m3

The reference beam showed lamp intensity fluctuations of 119 ppm.

Disk space = 1.012859E+09 bytes free: One entry at every 5 minutes.
There is space for 215319 hours (8972 days) more data

25-jan-10 09:20:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

25-jan-10 09:29:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.862 ref(beam) = 2.637
. Lamp 2 (470 nm): sen(beam) = 2.711 ref(beam) = 2.953
. Lamp 3 (520 nm): sen(beam) = 2.308 ref(beam) = 3.009
. Lamp 4 (590 nm): sen(beam) = 2.471 ref(beam) = 3.983
. Lamp 5 (660 nm): sen(beam) = 1.909 ref(beam) = 2.563
. Lamp 6 (880 nm): sen(beam) = 3.197 ref(beam) = 3.783
. Lamp 7 (950 nm): sen(beam) = 1.972 ref(beam) = 2.457

25-jan-10 14:55:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 5.41 hours
. Total airflow this filter = 1.29 cubic meters
. Mean BC concentration of all lamps = 1876 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.549 sen(zero) = 0.021
. ref(beam) = 2.649 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2459 ng
Mean aerosol black carbon concentration = 1933 ng/m3

The reference beam showed lamp intensity fluctuations of 179 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.679 sen(zero) = 0.021
. ref(beam) = 2.952 ref(zero) = 0.021
. Optical attenuation of filter deposit = 47
. Total aerosol black carbon on filter = 2422 ng
Mean aerosol black carbon concentration = 1903 ng/m3

The reference beam showed lamp intensity fluctuations of 83 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.515 sen(zero) = 0.021
. ref(beam) = 3.006 ref(zero) = 0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2358 ng
Mean aerosol black carbon concentration = 1853 ng/m3

The reference beam showed lamp intensity fluctuations of 88 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.736 sen(zero) = 0.021
. ref(beam) = 4.083 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2419 ng
Mean aerosol black carbon concentration = 1901 ng/m3

The reference beam showed lamp intensity fluctuations of 434 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.361 sen(zero) = 0.021
. ref(beam) = 2.564 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2423 ng
Mean aerosol black carbon concentration = 1905 ng/m3

The reference beam showed lamp intensity fluctuations of 218 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.500 sen(zero) = 0.021
. ref(beam) = 3.789 ref(zero) = 0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 2362 ng
Mean aerosol black carbon concentration = 1856 ng/m3

The reference beam showed lamp intensity fluctuations of 236 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.587 sen(zero) = 0.021
. ref(beam) = 2.464 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2270 ng
Mean aerosol black carbon concentration = 1784 ng/m3

The reference beam showed lamp intensity fluctuations of 293 ppm.

Disk space = 1.012826E+09 bytes free: One entry at every 5 minutes.
There is space for 215312 hours (8971 days) more data

25-jan-10 14:55:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

25-jan-10 15:04:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.834 ref(beam) = 2.623
. Lamp 2 (470 nm): sen(beam) = 2.703 ref(beam) = 2.934
. Lamp 3 (520 nm): sen(beam) = 2.289 ref(beam) = 3.014
. Lamp 4 (590 nm): sen(beam) = 2.443 ref(beam) = 3.984
. Lamp 5 (660 nm): sen(beam) = 1.902 ref(beam) = 2.543
. Lamp 6 (880 nm): sen(beam) = 3.173 ref(beam) = 3.786
. Lamp 7 (950 nm): sen(beam) = 1.966 ref(beam) = 2.438

25-jan-10 19:10:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 4.08 hours
. Total airflow this filter = .97 cubic meters
. Mean BC concentration of all lamps = 2416 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.542 sen(zero) = 0.021
. ref(beam) = 2.649 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2469 ng
Mean aerosol black carbon concentration = 2587 ng/m3

The reference beam showed lamp intensity fluctuations of 85 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.701 sen(zero) = 0.021
. ref(beam) = 2.939 ref(zero) = 0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2364 ng
Mean aerosol black carbon concentration = 2477 ng/m3

The reference beam showed lamp intensity fluctuations of 36 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.533 sen(zero) = 0.021
. ref(beam) = 3.016 ref(zero) = 0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2263 ng
Mean aerosol black carbon concentration = 2371 ng/m3

The reference beam showed lamp intensity fluctuations of 39 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.777 sen(zero) = 0.021
. ref(beam) = 4.148 ref(zero) = 0.021
. Optical attenuation of filter deposit = 35

. Total aerosol black carbon on filter = 2304 ng
Mean aerosol black carbon concentration = 2414 ng/m3

The reference beam showed lamp intensity fluctuations of 289 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.386 sen(zero) =   0.021
.   ref(beam) =   2.564 ref(zero) =   0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2327 ng
Mean aerosol black carbon concentration = 2439 ng/m3

The reference beam showed lamp intensity fluctuations of 110 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.536 sen(zero) =   0.021
.   ref(beam) =   3.824 ref(zero) =   0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2236 ng
Mean aerosol black carbon concentration = 2342 ng/m3

The reference beam showed lamp intensity fluctuations of 137 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.617 sen(zero) =   0.021
.   ref(beam) =   2.473 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2176 ng
Mean aerosol black carbon concentration = 2279 ng/m3

The reference beam showed lamp intensity fluctuations of 192 ppm.

Disk space = 1.012793E+09 bytes free: One entry at every 5 minutes.
There is space for 215305 hours (8971 days) more data

25-jan-10 19:10:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

25-jan-10 19:19:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.795 ref(beam) =   2.598
. Lamp 2 (470 nm): sen(beam) =   2.668 ref(beam) =   2.915
. Lamp 3 (520 nm): sen(beam) =   2.282 ref(beam) =   2.974
. Lamp 4 (590 nm): sen(beam) =   2.469 ref(beam) =   3.977
. Lamp 5 (660 nm): sen(beam) =   1.892 ref(beam) =   2.537
. Lamp 6 (880 nm): sen(beam) =   3.198 ref(beam) =   3.755

. Lamp 7 (950 nm): sen(beam) =   1.968 ref(beam) =   2.438

25-jan-10 22:15:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 2.91 hours
.   Total airflow this filter = .69 cubic meters
.   Mean BC concentration of all lamps = 3404 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.489 sen(zero) =   0.021
.   ref(beam) =   2.605 ref(zero) =   0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2484 ng
Mean aerosol black carbon concentration = 3674 ng/m3

The reference beam showed lamp intensity fluctuations of 82 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.663 sen(zero) =   0.021
.   ref(beam) =   2.911 ref(zero) =   0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2361 ng
Mean aerosol black carbon concentration = 3493 ng/m3

The reference beam showed lamp intensity fluctuations of 123 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.519 sen(zero) =   0.021
.   ref(beam) =   2.967 ref(zero) =   0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2250 ng
Mean aerosol black carbon concentration = 3328 ng/m3

The reference beam showed lamp intensity fluctuations of 68 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.761 sen(zero) =   0.021
.   ref(beam) =   4.067 ref(zero) =   0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2288 ng
Mean aerosol black carbon concentration = 3385 ng/m3

The reference beam showed lamp intensity fluctuations of 130 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.363 sen(zero) =   0.021
.   ref(beam) =   2.536 ref(zero) =   0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2323 ng
Mean aerosol black carbon concentration = 3436 ng/m3

The reference beam showed lamp intensity fluctuations of 92 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.528 sen(zero) = 0.021
. ref(beam) = 3.756 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2227 ng
Mean aerosol black carbon concentration = 3295 ng/m3

The reference beam showed lamp intensity fluctuations of 90 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.595 sen(zero) = 0.021
. ref(beam) = 2.442 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2178 ng
Mean aerosol black carbon concentration = 3222 ng/m3

The reference beam showed lamp intensity fluctuations of 100 ppm.

Disk space = 1.012777E+09 bytes free: One entry at every 5 minutes.
There is space for 215301 hours (8971 days) more data

25-jan-10 22:15:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

25-jan-10 22:24:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.798 ref(beam) = 2.631
. Lamp 2 (470 nm): sen(beam) = 2.679 ref(beam) = 2.972
. Lamp 3 (520 nm): sen(beam) = 2.282 ref(beam) = 2.990
. Lamp 4 (590 nm): sen(beam) = 2.460 ref(beam) = 3.979
. Lamp 5 (660 nm): sen(beam) = 1.897 ref(beam) = 2.594
. Lamp 6 (880 nm): sen(beam) = 3.193 ref(beam) = 3.775
. Lamp 7 (950 nm): sen(beam) = 1.967 ref(beam) = 2.479

26-jan-10 01:40:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 3.24 hours
.   Total airflow this filter = .77 cubic meters
.   Mean BC concentration of all lamps = 3093 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.492 sen(zero) =   0.021
.   ref(beam) =   2.646 ref(zero) =   0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2475 ng
Mean aerosol black carbon concentration = 3276 ng/m3

The reference beam showed lamp intensity fluctuations of 73 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.661 sen(zero) =   0.021
.   ref(beam) =   2.971 ref(zero) =   0.021
. Optical attenuation of filter deposit = 46
. Total aerosol black carbon on filter = 2379 ng
Mean aerosol black carbon concentration = 3148 ng/m3

The reference beam showed lamp intensity fluctuations of 53 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.507 sen(zero) =   0.021
.   ref(beam) =   2.987 ref(zero) =   0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2287 ng
Mean aerosol black carbon concentration = 3027 ng/m3

The reference beam showed lamp intensity fluctuations of 43 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.750 sen(zero) =   0.021
.   ref(beam) =   4.099 ref(zero) =   0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2340 ng
Mean aerosol black carbon concentration = 3097 ng/m3

The reference beam showed lamp intensity fluctuations of 178 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.360 sen(zero) =   0.021
.   ref(beam) =   2.601 ref(zero) =   0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2370 ng
Mean aerosol black carbon concentration = 3136 ng/m3

The reference beam showed lamp intensity fluctuations of 74 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) =   2.515 sen(zero) =   0.021
.   ref(beam) =   3.790 ref(zero) =   0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2287 ng
Mean aerosol black carbon concentration = 3027 ng/m3

The reference beam showed lamp intensity fluctuations of 94 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.593 sen(zero) =   0.021
.   ref(beam) =   2.496 ref(zero) =   0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2223 ng
Mean aerosol black carbon concentration = 2942 ng/m3

The reference beam showed lamp intensity fluctuations of 144 ppm.

Disk space = 1.012744E+09 bytes free: One entry at every 5 minutes.
There is space for 215294 hours (8971 days) more data

26-jan-10 01:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

26-jan-10 01:49:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.761 ref(beam) =   2.649
. Lamp 2 (470 nm): sen(beam) =   2.659 ref(beam) =   2.964
. Lamp 3 (520 nm): sen(beam) =   2.263 ref(beam) =   2.985
. Lamp 4 (590 nm): sen(beam) =   2.441 ref(beam) =   3.985
. Lamp 5 (660 nm): sen(beam) =   1.883 ref(beam) =   2.578
. Lamp 6 (880 nm): sen(beam) =   3.167 ref(beam) =   3.770
. Lamp 7 (950 nm): sen(beam) =   1.958 ref(beam) =   2.468

26-jan-10 06:30:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 4.66 hours
.   Total airflow this filter = 1.11 cubic meters
.   Mean BC concentration of all lamps = 2077 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.498 sen(zero) =   0.021
.   ref(beam) =   2.662 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2437 ng

Mean aerosol black carbon concentration = 2228 ng/m3

The reference beam showed lamp intensity fluctuations of 87 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.678 sen(zero) = 0.021
. ref(beam) = 2.963 ref(zero) = 0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2317 ng
Mean aerosol black carbon concentration = 2118 ng/m3

The reference beam showed lamp intensity fluctuations of 46 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.516 sen(zero) = 0.021
. ref(beam) = 2.981 ref(zero) = 0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2233 ng
Mean aerosol black carbon concentration = 2042 ng/m3

The reference beam showed lamp intensity fluctuations of 50 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.755 sen(zero) = 0.021
. ref(beam) = 4.095 ref(zero) = 0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2280 ng
Mean aerosol black carbon concentration = 2084 ng/m3

The reference beam showed lamp intensity fluctuations of 220 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.368 sen(zero) = 0.021
. ref(beam) = 2.582 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2290 ng
Mean aerosol black carbon concentration = 2094 ng/m3

The reference beam showed lamp intensity fluctuations of 104 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.515 sen(zero) = 0.021
. ref(beam) = 3.781 ref(zero) = 0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2214 ng
Mean aerosol black carbon concentration = 2024 ng/m3

The reference beam showed lamp intensity fluctuations of 117 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.600 sen(zero) = 0.021
. ref(beam) = 2.480 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2131 ng

Mean aerosol black carbon concentration = 1948 ng/m3

The reference beam showed lamp intensity fluctuations of 148 ppm.

Disk space = 1.012711E+09 bytes free: One entry at every 5 minutes.
There is space for 215287 hours (8970 days) more data

26-jan-10 06:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

26-jan-10 06:39:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.823 ref(beam) = 2.727
. Lamp 2 (470 nm): sen(beam) = 2.714 ref(beam) = 3.009
. Lamp 3 (520 nm): sen(beam) = 2.277 ref(beam) = 3.053
. Lamp 4 (590 nm): sen(beam) = 2.457 ref(beam) = 4.071
. Lamp 5 (660 nm): sen(beam) = 1.928 ref(beam) = 2.612
. Lamp 6 (880 nm): sen(beam) = 3.186 ref(beam) = 3.844
. Lamp 7 (950 nm): sen(beam) = 1.997 ref(beam) = 2.509

26-jan-10 10:55:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 4.24 hours
. Total airflow this filter = 1.01 cubic meters
. Mean BC concentration of all lamps = 2309 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.532 sen(zero) = 0.021
. ref(beam) = 2.730 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2443 ng
Mean aerosol black carbon concentration = 2457 ng/m3

The reference beam showed lamp intensity fluctuations of 115 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.701 sen(zero) = 0.021
. ref(beam) = 3.005 ref(zero) = 0.021
. Optical attenuation of filter deposit = 46
. Total aerosol black carbon on filter = 2367 ng
Mean aerosol black carbon concentration = 2381 ng/m3

The reference beam showed lamp intensity fluctuations of 64 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.520 sen(zero) = 0.021
. ref(beam) = 3.045 ref(zero) = 0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2266 ng
Mean aerosol black carbon concentration = 2279 ng/m3

The reference beam showed lamp intensity fluctuations of 65 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.743 sen(zero) = 0.021
. ref(beam) = 4.132 ref(zero) = 0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2304 ng
Mean aerosol black carbon concentration = 2317 ng/m3

The reference beam showed lamp intensity fluctuations of 358 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.388 sen(zero) = 0.021
. ref(beam) = 2.603 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2331 ng
Mean aerosol black carbon concentration = 2344 ng/m3

The reference beam showed lamp intensity fluctuations of 177 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.520 sen(zero) = 0.021
. ref(beam) = 3.831 ref(zero) = 0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2214 ng
Mean aerosol black carbon concentration = 2226 ng/m3

The reference beam showed lamp intensity fluctuations of 206 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.618 sen(zero) = 0.021
. ref(beam) = 2.501 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2147 ng
Mean aerosol black carbon concentration = 2160 ng/m3

The reference beam showed lamp intensity fluctuations of 250 ppm.

Disk space = 1.012695E+09 bytes free: One entry at every 5 minutes.
There is space for 215284 hours (8970 days) more data

26-jan-10 10:55:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

26-jan-10 11:04:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.801 ref(beam) =   2.715
. Lamp 2 (470 nm): sen(beam) =   2.665 ref(beam) =   3.035
. Lamp 3 (520 nm): sen(beam) =   2.273 ref(beam) =   3.049
. Lamp 4 (590 nm): sen(beam) =   2.419 ref(beam) =   4.015
. Lamp 5 (660 nm): sen(beam) =   1.883 ref(beam) =   2.627
. Lamp 6 (880 nm): sen(beam) =   3.171 ref(beam) =   3.826
. Lamp 7 (950 nm): sen(beam) =   1.952 ref(beam) =   2.509

26-jan-10 15:10:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 4.08 hours
.   Total airflow this filter = .97 cubic meters
.   Mean BC concentration of all lamps = 2434 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.501 sen(zero) =   0.021
.   ref(beam) =   2.715 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2465 ng
Mean aerosol black carbon concentration = 2583 ng/m3

The reference beam showed lamp intensity fluctuations of 134 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.649 sen(zero) =   0.021
.   ref(beam) =   3.028 ref(zero) =   0.021
. Optical attenuation of filter deposit = 46
. Total aerosol black carbon on filter = 2407 ng
Mean aerosol black carbon concentration = 2522 ng/m3

The reference beam showed lamp intensity fluctuations of 98 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.505 sen(zero) =   0.021
.   ref(beam) =   3.038 ref(zero) =   0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2288 ng
Mean aerosol black carbon concentration = 2397 ng/m3

The reference beam showed lamp intensity fluctuations of 94 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.704 sen(zero) =   0.021
.   ref(beam) =   4.070 ref(zero) =   0.021
. Optical attenuation of filter deposit = 36

. Total aerosol black carbon on filter = 2329 ng
Mean aerosol black carbon concentration = 2440 ng/m3

The reference beam showed lamp intensity fluctuations of 371 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.344 sen(zero) =   0.021
.   ref(beam) =   2.614 ref(zero) =   0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2371 ng
Mean aerosol black carbon concentration = 2485 ng/m3

The reference beam showed lamp intensity fluctuations of 176 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.500 sen(zero) =   0.021
.   ref(beam) =   3.808 ref(zero) =   0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2223 ng
Mean aerosol black carbon concentration = 2330 ng/m3

The reference beam showed lamp intensity fluctuations of 204 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.573 sen(zero) =   0.021
.   ref(beam) =   2.497 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2179 ng
Mean aerosol black carbon concentration = 2284 ng/m3

The reference beam showed lamp intensity fluctuations of 238 ppm.

Disk space = 1.012662E+09 bytes free: One entry at every 5 minutes.
There is space for 215277 hours (8970 days) more data

26-jan-10 15:10:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

26-jan-10 15:19:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.923 ref(beam) =   2.679
. Lamp 2 (470 nm): sen(beam) =   2.784 ref(beam) =   2.992
. Lamp 3 (520 nm): sen(beam) =   2.345 ref(beam) =   3.026
. Lamp 4 (590 nm): sen(beam) =   2.457 ref(beam) =   3.932
. Lamp 5 (660 nm): sen(beam) =   1.950 ref(beam) =   2.576
. Lamp 6 (880 nm): sen(beam) =   3.232 ref(beam) =   3.763

. Lamp 7 (950 nm): sen(beam) =   2.010 ref(beam) =   2.458

26-jan-10 18:45:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 3.41 hours
.   Total airflow this filter = .81 cubic meters
.   Mean BC concentration of all lamps = 2832 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.584 sen(zero) =   0.021
.   ref(beam) =   2.721 ref(zero) =   0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2502 ng
Mean aerosol black carbon concentration = 3146 ng/m3

The reference beam showed lamp intensity fluctuations of 174 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.766 sen(zero) =   0.021
.   ref(beam) =   3.004 ref(zero) =   0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2327 ng
Mean aerosol black carbon concentration = 2926 ng/m3

The reference beam showed lamp intensity fluctuations of 78 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.587 sen(zero) =   0.021
.   ref(beam) =   3.035 ref(zero) =   0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2216 ng
Mean aerosol black carbon concentration = 2786 ng/m3

The reference beam showed lamp intensity fluctuations of 77 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.829 sen(zero) =   0.021
.   ref(beam) =   4.150 ref(zero) =   0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2241 ng
Mean aerosol black carbon concentration = 2818 ng/m3

The reference beam showed lamp intensity fluctuations of 610 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.444 sen(zero) =   0.021
.   ref(beam) =   2.615 ref(zero) =   0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2253 ng
Mean aerosol black carbon concentration = 2833 ng/m3

The reference beam showed lamp intensity fluctuations of 267 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.627 sen(zero) =   0.021
.   ref(beam) =   3.829 ref(zero) =   0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2142 ng
Mean aerosol black carbon concentration = 2693 ng/m3

The reference beam showed lamp intensity fluctuations of 309 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.683 sen(zero) =   0.021
.   ref(beam) =   2.517 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2084 ng
Mean aerosol black carbon concentration = 2621 ng/m3

The reference beam showed lamp intensity fluctuations of 381 ppm.

Disk space = 1.012646E+09 bytes free: One entry at every 5 minutes.
There is space for 215273 hours (8970 days) more data

26-jan-10 18:45:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

26-jan-10 18:54:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.864 ref(beam) =   2.708
. Lamp 2 (470 nm): sen(beam) =   2.731 ref(beam) =   2.986
. Lamp 3 (520 nm): sen(beam) =   2.303 ref(beam) =   3.037
. Lamp 4 (590 nm): sen(beam) =   2.477 ref(beam) =   4.040
. Lamp 5 (660 nm): sen(beam) =   1.934 ref(beam) =   2.591
. Lamp 6 (880 nm): sen(beam) =   3.223 ref(beam) =   3.822
. Lamp 7 (950 nm): sen(beam) =   2.007 ref(beam) =   2.493

26-jan-10 21:00:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 2.08 hours
.   Total airflow this filter = .49 cubic meters
.   Mean BC concentration of all lamps = 4645 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.520 sen(zero) =   0.021
.   ref(beam) =   2.726 ref(zero) =   0.021

. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2454 ng
Mean aerosol black carbon concentration = 5142 ng/m3

The reference beam showed lamp intensity fluctuations of 115 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.716 sen(zero) =   0.021
.   ref(beam) =   2.989 ref(zero) =   0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2286 ng
Mean aerosol black carbon concentration = 4789 ng/m3

The reference beam showed lamp intensity fluctuations of 59 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.545 sen(zero) =   0.021
.   ref(beam) =   3.037 ref(zero) =   0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2179 ng
Mean aerosol black carbon concentration = 4566 ng/m3

The reference beam showed lamp intensity fluctuations of 79 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.796 sen(zero) =   0.021
.   ref(beam) =   4.170 ref(zero) =   0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2206 ng
Mean aerosol black carbon concentration = 4622 ng/m3

The reference beam showed lamp intensity fluctuations of 201 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.415 sen(zero) =   0.021
.   ref(beam) =   2.602 ref(zero) =   0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2213 ng
Mean aerosol black carbon concentration = 4636 ng/m3

The reference beam showed lamp intensity fluctuations of 150 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.581 sen(zero) =   0.021
.   ref(beam) =   3.844 ref(zero) =   0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2123 ng
Mean aerosol black carbon concentration = 4450 ng/m3

The reference beam showed lamp intensity fluctuations of 133 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.651 sen(zero) =   0.021
.   ref(beam) =   2.514 ref(zero) =   0.021

. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2058 ng
Mean aerosol black carbon concentration = 4312 ng/m3

The reference beam showed lamp intensity fluctuations of 119 ppm.

Disk space = 1.012613E+09 bytes free: One entry at every 5 minutes.
There is space for 215266 hours (8969 days) more data

26-jan-10 21:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

26-jan-10 21:09:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.850 ref(beam) = 2.725
. Lamp 2 (470 nm): sen(beam) = 2.720 ref(beam) = 2.996
. Lamp 3 (520 nm): sen(beam) = 2.284 ref(beam) = 3.033
. Lamp 4 (590 nm): sen(beam) = 2.461 ref(beam) = 4.045
. Lamp 5 (660 nm): sen(beam) = 1.928 ref(beam) = 2.598
. Lamp 6 (880 nm): sen(beam) = 3.190 ref(beam) = 3.833
. Lamp 7 (950 nm): sen(beam) = 2.002 ref(beam) = 2.497

26-jan-10 23:25:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 2.25 hours
. Total airflow this filter = .53 cubic meters
. Mean BC concentration of all lamps = 4388 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.486 sen(zero) = 0.021
. ref(beam) = 2.743 ref(zero) = 0.021
. Optical attenuation of filter deposit = 62
. Total aerosol black carbon on filter = 2551 ng
Mean aerosol black carbon concentration = 4934 ng/m3

The reference beam showed lamp intensity fluctuations of 47 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.699 sen(zero) = 0.021
. ref(beam) = 2.998 ref(zero) = 0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2332 ng
Mean aerosol black carbon concentration = 4511 ng/m3

The reference beam showed lamp intensity fluctuations of 58 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.523 sen(zero) =   0.021
.   ref(beam) =   3.033 ref(zero) =   0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2228 ng
Mean aerosol black carbon concentration = 4309 ng/m3

The reference beam showed lamp intensity fluctuations of 50 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.776 sen(zero) =   0.021
.   ref(beam) =   4.180 ref(zero) =   0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2255 ng
Mean aerosol black carbon concentration = 4361 ng/m3

The reference beam showed lamp intensity fluctuations of 175 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.404 sen(zero) =   0.021
.   ref(beam) =   2.611 ref(zero) =   0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2258 ng
Mean aerosol black carbon concentration = 4367 ng/m3

The reference beam showed lamp intensity fluctuations of 65 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.547 sen(zero) =   0.021
.   ref(beam) =   3.857 ref(zero) =   0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2165 ng
Mean aerosol black carbon concentration = 4187 ng/m3

The reference beam showed lamp intensity fluctuations of 63 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.644 sen(zero) =   0.021
.   ref(beam) =   2.520 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2092 ng
Mean aerosol black carbon concentration = 4046 ng/m3

The reference beam showed lamp intensity fluctuations of 91 ppm.

Disk space = 1.012613E+09 bytes free: One entry at every 5 minutes.
There is space for 215266 hours (8969 days) more data

26-jan-10 23:25:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

26-jan-10 23:34:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.803 ref(beam) =   2.763
. Lamp 2 (470 nm): sen(beam) =   2.660 ref(beam) =   3.048
. Lamp 3 (520 nm): sen(beam) =   2.258 ref(beam) =   3.065
. Lamp 4 (590 nm): sen(beam) =   2.449 ref(beam) =   4.102
. Lamp 5 (660 nm): sen(beam) =   1.897 ref(beam) =   2.654
. Lamp 6 (880 nm): sen(beam) =   3.181 ref(beam) =   3.874
. Lamp 7 (950 nm): sen(beam) =   1.980 ref(beam) =   2.552

27-jan-10 01:20:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 1.75 hours
.   Total airflow this filter = .41 cubic meters
.   Mean BC concentration of all lamps = 5465 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.460 sen(zero) =   0.021
.   ref(beam) =   2.775 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2434 ng
Mean aerosol black carbon concentration = 6119 ng/m3

The reference beam showed lamp intensity fluctuations of 100 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.659 sen(zero) =   0.021
.   ref(beam) =   3.048 ref(zero) =   0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2241 ng
Mean aerosol black carbon concentration = 5634 ng/m3

The reference beam showed lamp intensity fluctuations of 133 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.508 sen(zero) =   0.021
.   ref(beam) =   3.061 ref(zero) =   0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2127 ng
Mean aerosol black carbon concentration = 5349 ng/m3

The reference beam showed lamp intensity fluctuations of 111 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.764 sen(zero) =   0.021
.   ref(beam) =   4.214 ref(zero) =   0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2151 ng
Mean aerosol black carbon concentration = 5409 ng/m3

The reference beam showed lamp intensity fluctuations of 140 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.380 sen(zero) =   0.021
.   ref(beam) =   2.659 ref(zero) =   0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2166 ng
Mean aerosol black carbon concentration = 5446 ng/m3

The reference beam showed lamp intensity fluctuations of 137 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.538 sen(zero) = 0.021
. ref(beam) = 3.885 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2075 ng
Mean aerosol black carbon concentration = 5217 ng/m3

The reference beam showed lamp intensity fluctuations of 151 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.621 sen(zero) = 0.021
. ref(beam) = 2.564 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2020 ng
Mean aerosol black carbon concentration = 5079 ng/m3

The reference beam showed lamp intensity fluctuations of 182 ppm.

Disk space = 1.012597E+09 bytes free: One entry at every 5 minutes.
There is space for 215263 hours (8969 days) more data

27-jan-10 01:20:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

27-jan-10 01:29:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.872 ref(beam) = 2.737
. Lamp 2 (470 nm): sen(beam) = 2.713 ref(beam) = 3.015
. Lamp 3 (520 nm): sen(beam) = 2.291 ref(beam) = 3.054
. Lamp 4 (590 nm): sen(beam) = 2.478 ref(beam) = 4.081
. Lamp 5 (660 nm): sen(beam) = 1.925 ref(beam) = 2.624
. Lamp 6 (880 nm): sen(beam) = 3.215 ref(beam) = 3.856
. Lamp 7 (950 nm): sen(beam) = 2.000 ref(beam) = 2.520

27-jan-10 03:40:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 2.16 hours
. Total airflow this filter = .51 cubic meters
. Mean BC concentration of all lamps = 4267 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.507 sen(zero) = 0.021
. ref(beam) = 2.746 ref(zero) = 0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2476 ng

Mean aerosol black carbon concentration = 4980 ng/m3

The reference beam showed lamp intensity fluctuations of 79 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.728 sen(zero) = 0.021
. ref(beam) = 3.014 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2202 ng
Mean aerosol black carbon concentration = 4429 ng/m3

The reference beam showed lamp intensity fluctuations of 119 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.560 sen(zero) = 0.021
. ref(beam) = 3.049 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2079 ng
Mean aerosol black carbon concentration = 4182 ng/m3

The reference beam showed lamp intensity fluctuations of 84 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.811 sen(zero) = 0.021
. ref(beam) = 4.180 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2097 ng
Mean aerosol black carbon concentration = 4218 ng/m3

The reference beam showed lamp intensity fluctuations of 144 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.424 sen(zero) = 0.021
. ref(beam) = 2.625 ref(zero) = 0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 2095 ng
Mean aerosol black carbon concentration = 4214 ng/m3

The reference beam showed lamp intensity fluctuations of 96 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.599 sen(zero) = 0.021
. ref(beam) = 3.861 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 1984 ng
Mean aerosol black carbon concentration = 3991 ng/m3

The reference beam showed lamp intensity fluctuations of 103 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.659 sen(zero) = 0.021
. ref(beam) = 2.527 ref(zero) = 0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1915 ng

Mean aerosol black carbon concentration = 3852 ng/m3

The reference beam showed lamp intensity fluctuations of 116 ppm.

Disk space = 1.012564E+09 bytes free: One entry at every 5 minutes.
There is space for 215256 hours (8969 days) more data

27-jan-10 03:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

27-jan-10 03:49:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.936 ref(beam) = 2.710
. Lamp 2 (470 nm): sen(beam) = 2.765 ref(beam) = 3.009
. Lamp 3 (520 nm): sen(beam) = 2.335 ref(beam) = 2.997
. Lamp 4 (590 nm): sen(beam) = 2.518 ref(beam) = 3.998
. Lamp 5 (660 nm): sen(beam) = 1.960 ref(beam) = 2.615
. Lamp 6 (880 nm): sen(beam) = 3.268 ref(beam) = 3.793
. Lamp 7 (950 nm): sen(beam) = 2.034 ref(beam) = 2.505

27-jan-10 06:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 2.16 hours
. Total airflow this filter = .51 cubic meters
. Mean BC concentration of all lamps = 4385 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.547 sen(zero) = 0.021
. ref(beam) = 2.727 ref(zero) = 0.021
. Optical attenuation of filter deposit = 61
. Total aerosol black carbon on filter = 2504 ng
Mean aerosol black carbon concentration = 5037 ng/m3

The reference beam showed lamp intensity fluctuations of 103 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.753 sen(zero) = 0.021
. ref(beam) = 3.012 ref(zero) = 0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2259 ng
Mean aerosol black carbon concentration = 4545 ng/m3

The reference beam showed lamp intensity fluctuations of 47 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.583 sen(zero) = 0.021
. ref(beam) = 2.996 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2134 ng
Mean aerosol black carbon concentration = 4294 ng/m3

The reference beam showed lamp intensity fluctuations of 58 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.844 sen(zero) = 0.021
. ref(beam) = 4.126 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2154 ng
Mean aerosol black carbon concentration = 4333 ng/m3

The reference beam showed lamp intensity fluctuations of 276 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.446 sen(zero) = 0.021
. ref(beam) = 2.627 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2165 ng
Mean aerosol black carbon concentration = 4356 ng/m3

The reference beam showed lamp intensity fluctuations of 136 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.640 sen(zero) = 0.021
. ref(beam) = 3.815 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2050 ng
Mean aerosol black carbon concentration = 4124 ng/m3

The reference beam showed lamp intensity fluctuations of 142 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.686 sen(zero) = 0.021
. ref(beam) = 2.526 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 1993 ng
Mean aerosol black carbon concentration = 4010 ng/m3

The reference beam showed lamp intensity fluctuations of 181 ppm.

Disk space = 1.012548E+09 bytes free: One entry at every 5 minutes.
There is space for 215252 hours (8969 days) more data

27-jan-10 06:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

27-jan-10 06:09:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.861 ref(beam) =   2.735
. Lamp 2 (470 nm): sen(beam) =   2.729 ref(beam) =   3.032
. Lamp 3 (520 nm): sen(beam) =   2.274 ref(beam) =   3.031
. Lamp 4 (590 nm): sen(beam) =   2.459 ref(beam) =   4.055
. Lamp 5 (660 nm): sen(beam) =   1.941 ref(beam) =   2.639
. Lamp 6 (880 nm): sen(beam) =   3.189 ref(beam) =   3.841
. Lamp 7 (950 nm): sen(beam) =   2.016 ref(beam) =   2.534

27-jan-10 08:40:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 2.5 hours
.   Total airflow this filter = .59 cubic meters
.   Mean BC concentration of all lamps = 3846 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.521 sen(zero) =   0.021
.   ref(beam) =   2.756 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2468 ng
Mean aerosol black carbon concentration = 4281 ng/m3

The reference beam showed lamp intensity fluctuations of 115 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.718 sen(zero) =   0.021
.   ref(beam) =   3.036 ref(zero) =   0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2291 ng
Mean aerosol black carbon concentration = 3973 ng/m3

The reference beam showed lamp intensity fluctuations of 39 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.533 sen(zero) =   0.021
.   ref(beam) =   3.032 ref(zero) =   0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2164 ng
Mean aerosol black carbon concentration = 3753 ng/m3

The reference beam showed lamp intensity fluctuations of 58 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.800 sen(zero) =   0.021
.   ref(beam) =   4.208 ref(zero) =   0.021
. Optical attenuation of filter deposit = 33

. Total aerosol black carbon on filter = 2190 ng
Mean aerosol black carbon concentration = 3799 ng/m3

The reference beam showed lamp intensity fluctuations of 321 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.423 sen(zero) =   0.021
.   ref(beam) =   2.658 ref(zero) =   0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2227 ng
Mean aerosol black carbon concentration = 3861 ng/m3

The reference beam showed lamp intensity fluctuations of 164 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.567 sen(zero) =   0.021
.   ref(beam) =   3.874 ref(zero) =   0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2108 ng
Mean aerosol black carbon concentration = 3655 ng/m3

The reference beam showed lamp intensity fluctuations of 164 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.664 sen(zero) =   0.021
.   ref(beam) =   2.566 ref(zero) =   0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2075 ng
Mean aerosol black carbon concentration = 3598 ng/m3

The reference beam showed lamp intensity fluctuations of 256 ppm.

Disk space = 1.012548E+09 bytes free: One entry at every 5 minutes.
There is space for 215252 hours (8969 days) more data

27-jan-10 08:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

27-jan-10 08:49:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.868 ref(beam) =   2.717
. Lamp 2 (470 nm): sen(beam) =   2.741 ref(beam) =   3.002
. Lamp 3 (520 nm): sen(beam) =   2.274 ref(beam) =   3.052
. Lamp 4 (590 nm): sen(beam) =   2.481 ref(beam) =   4.114
. Lamp 5 (660 nm): sen(beam) =   1.954 ref(beam) =   2.618
. Lamp 6 (880 nm): sen(beam) =   3.204 ref(beam) =   3.867

. Lamp 7 (950 nm): sen(beam) =   2.031 ref(beam) =   2.531

27-jan-10 12:05:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 3.24 hours
.   Total airflow this filter = .77 cubic meters
.   Mean BC concentration of all lamps = 2983 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.524 sen(zero) =   0.021
.   ref(beam) =   2.706 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2453 ng
Mean aerosol black carbon concentration = 3246 ng/m3

The reference beam showed lamp intensity fluctuations of 216 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.712 sen(zero) =   0.021
.   ref(beam) =   2.988 ref(zero) =   0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2320 ng
Mean aerosol black carbon concentration = 3070 ng/m3

The reference beam showed lamp intensity fluctuations of 185 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.520 sen(zero) =   0.021
.   ref(beam) =   3.034 ref(zero) =   0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2195 ng
Mean aerosol black carbon concentration = 2906 ng/m3

The reference beam showed lamp intensity fluctuations of 155 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.746 sen(zero) =   0.021
.   ref(beam) =   4.124 ref(zero) =   0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2235 ng
Mean aerosol black carbon concentration = 2958 ng/m3

The reference beam showed lamp intensity fluctuations of 648 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.400 sen(zero) =   0.021
.   ref(beam) =   2.590 ref(zero) =   0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2277 ng
Mean aerosol black carbon concentration = 3013 ng/m3

The reference beam showed lamp intensity fluctuations of 333 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.517 sen(zero) = 0.021
. ref(beam) = 3.824 ref(zero) = 0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2167 ng
Mean aerosol black carbon concentration = 2868 ng/m3

The reference beam showed lamp intensity fluctuations of 379 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.628 sen(zero) = 0.021
. ref(beam) = 2.499 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2129 ng
Mean aerosol black carbon concentration = 2818 ng/m3

The reference beam showed lamp intensity fluctuations of 480 ppm.

Disk space = 1.012531E+09 bytes free: One entry at every 5 minutes.
There is space for 215249 hours (8969 days) more data

27-jan-10 12:05:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

27-jan-10 12:14:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.894 ref(beam) = 2.614
. Lamp 2 (470 nm): sen(beam) = 2.750 ref(beam) = 2.932
. Lamp 3 (520 nm): sen(beam) = 2.306 ref(beam) = 2.981
. Lamp 4 (590 nm): sen(beam) = 2.458 ref(beam) = 3.935
. Lamp 5 (660 nm): sen(beam) = 1.937 ref(beam) = 2.540
. Lamp 6 (880 nm): sen(beam) = 3.198 ref(beam) = 3.747
. Lamp 7 (950 nm): sen(beam) = 2.007 ref(beam) = 2.436

27-jan-10 20:35:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 8.33 hours
. Total airflow this filter = 1.98 cubic meters
. Mean BC concentration of all lamps = 1103 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.567 sen(zero) = 0.021
. ref(beam) = 2.620 ref(zero) = 0.021

. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2433 ng
Mean aerosol black carbon concentration = 1236 ng/m3

The reference beam showed lamp intensity fluctuations of 235 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.760 sen(zero) = 0.021
. ref(beam) = 2.927 ref(zero) = 0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2235 ng
Mean aerosol black carbon concentration = 1135 ng/m3

The reference beam showed lamp intensity fluctuations of 108 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.573 sen(zero) = 0.021
. ref(beam) = 2.972 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2120 ng
Mean aerosol black carbon concentration = 1077 ng/m3

The reference beam showed lamp intensity fluctuations of 110 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.786 sen(zero) = 0.021
. ref(beam) = 4.004 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2147 ng
Mean aerosol black carbon concentration = 1091 ng/m3

The reference beam showed lamp intensity fluctuations of 591 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.423 sen(zero) = 0.021
. ref(beam) = 2.530 ref(zero) = 0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 2162 ng
Mean aerosol black carbon concentration = 1098 ng/m3

The reference beam showed lamp intensity fluctuations of 300 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.561 sen(zero) = 0.021
. ref(beam) = 3.736 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2077 ng
Mean aerosol black carbon concentration = 1055 ng/m3

The reference beam showed lamp intensity fluctuations of 342 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.644 sen(zero) = 0.021
. ref(beam) = 2.429 ref(zero) = 0.021

. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2020 ng
Mean aerosol black carbon concentration = 1026 ng/m3

The reference beam showed lamp intensity fluctuations of 433 ppm.

Disk space = 1.012498E+09 bytes free: One entry at every 5 minutes.
There is space for 215242 hours (8968 days) more data

27-jan-10 20:35:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

27-jan-10 20:44:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.887 ref(beam) =   2.577
. Lamp 2 (470 nm): sen(beam) =   2.722 ref(beam) =   2.904
. Lamp 3 (520 nm): sen(beam) =   2.328 ref(beam) =   2.949
. Lamp 4 (590 nm): sen(beam) =   2.462 ref(beam) =   3.856
. Lamp 5 (660 nm): sen(beam) =   1.905 ref(beam) =   2.497
. Lamp 6 (880 nm): sen(beam) =   3.206 ref(beam) =   3.681
. Lamp 7 (950 nm): sen(beam) =   1.971 ref(beam) =   2.388

28-jan-10 15:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 18.24 hours
. Total airflow this filter = 4.35 cubic meters
. Mean BC concentration of all lamps = 553 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.593 sen(zero) = 0.021
. ref(beam) = 2.586 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2435 ng
Mean aerosol black carbon concentration = 561 ng/m3

The reference beam showed lamp intensity fluctuations of 102 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.692 sen(zero) = 0.021
. ref(beam) = 2.898 ref(zero) = 0.021
. Optical attenuation of filter deposit = 47
. Total aerosol black carbon on filter = 2451 ng
Mean aerosol black carbon concentration = 565 ng/m3

The reference beam showed lamp intensity fluctuations of 55 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.534 sen(zero) = 0.021
. ref(beam) = 2.940 ref(zero) = 0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2375 ng
Mean aerosol black carbon concentration = 548 ng/m3

The reference beam showed lamp intensity fluctuations of 58 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.778 sen(zero) = 0.021
. ref(beam) = 3.909 ref(zero) = 0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2217 ng
Mean aerosol black carbon concentration = 511 ng/m3

The reference beam showed lamp intensity fluctuations of 251 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.309 sen(zero) = 0.021
. ref(beam) = 2.482 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2689 ng
Mean aerosol black carbon concentration = 620 ng/m3

The reference beam showed lamp intensity fluctuations of 128 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.496 sen(zero) = 0.021
. ref(beam) = 3.665 ref(zero) = 0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 2383 ng
Mean aerosol black carbon concentration = 550 ng/m3

The reference beam showed lamp intensity fluctuations of 143 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.584 sen(zero) = 0.021
. ref(beam) = 2.376 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2247 ng
Mean aerosol black carbon concentration = 518 ng/m3

The reference beam showed lamp intensity fluctuations of 178 ppm.

Disk space = 1.012466E+09 bytes free: One entry at every 5 minutes.
There is space for 215235 hours (8968 days) more data

28-jan-10 15:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

28-jan-10 15:09:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.725 ref(beam) = 2.571
. Lamp 2 (470 nm): sen(beam) = 2.569 ref(beam) = 2.910
. Lamp 3 (520 nm): sen(beam) = 2.248 ref(beam) = 2.881
. Lamp 4 (590 nm): sen(beam) = 2.350 ref(beam) = 3.813
. Lamp 5 (660 nm): sen(beam) = 1.836 ref(beam) = 2.504
. Lamp 6 (880 nm): sen(beam) = 3.094 ref(beam) = 3.675
. Lamp 7 (950 nm): sen(beam) = 1.835 ref(beam) = 2.395

29-jan-10 04:10:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 12.99 hours
. Total airflow this filter = 3.1 cubic meters
. Mean BC concentration of all lamps = 694 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.459 sen(zero) = 0.021
. ref(beam) = 2.596 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2435 ng
Mean aerosol black carbon concentration = 790 ng/m3

The reference beam showed lamp intensity fluctuations of 82 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.673 sen(zero) = 0.021
. ref(beam) = 2.912 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2173 ng
Mean aerosol black carbon concentration = 705 ng/m3

The reference beam showed lamp intensity fluctuations of 44 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.518 sen(zero) = 0.021
. ref(beam) = 2.937 ref(zero) = 0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2176 ng
Mean aerosol black carbon concentration = 706 ng/m3

The reference beam showed lamp intensity fluctuations of 53 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.717 sen(zero) = 0.021
. ref(beam) = 3.942 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2184 ng
Mean aerosol black carbon concentration = 708 ng/m3

The reference beam showed lamp intensity fluctuations of 209 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.358 sen(zero) = 0.021
. ref(beam) = 2.515 ref(zero) = 0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 2037 ng
Mean aerosol black carbon concentration = 661 ng/m3

The reference beam showed lamp intensity fluctuations of 106 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.482 sen(zero) = 0.021
. ref(beam) = 3.696 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2103 ng
Mean aerosol black carbon concentration = 682 ng/m3

The reference beam showed lamp intensity fluctuations of 116 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.568 sen(zero) = 0.021
. ref(beam) = 2.418 ref(zero) = 0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1876 ng
Mean aerosol black carbon concentration = 609 ng/m3

The reference beam showed lamp intensity fluctuations of 148 ppm.

Disk space = 1.012351E+09 bytes free: One entry at every 5 minutes.
There is space for 215211 hours (8967 days) more data

29-jan-10 04:10:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

29-jan-10 04:19:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.757 ref(beam) = 2.596
. Lamp 2 (470 nm): sen(beam) = 2.656 ref(beam) = 2.926
. Lamp 3 (520 nm): sen(beam) = 2.235 ref(beam) = 2.965
. Lamp 4 (590 nm): sen(beam) = 2.340 ref(beam) = 3.857
. Lamp 5 (660 nm): sen(beam) = 1.853 ref(beam) = 2.513
. Lamp 6 (880 nm): sen(beam) = 3.065 ref(beam) = 3.696
. Lamp 7 (950 nm): sen(beam) = 1.908 ref(beam) = 2.406

29-jan-10 20:15:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 15.91 hours
. Total airflow this filter = 3.79 cubic meters
. Mean BC concentration of all lamps = 609 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.564 sen(zero) = 0.021
. ref(beam) = 2.681 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2437 ng

Mean aerosol black carbon concentration = 645 ng/m3

The reference beam showed lamp intensity fluctuations of 149 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.721 sen(zero) = 0.021
. ref(beam) = 2.963 ref(zero) = 0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2308 ng
Mean aerosol black carbon concentration = 611 ng/m3

The reference beam showed lamp intensity fluctuations of 91 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.515 sen(zero) = 0.021
. ref(beam) = 2.999 ref(zero) = 0.021
. Optical attenuation of filter deposit = 40
. Total aerosol black carbon on filter = 2294 ng
Mean aerosol black carbon concentration = 607 ng/m3

The reference beam showed lamp intensity fluctuations of 96 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.809 sen(zero) = 0.021
. ref(beam) = 4.258 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2325 ng
Mean aerosol black carbon concentration = 615 ng/m3

The reference beam showed lamp intensity fluctuations of 413 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.410 sen(zero) = 0.021
. ref(beam) = 2.613 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2272 ng
Mean aerosol black carbon concentration = 601 ng/m3

The reference beam showed lamp intensity fluctuations of 226 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.527 sen(zero) = 0.021
. ref(beam) = 3.861 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2295 ng
Mean aerosol black carbon concentration = 607 ng/m3

The reference beam showed lamp intensity fluctuations of 216 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.644 sen(zero) = 0.021
. ref(beam) = 2.550 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2174 ng

Mean aerosol black carbon concentration = 575 ng/m3

The reference beam showed lamp intensity fluctuations of 309 ppm.

Disk space = 1.012269E+09 bytes free: One entry at every 5 minutes.
There is space for 215193 hours (8966 days) more data

29-jan-10 20:15:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

29-jan-10 20:24:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.790 ref(beam) =   2.718
. Lamp 2 (470 nm): sen(beam) =   2.676 ref(beam) =   2.992
. Lamp 3 (520 nm): sen(beam) =   2.238 ref(beam) =   3.033
. Lamp 4 (590 nm): sen(beam) =   2.497 ref(beam) =   4.183
. Lamp 5 (660 nm): sen(beam) =   1.920 ref(beam) =   2.628
. Lamp 6 (880 nm): sen(beam) =   3.196 ref(beam) =   3.886
. Lamp 7 (950 nm): sen(beam) =   2.016 ref(beam) =   2.555

30-jan-10 12:30:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 16.08 hours
. Total airflow this filter = 3.83 cubic meters
. Mean BC concentration of all lamps = 566 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.521 sen(zero) = 0.021
. ref(beam) = 2.718 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2438 ng
Mean aerosol black carbon concentration = 638 ng/m3

The reference beam showed lamp intensity fluctuations of 87 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.720 sen(zero) = 0.021
. ref(beam) = 2.984 ref(zero) = 0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2249 ng
Mean aerosol black carbon concentration = 588 ng/m3

The reference beam showed lamp intensity fluctuations of 59 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.543 sen(zero) = 0.021
. ref(beam) = 3.021 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2086 ng
Mean aerosol black carbon concentration = 546 ng/m3

The reference beam showed lamp intensity fluctuations of 73 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.817 sen(zero) = 0.021
. ref(beam) = 4.222 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2118 ng
Mean aerosol black carbon concentration = 554 ng/m3

The reference beam showed lamp intensity fluctuations of 309 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.413 sen(zero) = 0.021
. ref(beam) = 2.610 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2162 ng
Mean aerosol black carbon concentration = 566 ng/m3

The reference beam showed lamp intensity fluctuations of 184 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.567 sen(zero) = 0.021
. ref(beam) = 3.861 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2041 ng
Mean aerosol black carbon concentration = 534 ng/m3

The reference beam showed lamp intensity fluctuations of 175 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.647 sen(zero) = 0.021
. ref(beam) = 2.538 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2035 ng
Mean aerosol black carbon concentration = 532 ng/m3

The reference beam showed lamp intensity fluctuations of 209 ppm.

Disk space = 1.012204E+09 bytes free: One entry at every 5 minutes.
There is space for 215179 hours (8966 days) more data

30-jan-10 12:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

30-jan-10 12:39:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.846 ref(beam) = 2.759
. Lamp 2 (470 nm): sen(beam) = 2.735 ref(beam) = 3.018
. Lamp 3 (520 nm): sen(beam) = 2.296 ref(beam) = 3.079
. Lamp 4 (590 nm): sen(beam) = 2.519 ref(beam) = 4.180
. Lamp 5 (660 nm): sen(beam) = 1.949 ref(beam) = 2.632
. Lamp 6 (880 nm): sen(beam) = 3.236 ref(beam) = 3.918
. Lamp 7 (950 nm): sen(beam) = 2.036 ref(beam) = 2.552

30-jan-10 19:20:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 6.66 hours
. Total airflow this filter = 1.59 cubic meters
. Mean BC concentration of all lamps = 1339 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.566 sen(zero) = 0.021
. ref(beam) = 2.772 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2454 ng

Mean aerosol black carbon concentration = 1562 ng/m3

The reference beam showed lamp intensity fluctuations of 193 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.788 sen(zero) = 0.021
. ref(beam) = 3.020 ref(zero) = 0.021
. Optical attenuation of filter deposit = 42
. Total aerosol black carbon on filter = 2187 ng
Mean aerosol black carbon concentration = 1392 ng/m3

The reference beam showed lamp intensity fluctuations of 110 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.601 sen(zero) = 0.021
. ref(beam) = 3.079 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2056 ng
Mean aerosol black carbon concentration = 1308 ng/m3

The reference beam showed lamp intensity fluctuations of 100 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.883 sen(zero) = 0.021
. ref(beam) = 4.295 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2064 ng
Mean aerosol black carbon concentration = 1314 ng/m3

The reference beam showed lamp intensity fluctuations of 477 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.464 sen(zero) = 0.021
. ref(beam) = 2.637 ref(zero) = 0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 2076 ng
Mean aerosol black carbon concentration = 1321 ng/m3

The reference beam showed lamp intensity fluctuations of 241 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.648 sen(zero) = 0.021
. ref(beam) = 3.932 ref(zero) = 0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 1973 ng
Mean aerosol black carbon concentration = 1256 ng/m3

The reference beam showed lamp intensity fluctuations of 268 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.702 sen(zero) = 0.021
. ref(beam) = 2.564 ref(zero) = 0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1916 ng

Mean aerosol black carbon concentration = 1219 ng/m3

The reference beam showed lamp intensity fluctuations of 353 ppm.

Disk space = 1.012105E+09 bytes free: One entry at every 5 minutes.
There is space for 215158 hours (8965 days) more data

30-jan-10 19:20:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

30-jan-10 19:29:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.824 ref(beam) =   2.774
. Lamp 2 (470 nm): sen(beam) =   2.679 ref(beam) =   3.050
. Lamp 3 (520 nm): sen(beam) =   2.279 ref(beam) =   3.103
. Lamp 4 (590 nm): sen(beam) =   2.503 ref(beam) =   4.207
. Lamp 5 (660 nm): sen(beam) =   1.911 ref(beam) =   2.660
. Lamp 6 (880 nm): sen(beam) =   3.226 ref(beam) =   3.937
. Lamp 7 (950 nm): sen(beam) =   2.004 ref(beam) =   2.580

30-jan-10 21:50:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 2.33 hours
.   Total airflow this filter = .55 cubic meters
.   Mean BC concentration of all lamps = 3378 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.509 sen(zero) =   0.021
.   ref(beam) =   2.787 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2458 ng
Mean aerosol black carbon concentration = 4578 ng/m3

The reference beam showed lamp intensity fluctuations of 63 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.822 sen(zero) =   0.021
.   ref(beam) =   3.052 ref(zero) =   0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 1918 ng
Mean aerosol black carbon concentration = 3573 ng/m3

The reference beam showed lamp intensity fluctuations of 63 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.657 sen(zero) = 0.021
. ref(beam) = 3.102 ref(zero) = 0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 1756 ng
Mean aerosol black carbon concentration = 3270 ng/m3

The reference beam showed lamp intensity fluctuations of 51 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.958 sen(zero) = 0.021
. ref(beam) = 4.330 ref(zero) = 0.021
. Optical attenuation of filter deposit = 26
. Total aerosol black carbon on filter = 1732 ng
Mean aerosol black carbon concentration = 3225 ng/m3

The reference beam showed lamp intensity fluctuations of 113 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.501 sen(zero) = 0.021
. ref(beam) = 2.669 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 1720 ng
Mean aerosol black carbon concentration = 3204 ng/m3

The reference beam showed lamp intensity fluctuations of 60 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.738 sen(zero) = 0.021
. ref(beam) = 3.955 ref(zero) = 0.021
. Optical attenuation of filter deposit = 16
. Total aerosol black carbon on filter = 1582 ng
Mean aerosol black carbon concentration = 2946 ng/m3

The reference beam showed lamp intensity fluctuations of 67 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.736 sen(zero) = 0.021
. ref(beam) = 2.596 ref(zero) = 0.021
. Optical attenuation of filter deposit = 14
. Total aerosol black carbon on filter = 1530 ng
Mean aerosol black carbon concentration = 2849 ng/m3

The reference beam showed lamp intensity fluctuations of 78 ppm.

Disk space = 1.012072E+09 bytes free: One entry at every 5 minutes.
There is space for 215151 hours (8965 days) more data

30-jan-10 21:50:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

30-jan-10 21:59:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.908 ref(beam) =   2.748
. Lamp 2 (470 nm): sen(beam) =   2.773 ref(beam) =   3.014
. Lamp 3 (520 nm): sen(beam) =   2.328 ref(beam) =   3.046
. Lamp 4 (590 nm): sen(beam) =   2.556 ref(beam) =   4.135
. Lamp 5 (660 nm): sen(beam) =   1.977 ref(beam) =   2.627
. Lamp 6 (880 nm): sen(beam) =   3.284 ref(beam) =   3.878
. Lamp 7 (950 nm): sen(beam) =   2.068 ref(beam) =   2.546

31-jan-10 02:15:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 4.24 hours
.   Total airflow this filter = 1.01 cubic meters
.   Mean BC concentration of all lamps = 1677 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.567 sen(zero) =   0.021
.   ref(beam) =   2.772 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2458 ng
Mean aerosol black carbon concentration = 2472 ng/m3

The reference beam showed lamp intensity fluctuations of 55 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.945 sen(zero) =   0.021
.   ref(beam) =   3.021 ref(zero) =   0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 1790 ng
Mean aerosol black carbon concentration = 1800 ng/m3

The reference beam showed lamp intensity fluctuations of 38 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.743 sen(zero) =   0.021
.   ref(beam) =   3.051 ref(zero) =   0.021
. Optical attenuation of filter deposit = 28
. Total aerosol black carbon on filter = 1617 ng
Mean aerosol black carbon concentration = 1626 ng/m3

The reference beam showed lamp intensity fluctuations of 39 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   2.081 sen(zero) =   0.021
.   ref(beam) =   4.302 ref(zero) =   0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 1564 ng
Mean aerosol black carbon concentration = 1573 ng/m3

The reference beam showed lamp intensity fluctuations of 151 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.608 sen(zero) =   0.021
.   ref(beam) =   2.650 ref(zero) =   0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 1526 ng
Mean aerosol black carbon concentration = 1534 ng/m3

The reference beam showed lamp intensity fluctuations of 81 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.866 sen(zero) = 0.021
. ref(beam) = 3.920 ref(zero) = 0.021
. Optical attenuation of filter deposit = 14
. Total aerosol black carbon on filter = 1391 ng
Mean aerosol black carbon concentration = 1399 ng/m3

The reference beam showed lamp intensity fluctuations of 112 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.844 sen(zero) = 0.021
. ref(beam) = 2.583 ref(zero) = 0.021
. Optical attenuation of filter deposit = 12
. Total aerosol black carbon on filter = 1330 ng
Mean aerosol black carbon concentration = 1338 ng/m3

The reference beam showed lamp intensity fluctuations of 105 ppm.

Disk space = 1.012056E+09 bytes free: One entry at every 5 minutes.
There is space for 215148 hours (8964 days) more data

31-jan-10 02:15:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

31-jan-10 02:24:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.966 ref(beam) = 2.773
. Lamp 2 (470 nm): sen(beam) = 2.759 ref(beam) = 3.047
. Lamp 3 (520 nm): sen(beam) = 2.361 ref(beam) = 3.084
. Lamp 4 (590 nm): sen(beam) = 2.626 ref(beam) = 4.231
. Lamp 5 (660 nm): sen(beam) = 1.970 ref(beam) = 2.670
. Lamp 6 (880 nm): sen(beam) = 3.350 ref(beam) = 3.939
. Lamp 7 (950 nm): sen(beam) = 2.066 ref(beam) = 2.599

31-jan-10 12:40:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 10.25 hours
. Total airflow this filter = 2.44 cubic meters
. Mean BC concentration of all lamps = 805 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.592 sen(zero) = 0.021
. ref(beam) = 2.736 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2433 ng

Mean aerosol black carbon concentration = 1002 ng/m3

The reference beam showed lamp intensity fluctuations of 119 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.829 sen(zero) = 0.021
. ref(beam) = 3.019 ref(zero) = 0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2051 ng
Mean aerosol black carbon concentration = 845 ng/m3

The reference beam showed lamp intensity fluctuations of 65 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.666 sen(zero) = 0.021
. ref(beam) = 3.051 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 1912 ng
Mean aerosol black carbon concentration = 788 ng/m3

The reference beam showed lamp intensity fluctuations of 86 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.897 sen(zero) = 0.021
. ref(beam) = 4.109 ref(zero) = 0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 1914 ng
Mean aerosol black carbon concentration = 789 ng/m3

The reference beam showed lamp intensity fluctuations of 316 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.476 sen(zero) = 0.021
. ref(beam) = 2.601 ref(zero) = 0.021
. Optical attenuation of filter deposit = 26
. Total aerosol black carbon on filter = 1888 ng
Mean aerosol black carbon concentration = 778 ng/m3

The reference beam showed lamp intensity fluctuations of 166 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.705 sen(zero) = 0.021
. ref(beam) = 3.829 ref(zero) = 0.021
. Optical attenuation of filter deposit = 18
. Total aerosol black carbon on filter = 1783 ng
Mean aerosol black carbon concentration = 734 ng/m3

The reference beam showed lamp intensity fluctuations of 199 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.693 sen(zero) = 0.021
. ref(beam) = 2.508 ref(zero) = 0.021
. Optical attenuation of filter deposit = 16
. Total aerosol black carbon on filter = 1701 ng

Mean aerosol black carbon concentration = 701 ng/m3

The reference beam showed lamp intensity fluctuations of 247 ppm.

Disk space = 1.012023E+09 bytes free: One entry at every 5 minutes.
There is space for 215141 hours (8964 days) more data

31-jan-10 12:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

31-jan-10 12:49:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.898 ref(beam) = 2.712
. Lamp 2 (470 nm): sen(beam) = 2.748 ref(beam) = 3.015
. Lamp 3 (520 nm): sen(beam) = 2.322 ref(beam) = 3.033
. Lamp 4 (590 nm): sen(beam) = 2.450 ref(beam) = 3.959
. Lamp 5 (660 nm): sen(beam) = 1.921 ref(beam) = 2.593
. Lamp 6 (880 nm): sen(beam) = 3.209 ref(beam) = 3.792
. Lamp 7 (950 nm): sen(beam) = 1.988 ref(beam) = 2.490

31-jan-10 18:30:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 5.66 hours
. Total airflow this filter = 1.35 cubic meters
. Mean BC concentration of all lamps = 1538 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.604 sen(zero) = 0.021
. ref(beam) = 2.757 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2442 ng
Mean aerosol black carbon concentration = 1833 ng/m3

The reference beam showed lamp intensity fluctuations of 237 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.816 sen(zero) = 0.021
. ref(beam) = 3.031 ref(zero) = 0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2143 ng
Mean aerosol black carbon concentration = 1609 ng/m3

The reference beam showed lamp intensity fluctuations of 108 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.636 sen(zero) = 0.021
. ref(beam) = 3.046 ref(zero) = 0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2005 ng
Mean aerosol black carbon concentration = 1505 ng/m3

The reference beam showed lamp intensity fluctuations of 115 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.902 sen(zero) = 0.021
. ref(beam) = 4.191 ref(zero) = 0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2005 ng
Mean aerosol black carbon concentration = 1505 ng/m3

The reference beam showed lamp intensity fluctuations of 699 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.478 sen(zero) = 0.021
. ref(beam) = 2.638 ref(zero) = 0.021
. Optical attenuation of filter deposit = 27
. Total aerosol black carbon on filter = 2009 ng
Mean aerosol black carbon concentration = 1509 ng/m3

The reference beam showed lamp intensity fluctuations of 362 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.687 sen(zero) = 0.021
. ref(beam) = 3.867 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 1893 ng
Mean aerosol black carbon concentration = 1421 ng/m3

The reference beam showed lamp intensity fluctuations of 388 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.709 sen(zero) = 0.021
. ref(beam) = 2.557 ref(zero) = 0.021
. Optical attenuation of filter deposit = 17
. Total aerosol black carbon on filter = 1844 ng
Mean aerosol black carbon concentration = 1385 ng/m3

The reference beam showed lamp intensity fluctuations of 478 ppm.

Disk space = 1.011974E+09 bytes free: One entry at every 5 minutes.
There is space for 215131 hours (8964 days) more data

31-jan-10 18:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

31-jan-10 18:39:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.901 ref(beam) =   2.716
. Lamp 2 (470 nm): sen(beam) =   2.760 ref(beam) =   2.989
. Lamp 3 (520 nm): sen(beam) =   2.333 ref(beam) =   3.033
. Lamp 4 (590 nm): sen(beam) =   2.525 ref(beam) =   4.056
. Lamp 5 (660 nm): sen(beam) =   1.954 ref(beam) =   2.586
. Lamp 6 (880 nm): sen(beam) =   3.268 ref(beam) =   3.837
. Lamp 7 (950 nm): sen(beam) =   2.042 ref(beam) =   2.497

31-jan-10 22:45:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 4.08 hours
.   Total airflow this filter = .97 cubic meters
.   Mean BC concentration of all lamps = 1913 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.564 sen(zero) =   0.021
.   ref(beam) =   2.736 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2466 ng
Mean aerosol black carbon concentration = 2584 ng/m3

The reference beam showed lamp intensity fluctuations of 41 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.885 sen(zero) =   0.021
.   ref(beam) =   2.993 ref(zero) =   0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 1926 ng
Mean aerosol black carbon concentration = 2018 ng/m3

The reference beam showed lamp intensity fluctuations of 28 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.698 sen(zero) =   0.021
.   ref(beam) =   3.034 ref(zero) =   0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 1775 ng
Mean aerosol black carbon concentration = 1860 ng/m3

The reference beam showed lamp intensity fluctuations of 31 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.988 sen(zero) =   0.021
.   ref(beam) =   4.197 ref(zero) =   0.021
. Optical attenuation of filter deposit = 27

. Total aerosol black carbon on filter = 1750 ng
Mean aerosol black carbon concentration = 1833 ng/m3

The reference beam showed lamp intensity fluctuations of 131 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.543 sen(zero) =   0.021
.   ref(beam) =   2.601 ref(zero) =   0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 1723 ng
Mean aerosol black carbon concentration = 1805 ng/m3

The reference beam showed lamp intensity fluctuations of 53 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.780 sen(zero) =   0.021
.   ref(beam) =   3.865 ref(zero) =   0.021
. Optical attenuation of filter deposit = 16
. Total aerosol black carbon on filter = 1607 ng
Mean aerosol black carbon concentration = 1684 ng/m3

The reference beam showed lamp intensity fluctuations of 54 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.777 sen(zero) =   0.021
.   ref(beam) =   2.523 ref(zero) =   0.021
. Optical attenuation of filter deposit = 14
. Total aerosol black carbon on filter = 1537 ng
Mean aerosol black carbon concentration = 1610 ng/m3

The reference beam showed lamp intensity fluctuations of 87 ppm.

Disk space = 1.011941E+09 bytes free: One entry at every 5 minutes.
There is space for 215124 hours (8964 days) more data

31-jan-10 22:45:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

31-jan-10 22:54:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.904 ref(beam) =   2.716
. Lamp 2 (470 nm): sen(beam) =   2.731 ref(beam) =   2.999
. Lamp 3 (520 nm): sen(beam) =   2.306 ref(beam) =   3.034
. Lamp 4 (590 nm): sen(beam) =   2.511 ref(beam) =   4.089
. Lamp 5 (660 nm): sen(beam) =   1.935 ref(beam) =   2.607
. Lamp 6 (880 nm): sen(beam) =   3.235 ref(beam) =   3.841

. Lamp 7 (950 nm): sen(beam) =   2.018 ref(beam) =   2.524

01-feb-10 11:30:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 12.58 hours
.   Total airflow this filter = 3 cubic meters
.   Mean BC concentration of all lamps = 734 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.572 sen(zero) =   0.021
.   ref(beam) =   2.716 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2447 ng
Mean aerosol black carbon concentration = 820 ng/m3

The reference beam showed lamp intensity fluctuations of 117 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.751 sen(zero) =   0.021
.   ref(beam) =   2.991 ref(zero) =   0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2253 ng
Mean aerosol black carbon concentration = 755 ng/m3

The reference beam showed lamp intensity fluctuations of 50 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.575 sen(zero) =   0.021
.   ref(beam) =   3.021 ref(zero) =   0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2134 ng
Mean aerosol black carbon concentration = 715 ng/m3

The reference beam showed lamp intensity fluctuations of 60 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.818 sen(zero) =   0.021
.   ref(beam) =   4.132 ref(zero) =   0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2159 ng
Mean aerosol black carbon concentration = 723 ng/m3

The reference beam showed lamp intensity fluctuations of 379 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.420 sen(zero) =   0.021
.   ref(beam) =   2.590 ref(zero) =   0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2184 ng
Mean aerosol black carbon concentration = 732 ng/m3

The reference beam showed lamp intensity fluctuations of 192 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.583 sen(zero) = 0.021
. ref(beam) = 3.817 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2106 ng
Mean aerosol black carbon concentration = 706 ng/m3

The reference beam showed lamp intensity fluctuations of 216 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.645 sen(zero) = 0.021
. ref(beam) = 2.506 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 2059 ng
Mean aerosol black carbon concentration = 690 ng/m3

The reference beam showed lamp intensity fluctuations of 272 ppm.

Disk space = 1.011925E+09 bytes free: One entry at every 5 minutes.
There is space for 215120 hours (8963 days) more data

01-feb-10 11:30:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

01-feb-10 11:39:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.870 ref(beam) = 2.701
. Lamp 2 (470 nm): sen(beam) = 2.722 ref(beam) = 2.980
. Lamp 3 (520 nm): sen(beam) = 2.273 ref(beam) = 3.023
. Lamp 4 (590 nm): sen(beam) = 2.428 ref(beam) = 4.007
. Lamp 5 (660 nm): sen(beam) = 1.909 ref(beam) = 2.569
. Lamp 6 (880 nm): sen(beam) = 3.153 ref(beam) = 3.808
. Lamp 7 (950 nm): sen(beam) = 1.980 ref(beam) = 2.480

01-feb-10 18:05:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 6.41 hours
. Total airflow this filter = 1.53 cubic meters
. Mean BC concentration of all lamps = 1421 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.574 sen(zero) = 0.021
. ref(beam) = 2.714 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2431 ng

Mean aerosol black carbon concentration = 1609 ng/m3

The reference beam showed lamp intensity fluctuations of 255 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.758 sen(zero) = 0.021
. ref(beam) = 2.981 ref(zero) = 0.021
. Optical attenuation of filter deposit = 43
. Total aerosol black carbon on filter = 2231 ng
Mean aerosol black carbon concentration = 1477 ng/m3

The reference beam showed lamp intensity fluctuations of 134 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.565 sen(zero) = 0.021
. ref(beam) = 3.022 ref(zero) = 0.021
. Optical attenuation of filter deposit = 36
. Total aerosol black carbon on filter = 2106 ng
Mean aerosol black carbon concentration = 1394 ng/m3

The reference beam showed lamp intensity fluctuations of 133 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.792 sen(zero) = 0.021
. ref(beam) = 4.107 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2118 ng
Mean aerosol black carbon concentration = 1402 ng/m3

The reference beam showed lamp intensity fluctuations of 720 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.421 sen(zero) = 0.021
. ref(beam) = 2.571 ref(zero) = 0.021
. Optical attenuation of filter deposit = 29
. Total aerosol black carbon on filter = 2129 ng
Mean aerosol black carbon concentration = 1409 ng/m3

The reference beam showed lamp intensity fluctuations of 341 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.556 sen(zero) = 0.021
. ref(beam) = 3.816 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2031 ng
Mean aerosol black carbon concentration = 1345 ng/m3

The reference beam showed lamp intensity fluctuations of 371 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.642 sen(zero) = 0.021
. ref(beam) = 2.488 ref(zero) = 0.021
. Optical attenuation of filter deposit = 19
. Total aerosol black carbon on filter = 1980 ng

Mean aerosol black carbon concentration = 1311 ng/m3

The reference beam showed lamp intensity fluctuations of 464 ppm.

Disk space = 1.011843E+09 bytes free: One entry at every 5 minutes.
There is space for 215103 hours (8963 days) more data

01-feb-10 18:05:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

01-feb-10 18:14:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.860 ref(beam) = 2.681
. Lamp 2 (470 nm): sen(beam) = 2.709 ref(beam) = 2.964
. Lamp 3 (520 nm): sen(beam) = 2.296 ref(beam) = 3.013
. Lamp 4 (590 nm): sen(beam) = 2.450 ref(beam) = 3.983
. Lamp 5 (660 nm): sen(beam) = 1.905 ref(beam) = 2.553
. Lamp 6 (880 nm): sen(beam) = 3.193 ref(beam) = 3.791
. Lamp 7 (950 nm): sen(beam) = 1.984 ref(beam) = 2.461

01-feb-10 23:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 4.75 hours
. Total airflow this filter = 1.13 cubic meters
. Mean BC concentration of all lamps = 1682 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.559 sen(zero) = 0.021
. ref(beam) = 2.712 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2443 ng
Mean aerosol black carbon concentration = 2193 ng/m3

The reference beam showed lamp intensity fluctuations of 58 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.833 sen(zero) = 0.021
. ref(beam) = 2.972 ref(zero) = 0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 1978 ng
Mean aerosol black carbon concentration = 1776 ng/m3

The reference beam showed lamp intensity fluctuations of 49 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.657 sen(zero) =   0.021
.   ref(beam) =   3.017 ref(zero) =   0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 1826 ng
Mean aerosol black carbon concentration = 1639 ng/m3

The reference beam showed lamp intensity fluctuations of 50 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.932 sen(zero) =   0.021
.   ref(beam) =   4.165 ref(zero) =   0.021
. Optical attenuation of filter deposit = 27
. Total aerosol black carbon on filter = 1801 ng
Mean aerosol black carbon concentration = 1617 ng/m3

The reference beam showed lamp intensity fluctuations of 143 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.498 sen(zero) =   0.021
.   ref(beam) =   2.581 ref(zero) =   0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 1783 ng
Mean aerosol black carbon concentration = 1601 ng/m3

The reference beam showed lamp intensity fluctuations of 85 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.711 sen(zero) =   0.021
.   ref(beam) =   3.839 ref(zero) =   0.021
. Optical attenuation of filter deposit = 17
. Total aerosol black carbon on filter = 1669 ng
Mean aerosol black carbon concentration = 1499 ng/m3

The reference beam showed lamp intensity fluctuations of 78 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.727 sen(zero) =   0.021
.   ref(beam) =   2.505 ref(zero) =   0.021
. Optical attenuation of filter deposit = 15
. Total aerosol black carbon on filter = 1609 ng
Mean aerosol black carbon concentration = 1445 ng/m3

The reference beam showed lamp intensity fluctuations of 107 ppm.

Disk space = 1.01181E+09 bytes free: One entry at every 5 minutes.
There is space for 215096 hours (8962 days) more data

01-feb-10 23:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

01-feb-10 23:09:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.876 ref(beam) =   2.711
. Lamp 2 (470 nm): sen(beam) =   2.720 ref(beam) =   2.985
. Lamp 3 (520 nm): sen(beam) =   2.298 ref(beam) =   3.028
. Lamp 4 (590 nm): sen(beam) =   2.491 ref(beam) =   4.069
. Lamp 5 (660 nm): sen(beam) =   1.924 ref(beam) =   2.592
. Lamp 6 (880 nm): sen(beam) =   3.219 ref(beam) =   3.837
. Lamp 7 (950 nm): sen(beam) =   2.006 ref(beam) =   2.509

02-feb-10 18:40:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 19.5 hours
.   Total airflow this filter = 4.65 cubic meters
.   Mean BC concentration of all lamps = 479 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.552 sen(zero) =   0.021
.   ref(beam) =   2.683 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2434 ng
Mean aerosol black carbon concentration = 525 ng/m3

The reference beam showed lamp intensity fluctuations of 102 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.729 sen(zero) =   0.021
.   ref(beam) =   2.963 ref(zero) =   0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2276 ng
Mean aerosol black carbon concentration = 491 ng/m3

The reference beam showed lamp intensity fluctuations of 60 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.554 sen(zero) =   0.021
.   ref(beam) =   3.001 ref(zero) =   0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2168 ng
Mean aerosol black carbon concentration = 468 ng/m3

The reference beam showed lamp intensity fluctuations of 55 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.738 sen(zero) =   0.021
.   ref(beam) =   3.990 ref(zero) =   0.021
. Optical attenuation of filter deposit = 34
. Total aerosol black carbon on filter = 2206 ng
Mean aerosol black carbon concentration = 476 ng/m3

The reference beam showed lamp intensity fluctuations of 272 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.383 sen(zero) =   0.021
.   ref(beam) =   2.534 ref(zero) =   0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2218 ng
Mean aerosol black carbon concentration = 479 ng/m3

The reference beam showed lamp intensity fluctuations of 144 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) =   2.512 sen(zero) =   0.021
.   ref(beam) =   3.747 ref(zero) =   0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2157 ng
Mean aerosol black carbon concentration = 465 ng/m3

The reference beam showed lamp intensity fluctuations of 159 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.592 sen(zero) =   0.021
.   ref(beam) =   2.436 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2098 ng
Mean aerosol black carbon concentration = 453 ng/m3

The reference beam showed lamp intensity fluctuations of 199 ppm.

Disk space = 1.011794E+09 bytes free: One entry at every 5 minutes.
There is space for 215092 hours (8962 days) more data

02-feb-10 18:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

02-feb-10 18:49:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.830 ref(beam) =   2.667
. Lamp 2 (470 nm): sen(beam) =   2.680 ref(beam) =   2.960
. Lamp 3 (520 nm): sen(beam) =   2.278 ref(beam) =   3.021
. Lamp 4 (590 nm): sen(beam) =   2.369 ref(beam) =   3.895
. Lamp 5 (660 nm): sen(beam) =   1.857 ref(beam) =   2.523
. Lamp 6 (880 nm): sen(beam) =   3.117 ref(beam) =   3.752
. Lamp 7 (950 nm): sen(beam) =   1.917 ref(beam) =   2.419

03-feb-10 02:15:00 Measurements ended

.   Number of lamps (L) = 7
.   Filter running time = 7.41 hours
.   Total airflow this filter = 1.76 cubic meters
.   Mean BC concentration of all lamps = 1302 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) =   1.575 sen(zero) =   0.021
.   ref(beam) =   2.713 ref(zero) =   0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2433 ng
Mean aerosol black carbon concentration = 1390 ng/m3

The reference beam showed lamp intensity fluctuations of 121 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) =   1.727 sen(zero) =   0.021
.   ref(beam) =   2.976 ref(zero) =   0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2285 ng
Mean aerosol black carbon concentration = 1306 ng/m3

The reference beam showed lamp intensity fluctuations of 55 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) =   1.550 sen(zero) =   0.021
.   ref(beam) =   3.033 ref(zero) =   0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2215 ng
Mean aerosol black carbon concentration = 1266 ng/m3

The reference beam showed lamp intensity fluctuations of 72 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) =   1.763 sen(zero) =   0.021
.   ref(beam) =   4.109 ref(zero) =   0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2268 ng
Mean aerosol black carbon concentration = 1296 ng/m3

The reference beam showed lamp intensity fluctuations of 365 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.377 sen(zero) =   0.021
.   ref(beam) =   2.562 ref(zero) =   0.021
. Optical attenuation of filter deposit = 31
. Total aerosol black carbon on filter = 2281 ng
Mean aerosol black carbon concentration = 1304 ng/m3

The reference beam showed lamp intensity fluctuations of 172 ppm.

Report for lamp 6 (880 nm):

. Ending voltages: sen(beam) = 2.508 sen(zero) = 0.021
. ref(beam) = 3.819 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2268 ng
Mean aerosol black carbon concentration = 1296 ng/m3

The reference beam showed lamp intensity fluctuations of 177 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.591 sen(zero) = 0.021
. ref(beam) = 2.476 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2200 ng
Mean aerosol black carbon concentration = 1257 ng/m3

The reference beam showed lamp intensity fluctuations of 250 ppm.

Disk space = 1.011679E+09 bytes free: One entry at every 5 minutes.
There is space for 215068 hours (8961 days) more data

03-feb-10 02:15:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

03-feb-10 02:24:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.883 ref(beam) = 2.679
. Lamp 2 (470 nm): sen(beam) = 2.718 ref(beam) = 2.952
. Lamp 3 (520 nm): sen(beam) = 2.298 ref(beam) = 2.993
. Lamp 4 (590 nm): sen(beam) = 2.445 ref(beam) = 3.938
. Lamp 5 (660 nm): sen(beam) = 1.902 ref(beam) = 2.536
. Lamp 6 (880 nm): sen(beam) = 3.186 ref(beam) = 3.741
. Lamp 7 (950 nm): sen(beam) = 1.975 ref(beam) = 2.445

03-feb-10 08:25:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 6 hours
. Total airflow this filter = 1.43 cubic meters
. Mean BC concentration of all lamps = 1640 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.582 sen(zero) = 0.021
. ref(beam) = 2.702 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2449 ng

Mean aerosol black carbon concentration = 1734 ng/m3

The reference beam showed lamp intensity fluctuations of 79 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.723 sen(zero) = 0.021
. ref(beam) = 2.956 ref(zero) = 0.021
. Optical attenuation of filter deposit = 45
. Total aerosol black carbon on filter = 2341 ng
Mean aerosol black carbon concentration = 1658 ng/m3

The reference beam showed lamp intensity fluctuations of 57 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.546 sen(zero) = 0.021
. ref(beam) = 2.993 ref(zero) = 0.021
. Optical attenuation of filter deposit = 39
. Total aerosol black carbon on filter = 2251 ng
Mean aerosol black carbon concentration = 1594 ng/m3

The reference beam showed lamp intensity fluctuations of 53 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.776 sen(zero) = 0.021
. ref(beam) = 4.078 ref(zero) = 0.021
. Optical attenuation of filter deposit = 35
. Total aerosol black carbon on filter = 2295 ng
Mean aerosol black carbon concentration = 1626 ng/m3

The reference beam showed lamp intensity fluctuations of 204 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.386 sen(zero) = 0.021
. ref(beam) = 2.551 ref(zero) = 0.021
. Optical attenuation of filter deposit = 32
. Total aerosol black carbon on filter = 2328 ng
Mean aerosol black carbon concentration = 1649 ng/m3

The reference beam showed lamp intensity fluctuations of 110 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.528 sen(zero) = 0.021
. ref(beam) = 3.768 ref(zero) = 0.021
. Optical attenuation of filter deposit = 23
. Total aerosol black carbon on filter = 2294 ng
Mean aerosol black carbon concentration = 1625 ng/m3

The reference beam showed lamp intensity fluctuations of 114 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.609 sen(zero) = 0.021
. ref(beam) = 2.471 ref(zero) = 0.021
. Optical attenuation of filter deposit = 21
. Total aerosol black carbon on filter = 2248 ng

Mean aerosol black carbon concentration = 1592 ng/m3

The reference beam showed lamp intensity fluctuations of 150 ppm.

Disk space = 1.01163E+09 bytes free: One entry at every 5 minutes.
There is space for 215057 hours (8961 days) more data

03-feb-10 08:25:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

03-feb-10 08:34:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.820 ref(beam) = 2.693
. Lamp 2 (470 nm): sen(beam) = 2.671 ref(beam) = 2.979
. Lamp 3 (520 nm): sen(beam) = 2.259 ref(beam) = 3.012
. Lamp 4 (590 nm): sen(beam) = 2.416 ref(beam) = 3.979
. Lamp 5 (660 nm): sen(beam) = 1.877 ref(beam) = 2.564
. Lamp 6 (880 nm): sen(beam) = 3.145 ref(beam) = 3.782
. Lamp 7 (950 nm): sen(beam) = 1.954 ref(beam) = 2.471

03-feb-10 16:00:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 7.41 hours
. Total airflow this filter = 1.76 cubic meters
. Mean BC concentration of all lamps = 1366 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.486 sen(zero) = 0.021
. ref(beam) = 2.664 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2453 ng
Mean aerosol black carbon concentration = 1402 ng/m3

The reference beam showed lamp intensity fluctuations of 270 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.630 sen(zero) = 0.021
. ref(beam) = 2.958 ref(zero) = 0.021
. Optical attenuation of filter deposit = 46
. Total aerosol black carbon on filter = 2415 ng
Mean aerosol black carbon concentration = 1380 ng/m3

The reference beam showed lamp intensity fluctuations of 132 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.462 sen(zero) = 0.021
. ref(beam) = 2.989 ref(zero) = 0.021
. Optical attenuation of filter deposit = 41
. Total aerosol black carbon on filter = 2348 ng
Mean aerosol black carbon concentration = 1342 ng/m3

The reference beam showed lamp intensity fluctuations of 135 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.622 sen(zero) = 0.021
. ref(beam) = 3.917 ref(zero) = 0.021
. Optical attenuation of filter deposit = 37
. Total aerosol black carbon on filter = 2401 ng
Mean aerosol black carbon concentration = 1373 ng/m3

The reference beam showed lamp intensity fluctuations of 651 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) = 1.305 sen(zero) = 0.021
. ref(beam) = 2.514 ref(zero) = 0.021
. Optical attenuation of filter deposit = 33
. Total aerosol black carbon on filter = 2413 ng
Mean aerosol black carbon concentration = 1379 ng/m3

The reference beam showed lamp intensity fluctuations of 330 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) = 2.389 sen(zero) = 0.021
. ref(beam) = 3.703 ref(zero) = 0.021
. Optical attenuation of filter deposit = 24
. Total aerosol black carbon on filter = 2385 ng
Mean aerosol black carbon concentration = 1364 ng/m3

The reference beam showed lamp intensity fluctuations of 367 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) = 1.520 sen(zero) = 0.021
. ref(beam) = 2.407 ref(zero) = 0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2307 ng
Mean aerosol black carbon concentration = 1319 ng/m3

The reference beam showed lamp intensity fluctuations of 457 ppm.

Disk space = 1.011597E+09 bytes free: One entry at every 5 minutes.
There is space for 215050 hours (8960 days) more data

03-feb-10 16:00:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.

AETHALOMETER

Aethalometer No. 955

03-feb-10 16:09:56 Measurements started
Starting voltages:
. sen(zero) = 0.021 ref(zero) = 0.021
. Lamp 1 (370 nm): sen(beam) = 2.795 ref(beam) = 2.624
. Lamp 2 (470 nm): sen(beam) = 2.670 ref(beam) = 2.921
. Lamp 3 (520 nm): sen(beam) = 2.250 ref(beam) = 2.978
. Lamp 4 (590 nm): sen(beam) = 2.316 ref(beam) = 3.807
. Lamp 5 (660 nm): sen(beam) = 1.845 ref(beam) = 2.481
. Lamp 6 (880 nm): sen(beam) = 3.069 ref(beam) = 3.688
. Lamp 7 (950 nm): sen(beam) = 1.902 ref(beam) = 2.378

03-feb-10 21:40:00 Measurements ended

. Number of lamps (L) = 7
. Filter running time = 5.5 hours
. Total airflow this filter = 1.31 cubic meters
. Mean BC concentration of all lamps = 1718 ng/m3
.
Report for lamp 1 (370 nm):
. Ending voltages: sen(beam) = 1.539 sen(zero) = 0.021
. ref(beam) = 2.656 ref(zero) = 0.021
. Optical attenuation of filter deposit = 60
. Total aerosol black carbon on filter = 2431 ng
Mean aerosol black carbon concentration = 1882 ng/m3

The reference beam showed lamp intensity fluctuations of 87 ppm.

Report for lamp 2 (470 nm):
. Ending voltages: sen(beam) = 1.710 sen(zero) = 0.021
. ref(beam) = 2.927 ref(zero) = 0.021
. Optical attenuation of filter deposit = 44
. Total aerosol black carbon on filter = 2273 ng
Mean aerosol black carbon concentration = 1759 ng/m3

The reference beam showed lamp intensity fluctuations of 52 ppm.

Report for lamp 3 (520 nm):
. Ending voltages: sen(beam) = 1.531 sen(zero) = 0.021
. ref(beam) = 2.979 ref(zero) = 0.021
. Optical attenuation of filter deposit = 38
. Total aerosol black carbon on filter = 2171 ng
Mean aerosol black carbon concentration = 1680 ng/m3

The reference beam showed lamp intensity fluctuations of 57 ppm.

Report for lamp 4 (590 nm):
. Ending voltages: sen(beam) = 1.714 sen(zero) = 0.021
. ref(beam) = 3.967 ref(zero) = 0.021
. Optical attenuation of filter deposit = 34

. Total aerosol black carbon on filter = 2202 ng
Mean aerosol black carbon concentration = 1704 ng/m3

The reference beam showed lamp intensity fluctuations of 210 ppm.

Report for lamp 5 (660 nm):
. Ending voltages: sen(beam) =   1.367 sen(zero) =   0.021
.   ref(beam) =   2.501 ref(zero) =   0.021
. Optical attenuation of filter deposit = 30
. Total aerosol black carbon on filter = 2210 ng
Mean aerosol black carbon concentration = 1710 ng/m3

The reference beam showed lamp intensity fluctuations of 102 ppm.

Report for lamp 6 (880 nm):
. Ending voltages: sen(beam) =   2.472 sen(zero) =   0.021
.   ref(beam) =   3.723 ref(zero) =   0.021
. Optical attenuation of filter deposit = 22
. Total aerosol black carbon on filter = 2158 ng
Mean aerosol black carbon concentration = 1670 ng/m3

The reference beam showed lamp intensity fluctuations of 102 ppm.

Report for lamp 7 (950 nm):
. Ending voltages: sen(beam) =   1.576 sen(zero) =   0.021
.   ref(beam) =   2.410 ref(zero) =   0.021
. Optical attenuation of filter deposit = 20
. Total aerosol black carbon on filter = 2094 ng
Mean aerosol black carbon concentration = 1620 ng/m3

The reference beam showed lamp intensity fluctuations of 134 ppm.

Disk space = 1.011565E+09 bytes free: One entry at every 5 minutes.
There is space for 215043 hours (8960 days) more data

03-feb-10 21:40:00 Tape feeder mechanism advancing for 1 spot(s).

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MAGEE SCIEN.
AETHALOMETER

Aethalometer No. 955

03-feb-10 21:49:56 Measurements started
Starting voltages:
.   sen(zero) =   0.021 ref(zero) =   0.021
. Lamp 1 (370 nm): sen(beam) =   2.825 ref(beam) =   2.628
. Lamp 2 (470 nm): sen(beam) =   2.664 ref(beam) =   2.953
. Lamp 3 (520 nm): sen(beam) =   2.256 ref(beam) =   2.988
. Lamp 4 (590 nm): sen(beam) =   2.357 ref(beam) =   3.856
. Lamp 5 (660 nm): sen(beam) =   1.849 ref(beam) =   2.523
. Lamp 6 (880 nm): sen(beam) =   3.097 ref(beam) =   3.714

. Lamp 7 (950 nm): sen(beam) =   1.911 ref(beam) =   2.419
