# การแปรผันของความเข้มข้นและองค์ประกอบละอองลอยในจังหวัดนครราชสีมา ประเทศไทย

นางสาวจิณห์จุฬา โชติพิทยสุนนท์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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ปีการศึกษา 2552

# VARIATION IN AEROSOL CONCENTRATION AND COMPOSITION OVER CHANGWAT NAKHON RATCHASIMA, THAILAND

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Earth Sciences
Department of Geology
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| By | Miss Jinchula Chotpitayasunon |
| Field of Study | Earth Sciences |
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**จิณห์จุฬา โชติพิทยสุนนท์ : การแปรผันของความเข้มข้นและองค์ประกอบละอองลอยในจังหวัดนครราชสีมา ประเทศไทย. (VARIATION IN AEROSOL CONCENTRATION AND COMPOSITION OVER CHANGWAT NAKHON RATCHASIMA, THAILAND) อ.ที่ปรึกษาวิทยานิพนธ์หลัก : ดร.สธน วิจารณ์วรรณลักษณ์, 148 หน้า.**

การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษารูปแบบของละอองลอยท้องถิ่น ทั้งองค์ประกอบของละอองลอยและความเข้มข้นที่ตรวจวัดได้ขององค์ประกอบเหล่านั้น อีกทั้งหาความสัมพันธ์ระหว่างความเข้มข้นของละอองลอยในเดือนต่าง ๆ กับอุณหภูมิในบรรยากาศระดับล่าง (อุณหภูมิผิวพื้น) โดยเก็บตัวอย่างละอองลอยในบรรยากาศระดับล่าง ตั้งแต่เดือนมิถุนายน พ.ศ.2550 – เดือนมิถุนายน พ.ศ.2551 ณ สถานีวิจัยในชั้นบรรยากาศ อำเภอพิมาย จังหวัดนครราชสีมา

ระยะเวลาการเก็บตัวอย่างละอองลอยรวม 13 เดือน เก็บตัวอย่างทุก 15 วัน ใช้ตัวแทนการเก็บตัวอย่าง 3 วันแบบสุ่มเลือก โดยใช้เครื่องมัลติโนซซอลแคสเคสอิมแพคแซมเพิล ผ่านกระดาษกรอง 2 ชนิด คือ กระดาษกรองชนิดเส้นใยควอตซ์และกระดาษกรองชนิดโพลีคาร์บอเนต จากนั้น วิเคราะห์ละอองลอยคาร์บอนด้วยเครื่องออปติคอลเทอร์มอล โอซี/อีซี อะนาไลเซอร์ วิเคราะห์ไอออนที่ละลายน้ำได้ด้วยไอออนโครมาโทกราฟี และวิเคราะห์ตรวจสอบธาตุส่วนน้อยด้วยเทคนิคพาร์ติเคิลอินดิวซ์ เอกซเรย์ อิมิสชัน อีกทั้งวิเคราะห์องค์ประกอบดินในพื้นที่ศึกษาด้วยเครื่องเอกซเรย์ฟลูออเรสเซนต์ พบว่า ในฤดูแล้งมีความเข้มข้นของละอองลอยมากกว่าฤดูฝน และเมื่อวิเคราะห์องค์ประกอบทางเคมีของละอองลอยในแต่ละเดือน พบว่า ความเข้มข้นของละอองลอยมีค่าสูงมาก ในเดือนพฤศจิกายน พ.ศ.2550 โดยมีความเข้มข้นของซัลเฟตสูงที่สุด และเดือนมกราคม พ.ศ.2551 โดยมีความเข้มข้นของละอองลอยคาร์บอนสูงที่สุด ซึ่งทั้งซัลเฟต และละอองลอยคาร์บอนเป็นละอองลอยนั้นมีแหล่งที่มาจากกิจกรรมของมนุษย์เป็นหลัก จึงอาจกล่าวได้ว่ากิจกรรมของมนุษย์ในท้องถิ่น คือ แหล่งที่มาหลักของละอองลอยบริเวณสถานีวิจัย นอกจากนั้น อัตราส่วน $Cl^-/Na^+$ ของละอองลอยมีค่าแตกต่างจากอัตราส่วน $Cl^-/Na^+$ ของน้ำทะเลและดินในพื้นที่ แสดงว่าละอองลอยชนิดไอออนเกลือนั้นมาจากทั้งสองแหล่งปะปนกัน ส่วนอุณหภูมิผิวพื้นที่ต่ำเนื่องจากความกดอากาศสูงจะส่งผลให้ความเข้มข้นของละอองลอยมีค่าสูงขึ้น เนื่องจากละอองลอยไม่สามารถฟุ้งกระจายได้ จึงสะสมอยู่ในชั้นบรรยากาศระดับล่าง

ภาควิชา ธรณีวิทยา ลายมือชื่อนิสิต จิณห์จุฬา โชติพิทยสุนนท์

สาขาวิชา โลกศาสตร์ ลายมือชื่ออ.ที่ปรึกษาวิทยานิพนธ์หลัก

ปีการศึกษา 2552

# # 4972248123 : MAJOR EARTH SCIENCES

KEYWORDS : ATMOSPHERIC AEROSOL / SURFACE TEMPERATURE / PHIMAI

JINCHULA CHOTPITAYASUNON : VARIATION IN AEROSOL CONCENTRATION AND COMPOSITION OVER CHANGWAT NAKHON RATCHASIMA, THAILAND. THESIS ADVISOR : SATHON VIJARNWANNALUK, Ph.D., 148 pp.

The objective of this research is to investigate aerosol chemical concentrations and compositions in Thailand. Moreover, the relationship between aerosol chemical concentrations and temperature of the surface atmosphere were studied. The aerosol samples were analyzed for the ground-based aerosol compositions and concentrations during June 2007 to June 2008 at the Observatory for Atmospheric Research at Phimai, Changwat Nakhon Ratchasima.

Multi-nozzle cascade impact samplers collected aerosol samples once per 15 days for 13 months. Each sample was the representative data of a half month. The samplers consisted of quartz fiber filters and polycarbonate filters. The samples were analyzed for carbonaceous aerosols by optical thermal OC/EC analyzer, for water-soluble aerosols by ion chromatography and for trace elements by particle induced x-ray emission. Meantime, the soil samples around the Observatory were determined using x-ray fluorescence. It was found that the combined measurable aerosol concentrations were high in November 2007 owing to sulfate but the concentrations were high in January 2008 due to OC. Both sulfate and OC were originated from human activities, for example, transportation etc. Consequently, the main sources of aerosols at the Observatory were the local activities. $Cl^-/Na^+$ ratios of the aerosols were different from the ratios of sea water and soil samples so salt particles at the Observatory originated from both soil dust and sea water. Moreover, the low surface temperature was the cause of the high aerosol concentrations because the aerosol could not be spread widely by wind.

Department : Geology

Field of Study : Earth Sciences

Academic Year : 2009

Student's Signature

Advisor's Signature

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# CONTENTS

# LIST OF TABLES

Table Page

Table Page

# LIST OF FIGURES

# CHAPTER I

# INTRODUCTION

Earth's atmosphere consists primarily of gases and particles, such as aerosols and clouds. Aerosols are suspended liquid or solid particles which present throughout the boundary layer. Aerosol mass concentrations depend on several factors such as locations, meteorological conditions and presence of sources. The aerosol radiative effect can be direct or indirect. The direct effect is due to scattering and absorption of solar radiation by aerosols. The indirect effect comes from the action of aerosols as cloud condensation nuclei (CCN). CCN can increase the occurrence of clouds and change their properties.

The aerosol direct effect is related to their optical properties. The level of scattering and absorption depends on their physical and chemical properties. Several researches study the optical properties of aerosols at Phimai where only few study the chemical properties of aerosols. This research intended to study the aerosol chemical characterizations at the Observatory for Atmospheric Research at Phimai for correlating with the surface temperatures of the atmosphere in the same period.

## 1.1 Statement of Problem

Chemical compositions of atmospheric aerosols can be extremely variable, depending on the geographical and climatic region, so the aerosol chemical characterizations are the necessary knowledge in each area. It is not easy to study aerosols because not only they are short-lived and do not mixes homogeneously around the Earth, but also their concentrations may differ widely depending on the geographical region. Global aerosols are classified into different types: dust, biomass burning, sulfate/pollution, sea-salt, and their mixtures (Figure 1.1).

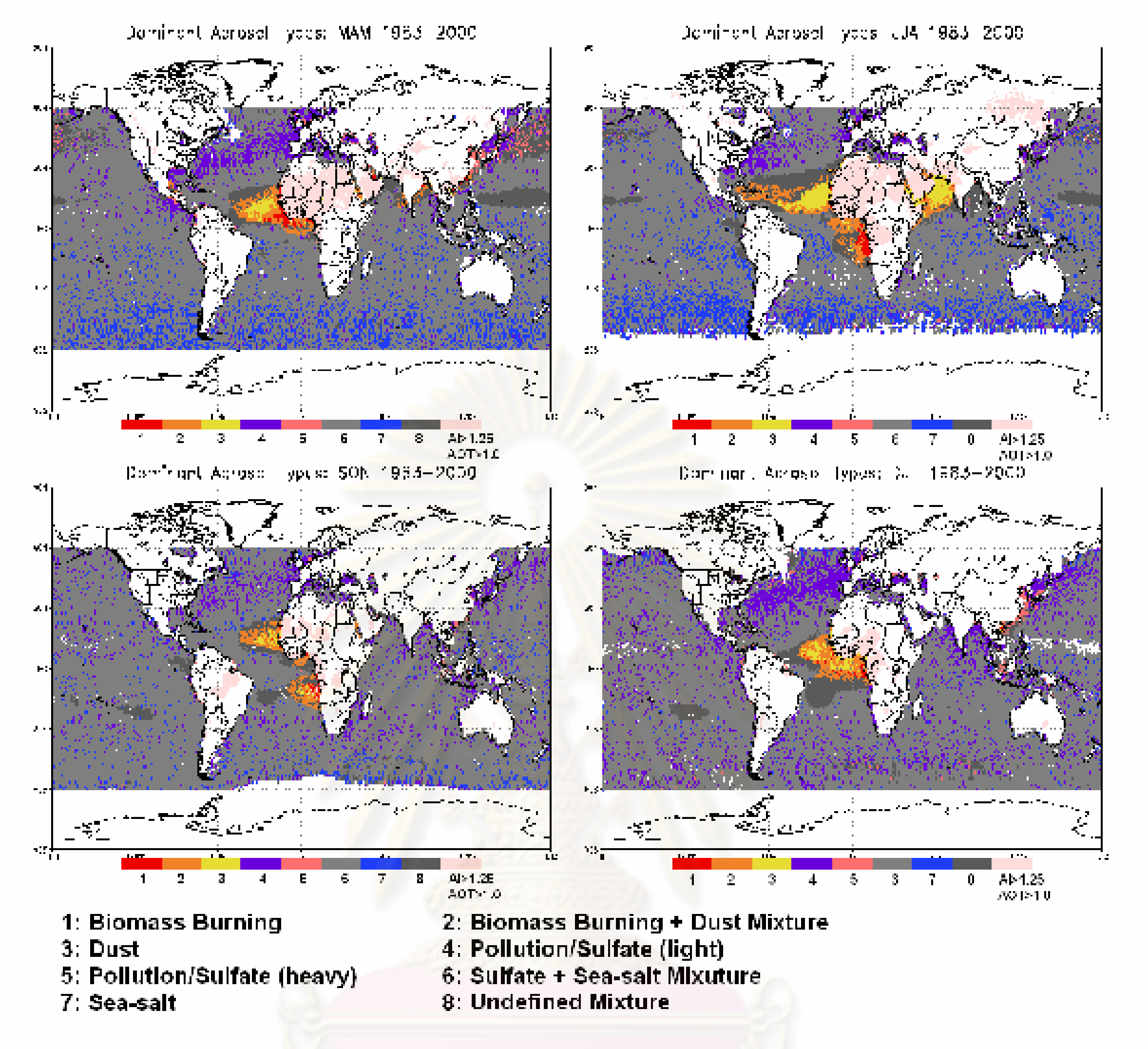


Figure 1.1 Global seasonal maps of dominant aerosol types based on a classification algorithm for identification of dominant types of aerosol. Land areas with TOMS AOT greater than 1 and AL greater than 1.25 are colored in light pink to indicate major aerosol sources (Jeong and Li, 2004).

Aerosol chemical compositions can vary throughout each region. Although, ground-based aerosol remote sensing can provide useful data, the aerosol chemical composition data can be obtained only on-site. The chemical composition data are essential for a complete understanding of the atmospheric aerosols so it is necessary to analyze aerosols collected from the study area.

Most of the studies of atmospheric aerosols in Thailand by optical instruments and models have been enforced continuously. For example, the SKYNET project which is an observation network to understand aerosol-cloud-radiation interaction in the atmosphere has been collected the aerosol data from Phimai, Thailand by radiation instruments since 2005. Meanwhile, the studies of atmospheric aerosol chemical compositions for comparing with the aerosol optical data were rare. There already were a few researches (e.g. Tsuruta et al., 2009; ABC-GOSAN, April 2005; AGS, 2009 etc.) that attempt to study aerosol chemical compositions in Phimai by cascade impactors. The data showed that the major chemical components of aerosol were much higher in the dry season than in the wet season. The main components in the fine particles were ammonium sulfate, elementary carbon (EC) and organic carbon (OC) (Tsuruta et al., 2009). The results of these researches were the correlations of the aerosol chemical composition data in Phimai and the data from other countries in Asia. Therefore, it is necessary to establish an understanding of the chemical aerosol compositions in Phimai, Thailand.

## 1.2 Objective

The objectives of this research were to investigate the chemical characteristics of atmospheric aerosols at the Observatory for Atmospheric Research in Phimai, Thailand using multi-nozzle cascade impact samplers and chemical analysis instruments and to correlate the data with the surface temperatures.

## 1.3 Scope of the Investigation

### 1.3.1 The study area

The study area pertains to the Observatory for Atmospheric Research at Phimai, Thailand which located in Northeastern part of Thailand. Figure1.2 shows the location of Phimai which is a city in Changwat Nakhon Ratchasima. The Observatory is situated at 15.184N and 102.565E. The instruments are placed on the roof of the Observatory, which is 10 meters from the ground or 202 meters above sea level. (Figure1.3)

Figure 1.2 Phimai (as shown in the big red dot) located outside on the northeast of Changwat Nakhon Ratchasima, Thailand (GEOGRAPHY, 2007).

Figure 1.3 The Observatory for Atmospheric Research at Phimai, Thailand

### 1.3.2 Sampling Period

Atmospheric aerosol samples were collected once every 15 days over a period of 13 months. A convenience sampling methodology was derived to collect the aerosol samples. Each collection which was a random 3-day sampling was representative of the aerosol data in 15 days. In other words, the information derived from the samples was expected to be the same had a complete census of the aerosol information whole 15 days because the local meteorological conditions were similar during a half month. The local meteorological data were collected every 10 seconds interval for several years non-stop using the meteorological instruments (Chapter III). The collecting campaign started from June 2007 to June 2008 owing to different seasons of the year. The data of June 2007 and June 2008 were the incomplete data so they were not suitable for analysis.

## 1.4 Assumption

Atmospheric aerosols contain sulfate, ammonium, nitrate, sodium, chloride, trace metals, carbonaceous material and crustal elements. The carbonaceous fraction of aerosol consists of both EC and OC which are well-known particle components of the atmosphere originated from fossil fuels and biomass combustion (Gustafsson et al, 2009; Husain et al, 2007; Corrigan et al, 2008). Source for chloride in aerosol is derived almost entirely from the sea surface but very little chloride is found in continental dust, except for arid and semi-arid climates where halite (NaCl) can be detected in the soils (Alves et al, 2007).

## 1.5 Limitation of Research

The aerosol sample could not be collected everyday so the 3-day samplings were considered to be the representatives of the atmospheric aerosol in 15 days. The days which the samples were collected were varying in each time due to random sampling.

The aerosol samples were sent to the laboratory at Center of Climate System Research, Japan due to cooperation between Thailand and Japan because the laboratory does not allow the person who is not a technician of the laboratory to analyze samples there. Consequently, all samples will have to be analyzed by the technicians of the laboratory for carbonaceous aerosols, water soluble ions and trace elements. The sample results were sent back to Thailand whenever they are done. At the moment only the results from carbonaceous aerosols and water soluble ions were sent back. The technicians in Japan cannot promise that they will send the trace elements results in time for this thesis.

## 1.6 Definition of Terms

*The Observatory* The aerosol sampling site for this thesis (The Observatory for Atmospheric Research at Phimai, Thailand)

*Atmospheric aerosol* Solid or liquid particles dissolved in air, which can change their chemical components frequently depending on various parameters such as wind speed and direction (Schmeling, 2003)

*Dry season* The period of the year from mid-October to mid-May when the northeast monsoons onset to Thailand (TMD, 2007)

*Rainy season* The period of the year from mid-May to mid October when the southwest monsoons onset in Thailand (TMD, 2007)

*Backward trajectory analysis* A complete system for computing simple air parcel trajectories to complex dispersion and deposition simulations (HYSPLIT, 2008) (http://ready.arl.noaa.gov/HYSPLIT.php)

*Fire map analysis* The maps are creates every 10 days, each showing the locations of all the fires detected by the MODIS on board the Terra and Aqua satellites during the sampling period, July 2007 to May 2008 (MODIS, 2008) (http://rapidfire.sci.gsfc.nasa.gov/firemaps/)

| | | |
|---|---|---|
| | *"Month"1, 2007* | The first 15 days in "Month", 2007 |
| For example; | *August1, 2007* | The first 15 days in August, 2007 |
| | *"Month"2, 2007* | The last 15 or 16 days in "Month", 2007 |
| For example; | *August2, 2007* | The last 16 days in August, 2007 |
| | *"Month"1, 2008* | The first 15 days in "Month", 2008 |
| For example; | *January1, 2008* | The first 15 days in January, 2008 |

| | | |
|---|---|---|
| | *"Month"2, 2008* | The last 14,15 or 16 days in "Month", 2008 |
| For example; | *January2, 2008* | The last 16 days in January, 2008 |
| | *Rainy season1* | The rainy season in period from July 2007 to early October 2007 |
| | *Rainy season2* | The rainy season in period from April 2008 to May 2008 |

## 1.7 Research Procedure of the Study

The first part of the study was collecting the aerosol samples at the Observatory using multi-nozzle cascade impact samplers. Second, the samples would be sent to Center of Climate System Research for analyzing. Third, the concentrations of the aerosol samples would be analyzed with backward trajectories and fire maps for detecting for tracking aerosol to their sources. Fourth, the concentrations would be correlated with the surface temperature data at the Observatory. Finally, the results would be concluded and published.

## 1.8 Expected Contribution

This study expects to gain an understanding of chemical components of atmospheric aerosols and the relationship between the aerosol components and surface temperature in Phimai, Thailand during June 2007 to June 2008.

# CHAPTER II

# THEORY AND LITERATURE REVIEW

This chapter was separated into two sections. Section 2.1 represents the basic understanding of atmosphere. Section 2.2 represents the basic understanding of atmospheric aerosols.

## 2.1 Basic Understanding of Atmosphere

The Earth is surrounded by a blanket of air called the atmosphere. The atmosphere becomes gradually thinner farther away from the Earth (Figure 2.1).

Figure 2.1 The Earth’s atmosphere from MESSENGER (NASA, 2009)

It is divided into four major layers related to differences in the temperature gradient; troposphere, stratosphere, mesosphere, and thermosphere (Ionosphere) (Figure 2.2).

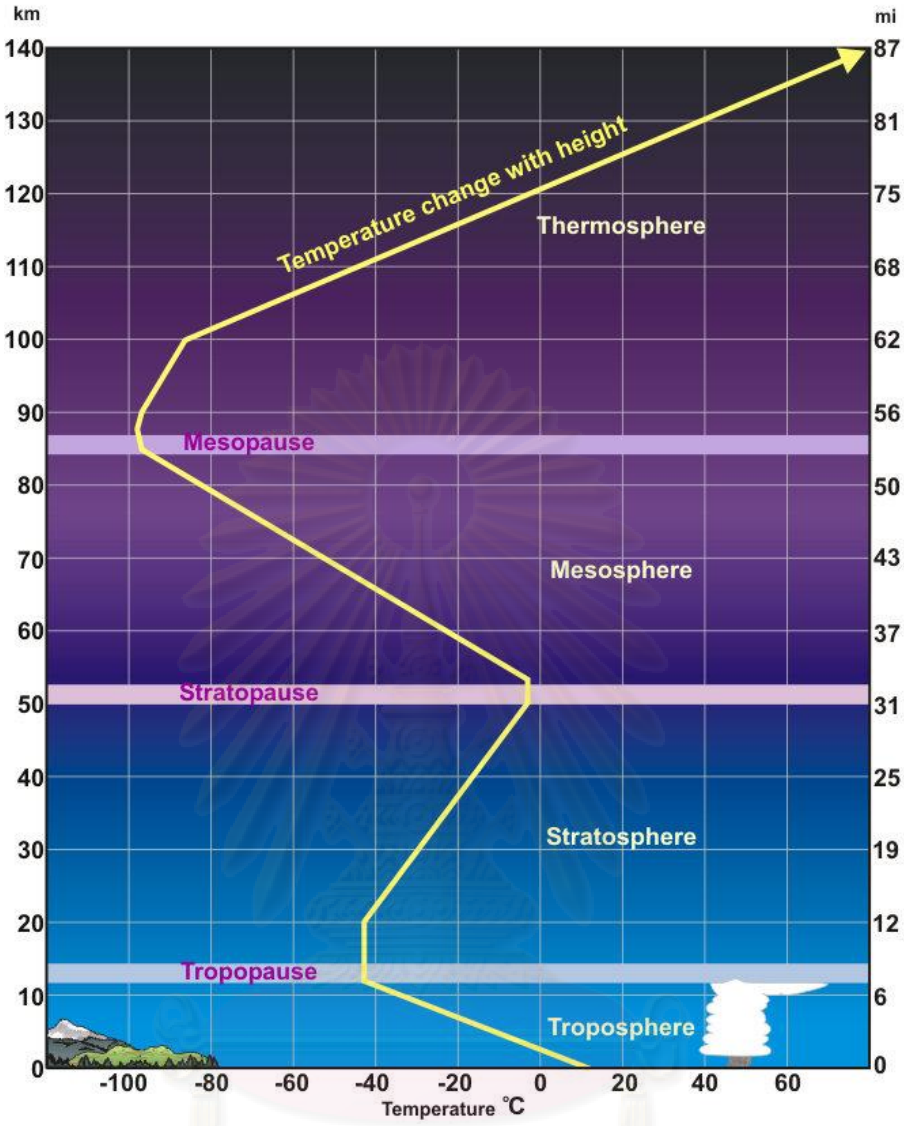


Figure 2.2 The Earth's atmospheric layers (NOAA, 2009)

The troposphere is the bottom layer in which we live. The temperature in this layer decreases with an increase in altitude. The temperature decrease continues to an average height of about 12 kilometers; although, the thickness of the troposphere is not the same everywhere. The troposphere is the chief focus of meteorologists because it is in this layer that essentially all important weather phenomena occur. Above the troposphere, the stratosphere is the second layer. The boundary between the troposphere and the stratosphere is known as the tropopause where the temperature nearly constant. The temperature in the stratosphere begins a rather sharp increase that continues until the stratopause. The mesosphere, the third layer, the temperature again decrease with height until at the mesopause. The thermosphere, the fourth layer, extends outward from the mesopause and no well-defined upper limit.

### 2.1.1 Composition of Atmosphere

(IPCC2001, 2008) The atmosphere is the most unstable and rapidly changing part of the system. The Earth's dry atmosphere is composed mainly of nitrogen ($N_2$, 78.1% volume mixing ratio), oxygen ($O_2$, 20.9% volume mixing ratio), and argon (Ar, 0.93% volume mixing ratio). These gases have only limited interaction with the incoming solar radiation and they do not interact with the infrared radiation emitted by the Earth. However, there are a number of trace gases, such as carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$) and ozone ($O_3$), which do absorb and emit infrared radiation. These so called greenhouse gases, with a total volume mixing ratio in dry air of less than 0.1% by volume, play an essential role in the Earth's energy budget. Moreover, the atmosphere contains water vapor ($H_2O$), which is also a natural greenhouse gas. Its volume mixing ratio is highly variable, but it is typically in the order of 1%. These greenhouse gases tend to raise the temperature near the Earth's surface because they absorb the infrared radiation emitted by the Earth and emit infrared radiation up and downward. Water vapor, $CO_2$ and $O_3$ also absorb solar short wave radiation.

The atmospheric distribution of ozone and its role in the Earth's energy budget is unique. Ozone in the lower part of the atmosphere, the troposphere and lower stratosphere, is a greenhouse gas. Higher up in the stratosphere, there is a natural layer of high ozone concentration which absorbs solar ultraviolet radiation. In this way this called ozone layer plays an essential role in the stratosphere's radiative balance, at the same time filtering out this potentially damaging form of radiation. Beside these gases, the atmosphere also contains solid and liquid particles (aerosols) and clouds which interact with the incoming and outgoing radiation in a complex and spatially very variable manner. The most variable component of the atmosphere is water in its various phases such as vapor, cloud droplets, and ice crystals. Water vapor is the strongest greenhouse gas. For these reasons and because the transition between the various phases absorb and release much energy, water vapor is central to the climate and its variability and change.

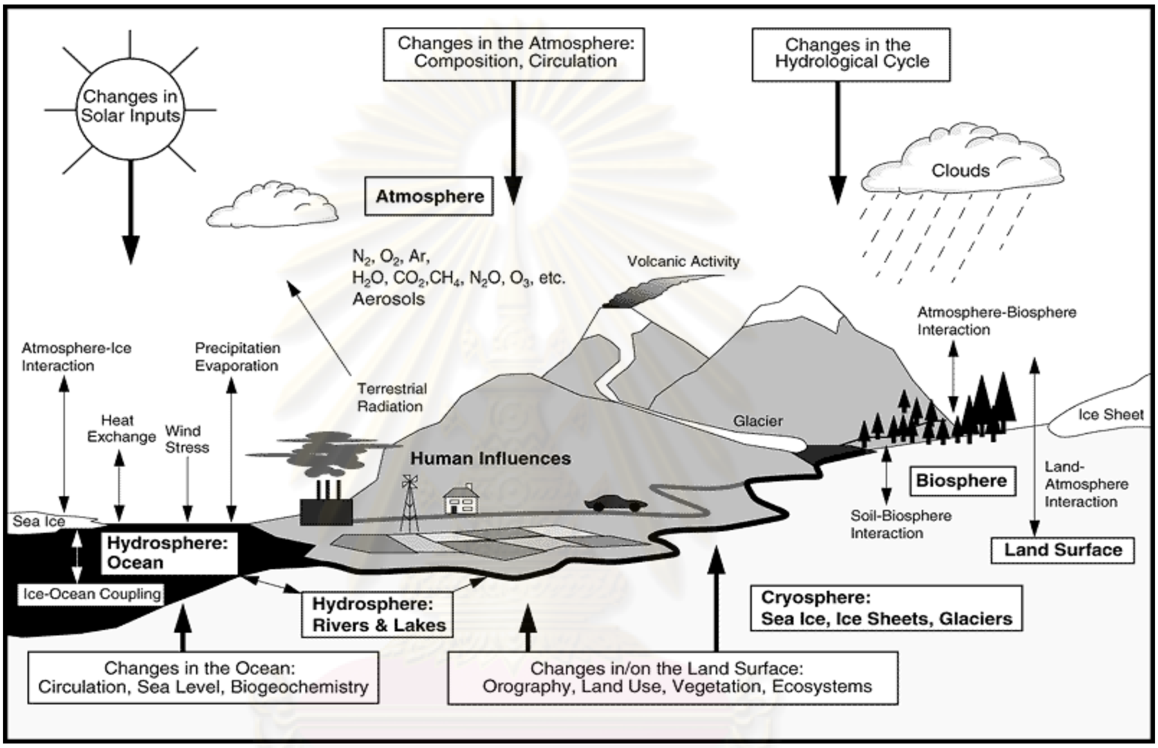


Figure 2.3 Schematic view of the components of the global climate system (bold), their processes and interactions (thin arrows) and some aspects that may change (bold arrows) (IPCC2007, 2008).

Water, the hydrosphere, is the component comprising all liquid surface and subterranean water, both fresh water, including rivers, lakes and aquifers, and saline water of the oceans and seas. Fresh water runoff from the land returning to the oceans in rivers influences the ocean's component and circulation. The oceans cover approximately 70% of the Earth's surface. They store and transport a large amount of energy and dissolve and store great quantities of carbon dioxide. Their circulation, driven by the wind and by density contrasts caused by salinity and thermal gradients (the so-called thermohaline circulation), is much slower than the atmospheric circulation.

Mainly due to the large thermal inertia of the oceans, they damp vast and strong temperature changes and function as a regulator of the Earth's climate and as a source of natural climate variability, in particular on the longer time scales (IPCC2001, 2008).

### 2.1.2 Energy Heat and Temperature

The ultimate source of energy that drives the climate system is radiation from the sun. About half of the radiation is in the visible short-wave part of the electromagnetic spectrum. The other half is mostly in the near-infrared part, with some in the ultraviolet part of the spectrum. Each square meter of the Earth's spherical surface outside the atmosphere receives an average throughout of 342 Watts of solar radiation, 31% of which is immediately reflected back into space by clouds, by the atmosphere, and by the Earth's surface. The remaining 235 $Wm^{-2}$ is partly absorbed by the atmosphere but most (168 $Wm^{-2}$) warms the Earth's surface: the land and the ocean. The Earth's surface returns that heat to the atmosphere, partly as infrared radiation, partly as sensible heat and as water vapour which releases its heat when it condenses higher up in the atmosphere. This exchange of energy between surface and atmosphere maintains under present conditions a global mean temperature near the surface of 14◦C, decreasing rapidly with height and reaching a mean temperature of -58◦C at the top of the troposphere. For a stable climate, a balance is required between incoming solar radiation and the outgoing radiation emitted by the climate system. Therefore the climate system itself must radiate on average 235 $Wm^{-2}$ back into space. Details of this energy balance can be seen in Figure 2.4, which shows on the left hand side what happens with the incoming solar radiation, and on the right hand side how the atmosphere emits the outgoing infrared radiation. Any physical object radiates energy of an amount and at wavelengths typical for the temperature of the object. For example, the higher temperature and more energy are radiated at shorter wavelengths.

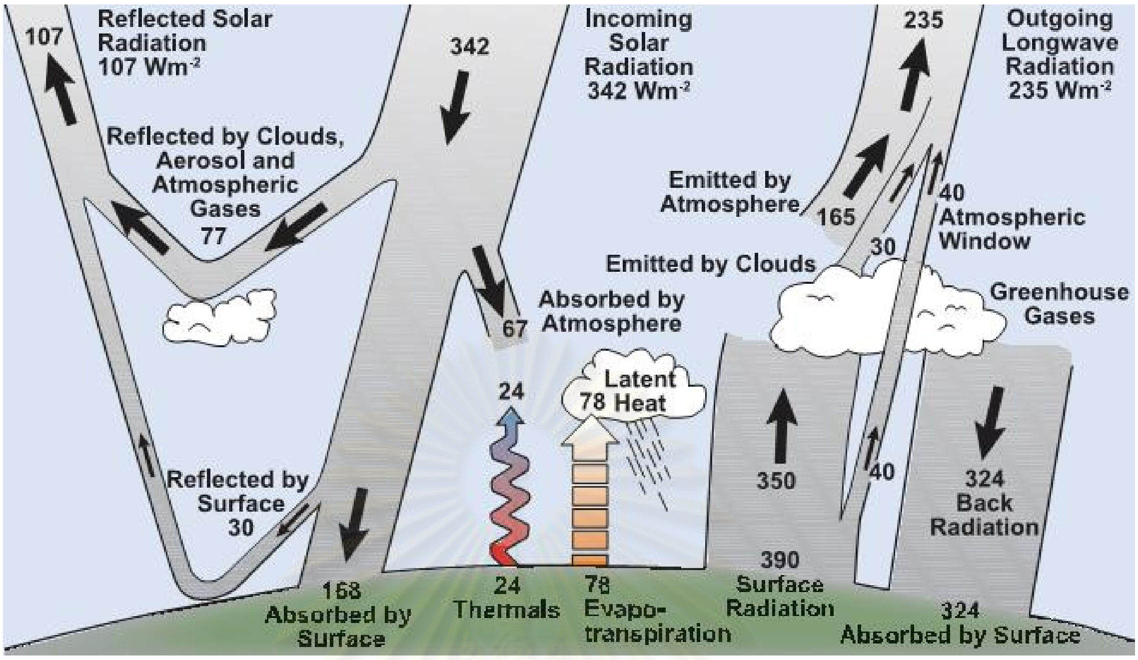


Figure 2.4 The Earth’s annual and global mean energy balance. Source: Kiehl and Trenberth, 1997: Earth’s Annual Global Mean Energy Budget, Bull. Am. Met. Soc. 78, 197-208. (IPCC2007, 2008)

For the Earth to radiate 235 $Wm^{-2}$, it should radiate at an effective emission temperature of -19◦C with typical wavelengths in the infrared part of the spectrum. This is 33◦C lower than the average temperature of 14◦C at the Earth's surface. To understand this, one must take into account the radiative properties of the atmosphere in the infrared part of the spectrum. The atmosphere contains several trace gases which absorb and emit infrared radiation. These called greenhouse gases absorb infrared radiation, emitted by the Earth's surface, the atmosphere and clouds, except in a transparent part of the spectrum called the "atmospheric window". They emit in turn infrared radiation in all directions including downward to the Earth's surface. Greenhouse gases trap heat within the atmosphere. This mechanism is called the natural greenhouse effect. The net result is an upward transfer of infrared radiation from warmer levels near the Earth's surface to colder levels at higher altitudes. The infrared radiation is effectively radiated back into space from an altitude with a temperature of, on average, -19◦C, in balance with the incoming radiation, whereas the Earth's surface is kept at a much higher temperature of on average 14◦C. This effective emission temperature of -19◦C corresponds in mid latitudes with a height of approximately 5 km. It is essential for the greenhouse effect that the temperature of the lower atmosphere is not constant (isothermal) but decreases with height. The natural greenhouse effect is part of the energy balance of the Earth, as can be seen schematically in the picture (Figure 2.4).

Clouds also play an important role in the Earth's energy balance and in particular in the natural greenhouse effect. Clouds absorb and emit infrared radiation and thus contribute to warming the Earth's surface, just like the greenhouse gases. On the other hand, most clouds are bright reflectors of solar radiation and tend to cool the climate system. The net average effect of the Earth's clouds cover in the present climate is a slight cooling: the reflection of radiation more than compensates for the greenhouse effect of clouds. However, this effect is highly variable, depending on height, type and optical properties of clouds.

In an equilibrium climate state the average net radiation at the top of the atmosphere is zero. A change in either the solar radiation or the infrared radiation changes the net radiation. The corresponding imbalance is called "radiative forcing". In practice, for this purpose, the top of the troposphere (the tropopause) is taken as the top of the atmosphere, because the stratosphere adjusts in a matter of months to changes in the radiative balance, whereas the surface-troposphere system adjusts much more slowly, owing principally to the large thermal inertia of the oceans. The radiative forcing of the surface troposphere system is then the change in net irradiance at the tropopause after allowing for stratospheric temperatures to readjust to radiative equilibrium, but with surface and tropospheric temperatures and state held fixed at the unperturbed values. External forcing, such as the solar radiation or the large amounts of aerosols ejected by volcanic eruption into the atmosphere, may vary on widely different time scales, causing natural variations in the radiative forcing. These variations may be negative or positive. In either case the climate system must react to restore the balance. A positive radiative forcing tends to warm the surface on average, whereas a negative radiative forcing tends to cool it. Internal climate processes and feedbacks may also cause variations in the radiative balance by their impact on the reflected solar radiation or emitted infrared radiation, but such variations are not considered part of radiative forcing. The present knowledge of radiative forcing and its variations have to include the anthropogenic change of the atmospheric compositions.

### 2.1.3 Atmospheric Circulation

The sun warms the Earth in latitudes near the equator. The air rises and flows toward Earth's poles, returning to the surface and flowing back to the equator. This motion, combined with the rotation of the Earth, moves heat and moisture around the planet creating winds and weather patterns. This circulation pattern is term a cell, or in some instances a convection cell.

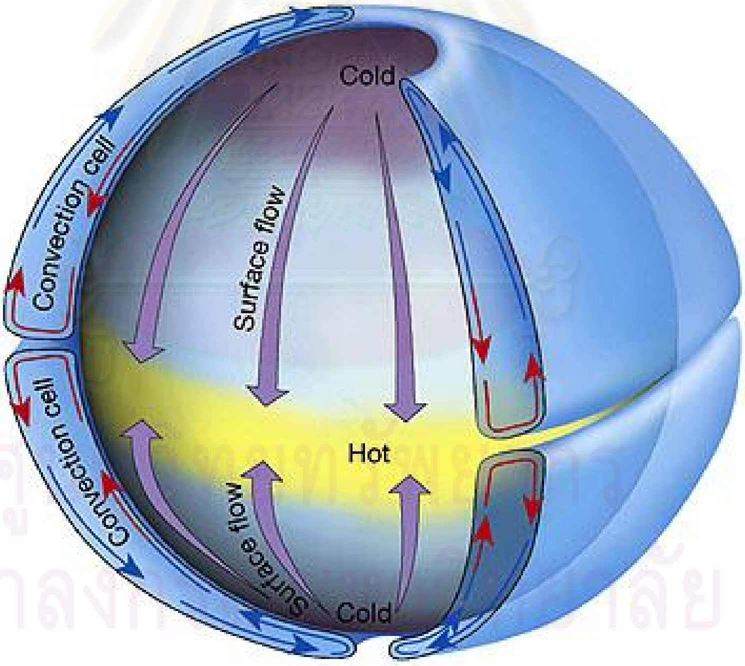


Figure 2.5 "Single cell" being either a single cell north or south of the equator (Lutgens and Tarbuck, 2000)

A non-rotating Earth would, in principle, experience at the surface a warming of air in the low latitudes and a cooling of air near the poles. The higher pole pressures drive the air towards the equator. There the warm air rises and cools, and then is driven poleward. This sets up an upper atmosphere flow towards the poles, where the air, now further cooled, sinks. That air is once again driven near the surface back towards the equator. This produces a single circulation cell (Figure 2.5). In fact, rotating world the Coriolis Force and other factors cause the single cell to break up into three cells, each with its characteristic circulation pattern. The largest cell, as determined by the area of ground over which it operates, is the Hadley Cell. The Ferrel Cell occurs between mid and high latitudes. The smallest cell is the Polar Cell (Figure 2.6).

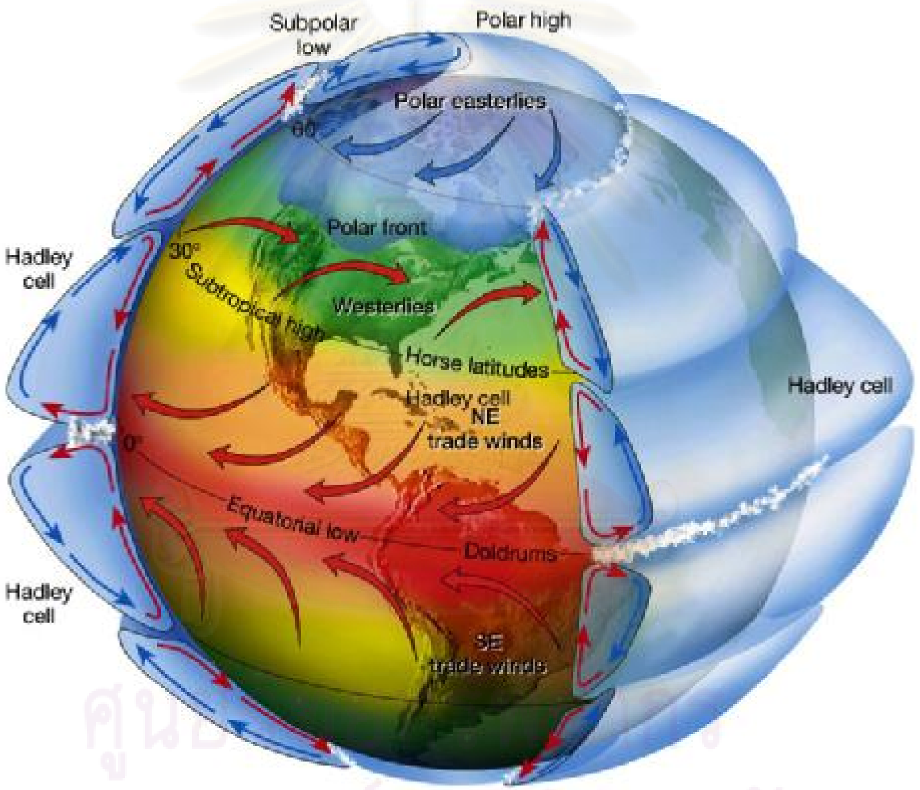


Figure 2.6 "Three cell" being either three cells north or south of the equator (Lutgens and Tarbuck, 2000)

Located near the equator, the doldrums are where the trade winds meet and where the pressure gradient decreases creating very little winds. That's why sailors find it difficult to cross the equator and why weather systems in the one hemisphere rarely cross into the other hemisphere. The doldrums are also called the intertropical convergence zone (ITCZ). The ITCZ moves north and south of the equator depending on the season and solar energy received. The location of the ITCZ can vary as much as 40° to 45° of latitude north or south of the equator based on the pattern of land and ocean. It is characterized by hot, humid weather with light winds. Major tropical rain forests are found in this zone. The ITCZ migrates north in July and south in January. (Figure 2.7).

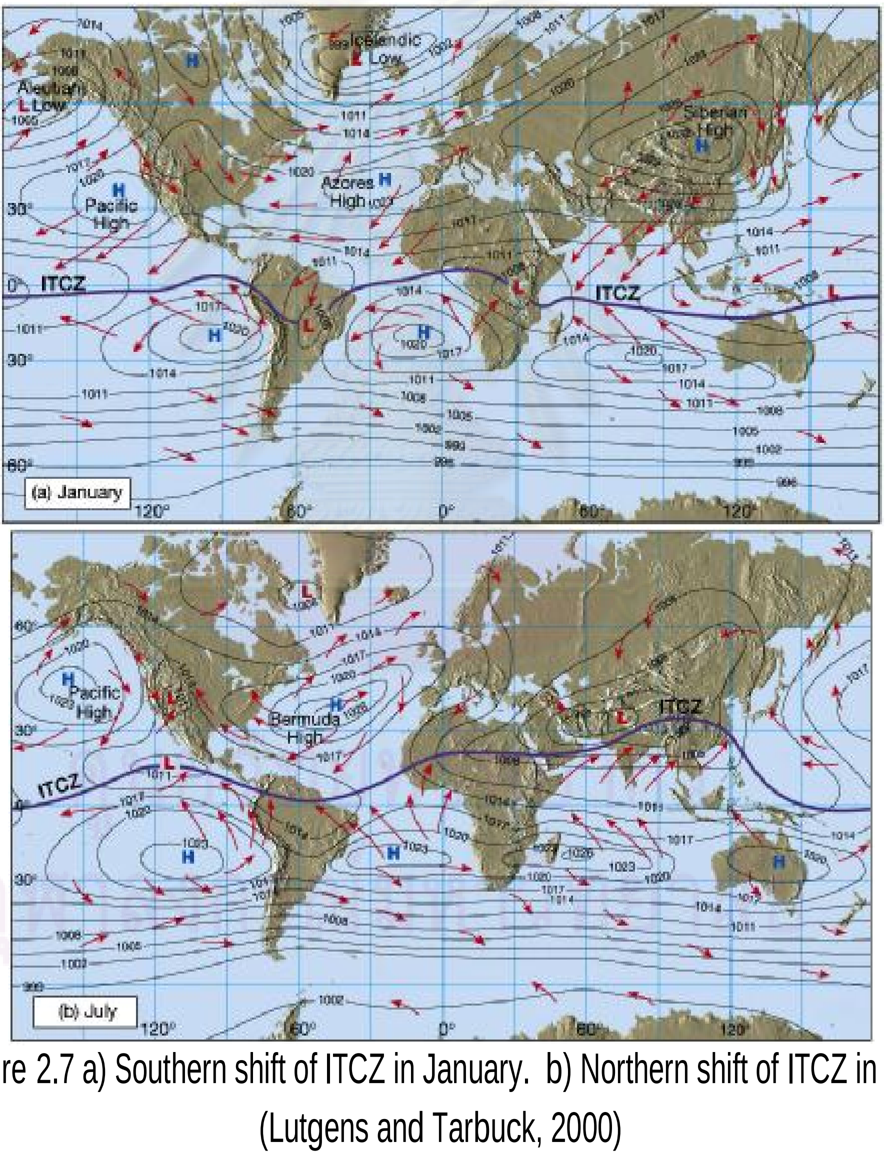


Figure 2.7 a) Southern shift of ITCZ in January. b) Northern shift of ITCZ in July (Lutgens and Tarbuck, 2000)

This shift in the wind directions owing to a northward or southward shift in the ITCZ results in the monsoons. Monsoons are wind systems that exhibit a pronounced seasonal reversal in direction. The best known monsoon is found in India and the Southeast Asia. In Thailand, the climate is under the influence of monsoon winds of seasonal character, the southwest monsoon and the northeast monsoon. The southwest monsoon which starts in May brings a stream of warm moist air from the Indian Ocean towards Thailand causing abundant rain over the country, especially the windward side of the mountains. Rainfall during this period is not only caused by the southwest monsoon but also by the ITCZ and tropical cyclones which produce a large amount of rainfall. May is the period of first arrival of the ITCZ to the Southern Part. It moves northwards rapidly and lies across southern China around June to early July that is the reason of dry spell over upper Thailand. The ITCZ then moves southerly direction to lie over the Northern and Northeastern Parts of Thailand in August and later over the Central and Southern Part in September and October, respectively. The northeast monsoon which starts in October brings the cold and dry air from the anticyclone in China mainland over major parts of Thailand, especially the Northern and Northeastern Parts which is higher latitude areas. In the Southern Part, this monsoon causes mild weather and abundant rain along the eastern coast of the part (TMD, 2007).

## 2.2 Basic Understanding of Atmospheric Aerosol

### 2.2.1 Aerosol Chemical Composition

The chemical compositions of aerosols are very difference depending on the aerosol types; for example, minerals, sulfates, nitrates, biological particles such as bacteria and pollen, organic particles, sea salt, etc. In some cases, these are composite particles consisting of several chemical substances. The fine and coarse particles of the atmospheric aerosols are different greatly because there is little mass transfer between the fine and coarse particles. Fine particles mainly man-made and coarse particles mainly natural. The fine aerosols are acidic and they contain most of sulfates, ammonium compounds, hydrocarbons, elemental carbon (soot) and toxic metals. Sulfates and nitrates are the major components of cloud condensation nuclei. Carbon (soot) can absorb light and thus have a negative impact on visibility. The coarse aerosols are basic and contain most of the crustal materials and their oxides, such as silicon, iron, calcium and aluminum, as well as large sea salt particles and vegetation debris (Coleman, 2009). The specific behaviour of aerosols of different chemical nature is responsible for the different chemical compositions of aerosols in the atmosphere at different altitudes. The vertical distribution of the chemical aerosol compositions in the troposphere is characterized, as a rule, by a weakly decreasing mass concentration of most elements contained in inorganic aerosols. For some elements, e.g. Fe, this decrease can be absent.

The concentration of $SiO_2$ decreases most strongly with altitude, which is apparently connected with relatively large sizes of particles containing silicon. The chemical compositions of aerosols in the upper troposphere and stratosphere are characterized by a high content of anion $SO_4^{2-}$ in the aerosol substances, a relatively high content of Fe and other elements characteristic of mineral substances. In the Junge layer at altitudes of 17-21 km, sulfuric acid and sulfates are the main components of the aerosol substances (Kondratyev et al, 2006).

### 2.2.2 Aerosol type

Atmospheric aerosols are tiny particles suspended in the air. Some occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels and the alteration of natural surface cover, also generate aerosols. Averaged over the globe, aerosols made by human activities currently account for about 10 percent of the total amount of aerosols in our atmosphere. Most of that 10 percent is concentrated in the Northern Hemisphere, especially downwind of industrial sites, slash-and-burn agricultural regions, and overgrazed grasslands (NASA, 2009). Many aerosol species (e.g. sulfates, secondary organics) are not directly emitted, but are formed in the atmosphere from gaseous precursors and aerosol species often combine to form mixed particles with optical properties and atmospheric lifetimes different from those of their compositions (Kommalapati and Valsaraj, 2009).

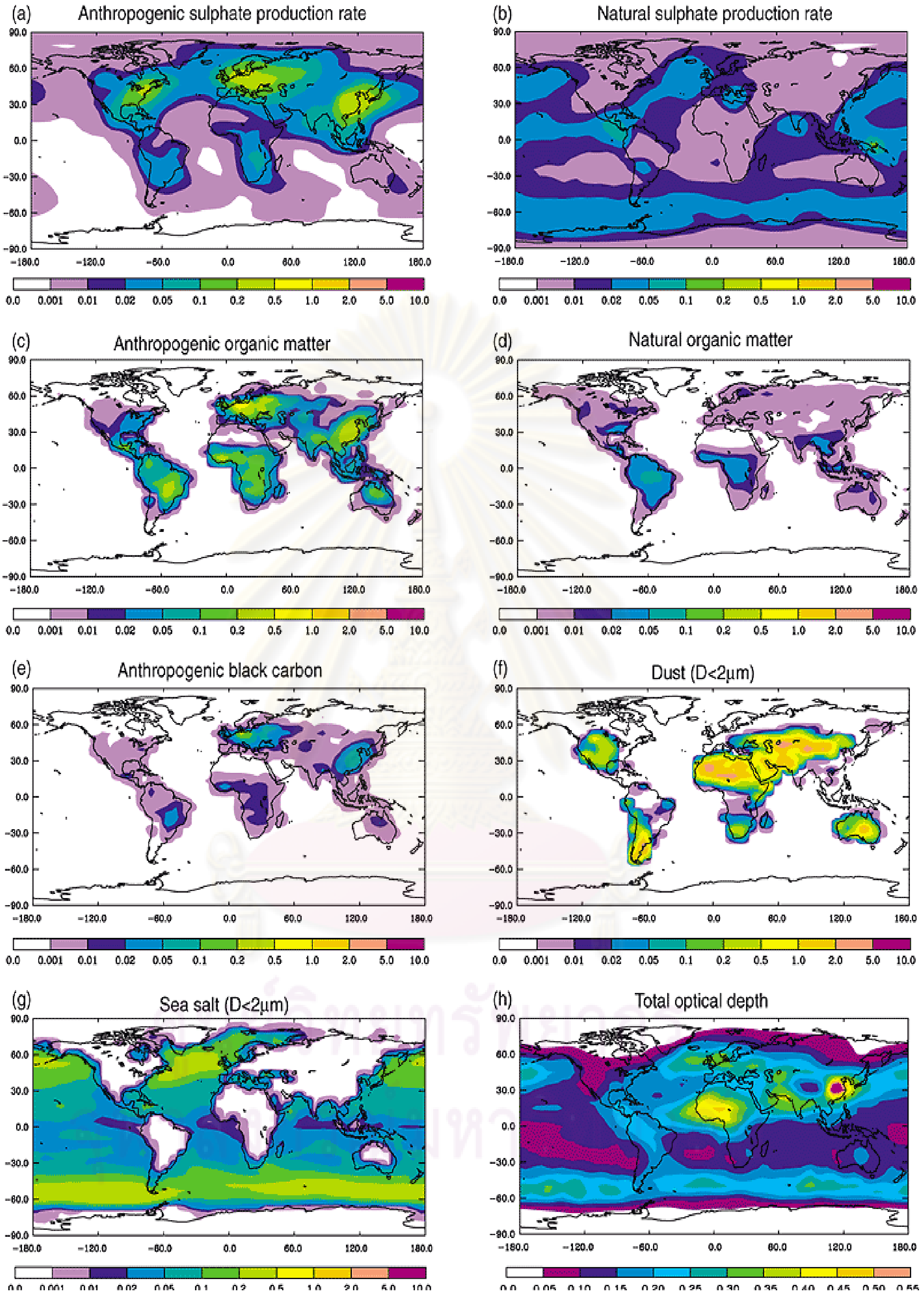


Figure 2.8 Annual average source strength in kg km$^{-2}$ hr$^{-1}$ for each of the aerosol types considered here (a to g) with total aerosol optical depth (IPCC2001, 2008)

Atmospheric aerosols can divide into primary and secondary aerosols. Primary aerosols include desert dust thrown up by the wind, sea salt flung into the air by the waves, industrial fumes and soot generated during fires. Secondary aerosols are those that form in the air as the result of the liquefaction and solidification of chemically transformed primary gases. Secondary aerosols may be anthropogenic in origin, such as the yellowish sulfur-laden clouds which form over industrialized regions, or may occur naturally, such as the clouds generated by volcanic emissions of $SO_2$, the bluish mists caused by emissions from continental vegetation or certain fogs that float over the surface of the ocean and which are caused by the dimethyl sulfide emitted by phytoplankton. Each aerosol type is different e.g. annual average aerosol source (Figure 2.8). Samples of aerosol types are shown below (IPCC2001, 2008).

### 2.2.2.1 Soil dust

Soil dust is a major contributor to aerosol loading and optical thickness, especially in sub-tropical and tropical regions. Dust source regions are mainly desert, dry lake beds, semi-arid desert fringes and areas in drier regions where vegetation has been reduced or soil surfaces have been disturbed by human activities. Major dust sources are found in the desert regions of the Northern Hemisphere. The atmospheric lifetime of dust depends on particle size; large particles are quickly removed from the atmosphere by gravitational settling, while sub-micron sized particles can have atmospheric lifetimes of several weeks.

### 2.2.2.2 Sea salt

Sea salt aerosols are a key aerosol constituent of the marine atmosphere, generated by various physical processes, especially the bursting of entrained air bubbles during whitecap formation (Monahan, 1968), resulting in a strong dependence on wind speed. The drops of 0.2 to 0.3 mm in diameter are the most prominent in the production of droplets by the bursting of air bubbles (Hayami and Toba, 1958). This type of aerosol may be the dominant contributor to both light scattering and cloud nuclei in those regions near the marine atmosphere.

#### 2.2.2.3 Industrial dust (primary anthropogenic aerosol)

Transportation, coal combustion, cement manufacturing, metallurgy and waste incineration are among the industrial and technical activities that produce primary aerosol particles. These aerosol sources are responsible for the most conspicuous impact of anthropogenic aerosols on environmental quality and have been widely monitored and regulated.

#### 2.2.2.4 Carbonaceous aerosol (organic and black carbon)

Carbonaceous compounds make up a large but highly variable fraction of the atmospheric aerosols. Organics are the largest single component of biomass burning aerosols (Artaxo et al, 1998). The main sources for carbonaceous aerosols are biomass and fossil fuel burning, the atmospheric oxidation of biogenic and anthropogenic volatile organic compounds (VOC). It should be noted that while the precursors of these aerosols are indeed of natural origins, the dependence of aerosol yield on the oxidation mechanism implies that aerosol production from biogenic emissions might be influenced by human activities.

#### 2.2.2.5 Primary biogenic aerosol

Primary biogenic aerosols consist of plant debris (cuticular waxes, leaf fragments etc.), humic matter and microbial particles. All biogenic VOC emissions are highly sensitive to changes in temperature, and some emissions respond to changes in solar radiation and precipitation (Guenther et al., 1995). In addition to the direct response to climatic changes, biogenic VOC emissions are also highly sensitive to climate-induced changes in plant species components and biomass distributions.

#### 2.2.2.6 Sulfates

Sulfate aerosols are produced by chemical reactions in the atmosphere from gaseous precursors (with the exception of sea salt sulfate and gypsum dust particles). The two main sulfate precursors are $SO_2$ from anthropogenic sources and volcanoes, and dimethylsulfide from biogenic sources, especially marine plankton.

#### 2.2.2.7 Nitrate

Nitrate is closely tied to the relative abundances of ammonium and sulfate. Ammonium sulfate ($(NH_4)_2SO_4$) and ammonium nitrate ($NH_4NO_3$) are commonly found in air masses influenced by anthropogenic emissions. A major anthropogenic aerosol source is emissions from mobile sources, which lead to high $NH_4NO_3$ concentrations, in the western regions of the U.S. (Weber, 2008).

#### 2.2.2.8 Volcanoes

Two components of volcanic emissions are of most significance for aerosols: primary dust and gaseous sulfur. Sulfur emissions occur mainly in the form of $SO_2$, even though other sulfur species may be present in the volcanic plume, predominantly $SO_4^{2-}$ aerosols and $H_2S$. Volcanic sources are important to the sulfate aerosols burden in the upper troposphere, where they might contribute to the formation of ice particles and thus represent a potential for a large indirect radiative effect (Graf et al, 1997).

### 2.2.3 Aerosol Size Distribution

All properties of aerosols depend on particle sizes, thus it is the most important parameter to study behavior of aerosols. Measurement of the number size distribution can serve several purposes. At the broadest level, this can be used to infer relative contributions to the aerosols from different sources, such as the presence of strong coarse modes due to mechanical generation processes, or ultrafine modes due to new particle production from condensation processes. This information is useful in interpretation of the aerosol system in the sampled air mass. For a given location, longer term measurements may be desirable. They can be used to identify aerosol sources especially when combined with aerosol chemistry observations. Size distribution measurements are needed to evaluate regional and global chemical transport and climate models that attempt to include size distributed aerosols as active constituents. Other applications of the number size distribution include: reconciliation of observed cloud condensation nuclei (CCN) through modeling, based on observed particle number and chemical composition size distributions and explaining observed particle mass in a given size range or observed light-scattering coefficients, all of which are examples of closure studies. Size distribution is the most important variables to constrain the role of the atmospheric particles in the Earth radiative budget. They are also linked to regulated variables such as particle mass (PM) and therefore of interest to air quality studies. However, data on their long-term variability are scarce, in particular at high altitudes where the occurrence of aerosols in elevated layers cannot be resolved from most instruments in space. Therefore it is importance to provide ground based measurements of suited aerosol variables to obtain closure between all independent information sources (Venzac et al, 2008). The aerosol size distribution data using cascade impaction measurement are useful to relate to the data from optical instruments for identifying the origins of the aerosols.

### 2.2.4 Aerosol as Cloud Condensation Nuclei

The role of aerosols was considered important mainly for shallow clouds, by acting as cloud condensation nuclei (CCN) and by determining the initial cloud drop concentrations (Rosenfeld, 2006). Clouds form by water condensing on aerosols. In the absence of CCN, air containing water vapour needs to be “supersaturated” to a humidity of about 400% before droplets spontaneously form so aerosols play a vital role in the formation of clouds (UCAR, 2007). The effects of atmospheric aerosols on the formation, characteristics, and lifetime of clouds are essential to climate studies because clouds themselves are an extremely important part of Earth’s climate system. It is known that an increase in the aerosol concentrations will increase the number of droplets in warm clouds but decrease their average size will reduce the rate of precipitation and extend the lifetime (Spichtinger and Cziczo, 2008).

Anthropogenic aerosols are believed to have two major effects on cloud properties: the increased number of nuclei results in a larger number of smaller cloud droplets, thus increasing the cloud brightness and the smaller droplets tends to inhibit rainfall, thus increasing cloud lifetime and the average cloud cover on Earth (National Research Council et al, 2001). Several researches (e.g. Blide and Svenningsson, 2004; Broekhuizen et al, 2004; Henning et al, 2005 etc) have investigated the CCN activity of internally mixed particles that included both inorganic and organic species. Different aerosols play different roles in cloud formation. Aerosols which come in different sizes are lofted to different heights in the atmosphere. Different types of clouds exist at different heights. Some clouds have smaller droplets than others; while clouds with larger droplets are more inclined to producing precipitation (UCAR, 2007). Therefore, the study of aerosol characterization is very essential for understanding Earth's climate.

### 2.2.5 Aerosol Filtration

Filtration is the simplest method of removing particles from the atmosphere for subsequent analysis. Solid separating technologies have two prime purposes: the removal of unwanted solids from suspension in a fluid and the recovery of a wanted solid product from its suspension. Air filtration is an effective technology for removing aerosols from a gas stream. The air filtration theory demonstrates the existence of a minimum efficiency value for some aerosol sizes and velocities (Dupoux and Briand, 2004). About human health effects, different filter types are intensively used in a variety of domains, such as respiratory protection, nuclear processing, hazardous materials and clean rooms (Golanski et al, 2009). Aerosol filtration theories are classed to 2 types, fibrous filters and nucleopore filters (Marre et al, 2004).

Fibrous filters consist of a mat of fine fibers arranged in such a way that most are perpendicular to the direction of air flow. It is mostly air inside. Thus the porosity is high -- from 70% to more than 99%. The size of the fibers ranges from submicrometers to 100 mm. The most common types of fibers in fibrous filters are cellulose (wood) fibers, glass fibers, and plastic fibers. The air velocity inside fibrous filter is often in the order of 10 cm/s. Quartz fiber filter (Figure 2.9) is one type of fibrous filters which was used for collection atmospheric aerosol samples (Gelencser, 2004). Several scientists collected carbonaceous aerosols by quartz fiber filters (e.g. Fisseha et al, 2006; Grover et al, 2008; Cheng et al, 2009 etc).

Figure 2.9 A quartz fiber filter (SKC, 2010)

A nucleopore filter is a kind of filter in which holes a few micrometers in size have been creates in a plastic (e.g. polycarbonate) membrane. The pores are of controlled and uniform size, produced by chemically etching radiation damage tracks of heavy ions with which the filters are bombarded as part of the production process (Evisa, 2010). A polycarbonate filter (Figure 2.10) is one of nucleopore filters which a number of researchers (e.g. Yatin et al, 1994; Cornejo et al, 1995; Makra et al, 2002: Saitoh and Sera, 2005 etc) chose to collect multiple elements in ambient aerosols.

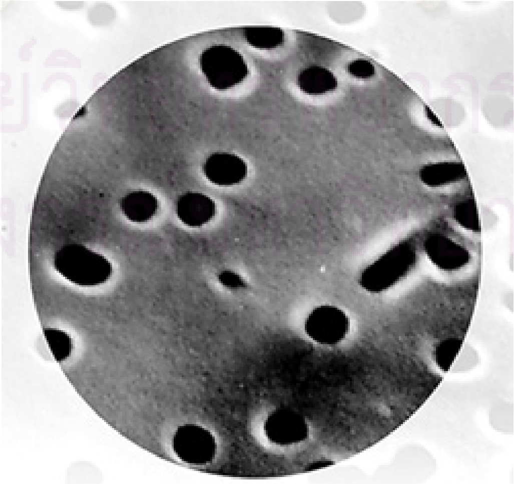


Figure 2.10 A polycarbonate filter (SKC, 2010)

Atmospheric aerosol samples often were collected using different filter types: quartz fiber filters and polycarbonate filters (e.g. Sciare et al, 2005; Maenhaut et al, 2007; Miranda and Tomaz, 2008 etc). Aerosol samples are not only colleted by quartz fiber filter and polycarbonate filter, but also by the other types of filters (e.g. Ali and Bacso, 1996; Tohno et al, 2001; Harpale et al, 2006 etc). The used filters will be carefully preserved from extraneous contamination before atmospheric aerosol samples will be removed for suitable chemical analysis.

# CHAPTER III

# METHODOLOGY AND DATA USED

## 3.1 Methodology

One of basic approaches to the measurement of aerosol particles is to sample the particle onto a collection surface and then analyze the collected particles. The advantages of the sample collection methods using sample collection equipments are the simplicity and low cost of sampling devices, their suitability for use under severe environmental conditions and that the collected particles may be subjected to different analysis techniques. The disadvantage of the sample collection techniques is the long time delay between sampling and analysis (Abdel-Salam and Dennis, 2009). Moreover, backward trajectories and fire maps were used for analyzing the sources of ambient aerosols in the Observatory, the sampling site. The Observatory is located among sugarcane cultivars 12 kilometers far from the Phimai town in Thailand. The climate of Thailand is controlled by monsoons. The dry season, during October to April, coincides with the period when the northeastern monsoon is blowing. The monsoon brings the dry air from China. In the other hand, the rainy season, May to October, coincides with the period when southwestern monsoon is blowing. The monsoon brings precipitations to Thailand; most areas of the country receive 1,200 – 1,600 mm. per year.

Nakhon Ratcahsima is located on Khorat plateau that is the lower part of Northeastern plateau of Thailand. The sequence of the plateau begins with a thin anhydrite ($CaSO_4$) layer followed by massive halite (in places more than 300 meters thick) (Japakasetr and Workman, 1981; Wongsomsak, 1986; Tabakh et al, 1998).

## 3.2 Equipment Used

### 3.2.1 Atmospheric Aerosol Sampling

Atmospheric aerosols were collected using multi-nozzle cascade impactors. Cascade impactors are particularly important in relation to measurement of aerosol particle size distributions (Kim et al, 2001; Sabty-Daily et al, 2005; Prasserttachato et al, 2006). In this study, aerosol samples were collected at the Observatory for 13 months during June 2007 to June 2008. The total of the filter sets, one set had 4 filters, were 156 sets but the filters set remained 132 sets when the samples in June 2007 and June 2008 which were incomplete were rejected. The samples were collected using multi-nozzle cascade impactors (MCI, Tokyo Dylec Co., Japan). These impactors have been used by several researchers (e.g. Okuda et al, 2007; Kang et al, 2008; Khan et al, 2010 etc) to collect different size fractions of airborne particulate samples. These multi-hole impactors, MCI, were used to evaluate particle bounce and the loading effect. The flow rate through the impactors was 20 l/min. It is important that the flow rate be as designed for the most effective collection because faster flow rates will result in the deposition of smaller particles and potentially in loss of viability or slower flow rates will deposit larger particles. The impactors were stored in a shelter fixed on the roof of the Observatory (Figure 3.1), to directly collect atmospheric aerosols with no use of any sampling tube. The air mass flew through the plastics tubes from the impactors to the pumps inside the building (Figure 3.2)

Figure 3.1 The impactors and the meteorological instruments are installed on the roof of the Observatory.

Figure 3.2 The direction of the air masses which moved through the impactors and flew through the plastic tubes which connected to the pumps in the building (the red arrows shown the direction of air flow).

The four-size range of atmospheric aerosols were d<1.0μm, 1.0μm<d< 2.5 μm, 2.5μm <d< 10 μm, and 10 μm<d. A field study of aerosol filtration was conducted to determine aerosol size distribution using quartz fiber filters and polycarbonate filters (Figure 3.3) (e.g. Sciare et al, 2005; Maenhaut et al, 2007; Miranda and Tomaz, 2008 etc). The filters were preserved in petri dishes before they were sent to the Center for Climate System Research (CCSR) in Japan for analysis.

Figure 3.3 The filters were used in this study
(top row: the polycarbonate filters (PC); bottom row: the quartz fiber filters (QF))

### 3.2.2 Chemical Analysis

The atmospheric aerosol samples on quartz fiber filters which were sent to CCSR were analyzed for OC and EC by optical thermal OC/EC analyzer (MODEL 2001, DRI). The optical thermal method has been widely used for quantifying OC and EC (Chow et al, 2005; Zhi et al, 2008; Cavalli et al, 2010). The carbon analyzer can effectively measure between 0.05 and 750 $\mu$g carbon $cm^{-2}$ for a typical punch size of 0.5 $cm^2$. The analysis by the carbon analyzer started with removing small sample punches from QF. Verification was performed by removing 10 punches from a 47-mm QF. The sample punches were heated under a stream of pure He (99.999%) and a laser is used to monitor the transmittance of the samples throughout the analysis. As the sample is heated, burning causes the laser absorption of the samples to rise above the initial value. After reaching the maximum operating temperature (selected by the operator and usually between 550°C and 900°C) of the oxygen-free segment of the analysis, the temperature is either reduced or hold constant, and the analysis gas is switched to a $He/O_2$ mixture. The sample is then reheated to near 900°C and all remaining carbon evolves with a concomitant decrease in the laser absorption. Carbon evolving from the sample after the sample's laser absorption has returned to the initial value is considered EC (Schauer et al, 2003). The carbonaceous concentrations found in the samples were subtracted by those on the filter blank determined by analyzing clean QF.

One sample punch of one PC was cut for analyzing trace elements using Proton Induced X-ray Emission (PIXE). Trace components of aerosols are important as indicators of sources and processes. Some may have health effects. Tracers include both elemental and molecular forms. Studies should be considered for assessment purposes on a case by case basis. For example, the filters for gravimetric technique could be archived for later multi-elemental analysis by PIXE for transition metals (WMO, 2008). One of the frequently applied techniques of trace elemental analytics of atmospheric aerosols is the PIXE method (Desaedeleer and Winchester, 1975; Eleftheriadis and Colbeck, 2001; Balouria et al, 2006). Considering that PIXE analyses often aim at measuring microgram per gram levels of trace elements and that the absolute amounts of analytic elements actually examined are then in the nanogram region or below, contamination control is very important (Grieken and Markowicz, 2002).

Portions of the PC were also analyzed for water soluble ions by ion chromatography (IC) (MODEL DX-500, Dionex Corp.). The chromatographic technique uses an ion-exchange column to suppress the detection of the ions of the solution which used as the mobile phase (Graham et al, 2004; Fosco and Schmeling, 2007; Osada et al, 2007; Xu et al, 2008). This process leaves only the species of interest to pass to the detector which normally a conductance cell. The ions that were determined by IC were $Cl^-$, $NO_3^-$, $SO_4^{2-}$, $Na^+$, $NH_4^+$, $K^+$, $Mg^{2+}$and $Ca^{2+}$. The IC technique has the advantage of chemical speciation and relatively low cost per analysis. Moreover, this technique has matured to the degree that the sensitivities for each ionic species, cost and maintenance are all reasonably well known (WMO, 2008).

Twelve soil samples from the various places around the Observatory were collected during the sampling period. The samples were kept from 10 meters far from the Observatory and deep 12 inches from the surface. The soil samples were analyzed using X-ray fluorescence spectrometer (XRF) at the XRF laboratory of Faculty of Science, Chulalongkorn University. This method is more accurate but the soil can not be too wet. Application of the XRF method gives the possibility to realize quick multi-element soil analysis and speciation analysis (Baranowski et al, 2002).

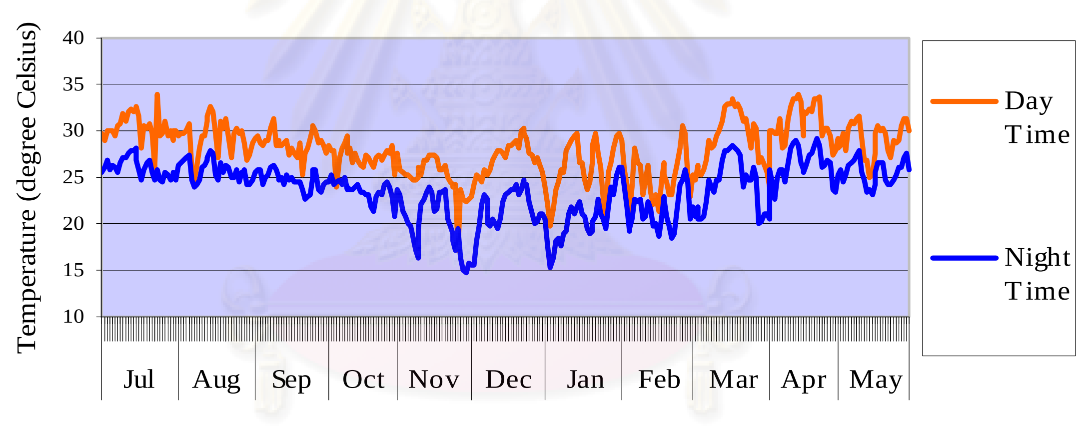
### 3.3 Meteorological Data

The data of meteorological measurements made at the Observatory during the sampling period 24 hours continuously. The instruments measure several meteorological parameters which were air temperature (Figure 3.4), wind direction (Figure 3.5), wind speed (Figure 3.5) and air pressure (Figure 3.4). Aerosol compositions and concentrations are found to vary with meteorological conditions (Sanchez-Ccoyllo and Andrade, 2002; Pang et al, 2009). The ambient temperature and local wind were found to be the most important factors that control the concentrations of aerosols (Hussein et al, 2006). The weather instruments are located on the same place of the impactors for treating the same condition.

The monthly average temperatures during the sampling period were highest in July 2007, 30.43◦C in the day time and 26.02◦C in the night time. The lowest monthly average temperatures were 24.86◦C in day time in February 2008 and 20.17◦C in night time in November 2007. The average day air pressures were not difference between day time and night time. The highest monthly average air pressure value was 988.62 hPa in February 2008 while the lowest monthly average air pressure value was 980.79 hPa in August 2007. These values were shown in Figure 3.6. The others were wind direction and wind speed which were shown in Figure 3.7.

Figure 3.4 The instruments which measure the temperatures and air pressures at the Observatory

Figure 3.5 The instrument which measures wind speed and wind direction at the Observatory



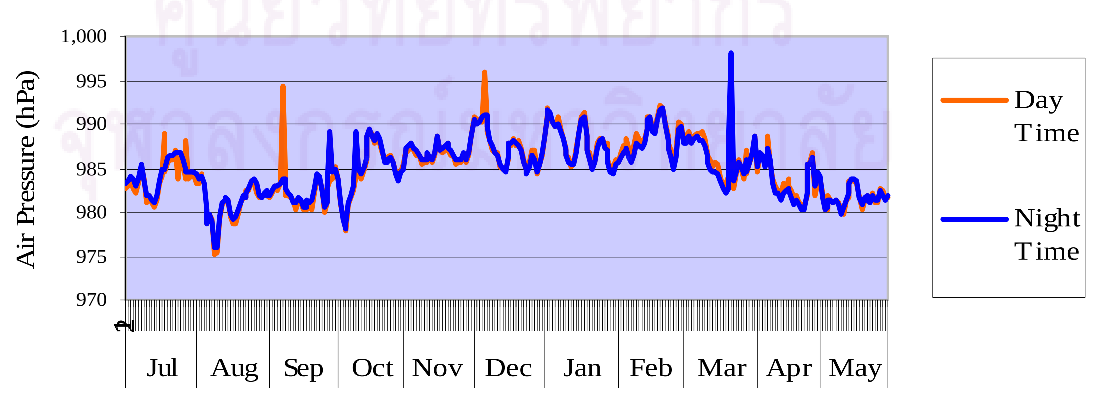


Figure 3.6 The temperature (top) and air pressure (bottom) during the sampling period

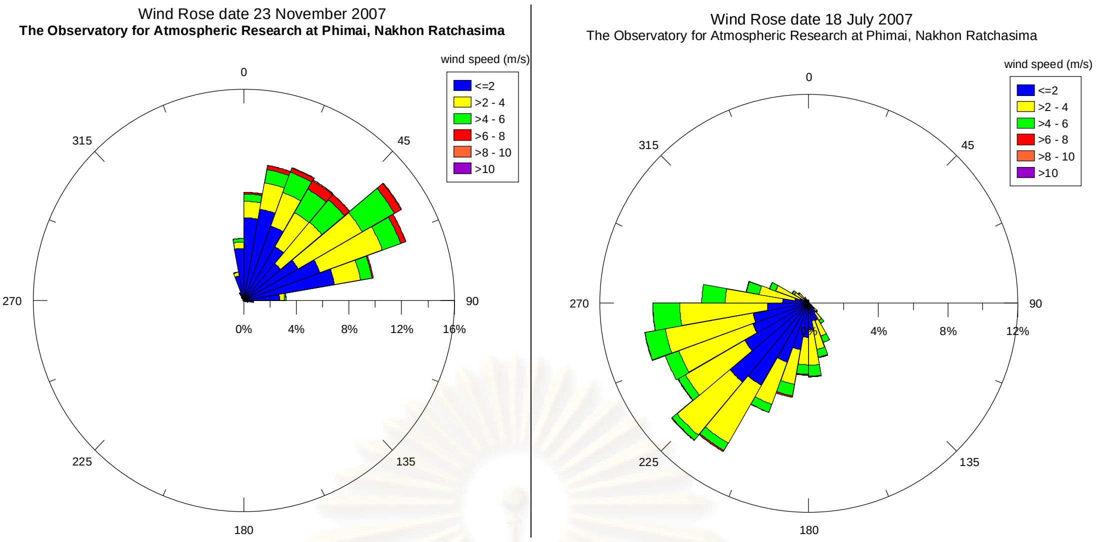


Figure 3.7 The example of the wind speed and the wind direction in the dry season (left) and the rainy season (right)

## 3.4 Backward Trajectory Analysis

Backward trajectories were used to investigate possible sources for aerosols. Backward trajectories analysis is a valuable tool for determining the transport patterns of air parcels arriving at particular locations at a specific time. Several researchers (e.g. Ma et al, 2003; Owega et al, 2004; Kocak et al, 2007; Pio et al, 2008; Li et al, 2010; Sharma et al, 2010 etc) demonstrated sources of aerosols by backward trajectories. In this study, NOAA HYSPRIT_4 was used for backward trajectory analysis. The HYSPLIT_4 (Hybrid Single-Particle Lagrangian Integrated Trajectory) model (source: http://ready.arl.noaa.gov/HYSPLIT.php) is a complete system for computing simple trajectories to complex dispersion and deposition simulations using either puff or particle approaches (Draxler and Hess, 2009).

## 3.5 Fire Map Analysis

In Phimai, farmers who grow sugarcane cropped their products and transported the sugarcane in November 2007. They burnt their field after harvest to get rid of weeds in January 2008. Biomass burning is an important primary source of carbonaceous aerosols. Fire maps were used to show burning of biomass. Several researchers used fire maps for signification sources of aerosols (e.g. Ma et al, 2003; Pio et al, 2008; Li et al, 2010 ; Sharma et al, 2010 etc). The fire maps analysis (source: http://rapidfire.sci.gsfc.nasa.gov/firemaps/) show the locations of the fires detected by MODIS on board the Terra and Aqua satellites over a 10-day period. Each colored dot on the maps indicates a location where MODIS detected at least one fire during the compositing period. Color ranges from red where the fire count is low to yellow where number of fires is large (MODIS, 2008; Giglio et al, 2003). Aerosol concentrations rise in the absence of significant fire activity (NASA, 2009). The agriculturists near the Observatory told that they always transport their products in November but apart from observation they transported their products during November 2007 to January 2008. It was hard to conclude that all agricultures in the Northeast Thailand transport their products in November and burn their field in January so MODIS fire map is a particularly good tool for tracking the fire in Thailand or near Thailand.

# CHAPTER IV

# RESULTS AND DISCUSSION

## 4.1 Chemical Composition

### 4.1.1 Combined Measurable Aerosol Concentration

The combined measurable concentration data for 22 times sampling were shown in Figure 4.1. The data were separated to two group, day time data and night time data. The concentration was getting high clearly in late October 2007 which the wind direction data from the Observatory presented the air masses transported from the northeastward of Thailand. Moreover, the backward trajectories in October 2007 confirmed that the air masses changed direction in the second week of the month.

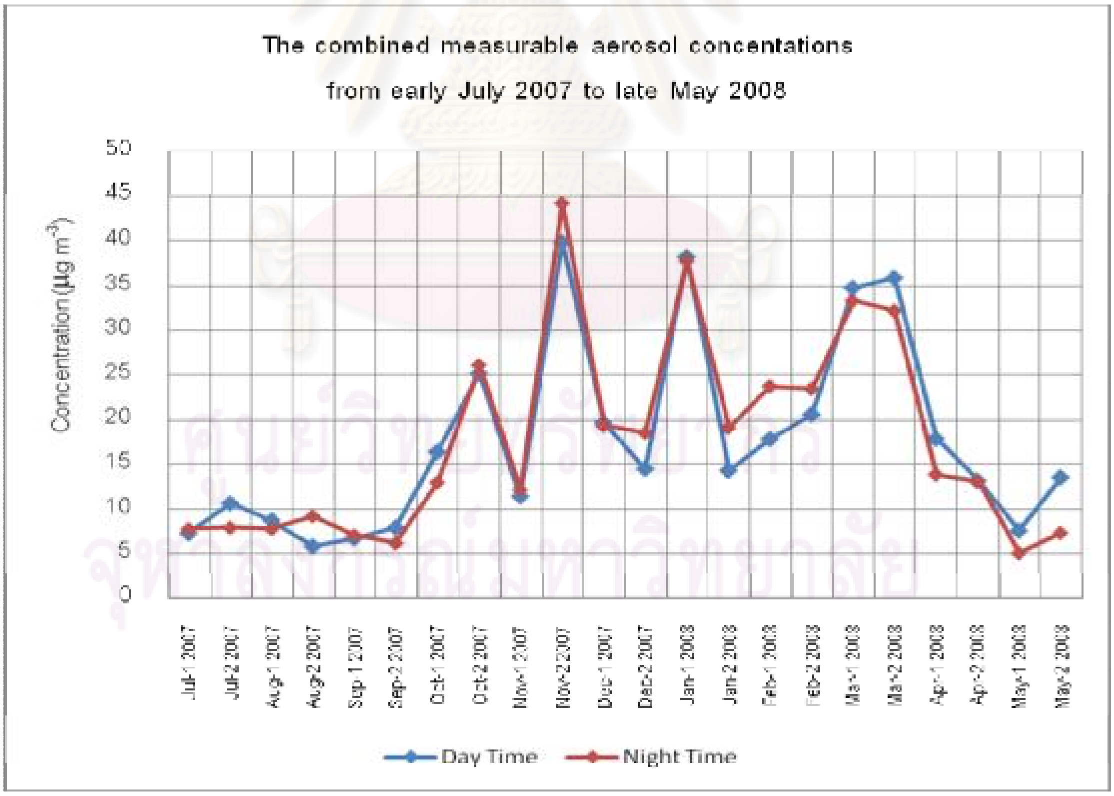


Figure 4.1 The combined measurable aerosol concentrations at the Observatory during the sampling period (early July 2007 to late May 2008)

When the monthly concentrations were considered, there were the observable three peaks (Figure 4.2). The pecks were in last November 2007, in early January 2008 and in March 2008. The concentration was getting low again in April 2008 when the dry season was over. The concentrations at the day time were similar to the concentrations at the night time every month in the sampling period owing to the meteorological data at the Observatory. The meteorology did not change too much between day time and night time. Due to the dry season, the temperatures in night time were lower than in day time. Consequently, the aerosol concentrations in night time were a little higher than in day time because the aerosols in the hotter air masses could be transported more higher than the aerosols in the cooler air masses. In contrast, in the rainy season, the aerosol concentrations were higher in day time than in night time because rain-falls were always found at night during the sampling period.

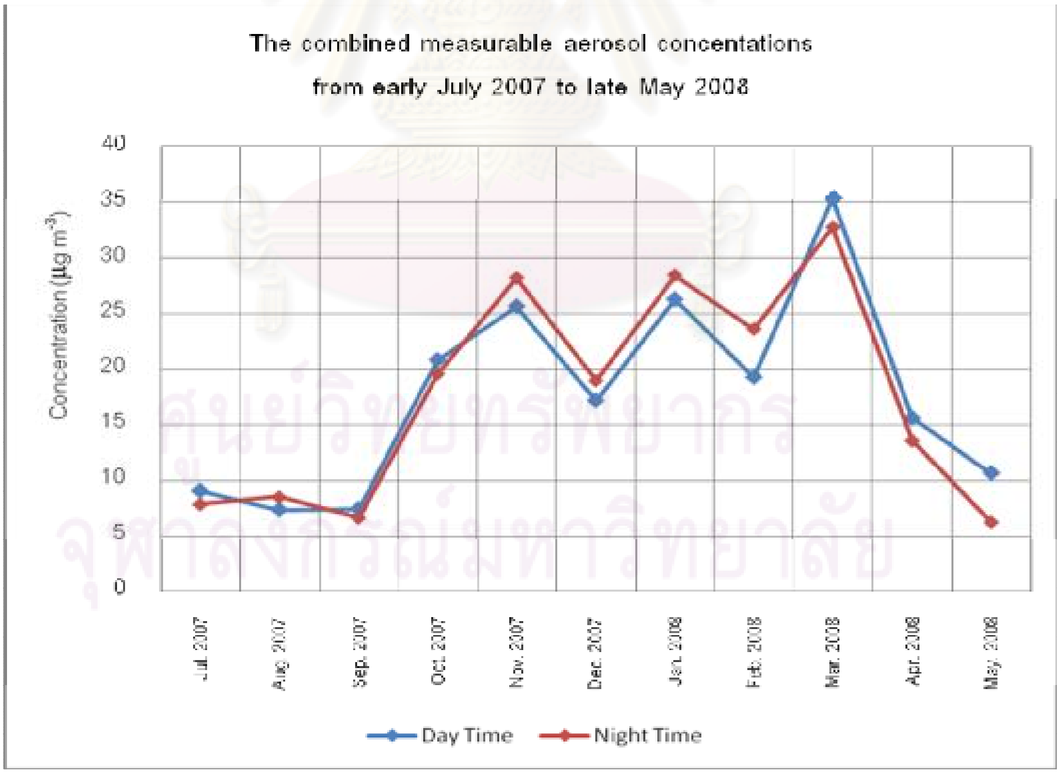


Figure 4.2 The monthly combined measurable aerosol concentrations at the Observatory during the sampling period (early July 2007 to late May 2008)

The fine aerosol concentration and the coarse aerosol concentration were analyzed and presented in Figure 4.3 and Figure 4.4 consecutively.

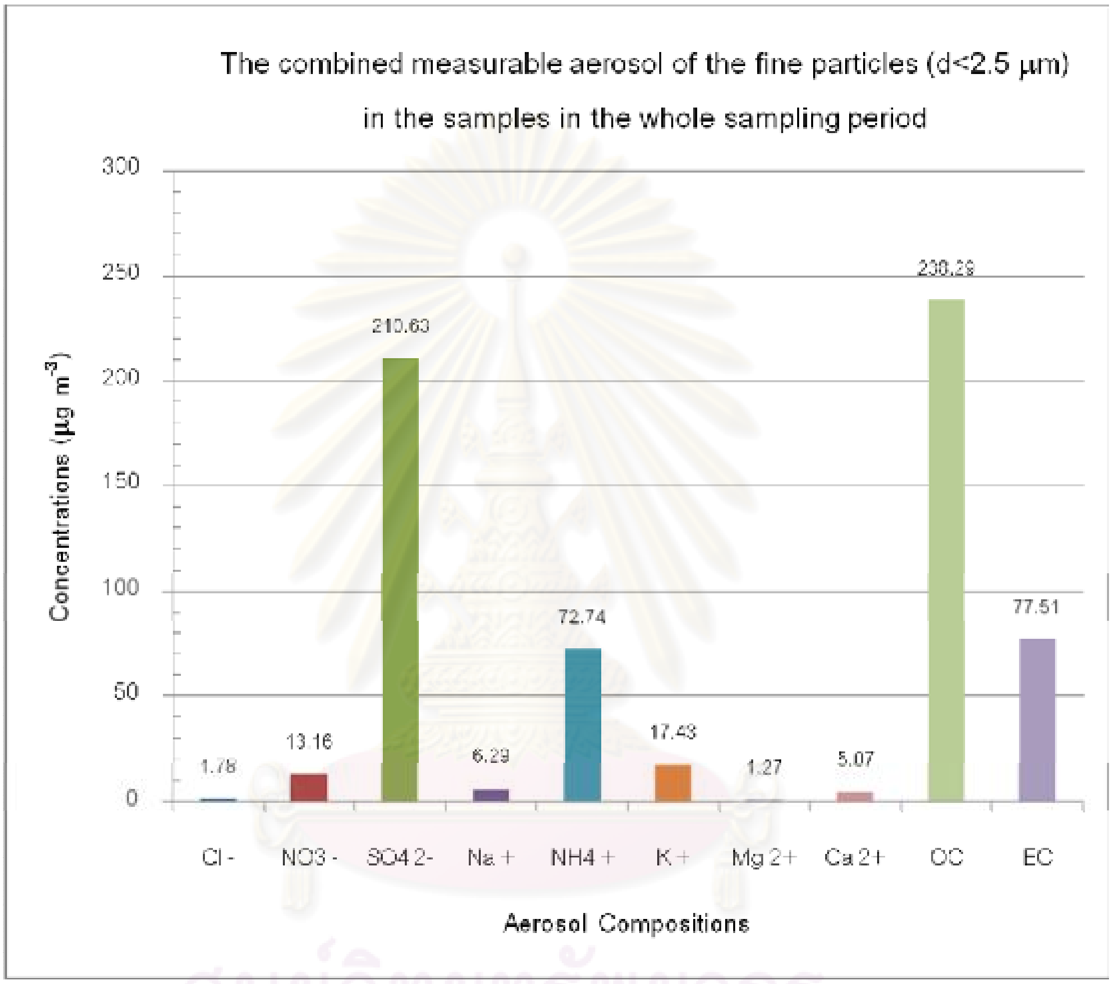


Figure 4.3 The combined measurable fine aerosols (d<2.5 μm) in the samples in the whole sampling period

The fine aerosols (particles smaller than 2.5 micrometer in diameter) can play important roles in the radiative balance of the atmosphere. They can act directly to cool the atmosphere by scattering incoming solar radiation, as well as indirectly by serving as CCN. Fine aerosols, particularly carbonaceous soots, can warm the atmosphere by absorbing incoming solar radiation. In addition, the fine aerosols have recently been implicated in the health effects of air pollution (Vedal et al, 2009). The main components of the fine aerosols in the Observatory were OC, EC and ammonium sulfate ($NH_4SO_4$).

The main components of coarse aerosols were OC and sodium nitrate ($NaNO_3$) (Figure 4.4). The coarse aerosols (particles larger than 2.5 micrometer but smaller than 10.0 micrometers in diameter) was less than the fine aerosols. OC was the highest concentration in both the fine aerosols and the coarse aerosols.

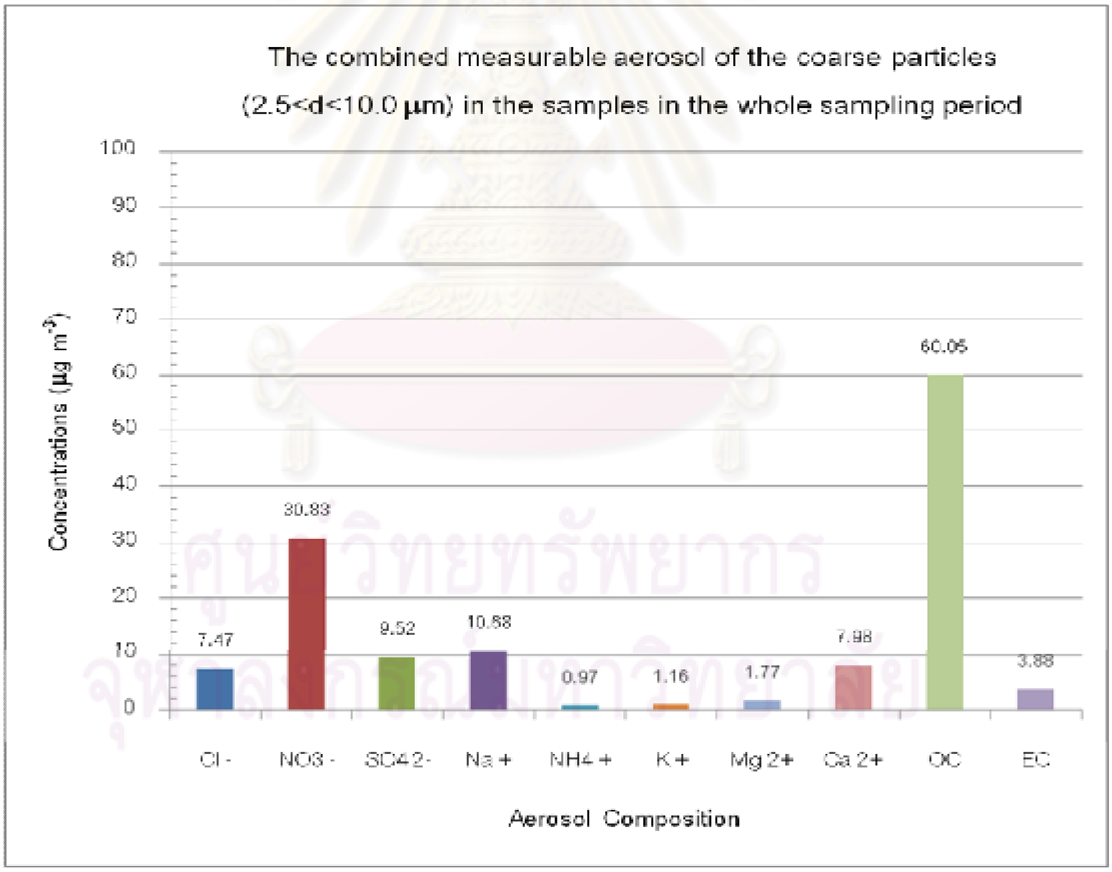


Figure 4.4 The combined measurable coarse aerosols (2.5<d<10.0 $\mu$m) in the samples in the whole sampling period

It was shown in the Figure 4.5 that the combined measurable aerosol concentrations in the dry season were more than in the rainy season in every species; especially, $SO_4^{2-}$ and OC. The concentrations in the rainy season were low due to precipitations. Rain washed out aerosols from the atmosphere (Yamagata et al, 2009; Hardin and Kahn, 2010).

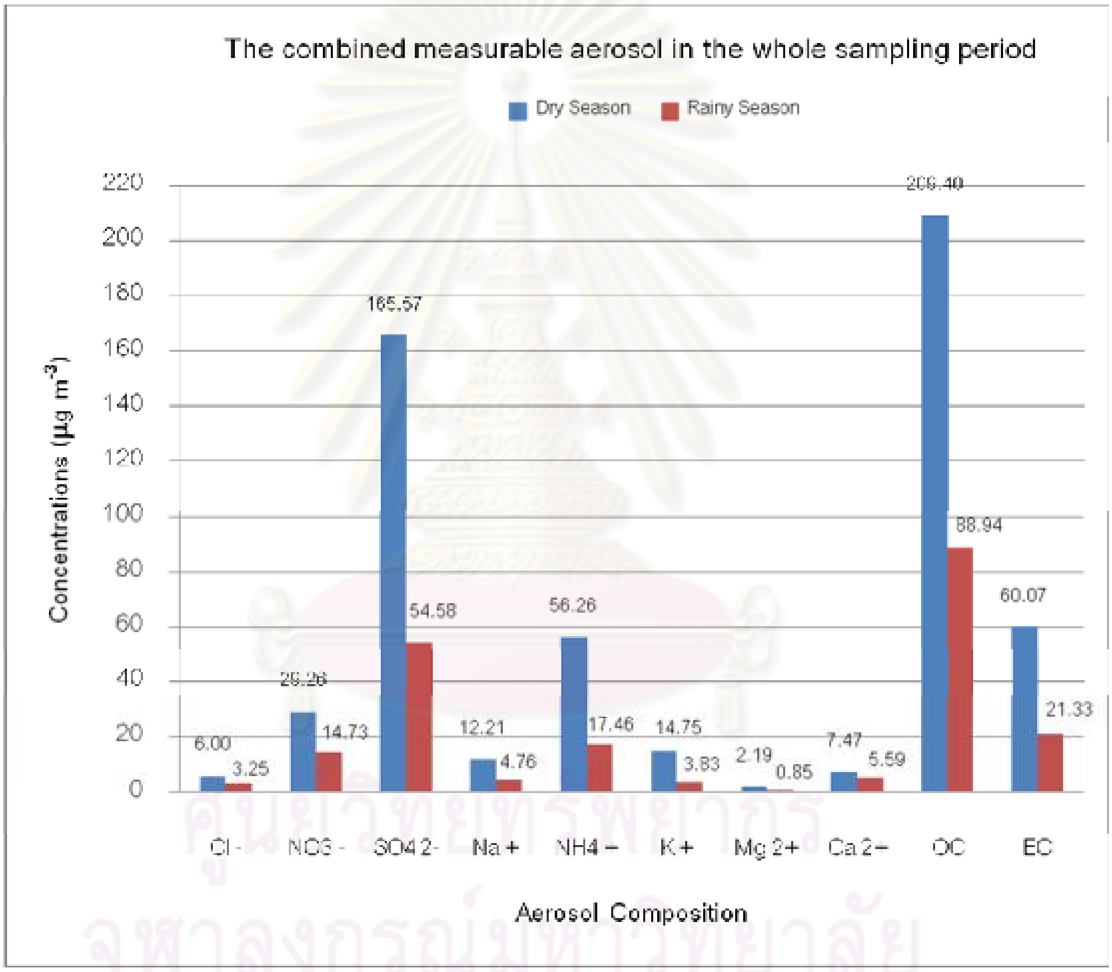


Figure 4.5 The combined measurable aerosols in the dry season and the rainy season

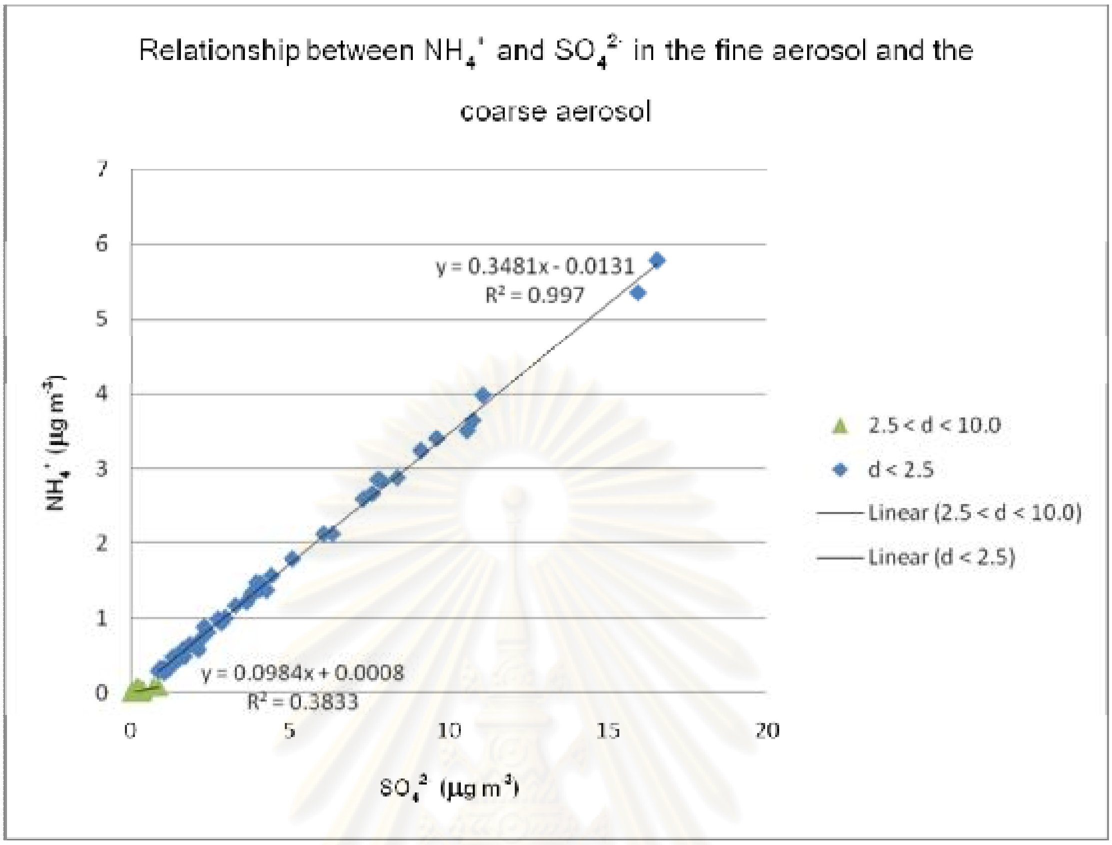


Figure 4.6 Relationship between $NH_4^+$ and $SO_4^{2-}$ in the sampling period

The $NH_4^+$ particles of non sea salt $SO_4^{2-}$ (nss- $SO_4^{2-}$) existed as $(NH_4)_2SO_4$. A positive correlation between $NH_4^+$ and $SO_4^{2-}$ was found in Figure 4.6. There was no difference in the $NH_4^+/SO_4^{2-}$ ratio of the fine particles among all the sampling period. Non sea-salt $SO_4^{2-}$ had a positive correlation with EC, and the ratio of EC/ $SO_4^{2-}$ was different between the dry season and the rainy season. In the Figure 4.7, the slops of linear regression equation were 0.055 in the rainy season1 (July 2007 to early October 2007), 0.259 in the rainy season2 (April 2008 to May 2008) and 0.095 in the dry season (late October 2007 to March 2008) so the aerosol characterization in each season was different. The correlation coefficient values in every season indicated a weak positive linear relationship. The values were 0.3038 in the rainy season1, 0.1823 in the rainy season2 and 0.0885 in the dry season. Occurrences of high EC concentration were mainly in early January 2008, while peck $SO_4^{2-}$ concentration occurred in late November 2007. This behavior of aerosols was due to the fact that the sources of EC and $SO_4^{2-}$ are not the same.

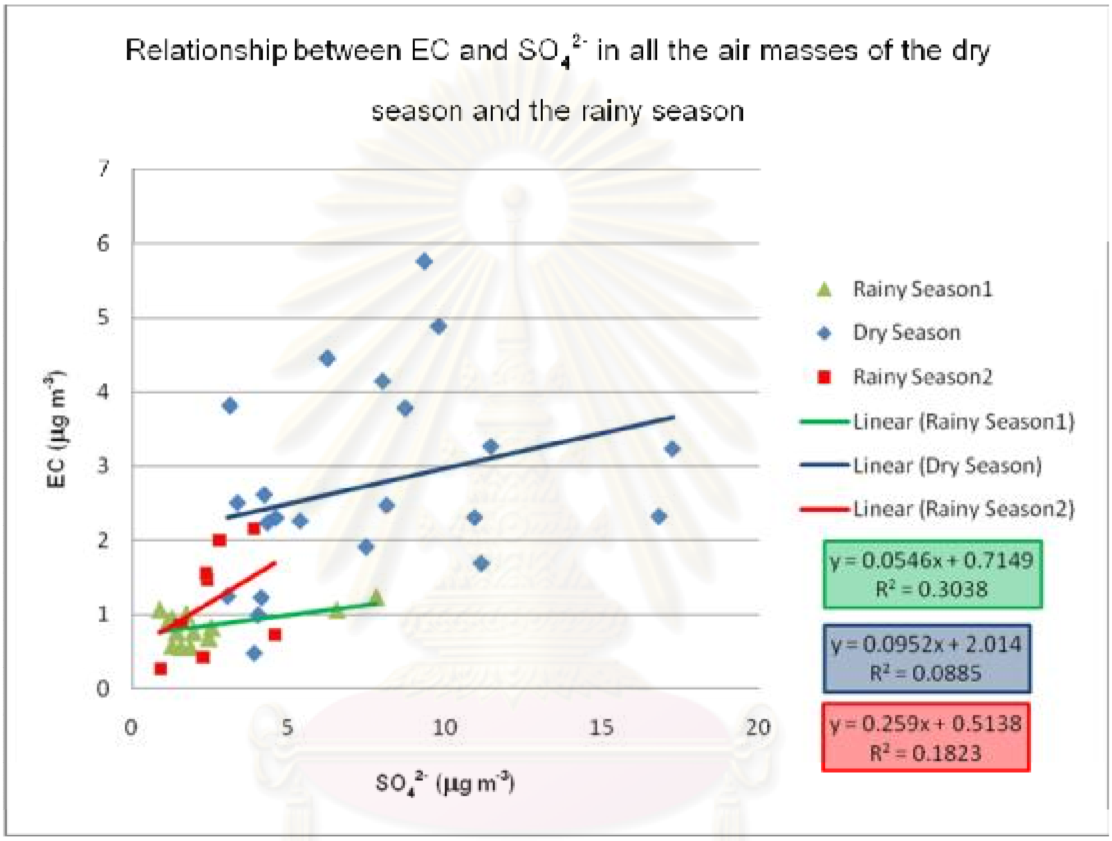


Figure 4.7 Relationship between EC and $SO_4^{2-}$ in the sampling period

The measurable concentration EC, OC and $SO_4^{2-}$ were plot in the same graph (Figure 4.8). It was found that the carbonaceous aerosols and $SO_4^{2-}$ had the same source in early January 2008 because their peaks in the time were exactly the same. Otherwise the patterns of the graphs in the other months of the sampling period were not similar. Consequently, aerosol samples at the Observatory probably originated from different source or different kind of biomass burning.

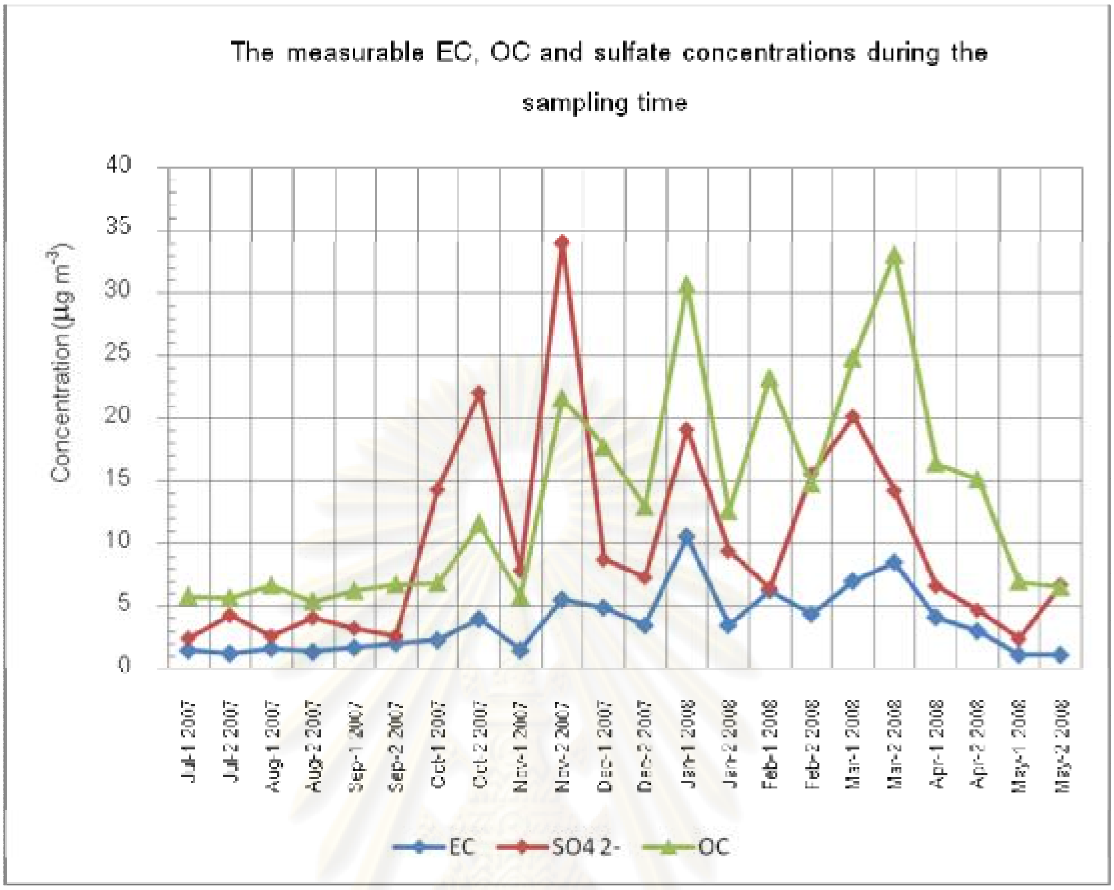


Figure 4.8 The measurable EC, OC and $SO_4^{2-}$ concentrations during the sampling period

The peck in late November 2007 was different from the peck in January 2008 and March 2008 because of $SO_4^{2-}$. The aerosol samples in November 2007 probably originated from the burning of fossil fuels due to transportation in the local place because the $SO_4^{2-}$ concentration was highest. In the other hand, the aerosol samples in January 2008 and March 2008 probably originated from the biomass burning during the harvest period because the OC concentration was highest. Moreover, the pecks in January 2008 and March 2008 were not exactly the same so the main aerosol source probably was not the same in each month.

Carbonaceous aerosols were the main components in the aerosol samples every month. Primary carbonaceous aerosols are emitted from various sources including coal combustion, residential wood combustion, etc. OC/EC ratio approach has been used for the estimation of analyzing carbonaceous aerosol source identification. The variations in OC/EC ratios likely reflects the varying contribution of sources with difference OC/EC ratios (Graham et al, 2004). In Figure 4.9, the OC/EC ratios in fine aerosols showed positive. A good relationship of data was found (R-squared = 1) in the rainy season1. The OC/EC ratios were different for each season so the main sources of atmospheric aerosols in the rainy season1, the rainy season2 and the dry season were different.

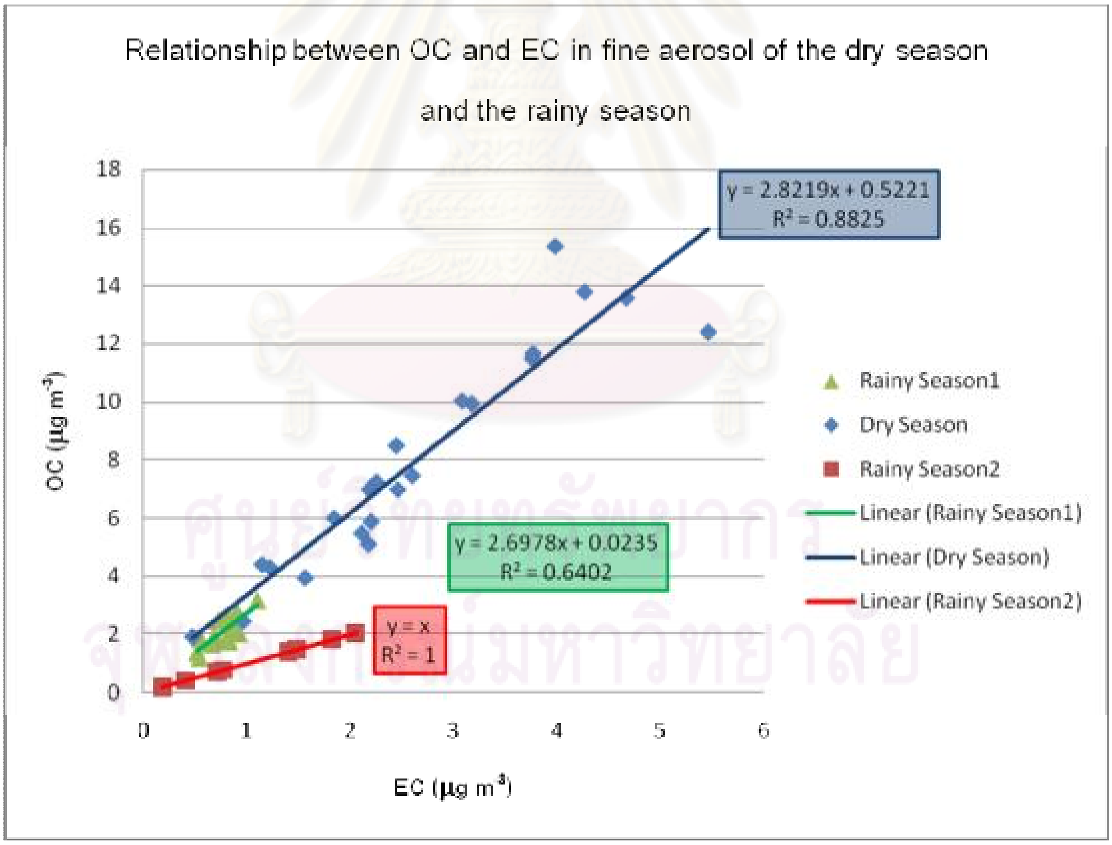


Figure 4.9 Relationship between EC and OC concentrations in fine aerosols during the sampling period

The sources of aerosols in the rainy season1 were different from the sources of aerosols in the rainy season2 owing to OC/EC ratios. The data points in the rainy season1 were tightly clustered so probably the sources of aerosols in this season were not various. In other word, the aerosols in the season1 might have been from local sources. The data points in the rainy season2 were less tightly clustered than in the rainy season2 but it was shown that the main sources of aerosols in the rainy season2 were the local sources; although, the sources of aerosols in both rainy season were different. The data points of OC/EC in the dry season were interesting because they were spread out far apart but a few points were near the points in the rainy season1. This result could infer that the possible sources of the aerosols at the Observatory were not only local sources but also the long-range transport sources. Therefore, some data points in the dry season were different from the points in the rainy season (both the rainy season1 and the rainy season2) extremely.

The combined measurable water soluble ions were shown in Figure 4.5. Although the carbonaceous aerosol was the main components in the atmospheric aerosols at the Observatory, the water soluble ions are important components of aerosols, both in continental and oceanic environments. Water soluble ions play an important role for the control of atmospheric processes. For example, they are able to form fog drops just before the saturation of steam (Murillo and Marin, 2010).

The $Na^+$ and $Cl^-$ may come from the ocean from the southwest direction of Thailand or come from the soil dust in the local area. The $Cl^-/Na^+$ ratios of combined measurable aerosol concentrations were plotted in Figure 4.10 and the $Cl^-/Na^+$ ratios of the soil samples were plotted in Figure 4.11. The $Cl^-/Na^+$ ratio of sea water is 1.8 (Parmar et al, 2001; Encinas et al, 2004). The $Cl^-/Na^+$ ratio of the soil samples in the sampling site was 1.0302.

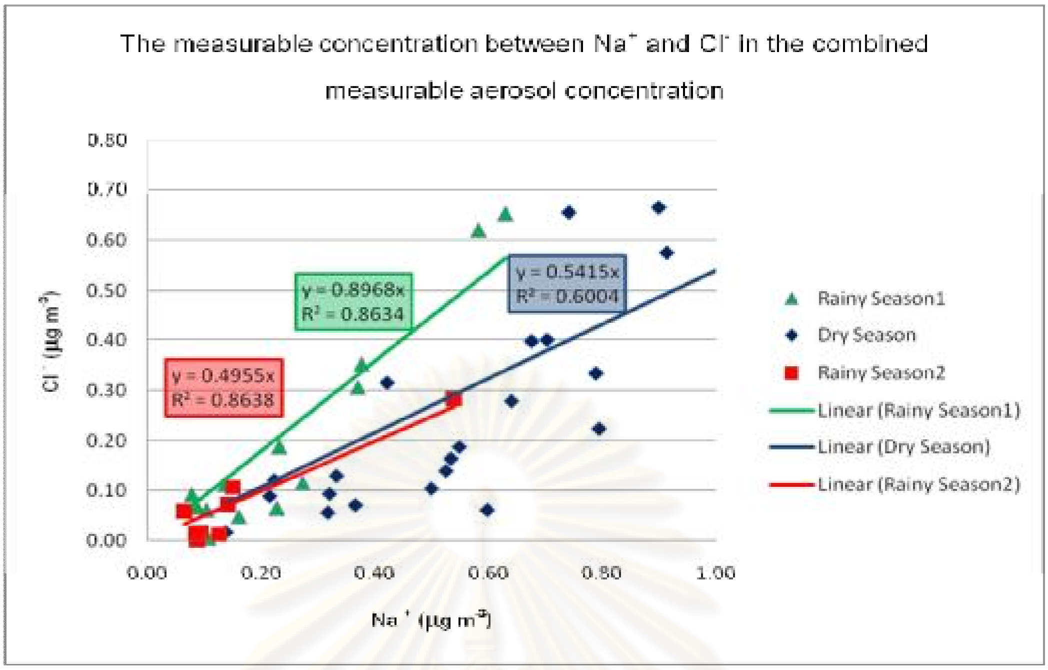


Figure 4.10 $Cl^-/Na^+$ ratios of the combined measurable aerosol concentration

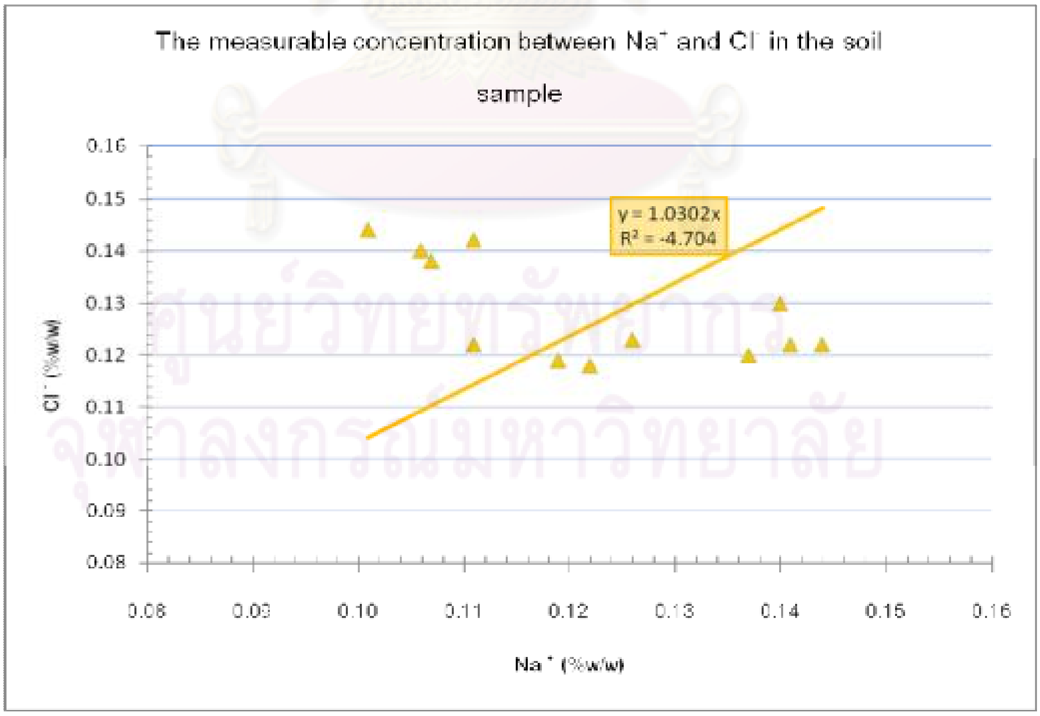


Figure 4.11 $Cl^-/Na^+$ ratios of the soil samples concentration

The $Cl^-/Na^+$ ratios of the combined measured aerosol concentrations were 0.8968 in the rainy season1, 0.4955 in the rainy season2 and 0.5415 in the dry season. All $Cl^-/Na^+$ ratios of the aerosols were less than the sea water ratio and the soil sample ratio. It was not clear that how many water soluble ions were transported from the sea water or how many particles were originated from the local soil dust but the results show clearly that the aerosols in Phimai not exactly originated from the single main source, sea water or soil dust.

The concentration of $Na^+$ in aerosols have been taken as the indicator of sea salt because it has the highest concentration in sea water (McDonald et al, 1982; Wai and Tanner, 2004; Guo et al, 2007).The total sea salt concentration can be estimated by knowing the mass concentrations of $Na^+$ and $Cl^-$ in the sample, through the empirical relation 4-1 which was used by several scientists (Nair et al, 2005; Virkkula et al, 2006; Marenco et al, 2007).

$$M_{seasalt}\ (\mu g\ m^{-3}) = M_{Cl}\ (\mu g\ m^{-3}) + 1.47 M_{Na}\ (\mu g\ m^{-3}) \qquad (4\text{-}1)$$

$M_{Cl}$ and $M_{Na}$ are the mass concentrations of $Cl^-$ and $Na^+$ in the aerosol samples. The value 1.47 is the mass ratio of $(Na^+ + K^+ + Mg^{2+} + Ca^{2+} + SO_4^{2-} + HCO_3^-)$ to $Na^+$ in sea water. The results of the calculation of sea salt aerosols in the samples were 0.82 $\mu g\ m^{-3}$ in the dry season (3.43% of combined measurable concentration) and 0.56 $\mu g\ m^{-3}$ in the rainy season (6.31% of combined measurable concentration). The combined measurable sea salt concentration was higher in the rainy season than in the dry season.

### 4.1.2 Soil Sample

Soil is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment (NRCS, 2010). Twelve soil samples were taken from the places around the Observatory and analyzed using XRF. The soil in Phimai, usually light red or brown is clay (Baranowski et al, 2002). The soil solution pH is 5.5-7.0. The soil components were shown in Figure 4.12.

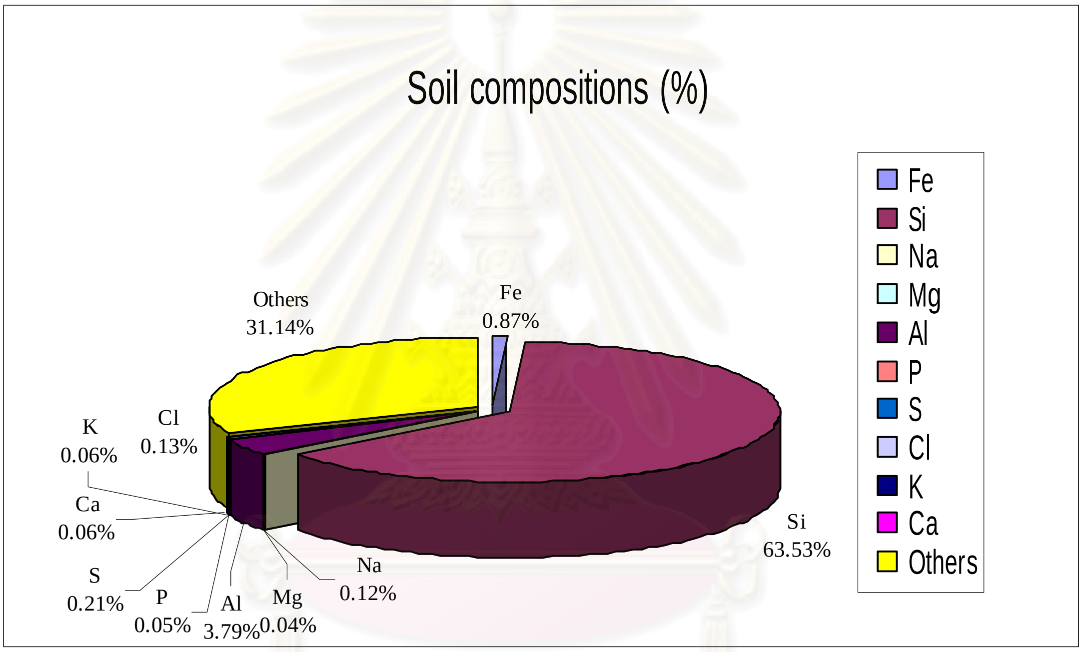


Figure 4.12 The measurable soil components at the Observatory

The dominant component of the soil samples was silicon (Si), 63.53%; In addition, the concentrations of aluminum (Al), 3.79%, and iron (Fe), 0.87%, were higher than the others. The $Fe_2O_3$ colours the soil red. Na and Cl were high because of halite in the rock formation.

## 4.2 Source of Atmospheric Aerosol

### 4.2.1 Backward Trajectory Analysis

The backward trajectories of air masses arriving at the Observatory in Phimai were run for a period of 168 hours at three different height; 500 meters above mean sea level (AMSL), 1000 meters AMSL and 1500 meters AMSL. The trajectories classified into two sectors, northeastward and southwestward. The air masses came to the Observatory from the southwestern direction (Figure 4.13) during July 2007 to the first week of October 2007.

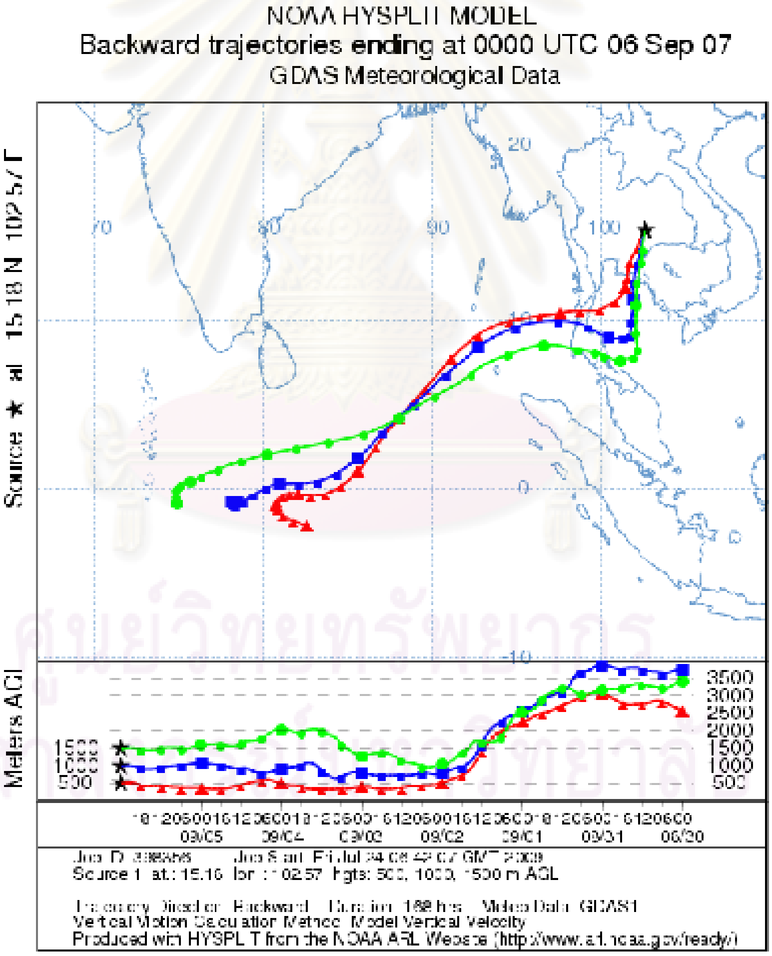


Figure 4.13 The example (September 2007) of backward trajectories in the rainy season (HYSPLIT, 2008)

Then, they changed their direction (Figure 4.14) in the second week of October 2007, to the northeastern direction (Figure 4.15) from last two weeks of October 2007 to April 2008. After that, the air masses changed their directions to the southwestern again in May 2008. In the rainy season, air masses came from the Southeast Thailand, the Union of Myanmar, the Gulf of Thailand and the Indian Ocean. In the other hand, air masses came from Lao People’s Democratic Republic, Socialist Republic of Vietnam, People’s Republic of China and the South China Sea in the dry season.

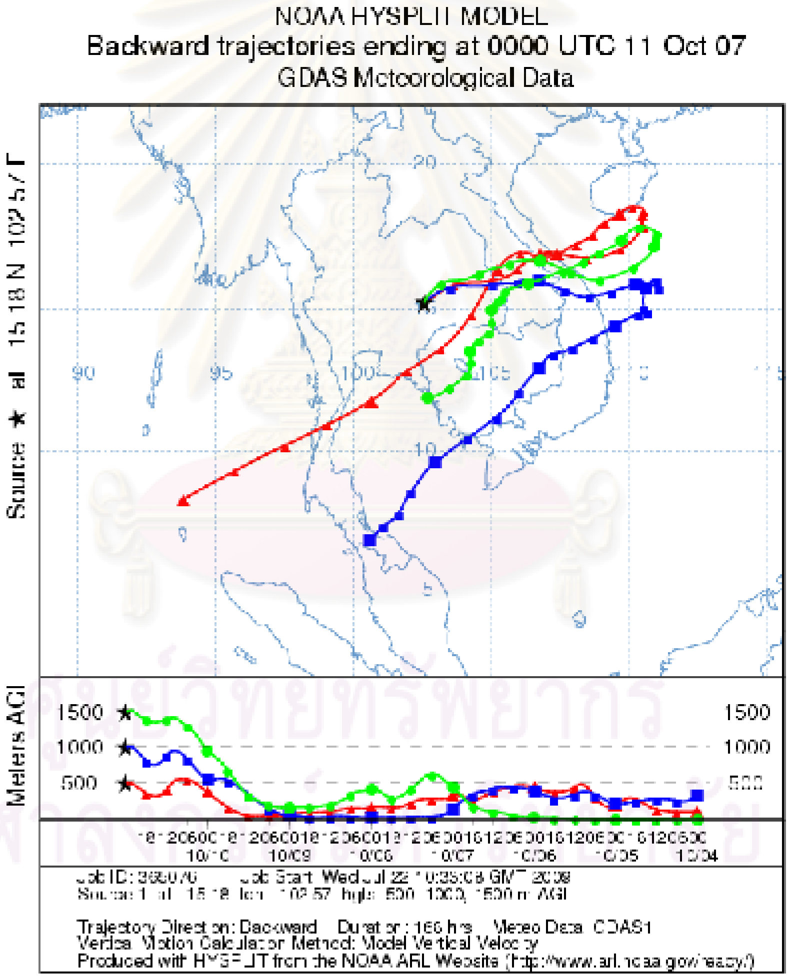


Figure 4.14 The backward trajectories (October 2007) during changing season (HYSPLIT, 2008)

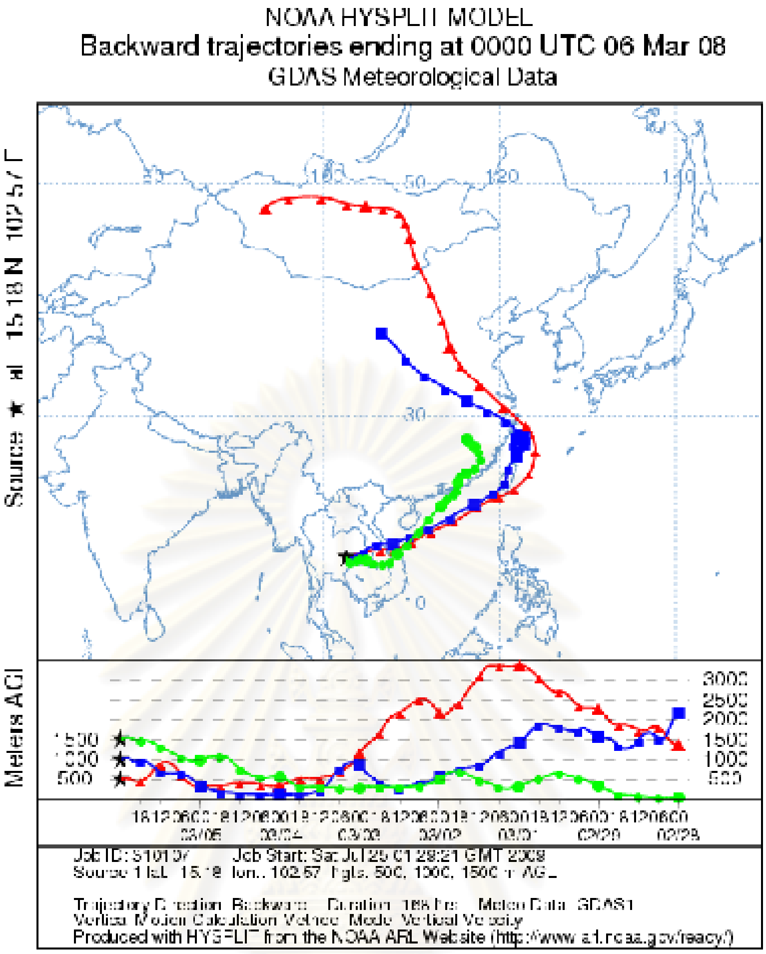


Figure 4.15 The example (March 2008) of backward trajectories in the dry season (HYSPLIT, 2008)

### 4.2.2 Fire Map Analysis

Fire analysis was shown using MODIS satellites detecting heat from wildfires, prescribed, agricultural burning or other fires. These maps were shown for looking for fires during the sampling period. Fires were low in the rainy season (Figure 4.16) during July 2007 to October 2007. It got more red spot in November in the south part of China. Obviously, the fires in the dry season (Figure 4.17) are more frequent than in the rainy season. The fires decreased in May 2008 when the air masses changed direction to the southwestward.

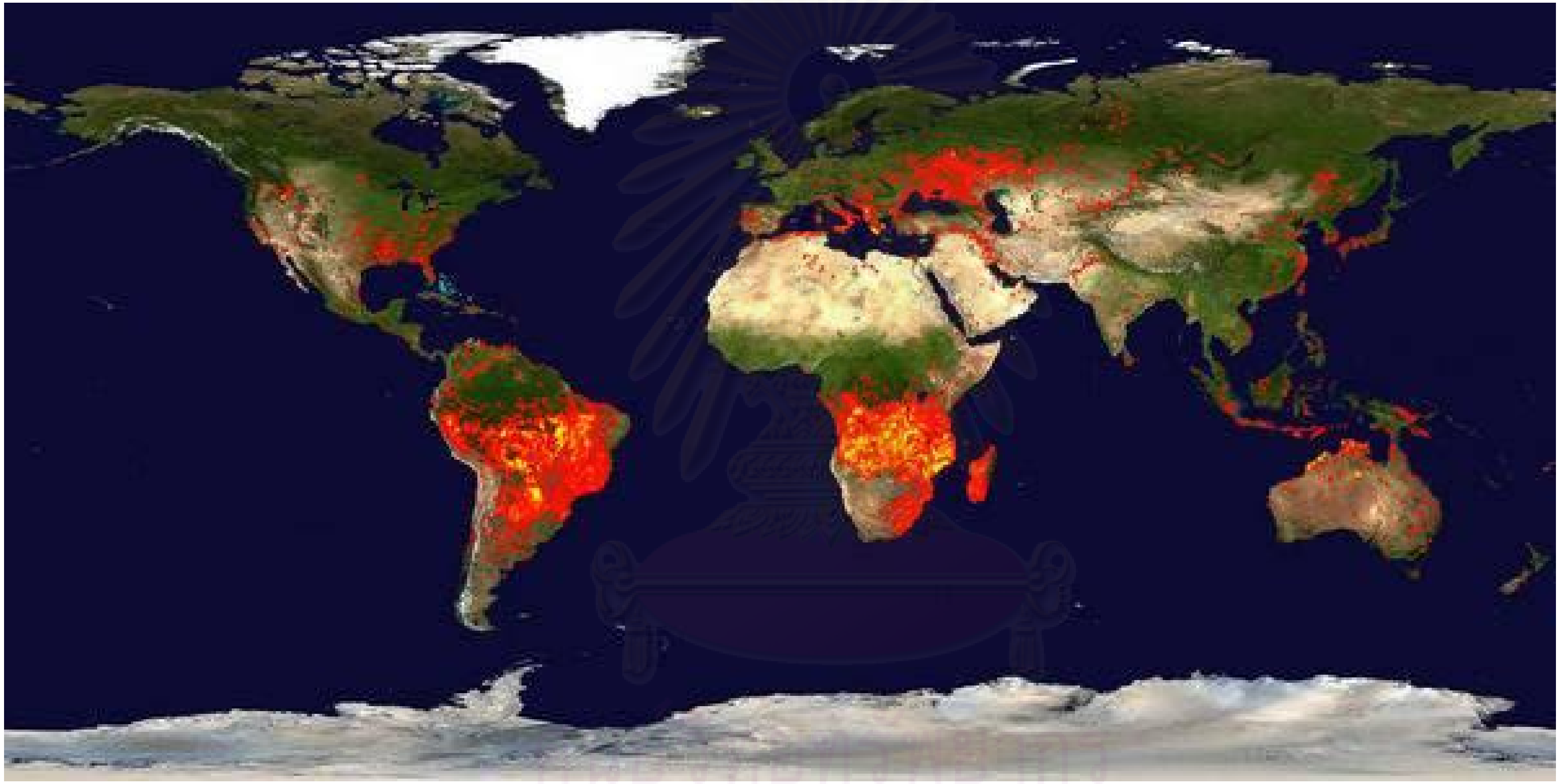


**Figure 4.16** Fire maps during the rainy season of the sampling period (MODIS, 2008)

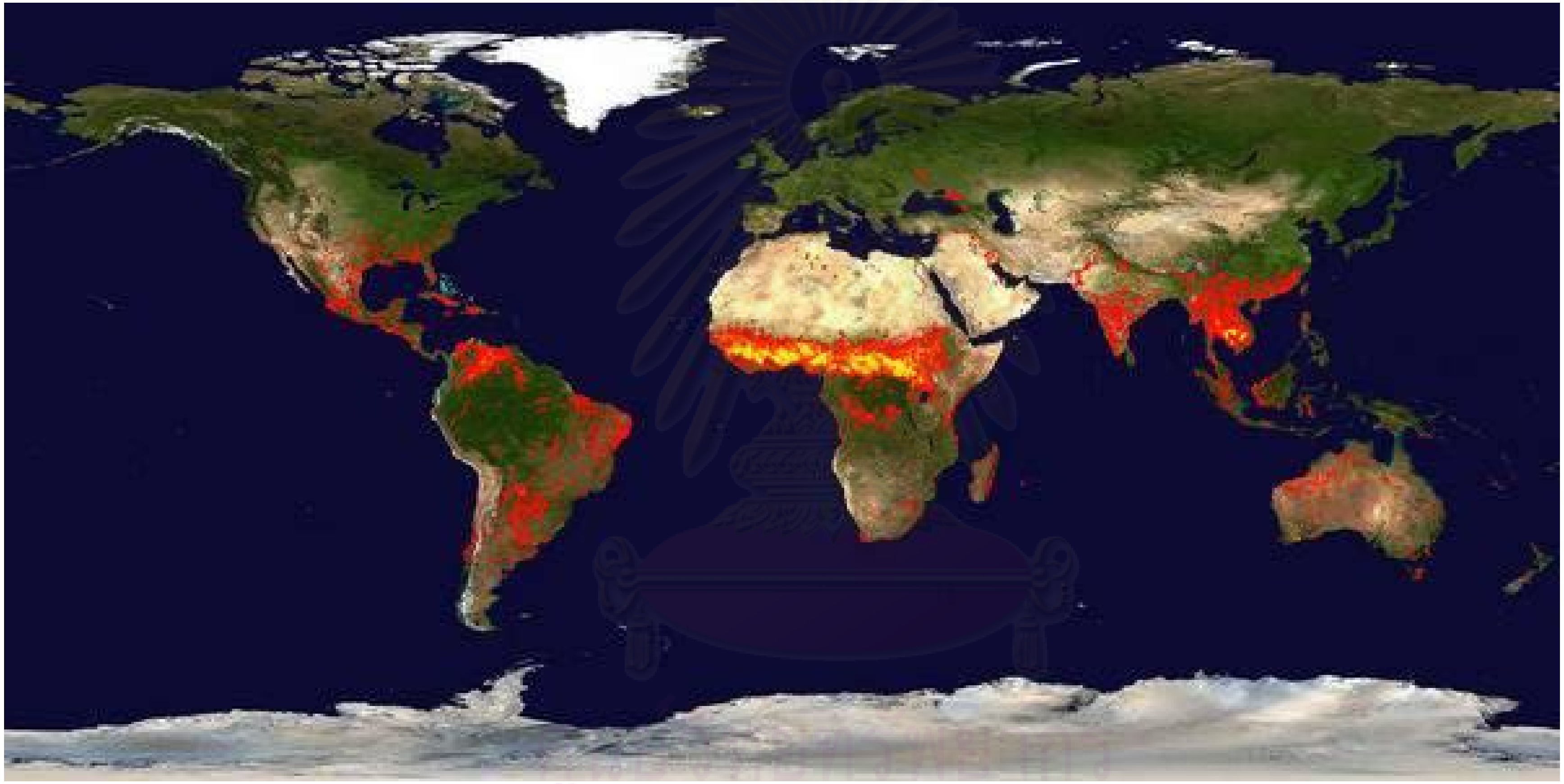


Figure 4.17 Fire maps during the dry season of the sampling period (MODIS, 2008)

Using backward trajectories, air masses arriving at Phimai can be classified in to two types depending on Asian Monsoons. Air masses arriving at the Observatory in the dry season came from the Asian Continent so they generally brought in higher total aerosol concentrations than those in the rainy season which were originated in the ocean. Backward trajectories, coupled with MODIS fire maps, showed that the biomass burning in both the local area and long-range area were changed by human activities, such as transportation and crop residue burning, and natural forest fires all the time so the aerosol compositions in each season were different.

The average sea salt concentration (calculated by equation 4-1) in the dry season was 0.82 $\mu$g m$^{-3}$, higher than in the rainy season which the average concentration was 0.56 $\mu$g m$^{-3}$ but the percentage of the average sea salt concentration in the dry season was, 3.43%, lower than the percentage of sea salt concentration in the rainy season which was 6.42% due to aerosol sources. These details were shown in table 4.1. The sources of sea salt particles in the dry season were local soil dust, rock salt factories and long-range transported. In the rainy season, aerosols were washed out by the precipitation so the total aerosol concentration was low but the sea salt particles from the ocean were taken with rain. The precipitation passing the study area brought salt particles from sea spray into the continent of Thailand owing to the southwest monsoon.

Table 4.1 Sea salt concentrations at the Observatory

| | Combined measurable salt ions concentration | Calculated sea salt concentration | Percentage of sea salt concentration |
|---|---|---|---|
| The dry season | 23.90 $\mu$g m$^{-3}$ | 0.82 $\mu$g m$^{-3}$ | 3.43% |
| The rainy season | 8.72 $\mu$g m$^{-3}$ | 0.56 $\mu$g m$^{-3}$ | 6.42% |

### 4.3 Relationship between Aerosol Concentration and Surface Temperature

The combined measurable aerosol concentrations were affected by the surface temperature. The observed surface temperature trends at the Observatory had an effect on the aerosol concentration trends. The aerosol concentrations were highest when the air temperatures were lowest (Figure 4.18) due to the moderate high pressure area from China, according to the backward trajectory analysis. The high pressure covered the study area so the aerosols could not be spread widely. The soil dust aerosols and the anthropological aerosols were wrapped within the lower place near the impactors. The aerosol concentrations would be high when the high pressure area came.

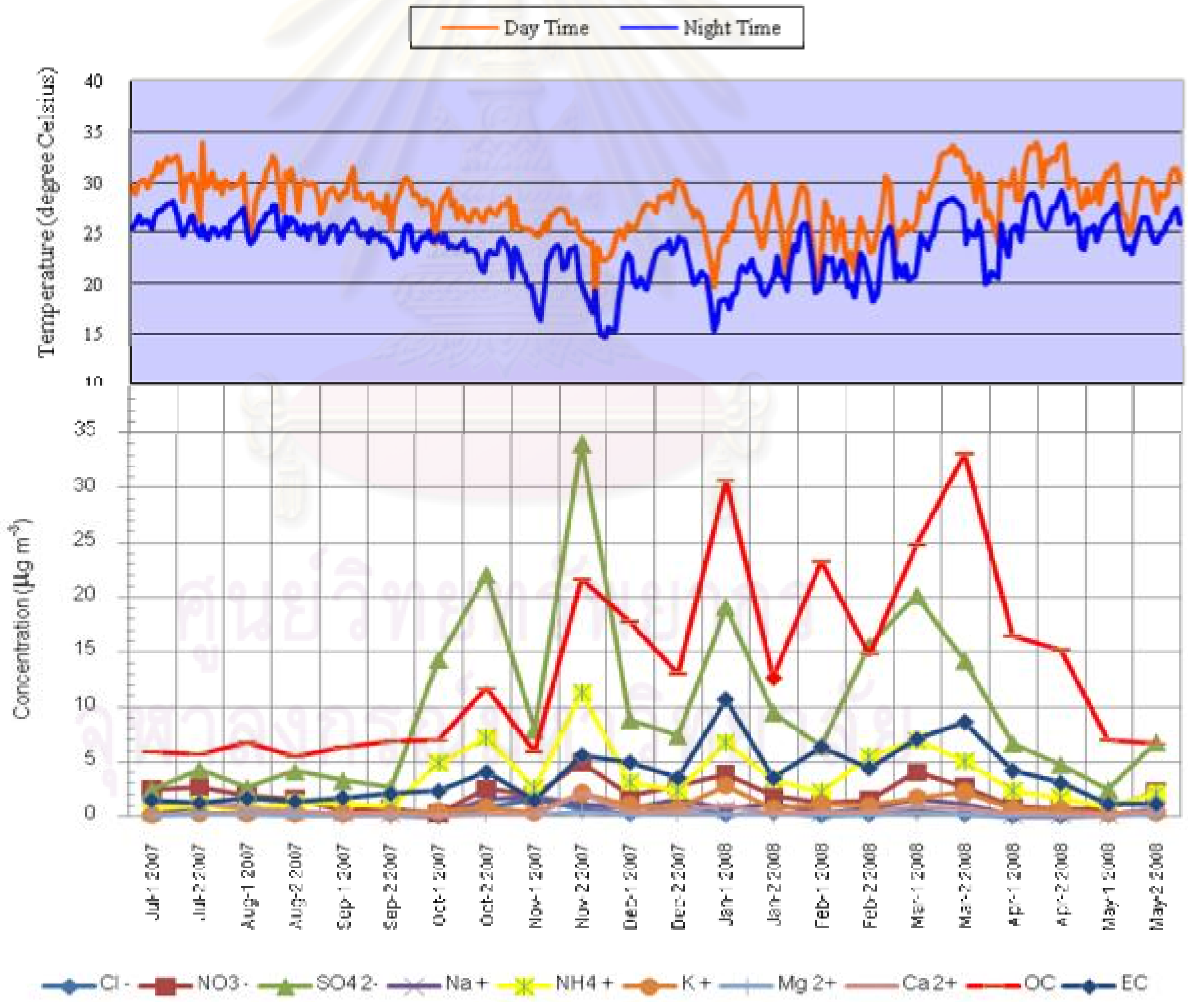


Figure 4.18 Relationship between the lower temperatures and the combined measurable aerosol concentrations during the sampling period

# CHAPTER V

# CONCLUSIONS AND RECOMMENDATION FOR FURTHER STUDY

## 5.1 Conclusion

The simultaneous collection of aerosols using QF and PC was conducted over the Observatory at Phimai. The combined measurable aerosol concentrations in the dry season were more than in the rainy season owing to rain. The chemical components of aerosols showed the pronounced variation.

$Na^+$ and $Cl^-$ were found to be two major components of salt. Water soluble fraction of $Na^+$ and $Cl^-$ showed variations with season. The $Cl^-/Na^+$ ratios were found to be transported from the regional area and long-range places because the ratios of the aerosol samples were different from the ratios of sea water and the ratios of the soil samples.

OC and sulfate were observed to be the major components all over the sampling period. The OC/EC ratios in each season were not the same. The compositions of aerosols at the study region were not exactly the same; although, the aerosol samples were collected in the same season but not the same year. The local human activities and the fire were the main factors of changing aerosol compositions in this area.

## 5.2 Recommendation for Further Study

Knowledge of aerosol chemical composition is a key to understanding a number of properties of ambient aerosol particles such as sources, size distribution, chemical evolution etc. Although filter based techniques have been widely used to determine aerosol chemical constituents, they should be collected continuously in several sites. The chemical aerosol compositions in Thailand should be monitored by sampling at several sites (Hodzic et al, 2004; Rompp et al, 2006; Sardar et al, 2005)and over different seasons in several years (Polissar and Hopke, 2001; Quinn et al, 2009). Moreover, the relationship between chemical aerosol compositions and optical properties of aerosols in Thailand is important to study (Hand et al, 2004; Cheng et al, 2008; Che et al, 2009). The aerosol optical properties, including asymmetry factor, phase-function, single-scattering albedo, refractive index and backscatter fraction, can describe the interaction between aerosols and solar radiation. The magnitude and sign of aerosol forcing depend on the optical properties which determined by aerosol distribution and chemical compositions.

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# APPENDICES

# APPENDIX A: Meteorological data at the Observatory from July 2007 to May 2008

The data had to convert to the acknowledged units

Temperature: the data = the temperature data in degree Celsius
Wind Speed: the data * 10 = the wind speed data in m s$^{-1}$
Wind Direction: the data * 72 = the wind direction in degree from north
Air Pressure: (the data * 200) + 880 = the air pressure in hPa

Table A-1 The daily average meteorological data during day time in the early July 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/7/07 | 29.65249509 | 0.30293084 | 3.58393082 | 0.51332967 |
| 2/7/07 | 28.94295107 | 0.22349722 | 3.52705804 | 0.51456500 |
| 3/7/07 | 29.98015406 | 0.31420751 | 3.67790239 | 0.51854234 |
| 4/7/07 | 30.09369487 | 0.27409633 | 3.65104769 | 0.51323000 |
| 5/7/07 | 30.11872826 | 0.32034104 | 3.40290506 | 0.51024230 |
| 6/7/07 | 29.43710162 | 0.25786284 | 3.44401517 | 0.51567495 |
| 7/7/07 | 30.61184539 | 0.26643967 | 3.51522161 | 0.52540141 |
| 8/7/07 | 30.76198364 | 0.26672784 | 3.67924292 | 0.51828148 |
| 9/7/07 | 31.87285991 | 0.26627435 | 3.56694247 | 0.50515227 |
| 10/7/07 | 30.97695714 | 0.24290790 | 3.04881303 | 0.50790397 |
| 11/7/07 | 32.02780046 | 0.34067527 | 3.61485696 | 0.50954650 |
| 12/7/07 | 32.43146713 | 0.39524462 | 3.61074508 | 0.50491486 |
| 13/7/07 | 31.98219097 | 0.38097317 | 3.64963632 | 0.50271038 |
| 14/7/07 | 32.34562479 | 0.33303651 | 3.56444344 | 0.50666000 |
| 15/7/07 | 32.50900897 | 0.31194439 | 3.61043328 | 0.51555546 |
| Mean | 30.92 | 0.30 | 3.54 | 0.51 |
| Converted Value | 30.92 | 3.00 | 255.11 | 982.42 |

Table A-2 The daily average meteorological data during night time in the early July 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/7/07 | 25.44099451 | 0.21948632 | 3.33303857 | 0.51580350 |
| 2/7/07 | 25.93489892 | 0.16592388 | 3.13755285 | 0.51728548 |
| 3/7/07 | 26.76006426 | 0.27042044 | 3.36315272 | 0.52027585 |
| 4/7/07 | 25.84540916 | 0.23042243 | 3.46438305 | 0.51909092 |
| 5/7/07 | 26.19030623 | 0.24900354 | 3.13441595 | 0.51545780 |
| 6/7/07 | 26.17140607 | 0.19272618 | 2.94204787 | 0.51852711 |
| 7/7/07 | 25.43463641 | 0.16559290 | 2.64725915 | 0.52674352 |
| 8/7/07 | 26.58767345 | 0.14429089 | 3.36313821 | 0.51731327 |
| 9/7/07 | 27.18736134 | 0.20439939 | 3.21982903 | 0.50934416 |
| 10/7/07 | 27.22321037 | 0.18357944 | 3.05288318 | 0.50928030 |
| 11/7/07 | 27.57927483 | 0.21761508 | 3.35657622 | 0.50951774 |
| 12/7/07 | 27.91217561 | 0.30831297 | 3.40703243 | 0.50700814 |
| 13/7/07 | 27.84565439 | 0.26842102 | 3.47542428 | 0.50499284 |
| 14/7/07 | 28.23528908 | 0.25307434 | 3.35983626 | 0.50931740 |
| 15/7/07 | 26.96281731 | 0.24046823 | 3.27581415 | 0.51745983 |
| Mean | 26.75 | 0.22 | 3.24 | 0.51 |
| Converted Value | 26.75 | 2.21 | 232.96 | 982.90 |

Table A-3 The daily average meteorological data during day time in the late July 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/7/07 | 24.63062069 | 0.270016246 | 0.734261187 | 0.554129837 |
| 17/7/07 | 23.56768519 | 0.27255521 | 0.750996728 | 0.556702876 |
| 18/7/07 | 24.40764745 | 0.169360854 | 1.010895671 | 0.543242095 |
| 19/7/07 | 26.62099722 | 0.15688802 | 1.345514196 | 0.535247353 |
| 20/7/07 | 28.42202222 | 0.128042721 | 2.574390577 | 0.53339367 |
| 21/7/07 | 29.66653843 | 0.129121552 | 2.063717221 | 0.525733075 |
| 22/7/07 | 27.54510995 | 0.198031094 | 1.017821252 | 0.528154464 |
| 23/7/07 | 26.08075162 | 0.242693004 | 0.849220259 | 0.539575833 |
| 24/7/07 | 22.74428264 | 0.269958379 | 0.72684245 | 0.542070833 |
| 25/7/07 | 20.61370671 | 0.214043821 | 0.78402618 | 0.541406637 |
| 26/7/07 | 25.61505 | 0.167349156 | 0.975748424 | 0.538465536 |
| 27/7/07 | 26.55915556 | 0.188474188 | 1.031562436 | 0.538749046 |
| 28/7/07 | 28.24588657 | 0.141075224 | 2.480459119 | 0.529777065 |
| 29/7/07 | 29.44380741 | 0.176221499 | 3.4394667 | 0.525711098 |
| 30/7/07 | 29.67384838 | 0.147942345 | 3.081613499 | 0.525522674 |
| 31/7/07 | 28.97170856 | 0.181777839 | 1.650330018 | 0.529301432 |
| Mean | 26.43 | 0.19 | 1.53 | 0.54 |
| Converted Value | 26.43 | 1.91 | 110.33 | 987.34 |

Table A-4 The daily average meteorological data during night time in the late July 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/7/07 | 20.79885302 | 0.246317507 | 0.907262002 | 0.553232038 |
| 17/7/07 | 19.36115282 | 0.208066332 | 0.911306047 | 0.554314903 |
| 18/7/07 | 18.87178052 | 0.134966129 | 1.037361825 | 0.543912417 |
| 19/7/07 | 19.29603034 | 0.083625015 | 1.392188287 | 0.534923578 |
| 20/7/07 | 20.38457046 | 0.100918025 | 1.648125706 | 0.529931791 |
| 21/7/07 | 20.72732584 | 0.097496674 | 1.916076323 | 0.524915338 |
| 22/7/07 | 22.70633703 | 0.160850903 | 1.324083405 | 0.527802191 |
| 23/7/07 | 20.95390297 | 0.210517322 | 0.959476199 | 0.535888001 |
| 24/7/07 | 20.5120152 | 0.203764606 | 1.107157787 | 0.540534185 |
| 25/7/07 | 19.38843694 | 0.219090289 | 0.965846054 | 0.542461119 |
| 26/7/07 | 21.81971847 | 0.129623082 | 0.835626209 | 0.536866472 |
| 27/7/07 | 23.93892685 | 0.160965323 | 0.781015612 | 0.53460214 |
| 28/7/07 | 23.28621455 | 0.097335028 | 1.953109025 | 0.528904502 |
| 29/7/07 | 25.17565691 | 0.119812342 | 2.808999102 | 0.523540855 |
| 30/7/07 | 25.95497689 | 0.125813793 | 2.679004639 | 0.522134344 |
| 31/7/07 | 25.95777464 | 0.159989003 | 1.900137078 | 0.526593627 |
| Mean | 21.82 | 0.15 | 1.45 | 0.54 |
| Converted Value | 21.82 | 1.54 | 104.07 | 987.01 |

Table A-5 The daily average meteorological data during day time in the early August 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/8/07 | 29.40890162 | 0.250805482 | 3.466244494 | 0.515697365 |
| 2/8/07 | 29.75351818 | 0.333482786 | 3.684388565 | 0.521239018 |
| 3/8/07 | 29.73744469 | 0.226533632 | 3.504959179 | 2.205418533 |
| 4/8/07 | 30.12664432 | 0.291351126 | 3.859052604 | 0.500343734 |
| 5/8/07 | 30.83934323 | 0.28092654 | 3.801003537 | 0.493042389 |
| 6/8/07 | 25.75771181 | 0.306901538 | 3.584007103 | 0.499020561 |
| 7/8/07 | 24.64028866 | 0.292432147 | 3.662478088 | 0.496344129 |
| 8/8/07 | 26.36834468 | 0.326697342 | 3.517722813 | 0.475309085 |
| 9/8/07 | 28.14155602 | 0.323870994 | 2.955122221 | 0.476845897 |
| 10/8/07 | 29.54238611 | 0.376410618 | 3.16140771 | 0.495502958 |
| 11/8/07 | 29.39299421 | 0.329378956 | 3.453567229 | 0.504383914 |
| 12/8/07 | 31.0415338 | 0.357779271 | 3.444921764 | 0.506114292 |
| 13/8/07 | 31.68106552 | 0.296340368 | 3.591940649 | 0.507331491 |
| 14/8/07 | 32.61232292 | 0.294224559 | 3.591842349 | 0.506369508 |
| 15/8/07 | 32.04924606 | 0.332688103 | 3.493640059 | 0.497714609 |
| Mean | 29.41 | 0.31 | 3.52 | 0.61 |
| Converted Value | 29.41 | 3.08 | 253.31 | 1002.68 |

Table A-6 The daily average meteorological data during night time in the early August 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/8/07 | 26.20018959 | 0.142349258 | 2.621256629 | 0.519225812 |
| 2/8/07 | 26.53509819 | 0.187659209 | 3.422982685 | 0.520608714 |
| 3/8/07 | 26.81018478 | 0.167542601 | 3.477287118 | 0.515639314 |
| 4/8/07 | 27.06434842 | 0.217019009 | 3.671744829 | 0.501334847 |
| 5/8/07 | 27.42892669 | 0.221349569 | 3.742248535 | 0.49380526 |
| 6/8/07 | 24.77580701 | 0.231707307 | 3.351641722 | 0.49916775 |
| 7/8/07 | 24.03104627 | 0.184671218 | 3.606319656 | 0.494209072 |
| 8/8/07 | 24.26369137 | 0.194185955 | 3.500851782 | 0.479115974 |
| 9/8/07 | 24.75241041 | 0.201882884 | 2.776350808 | 0.480084831 |
| 10/8/07 | 26.10078096 | 0.266714126 | 3.017686521 | 0.496936577 |
| 11/8/07 | 26.21621199 | 0.190823551 | 3.232029614 | 0.50511199 |
| 12/8/07 | 26.93608621 | 0.187033593 | 3.167311651 | 0.50718155 |
| 13/8/07 | 27.11793863 | 0.169219396 | 3.239687557 | 0.508337 |
| 14/8/07 | 27.79844982 | 0.163578903 | 3.357828487 | 0.506665344 |
| 15/8/07 | 27.7105019 | 0.200309695 | 3.242463141 | 0.498621735 |
| Mean | 26.25 | 0.20 | 3.30 | 0.50 |
| Converted Value | 26.25 | 1.95 | 237.25 | 980.35 |

Table A-7 The daily average meteorological data during day time in the late August 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/8/07 | 29.86406088 | 0.213225662 | 3.481869479 | 0.493122476 |
| 17/8/07 | 27.11868999 | 0.132872899 | 3.309061698 | 0.493394222 |
| 18/8/07 | 30.94966736 | 0.228495491 | 3.813839432 | 0.498276892 |
| 19/8/07 | 30.17755602 | 0.237938602 | 3.734673006 | 0.504829099 |
| 20/8/07 | 31.30195995 | 0.225413642 | 3.565372342 | 0.508556702 |
| 21/8/07 | 29.45744838 | 0.192250242 | 3.050287582 | 0.50817367 |
| 22/8/07 | 27.19534167 | 0.169379265 | 2.688839216 | 0.512099921 |
| 23/8/07 | 29.60679977 | 0.1653721 | 2.462652103 | 0.51248519 |
| 24/8/07 | 30.18302917 | 0.139912807 | 3.240969592 | 0.517212823 |
| 25/8/07 | 29.75574138 | 0.124515674 | 3.080500205 | 0.516579928 |
| 26/8/07 | 29.80725665 | 0.117053732 | 2.471481619 | 0.511467433 |
| 27/8/07 | 29.93301551 | 0.114876988 | 2.921557053 | 0.508519931 |
| 28/8/07 | 28.74397061 | 0.177280606 | 2.866128186 | 0.509481294 |
| 29/8/07 | 26.92299707 | 0.111692035 | 2.431510411 | 0.509116782 |
| 30/8/07 | 27.45382176 | 0.108725597 | 2.235057435 | 0.510323923 |
| 31/8/07 | 28.80277963 | 0.180489445 | 3.036927812 | 0.510092485 |
| Mean | 29.20 | 0.16 | 3.02 | 0.51 |
| Converted Value | 29.20 | 1.65 | 217.76 | 981.55 |

Table A-8 The daily average meteorological data during night time in the late August 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/8/07 | 25.37514966 | 0.112105573 | 2.649661775 | 0.496034101 |
| 17/8/07 | 24.68585213 | 0.175911164 | 2.614442327 | 0.496761092 |
| 18/8/07 | 26.60128055 | 0.17094496 | 3.277739372 | 0.501381162 |
| 19/8/07 | 25.56101778 | 0.154559885 | 3.21567308 | 0.505072672 |
| 20/8/07 | 26.42023617 | 0.149352778 | 2.741216228 | 0.509494739 |
| 21/8/07 | 26.00972936 | 0.156265809 | 2.947994397 | 0.508537852 |
| 22/8/07 | 25.01348166 | 0.139985386 | 2.546959678 | 0.51113396 |
| 23/8/07 | 24.91356061 | 0.141849363 | 2.595486032 | 0.513518258 |
| 24/8/07 | 25.82474373 | 0.106481653 | 2.770622092 | 0.517135202 |
| 25/8/07 | 24.50313005 | 0.102008479 | 2.934791142 | 0.518662325 |
| 26/8/07 | 25.63601424 | 0.105545504 | 2.772425302 | 0.51598708 |
| 27/8/07 | 25.32050311 | 0.079400629 | 2.844670598 | 0.50942227 |
| 28/8/07 | 25.85428366 | 0.11978526 | 2.04098302 | 0.507640426 |
| 29/8/07 | 24.13384568 | 0.114243956 | 2.207228051 | 0.51032978 |
| 30/8/07 | 24.17723101 | 0.097550552 | 2.500803019 | 0.512113718 |
| 31/8/07 | 24.68984598 | 0.145203974 | 2.367874134 | 0.509652441 |
| Mean | 25.29 | 0.13 | 2.68 | 0.51 |
| Converted Value | 25.29 | 1.29 | 193.63 | 981.79 |

Table A-9 The daily average meteorological data during day time in the early September 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/9/07 | 29.25766157 | 0.192412202 | 3.202217401 | 0.507990404 |
| 2/9/07 | 29.47301736 | 0.22716405 | 3.441036611 | 0.511122437 |
| 3/9/07 | 28.66008403 | 0.173400291 | 3.426634277 | 0.514321004 |
| 4/9/07 | 28.3404044 | 0.161026353 | 2.833234911 | 0.51276846 |
| 5/9/07 | 29.04787477 | 0.129744263 | 2.344135583 | 0.516351064 |
| 6/9/07 | 28.99361347 | 0.205528514 | 3.253603088 | 0.571130141 |
| 7/9/07 | 30.31908218 | 0.13057389 | 3.399498127 | 0.518860942 |
| 8/9/07 | 31.39504282 | 0.217638399 | 3.698074087 | 0.510046672 |
| 9/9/07 | 28.39375509 | 0.175152622 | 3.672335421 | 0.509818583 |
| 10/9/07 | 28.83226505 | 0.190335628 | 3.626294842 | 0.508469221 |
| 11/9/07 | 28.36019737 | 0.139488354 | 2.981102137 | 0.506219966 |
| 12/9/07 | 28.29167824 | 0.087930897 | 2.325373173 | 0.501825031 |
| 13/9/07 | 28.73576221 | 0.108402652 | 2.569438604 | 0.507171934 |
| 14/9/07 | 28.81768333 | 0.094577823 | 2.386588599 | 0.505323164 |
| 15/9/07 | 27.49504745 | 0.081456772 | 2.44884068 | 0.501628909 |
| Mean | 28.96 | 0.15 | 3.04 | 0.51 |
| Converted Value | 28.96 | 1.54 | 218.92 | 982.71 |

Table A-10 The daily average meteorological data during night time in the early September 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/9/07 | 25.57205525 | 0.144206891 | 2.762995919 | 0.508961017 |
| 2/9/07 | 25.76663185 | 0.150946081 | 2.734742934 | 0.512698906 |
| 3/9/07 | 25.68527494 | 0.103670698 | 2.182998223 | 0.514527479 |
| 4/9/07 | 24.13784587 | 0.133465518 | 2.601804409 | 0.514678827 |
| 5/9/07 | 25.03312371 | 0.092326554 | 2.809459178 | 0.516714325 |
| 6/9/07 | 25.34796002 | 0.094887164 | 2.830373399 | 0.518730092 |
| 7/9/07 | 25.92931512 | 0.07845909 | 3.083247039 | 0.518867657 |
| 8/9/07 | 26.32224858 | 0.14236489 | 3.156053394 | 0.513312152 |
| 9/9/07 | 25.84662517 | 0.103114542 | 2.505078231 | 0.510342195 |
| 10/9/07 | 24.97240228 | 0.135003366 | 2.817409343 | 0.510093969 |
| 11/9/07 | 24.78693306 | 0.089153598 | 2.267345691 | 0.505511987 |
| 12/9/07 | 24.96744283 | 0.086363757 | 2.624171362 | 0.504897887 |
| 13/9/07 | 24.11440702 | 0.082225033 | 2.762626415 | 0.508283403 |
| 14/9/07 | 25.34846891 | 0.072159014 | 2.472825898 | 0.507220569 |
| 15/9/07 | 24.75582582 | 0.105491605 | 2.571457981 | 0.503283681 |
| Mean | 25.24 | 0.11 | 2.68 | 0.51 |
| Converted Value | 25.24 | 1.08 | 192.88 | 982.24 |

Table A-11 The daily average meteorological data during day time in the late September 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/9/07 | 28.07704722 | 0.155688131 | 1.612996449 | 0.501447751 |
| 17/9/07 | 27.61725185 | 0.105251365 | 2.634068368 | 0.50436539 |
| 18/9/07 | 26.99505972 | 0.105587592 | 2.738141371 | 0.50263374 |
| 19/9/07 | 28.76021944 | 0.109653815 | 3.043409938 | 0.501781746 |
| 20/9/07 | 25.2897838 | 0.118436523 | 2.392980593 | 0.511032426 |
| 21/9/07 | 27.59294444 | 0.161901644 | 0.995462228 | 0.518311003 |
| 22/9/07 | 28.26789907 | 0.106496505 | 2.125639075 | 0.519295315 |
| 23/9/07 | 29.31686065 | 0.099341511 | 2.155735339 | 0.514187396 |
| 24/9/07 | 30.20020908 | 0.125440013 | 3.101069835 | 0.499589183 |
| 25/9/07 | 30.44087986 | 0.163687116 | 3.579198016 | 0.505942086 |
| 26/9/07 | 30.06288611 | 0.096936146 | 2.582266643 | 0.51374739 |
| 27/9/07 | 28.670232 | 0.124315394 | 2.379469048 | 0.517194507 |
| 28/9/07 | 28.88273403 | 0.15951871 | 3.537942167 | 0.51911445 |
| 29/9/07 | 28.42768866 | 0.111571684 | 3.037578413 | 0.526268019 |
| 30/9/07 | 27.67397708 | 0.120253048 | 2.839997179 | 0.519130142 |
| Mean | 28.42 | 0.12 | 2.58 | 0.51 |
| Converted Value | 28.42 | 1.24 | 186.03 | 982.32 |

Table A-12 The daily average meteorological data during night time in the late September 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/9/07 | 24.92550963 | 0.090525793 | 2.256436694 | 0.503003069 |
| 17/9/07 | 24.35208659 | 0.073531982 | 2.923012782 | 0.506552767 |
| 18/9/07 | 24.41620792 | 0.09890267 | 2.633260752 | 0.505621884 |
| 19/9/07 | 24.35615022 | 0.096477757 | 2.431699092 | 0.506210794 |
| 20/9/07 | 23.80944625 | 0.089147908 | 3.13665835 | 0.513579539 |
| 21/9/07 | 22.68047151 | 0.063678915 | 2.215711533 | 0.521306166 |
| 22/9/07 | 22.96925305 | 0.048177167 | 2.594462609 | 0.519982833 |
| 23/9/07 | 23.0685981 | 0.06100478 | 2.576888098 | 0.512344792 |
| 24/9/07 | 24.88100689 | 0.095144816 | 2.866403398 | 0.503176446 |
| 25/9/07 | 25.8049467 | 0.11890828 | 2.73628104 | 0.505929754 |
| 26/9/07 | 25.74564651 | 0.103678351 | 2.452861376 | 0.514876882 |
| 27/9/07 | 23.6065013 | 0.130942588 | 2.262954491 | 0.545680539 |
| 28/9/07 | 23.37989479 | 0.120295489 | 2.475805926 | 0.522359459 |
| 29/9/07 | 24.18014247 | 0.096547363 | 2.62631346 | 0.524351305 |
| 30/9/07 | 24.55384289 | 0.09388505 | 3.106288353 | 0.518810434 |
| Mean | 24.18 | 0.09 | 2.62 | 0.51 |
| Converted Value | 24.18 | 0.92 | 188.62 | 982.98 |

Table A-13 The daily average meteorological data during day time in the early October 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/10/07 | 28.35666366 | 0.108116804 | 3.284284866 | 0.503554708 |
| 2/10/07 | 27.92074722 | 0.124619257 | 3.1447602 | 0.497477305 |
| 3/10/07 | 27.82517708 | 0.230194383 | 3.531949094 | 0.48992714 |
| 4/10/07 | 24.04791944 | 0.336711536 | 3.251796374 | 0.489861699 |
| 5/10/07 | 27.04840648 | 0.289089602 | 2.815700298 | 0.50396548 |
| 6/10/07 | 28.11743032 | 0.203476551 | 2.918625163 | 0.50785818 |
| 7/10/07 | 28.62751296 | 0.159535007 | 3.347520154 | 0.512661984 |
| 8/10/07 | 29.35778148 | 0.10805465 | 3.010967906 | 0.520244472 |
| 9/10/07 | 27.71323125 | 0.120857063 | 3.360325735 | 0.523359217 |
| 10/10/07 | 28.11038032 | 0.134583473 | 1.717586682 | 0.519432862 |
| 11/10/07 | 26.4576125 | 0.131590325 | 1.220682385 | 0.524020651 |
| 12/10/07 | 27.63046925 | 0.131860219 | 1.147574077 | 0.530173866 |
| 13/10/07 | no data | | | |
| 14/10/07 | no data | | | |
| 15/10/07 | 26.74189815 | 0.19618469 | 0.708601248 | 0.54270358 |
| Mean | 27.54 | 0.17 | 2.57 | 0.51 |
| Converted Value | 27.54 | 1.75 | 185.32 | 982.54 |

Table A-14 The daily average meteorological data during night time in the early October 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/10/07 | 24.57510022 | 0.094582639 | 2.719424281 | 0.505009764 |
| 2/10/07 | 25.21358858 | 0.123073053 | 3.068530792 | 0.496564444 |
| 3/10/07 | 24.33092035 | 0.148188905 | 3.372183552 | 0.49094342 |
| 4/10/07 | 24.37181617 | 0.200952074 | 3.043847027 | 0.49297431 |
| 5/10/07 | 24.74104552 | 0.183018358 | 2.405986666 | 0.506038545 |
| 6/10/07 | 24.18971295 | 0.164064161 | 2.479901219 | 0.508973487 |
| 7/10/07 | 24.87480736 | 0.175176004 | 2.507772805 | 0.514486152 |
| 8/10/07 | 23.6524 | 0.117836958 | 2.558817647 | 0.546239744 |
| 9/10/07 | 23.9232438 | 0.076328829 | 3.468165398 | 0.523890271 |
| 10/10/07 | 23.66240186 | 0.097507376 | 2.546165756 | 0.521385943 |
| 11/10/07 | 23.64741967 | 0.097143702 | 1.687000961 | 0.526227125 |
| 12/10/07 | 24.05546347 | 0.090451962 | 1.534134538 | 0.531506932 |
| 13/10/07 | no data | | | |
| 14/10/07 | no data | | | |
| 15/10/07 | 24.32866073 | 0.132334945 | 0.886454271 | 0.543340347 |
| Mean | 24.27 | 0.13 | 0.52 | 0.52 |
| Converted Value | 24.27 | 1.31 | 37.15 | 983.19 |

Table A-15 The daily average meteorological data during day time in the late October 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/10/07 | 26.34810139 | 0.303710041 | 0.76803766 | 0.544229478 |
| 17/10/07 | 26.17990833 | 0.276373499 | 0.762906344 | 0.544406084 |
| 18/10/07 | 27.36269398 | 0.238268403 | 0.77892595 | 0.539208165 |
| 19/10/07 | 27.13037338 | 0.282803166 | 0.81333695 | 0.543328 |
| 20/10/07 | 26.51021736 | 0.267506315 | 0.772985682 | 0.539511176 |
| 21/10/07 | 26.1083794 | 0.198316737 | 0.913598953 | 0.53432001 |
| 22/10/07 | 27.20341537 | 0.222788998 | 0.748871764 | 0.529155572 |
| 23/10/07 | 27.38957523 | 0.286526906 | 0.765538936 | 0.529730158 |
| 24/10/07 | 27.05965787 | 0.264818957 | 0.762748209 | 0.53042123 |
| 25/10/07 | 26.77373519 | 0.240191411 | 0.749293861 | 0.531917205 |
| 26/10/07 | 27.47494815 | 0.259559704 | 0.684097845 | 0.527756462 |
| 27/10/07 | 27.85385159 | 0.252412497 | 0.725318041 | 0.523278175 |
| 28/10/07 | 27.76183125 | 0.171079713 | 1.12766851 | 0.522685818 |
| 29/10/07 | 28.39063542 | 0.268859428 | 0.77547583 | 0.523193547 |
| 30/10/07 | 25.28115903 | 0.19513855 | 0.989300736 | 0.527537112 |
| 31/10/07 | no data | | | |
| Mean | 26.99 | 0.25 | 0.81 | 0.53 |
| Converted Value | 26.99 | 2.49 | 58.26 | 986.54 |

Table A-16 The daily average meteorological data during night time in the late October 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/10/07 | 23.30890083 | 0.136173387 | 0.931383331 | 0.546800219 |
| 17/10/07 | 23.40148492 | 0.17305855 | 0.876702182 | 0.543451064 |
| 18/10/07 | 23.27912199 | 0.142625596 | 0.914896626 | 0.541051799 |
| 19/10/07 | 23.08470576 | 0.150185846 | 0.902656649 | 0.544146553 |
| 20/10/07 | 21.73933856 | 0.119857487 | 0.948109025 | 0.541721505 |
| 21/10/07 | 21.2135806 | 0.111938365 | 0.857175851 | 0.5350892 |
| 22/10/07 | 22.87348399 | 0.124415495 | 0.728013421 | 0.528951336 |
| 23/10/07 | 23.31081752 | 0.13855715 | 0.851664498 | 0.528842326 |
| 24/10/07 | 23.04793012 | 0.165088125 | 0.813294413 | 0.530350382 |
| 25/10/07 | 23.05515989 | 0.130728474 | 0.71771803 | 0.530976596 |
| 26/10/07 | 24.23713311 | 0.159998782 | 0.70846957 | 0.527793791 |
| 27/10/07 | 24.49336709 | 0.100289386 | 1.066659969 | 0.521517261 |
| 28/10/07 | 24.04747288 | 0.11995222 | 1.164245314 | 0.517497318 |
| 29/10/07 | 22.99043095 | 0.147863262 | 0.951263125 | 0.522602705 |
| 30/10/07 | 20.66200034 | 0.113708299 | 1.556529923 | 0.524058904 |
| 31/10/07 | no data | | | |
| Mean | 22.98 | 0.14 | 0.93 | 0.53 |
| Converted Value | 22.98 | 1.36 | 67.15 | 986.46 |

Table A-17 The daily average meteorological data during day time in the early November 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/11/07 | 27.56936111 | 0.137714466 | 1.599229103 | 0.535141073 |
| 2/11/07 | 25.68418476 | 0.283376456 | 0.785251295 | 0.534311405 |
| 3/11/07 | 25.40423819 | 0.235593047 | 0.799371622 | 0.534981659 |
| 4/11/07 | 25.37751216 | 0.288981106 | 0.808091901 | 0.538931839 |
| 5/11/07 | 25.28112917 | 0.255016934 | 0.791831546 | 0.535431951 |
| 6/11/07 | 25.12441597 | 0.31446874 | 0.801680184 | 0.532661813 |
| 7/11/07 | 24.83915741 | 0.310984591 | 0.823901022 | 0.532579678 |
| 8/11/07 | 24.71175139 | 0.272236968 | 0.827443144 | 0.527157829 |
| 9/11/07 | 24.91751111 | 0.241073042 | 0.799783677 | 0.528466627 |
| 10/11/07 | 25.99518495 | 0.237704952 | 0.812460441 | 0.528400347 |
| 11/11/07 | 25.21456402 | 0.340259245 | 0.7521092 | 0.533059355 |
| 12/11/07 | 26.7779 | 0.269827729 | 0.866863428 | 0.531080723 |
| 13/11/07 | 26.76394144 | 0.2147555 | 0.879274482 | 0.528445152 |
| 14/11/07 | 27.28807523 | 0.188020742 | 0.961039388 | 0.531949886 |
| 15/11/07 | 27.36299792 | 0.240680978 | 0.780940195 | 0.543467894 |
| Mean | 25.89 | 0.26 | 0.87 | 0.53 |
| Converted Value | 25.89 | 2.55 | 62.83 | 986.61 |

Table A-18 The daily average meteorological data during night time in the early November 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/11/07 | 23.60302766 | 0.1355694 | 0.893371585 | 0.535163102 |
| 2/11/07 | 23.04102143 | 0.214205254 | 0.90093868 | 0.53680314 |
| 3/11/07 | 21.27663432 | 0.159606888 | 0.875721976 | 0.537270978 |
| 4/11/07 | 20.82881456 | 0.145815478 | 1.029956162 | 0.538701885 |
| 5/11/07 | 19.95698275 | 0.146050405 | 1.068375153 | 0.537100884 |
| 6/11/07 | 19.7130096 | 0.155780458 | 1.043487797 | 0.535091815 |
| 7/11/07 | 18.36370555 | 0.114873013 | 1.042241367 | 0.531832331 |
| 8/11/07 | 17.01626787 | 0.110684521 | 1.095500084 | 0.529134997 |
| 9/11/07 | 16.42604939 | 0.083696944 | 1.092047743 | 0.529081362 |
| 10/11/07 | 19.58366757 | 0.097484728 | 0.883894647 | 0.529170922 |
| 11/11/07 | 22.18289471 | 0.174669933 | 0.724601462 | 0.534203483 |
| 12/11/07 | 22.71240239 | 0.117597272 | 0.723948855 | 0.531740055 |
| 13/11/07 | 23.41109797 | 0.125231226 | 0.789023665 | 0.530148202 |
| 14/11/07 | 23.95521507 | 0.203687195 | 0.849680216 | 0.533805186 |
| 15/11/07 | 23.52948851 | 0.199147254 | 0.850264449 | 0.543871525 |
| Mean | 21.04 | 0.15 | 0.92 | 0.53 |
| Converted Value | 21.04 | 1.46 | 66.54 | 986.84 |

Table A-19 The daily average meteorological data during day time in the late November 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/11/07 | 27.3615022 | 0.262173801 | 0.748525172 | 0.543779844 |
| 17/11/07 | 27.09475556 | 0.215288383 | 1.237135105 | 0.530604964 |
| 18/11/07 | 25.88709144 | 0.317732143 | 0.722589887 | 0.535191613 |
| 19/11/07 | 25.88787567 | 0.317769102 | 0.722691479 | 0.535193288 |
| 20/11/07 | 26.34299699 | 0.332497818 | 0.755130439 | 0.547251417 |
| 21/11/07 | 24.91945497 | 0.269414115 | 0.783316575 | 0.550377459 |
| 22/11/07 | 24.42119583 | 0.295280934 | 0.793379785 | 0.546663474 |
| 23/11/07 | 24.26195972 | 0.277074739 | 0.767931442 | 0.533560779 |
| 24/11/07 | 24.01183796 | 0.262410655 | 0.887255979 | 0.538597237 |
| 25/11/07 | 24.17043102 | 0.198555414 | 1.153649501 | 0.540913093 |
| 26/11/07 | 17.05946804 | 0.109970479 | 1.092034801 | 0.539701647 |
| 27/11/07 | 23.58504398 | 0.239654626 | 0.873970608 | 0.542281117 |
| 28/11/07 | 22.52564005 | 0.256987574 | 0.955375248 | 0.541397928 |
| 29/11/07 | 22.35011435 | 0.301187539 | 0.936926976 | 0.550358452 |
| 30/11/07 | 22.58921227 | 0.272149417 | 0.963951734 | 0.559846769 |
| Mean | 24.16 | 0.26 | 0.89 | 0.54 |
| Converted Value | 24.16 | 2.62 | 64.29 | 988.48 |

Table A-20 The daily average meteorological data during night time in the late November 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/11/07 | 21.4002173 | 0.118537556 | 0.819537007 | 0.543760987 |
| 17/11/07 | 21.62511527 | 0.082292185 | 1.512815069 | 0.531868453 |
| 18/11/07 | 23.4761905 | 0.155491172 | 0.769188214 | 0.534376706 |
| 19/11/07 | 23.47613932 | 0.155498229 | 0.769043843 | 0.534377158 |
| 20/11/07 | 23.7279955 | 0.263980677 | 0.767747924 | 0.548284477 |
| 21/11/07 | 20.5083339 | 0.159034565 | 1.086415518 | 0.55104148 |
| 22/11/07 | 19.79678129 | 0.119550985 | 0.766055374 | 0.548073843 |
| 23/11/07 | 18.93839085 | 0.10514799 | 1.140581567 | 0.538720074 |
| 24/11/07 | 18.28498147 | 0.126422205 | 0.974956764 | 0.539665826 |
| 25/11/07 | 17.13810057 | 0.099185347 | 1.105299841 | 0.541481224 |
| 26/11/07 | 19.34874705 | 0.140016628 | 1.048899921 | 0.54232511 |
| 27/11/07 | 16.25765439 | 0.116169819 | 1.205578119 | 0.541679876 |
| 28/11/07 | 15.0588411 | 0.151753705 | 1.185804582 | 0.538665289 |
| 29/11/07 | 14.73560403 | 0.13648809 | 1.135030798 | 0.547317846 |
| 30/11/07 | 15.78656141 | 0.171222909 | 1.118741201 | 0.555854599 |
| Mean | 19.30 | 0.14 | 1.03 | 0.54 |
| Converted Value | 19.30 | 1.40 | 73.95 | 988.50 |

Table A-21 The daily average meteorological data during day time in the early December 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/12/07 | 22.9414162 | 0.146351741 | 1.429432128 | 0.554321151 |
| 2/12/07 | 24.27913565 | 0.205559015 | 0.993086822 | 0.553206399 |
| 3/12/07 | 25.2099 | 0.226575453 | 0.885264333 | 0.553197152 |
| 4/12/07 | 25.12919167 | 0.248161682 | 0.807897148 | 0.55143892 |
| 5/12/07 | 24.46562338 | 0.250691272 | 0.876600725 | 0.579881512 |
| 6/12/07 | 25.82019537 | 0.315089719 | 0.749766532 | 0.552172677 |
| 7/12/07 | 25.64132199 | 0.250815682 | 0.788920963 | 0.54583631 |
| 8/12/07 | 25.33521782 | 0.154236882 | 1.434087859 | 0.541099974 |
| 9/12/07 | 25.7778838 | 0.13276855 | 1.355657481 | 0.535659246 |
| 10/12/07 | 26.93173356 | 0.17593833 | 1.214401991 | 0.533846448 |
| 11/12/07 | 27.43060671 | 0.146060971 | 1.438411154 | 0.534042608 |
| 12/12/07 | 27.93323819 | 0.202891537 | 1.413662974 | 0.526224918 |
| 13/12/07 | 27.91778796 | 0.1619056 | 1.268239082 | 0.524783684 |
| 14/12/07 | 27.6007838 | 0.159262087 | 1.184957107 | 0.523828881 |
| 15/12/07 | 26.99291505 | 0.151915576 | 1.018884576 | 0.530088637 |
| Mean | 25.96 | 0.20 | 1.12 | 0.54 |
| Converted Value | 25.96 | 1.95 | 80.92 | 988.53 |

Table A-22 The daily average meteorological data during night time in the early December 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/12/07 | 15.47285194 | 0.096762764 | 1.163317162 | 0.552457535 |
| 2/12/07 | 15.4387659 | 0.0661421 | 1.010701469 | 0.550436448 |
| 3/12/07 | 18.1158267 | 0.120372183 | 1.018635082 | 0.551977842 |
| 4/12/07 | 19.8324264 | 0.183109066 | 0.760909407 | 0.553947866 |
| 5/12/07 | 22.07513611 | 0.198411195 | 0.989464313 | 0.555377314 |
| 6/12/07 | 23.10364863 | 0.247029053 | 0.75047296 | 0.555352637 |
| 7/12/07 | 22.61236919 | 0.229379577 | 0.7955167 | 0.548665634 |
| 8/12/07 | 20.10944762 | 0.108188609 | 0.938010496 | 0.541057469 |
| 9/12/07 | 19.80093429 | 0.086105086 | 1.088099526 | 0.537173 |
| 10/12/07 | 20.60067806 | 0.109553025 | 0.964224879 | 0.533443671 |
| 11/12/07 | 20.05003086 | 0.075815445 | 1.299271096 | 0.531989134 |
| 12/12/07 | 19.52478355 | 0.061374897 | 1.849970101 | 0.526766779 |
| 13/12/07 | 20.58559619 | 0.082422016 | 1.461310718 | 0.523973674 |
| 14/12/07 | 22.30307476 | 0.09119257 | 1.169569845 | 0.523602539 |
| 15/12/07 | 23.16993656 | 0.11987842 | 1.18726243 | 0.53057848 |
| Mean | 20.19 | 0.13 | 1.10 | 0.54 |
| Converted Value | 20.19 | 1.25 | 78.94 | 988.22 |

Table A-23 The daily average meteorological data during day time in the late December 2007

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/12/07 | 28.51838116 | 0.164580461 | 1.062986002 | 0.53901297 |
| 17/12/07 | 28.50413079 | 0.189619218 | 0.917227362 | 0.538353699 |
| 18/12/07 | 28.74017986 | 0.224911854 | 0.850094314 | 0.541916745 |
| 19/12/07 | 28.93438495 | 0.178082979 | 1.011550878 | 0.538263811 |
| 20/12/07 | 28.09032546 | 0.127753683 | 1.498856788 | 0.54001927 |
| 21/12/07 | 30.08900463 | 0.131172599 | 3.398313574 | 0.536840774 |
| 22/12/07 | 30.15627639 | 0.133363853 | 3.441577138 | 0.52928956 |
| 23/12/07 | 29.82560833 | 0.146276873 | 3.283254393 | 0.524935655 |
| 24/12/07 | 29.20031389 | 0.126694283 | 2.577253345 | 0.524590455 |
| 25/12/07 | 27.69810556 | 0.167804144 | 1.381496563 | 0.528664169 |
| 26/12/07 | 27.42244722 | 0.160634405 | 1.182959526 | 0.535433101 |
| 27/12/07 | 26.5568912 | 0.173892657 | 1.021731301 | 0.534597466 |
| 28/12/07 | 27.16614306 | 0.167370593 | 1.089317792 | 0.521173114 |
| 29/12/07 | 26.41362523 | 0.287783238 | 0.805980866 | 0.527275626 |
| 30/12/07 | 25.47003542 | 0.266403932 | 0.773635418 | 0.532872576 |
| 31/12/07 | 24.0711919 | 0.31900628 | 0.771514604 | 0.543746277 |
| Mean | 27.93 | 0.19 | 1.57 | 0.53 |
| Converted Value | 27.93 | 1.85 | 112.80 | 986.71 |

Table A-24 The daily average meteorological data during night time in the late December 2007

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/12/07 | 23.41006408 | 0.134835368 | 1.066185773 | 0.539155969 |
| 17/12/07 | 23.70104679 | 0.11955525 | 1.009595221 | 0.539753875 |
| 18/12/07 | 23.65429549 | 0.13052568 | 0.960736116 | 0.540727154 |
| 19/12/07 | 24.32465903 | 0.151765969 | 1.00198398 | 0.539551821 |
| 20/12/07 | 23.10984242 | 0.121944012 | 1.506662341 | 0.538365637 |
| 21/12/07 | 23.57474067 | 0.117226681 | 2.49441341 | 0.535804627 |
| 22/12/07 | 24.67672417 | 0.137885409 | 2.503466316 | 0.528308638 |
| 23/12/07 | 24.29901056 | 0.125279742 | 2.294423929 | 0.523738007 |
| 24/12/07 | 24.28727142 | 0.126848971 | 2.113754992 | 0.522170661 |
| 25/12/07 | 22.36486942 | 0.142792528 | 1.335090136 | 0.525918171 |
| 26/12/07 | 21.0391271 | 0.108554192 | 1.422950222 | 0.532877128 |
| 27/12/07 | 20.07129391 | 0.091803495 | 1.380058753 | 0.530020743 |
| 28/12/07 | 20.33840102 | 0.082961286 | 1.591337455 | 0.522775941 |
| 29/12/07 | 21.17180264 | 0.180099792 | 1.025628839 | 0.526639941 |
| 30/12/07 | 20.95174765 | 0.196414836 | 0.972537989 | 0.53332069 |
| 31/12/07 | 20.53744627 | 0.294571878 | 0.880503916 | 0.54282927 |
| Mean | 22.59 | 0.14 | 1.47 | 0.53 |
| Converted Value | 22.59 | 1.41 | 106.02 | 986.52 |

Table A-25 The daily average meteorological data during day time in the early January 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/1/08 | 22.07718495 | 0.392312482 | 0.773377636 | 0.555362584 |
| 2/1/08 | 19.79341111 | 0.29157399 | 0.998406379 | 0.559044919 |
| 3/1/08 | 21.58074745 | 0.230043394 | 0.873799893 | 0.553303929 |
| 4/1/08 | 23.64123449 | 0.172330034 | 1.129767874 | 0.550688433 |
| 5/1/08 | 24.55756111 | 0.191880914 | 0.987934811 | 0.548375311 |
| 6/1/08 | 24.36930856 | 0.115395556 | 1.691272723 | 0.553467474 |
| 7/1/08 | 25.84427685 | 0.160809094 | 1.344268355 | 0.54785933 |
| 8/1/08 | 25.44746157 | 0.106054538 | 2.099716194 | 0.542405867 |
| 9/1/08 | 27.84037477 | 0.10771495 | 2.173814371 | 0.536025071 |
| 10/1/08 | 28.50057477 | 0.113475684 | 3.265952485 | 0.531911652 |
| 11/1/08 | 28.88342546 | 0.115680106 | 3.44696779 | 0.530427938 |
| 12/1/08 | 29.55120069 | 0.139544145 | 3.514468882 | 0.526262228 |
| 13/1/08 | 29.76111366 | 0.130232806 | 2.827608186 | 0.527358756 |
| 14/1/08 | 26.59401505 | 0.193979716 | 0.941010815 | 0.53635395 |
| 15/1/08 | 26.63067245 | 0.241001346 | 0.916579295 | 0.544897672 |
| Mean | 25.67 | 0.18 | 1.80 | 0.54 |
| Converted Value | 25.67 | 1.80 | 129.53 | 988.58 |

Table A-26 The daily average meteorological data during night time in the early January 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/1/08 | 17.67136998 | 0.316624129 | 0.828301459 | 0.554278815 |
| 2/1/08 | 15.38715397 | 0.178812789 | 0.715783643 | 0.558709818 |
| 3/1/08 | 16.30530073 | 0.125057798 | 0.884298634 | 0.5564529 |
| 4/1/08 | 18.27413882 | 0.101069034 | 0.763563769 | 0.551520108 |
| 5/1/08 | 18.40672454 | 0.109167117 | 0.934243205 | 0.548458881 |
| 6/1/08 | 18.50103998 | 0.125736798 | 1.190460235 | 0.549998452 |
| 7/1/08 | 17.53220075 | 0.091434455 | 1.495034709 | 0.546008728 |
| 8/1/08 | 18.84405602 | 0.099664693 | 1.854190889 | 0.541940874 |
| 9/1/08 | 19.20485567 | 0.089470189 | 2.152039204 | 0.535162372 |
| 10/1/08 | 21.12884756 | 0.08341212 | 2.470362327 | 0.532764329 |
| 11/1/08 | 21.82179349 | 0.085631164 | 2.766758575 | 0.528996687 |
| 12/1/08 | 21.17048095 | 0.074150267 | 2.637213746 | 0.527548447 |
| 13/1/08 | 21.94299465 | 0.115093121 | 2.104017319 | 0.526512039 |
| 14/1/08 | 22.39745656 | 0.161783542 | 1.232673326 | 0.533466473 |
| 15/1/08 | 21.13658932 | 0.162307894 | 1.123876795 | 0.544033997 |
| Mean | 19.32 | 0.13 | 1.54 | 0.54 |
| Converted Value | 19.32 | 1.28 | 111.13 | 988.48 |

Table A-27 The daily average meteorological data during day time in the late January 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/1/08 | 24.63062069 | 0.270016246 | 0.734261187 | 0.554129837 |
| 17/1/08 | 23.56768519 | 0.27255521 | 0.750996728 | 0.556702876 |
| 18/1/08 | 24.40764745 | 0.169360854 | 1.010895671 | 0.543242095 |
| 19/1/08 | 26.62099722 | 0.15688802 | 1.345514196 | 0.535247353 |
| 20/1/08 | 28.42202222 | 0.128042721 | 2.574390577 | 0.53339367 |
| 21/1/08 | 29.66653843 | 0.129121552 | 2.063717221 | 0.525733075 |
| 22/1/08 | 27.54510995 | 0.198031094 | 1.017821252 | 0.528154464 |
| 23/1/08 | 26.08075162 | 0.242693004 | 0.849220259 | 0.539575833 |
| 24/1/08 | 22.74428264 | 0.269958379 | 0.72684245 | 0.542070833 |
| 25/1/08 | 20.61370671 | 0.214043821 | 0.78402618 | 0.541406637 |
| 26/1/08 | 25.61505 | 0.167349156 | 0.975748424 | 0.538465536 |
| 27/1/08 | 26.55915556 | 0.188474188 | 1.031562436 | 0.538749046 |
| 28/1/08 | 28.24588657 | 0.141075224 | 2.480459119 | 0.529777065 |
| 29/1/08 | 29.44380741 | 0.176221499 | 3.4394667 | 0.525711098 |
| 30/1/08 | 29.67384838 | 0.147942345 | 3.081613499 | 0.525522674 |
| 31/1/08 | 28.97170856 | 0.181777839 | 1.650330018 | 0.529301432 |
| Mean | 26.43 | 0.19 | 1.53 | 0.54 |
| Converted Value | 26.43 | 1.91 | 110.33 | 987.34 |

Table A-28 The daily average meteorological data during night time in the late January 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/1/08 | 20.79885302 | 0.246317507 | 0.907262002 | 0.553232038 |
| 17/1/08 | 19.36115282 | 0.208066332 | 0.911306047 | 0.554314903 |
| 18/1/08 | 18.87178052 | 0.134966129 | 1.037361825 | 0.543912417 |
| 19/1/08 | 19.29603034 | 0.083625015 | 1.392188287 | 0.534923578 |
| 20/1/08 | 20.38457046 | 0.100918025 | 1.648125706 | 0.529931791 |
| 21/1/08 | 20.72732584 | 0.097496674 | 1.916076323 | 0.524915338 |
| 22/1/08 | 22.70633703 | 0.160850903 | 1.324083405 | 0.527802191 |
| 23/1/08 | 20.95390297 | 0.210517322 | 0.959476199 | 0.535888001 |
| 24/1/08 | 20.5120152 | 0.203764606 | 1.107157787 | 0.540534185 |
| 25/1/08 | 19.38843694 | 0.219090289 | 0.965846054 | 0.542461119 |
| 26/1/08 | 21.81971847 | 0.129623082 | 0.835626209 | 0.536866472 |
| 27/1/08 | 23.93892685 | 0.160965323 | 0.781015612 | 0.53460214 |
| 28/1/08 | 23.28621455 | 0.097335028 | 1.953109025 | 0.528904502 |
| 29/1/08 | 25.17565691 | 0.119812342 | 2.808999102 | 0.523540855 |
| 30/1/08 | 25.95497689 | 0.125813793 | 2.679004639 | 0.522134344 |
| 31/1/08 | 25.95777464 | 0.159989003 | 1.900137078 | 0.526593627 |
| Mean | 21.82 | 0.15 | 1.45 | 0.54 |
| Converted Value | 21.82 | 1.54 | 104.07 | 987.01 |

Table A-29 The daily average meteorological data during day time in the early February 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/2/08 | 25.74280694 | 0.151196771 | 1.509439691 | 0.528862507 |
| 2/2/08 | 24.17328472 | 0.226581916 | 0.806858097 | 0.533260745 |
| 3/2/08 | 20.1078125 | 0.208903571 | 0.741540834 | 0.537654612 |
| 4/2/08 | 21.30814213 | 0.18472286 | 1.089905646 | 0.537822868 |
| 5/2/08 | 23.92766319 | 0.144227903 | 1.059766553 | 0.542026082 |
| 6/2/08 | 28.14908426 | 0.188932508 | 0.977415172 | 0.536016084 |
| 7/2/08 | 26.6815 | 0.138315148 | 1.482924037 | 0.53387123 |
| 8/2/08 | 26.44659398 | 0.19878206 | 1.13428182 | 0.537346226 |
| 9/2/08 | 23.26167384 | 0.194326898 | 1.077732451 | 0.544464866 |
| 10/2/08 | 24.74586458 | 0.161877096 | 1.22267459 | 0.542006483 |
| 11/2/08 | 26.31300116 | 0.129616382 | 2.146832775 | 0.539515566 |
| 12/2/08 | 23.51831019 | 0.277267875 | 0.864014189 | 0.542010062 |
| 13/2/08 | 21.98606157 | 0.194414603 | 0.961371473 | 0.547956927 |
| 14/2/08 | 23.12233287 | 0.230715083 | 0.926899033 | 0.55357842 |
| 15/2/08 | 21.25573796 | 0.213517347 | 0.897038948 | 0.554490111 |
| Mean | 24.05 | 0.19 | 1.13 | 0.54 |
| Converted Value | 24.05 | 1.90 | 81.11 | 988.15 |

Table A-30 The daily average meteorological data during night time in the early February 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/2/08 | 23.93280969 | 0.165885276 | 1.194640393 | 0.527865668 |
| 2/2/08 | 21.83918325 | 0.215335355 | 0.764332952 | 0.53173686 |
| 3/2/08 | 19.18167863 | 0.196989651 | 0.733221431 | 0.533975981 |
| 4/2/08 | 19.48814129 | 0.156273526 | 0.771177073 | 0.534914782 |
| 5/2/08 | 20.50514772 | 0.073646741 | 1.639686658 | 0.536160729 |
| 6/2/08 | 22.7461266 | 0.102685392 | 1.244162078 | 0.530920274 |
| 7/2/08 | 22.32246879 | 0.138209781 | 1.383878304 | 0.527934469 |
| 8/2/08 | 22.67877223 | 0.154726212 | 1.369792836 | 0.531988086 |
| 9/2/08 | 20.53078244 | 0.165700903 | 0.970159263 | 0.539210824 |
| 10/2/08 | 20.84068949 | 0.148635925 | 1.070548494 | 0.538051777 |
| 11/2/08 | 22.25522254 | 0.128339928 | 1.334898032 | 0.536905907 |
| 12/2/08 | 21.64025993 | 0.231869033 | 1.038260521 | 0.539803155 |
| 13/2/08 | 19.81562113 | 0.194551564 | 0.784413743 | 0.546838161 |
| 14/2/08 | 20.03541874 | 0.214603188 | 0.866301992 | 0.552178386 |
| 15/2/08 | 18.76161845 | 0.197812581 | 0.848426779 | 0.553560956 |
| Mean | 21.10 | 0.17 | 1.07 | 0.54 |
| Converted Value | 21.10 | 1.66 | 76.87 | 987.49 |

Table A-31 The daily average meteorological data during day time in the late February 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/2/08 | 24.34566536 | 0.152495258 | 1.503690014 | 0.548475669 |
| 17/2/08 | 26.4566821 | 0.204852361 | 1.346781985 | 0.546811842 |
| 18/2/08 | 25.2490037 | 0.222640947 | 0.982649508 | 0.554028542 |
| 19/2/08 | 24.43678403 | 0.260264774 | 0.771750695 | 0.560259806 |
| 20/2/08 | 23.24007708 | 0.28480985 | 0.786990708 | 0.558988817 |
| 21/2/08 | 23.25341181 | 0.223272896 | 1.013678609 | 0.550871991 |
| 22/2/08 | 25.01451134 | 0.189812541 | 1.19123243 | 0.542684161 |
| 23/2/08 | 26.28257037 | 0.245373103 | 0.745122132 | 0.539273243 |
| 24/2/08 | 28.20987407 | 0.212491189 | 1.278095706 | 0.535197161 |
| 25/2/08 | 30.60923032 | 0.14981266 | 1.343337142 | 0.526331368 |
| 26/2/08 | 29.8545588 | 0.161555107 | 2.068890827 | 0.535269561 |
| 27/2/08 | 25.15995833 | 0.310389062 | 0.764455435 | 0.55134618 |
| 28/2/08 | 22.96657014 | 0.208989041 | 1.079558625 | 0.549782393 |
| 29/2/08 | 25.21737639 | 0.21194865 | 0.94104649 | 0.539964021 |
| Mean | 25.74 | 0.22 | 1.13 | 0.55 |
| Converted Value | 25.74 | 2.17 | 81.35 | 989.13 |

Table A-32 The daily average meteorological data during night time in the late February 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/2/08 | 20.60715679 | 0.141784682 | 1.157176326 | 0.546612186 |
| 17/2/08 | 22.97461869 | 0.129384129 | 1.333259674 | 0.544698392 |
| 18/2/08 | 22.67986784 | 0.209471168 | 0.89007796 | 0.55213527 |
| 19/2/08 | 20.88638136 | 0.240687028 | 0.761281299 | 0.558274357 |
| 20/2/08 | 19.76162639 | 0.269883624 | 0.816886539 | 0.559095452 |
| 21/2/08 | 18.33931639 | 0.163136952 | 0.97676899 | 0.550134057 |
| 22/2/08 | 19.02932293 | 0.125102665 | 1.065296421 | 0.540727801 |
| 23/2/08 | 21.25546473 | 0.098306912 | 1.065808391 | 0.536079732 |
| 24/2/08 | 24.22407687 | 0.111235725 | 1.612048263 | 0.530481544 |
| 25/2/08 | 24.80068407 | 0.079652981 | 1.983617156 | 0.524825977 |
| 26/2/08 | 25.66822337 | 0.110191093 | 2.710108522 | 0.531014909 |
| 27/2/08 | 24.38136248 | 0.246591143 | 0.901136754 | 0.547585643 |
| 28/2/08 | 20.54038668 | 0.186683092 | 0.782717552 | 0.548199288 |
| 29/2/08 | 21.94079824 | 0.172669411 | 0.780094201 | 0.539032561 |
| Mean | 21.93 | 0.16 | 1.20 | 0.54 |
| Converted Value | 21.93 | 1.63 | 86.59 | 988.70 |

Table A-33 The daily average meteorological data during day time in the early March 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/3/08 | 24.85695509 | 0.254096313 | 0.91834213 | 0.540157696 |
| 2/3/08 | 26.22777593 | 0.253819021 | 0.860577444 | 0.543473621 |
| 3/3/08 | 25.47282431 | 0.296429903 | 0.782881216 | 0.546200827 |
| 4/3/08 | 25.28630093 | 0.244393807 | 0.805873105 | 0.539947067 |
| 5/3/08 | 25.72809977 | 0.151355841 | 1.759601769 | 0.543351222 |
| 6/3/08 | 26.76750093 | 0.164235673 | 1.248488825 | 0.544685745 |
| 7/3/08 | 28.96787315 | 0.22423334 | 0.954104527 | 0.544450283 |
| 8/3/08 | 28.22971273 | 0.237944275 | 1.054343113 | 0.545278493 |
| 9/3/08 | 28.37776389 | 0.188289074 | 1.318813821 | 0.541649943 |
| 10/3/08 | 29.48469259 | 0.179042902 | 1.499048815 | 0.53411167 |
| 11/3/08 | 30.07768542 | 0.198147452 | 1.137873715 | 0.532297427 |
| 12/3/08 | 30.99436875 | 0.177299601 | 1.35862525 | 0.529862121 |
| 13/3/08 | 32.52665602 | 0.142373712 | 2.796036092 | 0.525994589 |
| 14/3/08 | 32.85758843 | 0.14359396 | 2.722543132 | 0.527990026 |
| 15/3/08 | 32.87818611 | 0.133845322 | 2.776739741 | 0.526763045 |
| Mean | 28.58 | 0.20 | 1.47 | 0.54 |
| Converted Value | 28.58 | 1.99 | 105.57 | 987.55 |

Table A-34 The daily average meteorological data during night time in the early March 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/3/08 | 20.77512233 | 0.188004515 | 0.94952123 | 0.53920599 |
| 2/3/08 | 21.84582907 | 0.195123297 | 0.999837455 | 0.541801191 |
| 3/3/08 | 20.43235813 | 0.232010343 | 1.018229726 | 0.543119667 |
| 4/3/08 | 20.54554027 | 0.187735313 | 0.901989204 | 0.539233581 |
| 5/3/08 | 20.70658728 | 0.17035486 | 0.930628524 | 0.541348504 |
| 6/3/08 | 22.35324085 | 0.167155052 | 0.924670386 | 0.54360403 |
| 7/3/08 | 24.76086317 | 0.149922388 | 1.093055159 | 0.541100536 |
| 8/3/08 | 24.06738638 | 0.157842011 | 1.382301861 | 0.54055013 |
| 9/3/08 | 23.45793141 | 0.143700683 | 1.247649004 | 0.537526505 |
| 10/3/08 | 24.6749225 | 0.149200904 | 1.066529949 | 0.532674897 |
| 11/3/08 | 24.80486164 | 0.112961602 | 1.010746392 | 0.52801143 |
| 12/3/08 | 26.86540881 | 0.13859248 | 1.275175598 | 0.524433395 |
| 13/3/08 | 27.87606054 | 0.106208149 | 2.122344802 | 0.522659423 |
| 14/3/08 | 27.96631136 | 0.10684177 | 3.205239133 | 0.523260196 |
| 15/3/08 | 28.21501868 | 0.098319181 | 2.791060961 | 0.521623086 |
| Mean | 23.96 | 0.15 | 1.39 | 0.53 |
| Converted Value | 23.96 | 1.54 | 100.41 | 986.94 |

Table A-35 The daily average meteorological data during day time in the late March 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/3/08 | 33.19885212 | 0.188276533 | 2.933837099 | 0.520889813 |
| 17/3/08 | 33.51508519 | 0.16746434 | 3.255129615 | 0.514086115 |
| 18/3/08 | 32.73513681 | 0.187807344 | 3.38303615 | 0.515565286 |
| 19/3/08 | 32.94426944 | 0.118982992 | 1.895192543 | 0.519927733 |
| 20/3/08 | 32.45014259 | 0.140917363 | 2.082049209 | 0.517564778 |
| 21/3/08 | 31.00547083 | 0.134722761 | 2.707364303 | 0.517628243 |
| 22/3/08 | 31.43277361 | 0.131642612 | 2.734946582 | 0.513931559 |
| 23/3/08 | 29.85264583 | 0.21389106 | 1.703692161 | 0.522215702 |
| 24/3/08 | 28.21911042 | 0.155732121 | 1.648288958 | 0.529952526 |
| 25/3/08 | 30.80781806 | 0.135365036 | 1.831442035 | 0.524936041 |
| 26/3/08 | 30.25057407 | 0.167802386 | 3.46480029 | 0.519047955 |
| 27/3/08 | 26.5568912 | 0.173892657 | 1.021731301 | 0.534597466 |
| 28/3/08 | 27.16614306 | 0.167370593 | 1.089317792 | 0.521173114 |
| 29/3/08 | 26.41362523 | 0.287783238 | 0.805980866 | 0.527275626 |
| 30/3/08 | 25.47003542 | 0.266403932 | 0.773635418 | 0.532872576 |
| 31/3/08 | 24.0711919 | 0.31900628 | 0.771514604 | 0.543746277 |
| Mean | 29.76 | 0.18 | 2.01 | 0.52 |
| Converted Value | 29.76 | 1.85 | 144.46 | 984.69 |

Table A-36 The daily average meteorological data during night time in the late March 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/3/08 | 28.33344522 | 0.113894994 | 3.005397563 | 0.517585331 |
| 17/3/08 | 28.51006272 | 0.136537127 | 3.129136612 | 0.513181069 |
| 18/3/08 | 28.1606118 | 0.180350401 | 2.998594491 | 0.510581474 |
| 19/3/08 | 27.84894002 | 0.133861661 | 2.331644417 | 0.513485918 |
| 20/3/08 | 27.45973217 | 0.202327006 | 1.980089881 | 0.539935302 |
| 21/3/08 | 23.98682265 | 0.293630604 | 2.115804918 | 0.590410516 |
| 22/3/08 | 25.14351704 | 0.245535013 | 2.791100341 | 0.517930235 |
| 23/3/08 | 24.78460526 | 0.131684378 | 2.216302626 | 0.522471281 |
| 24/3/08 | 24.74042073 | 0.147728078 | 0.876819989 | 0.528567312 |
| 25/3/08 | 26.1298677 | 0.099044448 | 2.051106254 | 0.525284949 |
| 26/3/08 | 24.91380987 | 0.13184935 | 2.846731866 | 0.521225457 |
| 27/3/08 | 20.07129391 | 0.091803495 | 1.380058753 | 0.530020743 |
| 28/3/08 | 20.33840102 | 0.082961286 | 1.591337455 | 0.522775941 |
| 29/3/08 | 21.17180264 | 0.180099792 | 1.025628839 | 0.526639941 |
| 30/3/08 | 20.95174765 | 0.196414836 | 0.972537989 | 0.53332069 |
| 31/3/08 | 20.53744627 | 0.294571878 | 0.880503916 | 0.54282927 |
| Mean | 24.56765792 | 0.166393397 | 2.012049744 | 0.528515339 |
| Converted Value | 24.57 | 1.66 | 144.87 | 985.70 |

Table A-37 The daily average meteorological data during day time in the early April 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/4/08 | 30.08605255 | 0.132461115 | 1.74067512 | 0.523426807 |
| 2/4/08 | 29.91866505 | 0.172149671 | 1.854053344 | 0.533341241 |
| 3/4/08 | 29.61324404 | 0.140399897 | 2.310209776 | 0.531906924 |
| 4/4/08 | 29.80117778 | 0.113696853 | 2.739368076 | 0.526558928 |
| 5/4/08 | 31.24928356 | 0.112025323 | 2.406384946 | 0.534307913 |
| 6/4/08 | 28.26605833 | 0.160725127 | 2.767448208 | 0.543022962 |
| 7/4/08 | 28.37130162 | 0.162682295 | 2.484823518 | 0.528871999 |
| 8/4/08 | 31.18522153 | 0.128257629 | 3.524829537 | 0.518692013 |
| 9/4/08 | 32.59040926 | 0.183510174 | 3.542939699 | 0.515463286 |
| 10/4/08 | 33.3636912 | 0.145500526 | 3.277101969 | 0.512629522 |
| 11/4/08 | 33.3112162 | 0.1595134 | 2.981504798 | 0.510220087 |
| 12/4/08 | 33.85544398 | 0.140551971 | 3.344525254 | 0.515863414 |
| 13/4/08 | 33.17676806 | 0.173370525 | 3.217679797 | 0.513619987 |
| 14/4/08 | 29.55036412 | 0.126127559 | 1.469997569 | 0.519205932 |
| 15/4/08 | 32.21285231 | 0.125715392 | 2.06101849 | 0.514998528 |
| Mean | 31.10 | 0.15 | 2.65 | 0.52 |
| Converted Value | 31.10 | 1.45 | 190.67 | 984.56 |

Table A-38 The daily average meteorological data during night time in the early April 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/4/08 | 25.84309641 | 0.091010499 | 2.294875278 | 0.526285185 |
| 2/4/08 | 24.49462998 | 0.139634444 | 2.865381975 | 0.533710154 |
| 3/4/08 | 22.74134949 | 0.085410141 | 2.622911043 | 0.532162866 |
| 4/4/08 | 25.12687305 | 0.094108871 | 2.282481667 | 0.525293409 |
| 5/4/08 | 25.66673039 | 0.08924824 | 2.095399466 | 0.531290821 |
| 6/4/08 | 25.72993001 | 0.123110853 | 2.855878055 | 0.536420171 |
| 7/4/08 | 24.39894534 | 0.111527836 | 2.092551006 | 0.530274635 |
| 8/4/08 | 26.47511072 | 0.090612267 | 2.708522267 | 0.516584566 |
| 9/4/08 | 28.16654005 | 0.122449453 | 3.101452969 | 0.511477098 |
| 10/4/08 | 28.76175378 | 0.135978753 | 3.083722344 | 0.510471868 |
| 11/4/08 | 28.95365204 | 0.140822662 | 3.021806805 | 0.506612453 |
| 12/4/08 | 28.45097653 | 0.08801316 | 2.725978484 | 0.51083018 |
| 13/4/08 | 26.67700853 | 0.149036085 | 2.668518455 | 0.51230262 |
| 14/4/08 | 25.76222506 | 0.099166871 | 1.129832863 | 0.513589078 |
| 15/4/08 | 25.53645841 | 0.094730713 | 2.935778485 | 0.512403541 |
| Mean | 26.19 | 0.11 | 2.57 | 0.52 |
| Converted Value | 26.19 | 1.10 | 184.73 | 984.13 |

Table A-39 The daily average meteorological data during day time in the late April 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/4/08 | 31.90392455 | 0.144043146 | 2.977785748 | 0.511553725 |
| 17/4/08 | 32.49883356 | 0.160547581 | 1.394564389 | 0.507692305 |
| 18/4/08 | 32.18680301 | 0.165953698 | 1.233476911 | 0.509103328 |
| 19/4/08 | 33.41421713 | 0.140602687 | 2.415545069 | 0.505584587 |
| 20/4/08 | 33.48467431 | 0.151142158 | 3.157605282 | 0.504527218 |
| 21/4/08 | 33.77616088 | 0.15303497 | 3.035279594 | 0.502560387 |
| 22/4/08 | 29.41486343 | 0.140126965 | 2.926635881 | 0.509960382 |
| 23/4/08 | 30.14417616 | 0.172210368 | 1.150692472 | 0.525420292 |
| 24/4/08 | 30.31522986 | 0.219170731 | 0.965517624 | 0.527798844 |
| 25/4/08 | 29.54129329 | 0.193074948 | 1.084823665 | 0.533694184 |
| 26/4/08 | no data | | | |
| 27/4/08 | no data | | | |
| 28/4/08 | 27.3826463 | 0.149555278 | 1.478170893 | 0.510059837 |
| 29/4/08 | 27.88826273 | 0.176953829 | 1.292331291 | 0.516686389 |
| 30/4/08 | 29.32932431 | 0.117208774 | 3.429400622 | 0.519490024 |
| Mean | 30.87 | 0.16 | 2.04 | 0.51 |
| Converted Value | 30.87 | 1.60 | 147.00 | 982.83 |

Table A-40 The daily average meteorological data during night time in the late April 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/4/08 | 26.24027512 | 0.075409162 | 2.864246483 | 0.508360295 |
| 17/4/08 | 27.47866486 | 0.084558984 | 1.726601449 | 0.503866737 |
| 18/4/08 | 27.67389 | 0.112707133 | 1.382257761 | 0.506121118 |
| 19/4/08 | 28.48561617 | 0.162464059 | 2.858994506 | 0.504363925 |
| 20/4/08 | 29.19708003 | 0.12742848 | 2.906528414 | 0.500989297 |
| 21/4/08 | 28.41881893 | 0.153520605 | 2.982324758 | 0.500700449 |
| 22/4/08 | 25.9314989 | 0.10519717 | 2.486781183 | 0.510347861 |
| 23/4/08 | 26.27079514 | 0.112246522 | 2.58284644 | 0.526652753 |
| 24/4/08 | 26.89429709 | 0.163612466 | 0.698267396 | 0.527246808 |
| 25/4/08 | 26.64936837 | 0.148971883 | 1.056153103 | 0.531098474 |
| 26/4/08 | no data | | | |
| 27/4/08 | no data | | | |
| 28/4/08 | 23.62161607 | 0.159159645 | 3.044433065 | 0.514745259 |
| 29/4/08 | 23.41336733 | 0.085329582 | 3.030610386 | 0.522992804 |
| 30/4/08 | 25.30597635 | 0.120854036 | 2.713785277 | 0.520920393 |
| Mean | 26.58 | 0.12 | 2.33 | 0.51 |
| Converted Value | 26.58 | 1.24 | 168.00 | 982.74 |

Table A-41 The daily average meteorological data during day time in the early May 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/5/08 | 28.04027731 | 0.203824456 | 3.032231535 | 0.510611426 |
| 2/5/08 | 28.44862569 | 0.215793016 | 3.208432007 | 0.501870285 |
| 3/5/07 | 29.80725787 | 0.264570099 | 2.736445708 | 0.500873202 |
| 4/5/08 | 27.90028588 | 0.253721857 | 2.953246717 | 0.509966748 |
| 5/5/08 | 30.14914329 | 0.163144401 | 3.160170754 | 0.506853858 |
| 6/5/08 | 30.98117222 | 0.18990023 | 3.575897178 | 0.50529017 |
| 7/5/08 | 30.66541019 | 0.185419799 | 3.303156716 | 0.506211438 |
| 8/5/08 | 31.41064051 | 0.194034975 | 3.584093177 | 0.505698428 |
| 9/5/08 | 31.67673356 | 0.222202794 | 3.52638573 | 0.500125927 |
| 10/5/08 | 29.15055301 | 0.181207909 | 2.594126731 | 0.498325598 |
| 11/5/08 | 26.88246852 | 0.188309821 | 0.869346447 | 0.506705409 |
| 12/5/08 | 26.83066458 | 0.215674307 | 1.163824169 | 0.50809164 |
| 13/5/08 | 24.91933264 | 0.181715178 | 1.705232952 | 0.517556248 |
| 14/5/08 | 25.34560787 | 0.092246458 | 2.27781329 | 0.517784754 |
| 15/5/08 | 27.51963519 | 0.126251675 | 1.182758341 | 0.517937489 |
| Mean | 28.65 | 0.19 | 2.59 | 0.51 |
| Converted Value | 28.65 | 1.92 | 186.59 | 981.52 |

Table A-42 The daily average meteorological data during night time in the early May 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 1/5/08 | 25.2584195 | 0.120019314 | 3.018062912 | 0.508636967 |
| 2/5/08 | 25.76681774 | 0.130484209 | 2.689042091 | 0.501107575 |
| 3/5/07 | 24.38510648 | 0.171442673 | 2.378092275 | 0.503312173 |
| 4/5/08 | 25.23814392 | 0.206368765 | 2.603174248 | 0.506540661 |
| 5/5/08 | 26.27047747 | 0.153742009 | 2.522009823 | 0.506915543 |
| 6/5/08 | 26.70960668 | 0.166358295 | 2.545536506 | 0.505124678 |
| 7/5/08 | 26.86560032 | 0.144564569 | 2.428121928 | 0.506432029 |
| 8/5/08 | 27.24143626 | 0.11291164 | 2.697905322 | 0.5044947 |
| 9/5/08 | 27.89569667 | 0.186848779 | 3.093777544 | 0.498826595 |
| 10/5/08 | 25.54062457 | 0.146522522 | 2.11295571 | 0.502413273 |
| 11/5/08 | 24.73371892 | 0.165470134 | 1.086583663 | 0.506956146 |
| 12/5/08 | 23.45936141 | 0.147173051 | 1.665274802 | 0.510623559 |
| 13/5/08 | 23.68764227 | 0.135908083 | 1.135353842 | 0.51588563 |
| 14/5/08 | 23.10983802 | 0.11022281 | 1.934015746 | 0.518974345 |
| 15/5/08 | 24.15366007 | 0.101443345 | 2.173883435 | 0.519172781 |
| Mean | 25.35 | 0.15 | 2.27 | 0.51 |
| Converted Value | 25.35 | 1.47 | 163.60 | 981.54 |

Table A-43 The daily average meteorological data during day time in the late May 2008

| Day Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/5/08 | 29.83481763 | 0.144206948 | 3.50194615 | 0.516617266 |
| 17/5/08 | 30.44807315 | 0.250950919 | 3.508524675 | 0.509078906 |
| 18/5/08 | 29.99868935 | 0.281676911 | 3.321178574 | 0.501757484 |
| 19/5/08 | 30.18396157 | 0.261944194 | 3.41713703 | 0.507029842 |
| 20/5/08 | 29.84807662 | 0.186138447 | 3.395087568 | 0.508854367 |
| 21/5/08 | 27.95532199 | 0.15090377 | 2.301364744 | 0.5083825 |
| 22/5/08 | 27.01878495 | 0.164348673 | 2.864025914 | 0.506599809 |
| 23/5/08 | 28.82860903 | 0.17965094 | 3.069539055 | 0.510422681 |
| 24/5/08 | 28.62941458 | 0.168019808 | 2.773586732 | 0.505642448 |
| 25/5/08 | 28.89741806 | 0.166236439 | 2.864952077 | 0.505354409 |
| 26/5/08 | 30.5956537 | 0.184280321 | 2.875410893 | 0.513958453 |
| 27/5/08 | 31.23061644 | 0.202855899 | 3.502647993 | 0.512480247 |
| 28/5/08 | 31.26179884 | 0.263846098 | 3.43745721 | 0.507741498 |
| 29/5/08 | 30.08044167 | 0.231583066 | 3.439667062 | 0.507439131 |
| 30/5/08 | no data | | | |
| 31/5/08 | no data | | | |
| Mean | 29.63 | 0.20 | 3.16 | 0.51 |
| Converted Value | 29.63 | 2.03 | 227.69 | 981.73 |

Table A-44 The daily average meteorological data during night time in the late May 2008

| Night Time | | | | |
|---|---|---|---|---|
| Date | Temperature | Wind Speed | Wind Direction | Air Pressure |
| 16/5/08 | 25.54096579 | 0.099836631 | 2.368188907 | 0.51690082 |
| 17/5/08 | 26.46325194 | 0.167650052 | 3.042564871 | 0.508281533 |
| 18/5/08 | 26.50345655 | 0.194409145 | 2.969604795 | 0.504036019 |
| 19/5/08 | 26.52879767 | 0.161374213 | 3.085393441 | 0.508557961 |
| 20/5/08 | 24.80445003 | 0.100227531 | 2.427862107 | 0.509455273 |
| 21/5/08 | 24.14421697 | 0.107882814 | 2.192666029 | 0.506506992 |
| 22/5/08 | 24.16253108 | 0.122104832 | 2.305256887 | 0.505533803 |
| 23/5/08 | 24.80076789 | 0.154604621 | 2.405282629 | 0.510000325 |
| 24/5/08 | 25.21833746 | 0.104628051 | 2.344787451 | 0.507148753 |
| 25/5/08 | 26.08773952 | 0.128626215 | 2.615943903 | 0.507263824 |
| 26/5/08 | 26.13036242 | 0.105869277 | 2.693687797 | 0.511979159 |
| 27/5/08 | 27.09895072 | 0.180954218 | 3.021886645 | 0.51005281 |
| 28/5/08 | 27.54542808 | 0.239254913 | 3.150951324 | 0.506504122 |
| 29/5/08 | 25.88677089 | 0.165924977 | 2.833751026 | 0.509353707 |
| 30/5/08 | no data | | | |
| 31/5/08 | no data | | | |
| Mean | 25.77971621 | 0.145239106 | 2.675559129 | 0.508683936 |
| Converted Value | 25.78 | 1.45 | 192.64 | 981.74 |

# APPENDIX B: Aerosol Combined Measurable Data

Table B-1 Limit of Quantification (LOQ) of Water Soluble Ion Concentration from July 2007 to May 2008

| sampling period | Filter No. | Limit of Quantification (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Jul.-1 2007 | 1/4～3/4 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 | 0.05 | 0.01 | 0.02 |
| | 4/4 | 0.1 | 0.05 | 0.05 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 |
| Jul.-2 2007 | 1/4～3/4 | 0.01 | 0.05 | 0.05 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |
| | 4/4 | 0.02 | 0.1 | 0.05 | 0.01 | 0.05 | 0.01 | 0.01 | 0.01 |
| Aug. 2007 | 1/4～3/4 | 0.05 | 0.1 | 0.01 | 0.1 | 0.05 | 0.02 | 0.01 | 0.02 |
| | 4/4 | 0.1 | 0.2 | 0.05 | 0.05 | 0.02 | 0.05 | 0.01 | 0.01 |
| Sep. 2007 | 1/4～3/4 | 0.05 | 0.02 | 0.1 | 0.05 | 0.02 | 0.01 | 0.01 | 0.02 |
| | 4/4 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |
| Oct. 2007 | 1/4～3/4 | 0.02 | 0.05 | 0.1 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| | 4/4 | 0.01 | 0.1 | 0.02 | 0.01 | 0.1 | 0.01 | 0.01 | 0.01 |
| Nov. 2007 | 1/4～3/4 | 0.02 | 0.1 | 0.05 | 0.01 | 0.05 | 0.02 | 0.02 | 0.05 |
| | 4/4 | 0.01 | 0.1 | 0.01 | 0.01 | 0.1 | 0.01 | 0.01 | 0.02 |
| Dec. 2007 | 1/4～3/4 | 0.02 | 0.01 | 0.01 | 0.1 | 0.05 | 0.01 | 0.01 | 0.01 |
| | 4/4 | 0.01 | 0.1 | 0.05 | 0.02 | 0.05 | 0.01 | 0.01 | 0.01 |
| Jan. 2008 | 1/4～3/4 | 0.02 | 0.02 | 0.1 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 |
| | 4/4 | 0.02 | 0.05 | 0.01 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 |
| Feb. 2008 | 1/4～3/4 | 0.01 | 0.05 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 |
| | 4/4 | 0.01 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mar. 2008 | 1/4～3/4 | 0.02 | 0.02 | 0.01 | 0.05 | 0.02 | 0.02 | 0.02 | 0.02 |
| | 4/4 | 0.1 | 0.05 | 0.1 | 0.05 | 0.02 | 0.05 | 0.02 | 0.02 |
| Apr. 2008 | 1/4～3/4 | 0.05 | 0.1 | 0.01 | 0.01 | 0.05 | 0.01 | 0.01 | 0.01 |
| | 4/4 | 0.01 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| May. 2008 | 1/4～3/4 | 0.01 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 4/4 | 0.01 | 0.05 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |

Table B-2 Water Soluble Ion Concentration Data from July 2007 to May 2008
(the green cells were the workable values because of LOQ)

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | m$^3$ | Cl$^-$ | NO$^{3-}$ | SO$_4^{2-}$ | Na$^+$ | NH$_4^+$ | K$^+$ | Mg$^{2+}$ | Ca$^{2+}$ |
| July-1 2007 | 12.975 | 0.02 | 0.04 | 0.56 | -0.01 | 0.20 | 0.06 | 0.00 | 0.03 |
| | 15.570 | 0.01 | 0.03 | 0.81 | 0.00 | 0.27 | 0.07 | 0.00 | 0.05 |
| | 13.075 | 0.00 | 0.03 | 0.45 | -0.01 | 0.18 | 0.04 | 0.00 | 0.03 |
| | 15.616 | 0.00 | 0.05 | 0.76 | 0.03 | 0.24 | 0.06 | 0.00 | 0.05 |
| | 13.041 | 0.00 | 0.07 | 1.18 | 0.00 | 0.43 | 0.11 | 0.00 | 0.04 |
| | 15.647 | 0.01 | 0.04 | 0.59 | 0.00 | 0.22 | 0.04 | 0.00 | 0.05 |
| July-2 2007 | 15.520 | 0.02 | 0.06 | 1.74 | 0.06 | 0.52 | 0.11 | 0.02 | 0.14 |
| | 13.214 | 0.00 | 0.03 | 1.72 | 0.03 | 0.55 | 0.12 | 0.01 | 0.09 |
| | 15.504 | 0.01 | 0.05 | 1.95 | 0.06 | 0.60 | 0.09 | 0.02 | 0.11 |
| | 12.981 | 0.01 | 0.02 | 1.47 | 0.03 | 0.47 | 0.09 | 0.01 | 0.05 |
| | 15.505 | 0.01 | 0.04 | 1.81 | 0.06 | 0.56 | 0.11 | 0.01 | 0.09 |
| | 13.252 | 0.01 | 0.03 | 1.11 | 0.02 | 0.39 | 0.05 | 0.00 | 0.03 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | m$^3$ | Cl$^-$ | NO$^{3-}$ | SO$_4^{2-}$ | Na$^+$ | NH$_4^+$ | K$^+$ | Mg$^{2+}$ | Ca$^{2+}$ |
| July-1 2007 | 12.975 | 0.02 | 0.12 | 0.23 | 0.06 | 0.04 | 0.02 | 0.01 | 0.09 |
| | 15.570 | 0.05 | 0.31 | 0.35 | 0.09 | 0.06 | 0.02 | 0.02 | 0.14 |
| | 13.075 | 0.01 | 0.09 | 0.21 | 0.03 | 0.04 | 0.02 | 0.01 | 0.07 |
| | 15.616 | 0.02 | 0.47 | 0.42 | 0.07 | 0.08 | 0.02 | 0.02 | 0.21 |
| | 13.041 | 0.02 | 0.21 | 0.41 | 0.04 | 0.11 | 0.02 | 0.01 | 0.12 |
| | 15.647 | 0.01 | 0.25 | 0.26 | 0.03 | 0.06 | 0.01 | 0.01 | 0.14 |
| July-2 2007 | 15.520 | 0.10 | 0.26 | 0.24 | 0.10 | 0.01 | 0.01 | 0.03 | 0.15 |
| | 13.214 | 0.09 | 0.29 | 0.32 | 0.12 | 0.02 | 0.02 | 0.03 | 0.15 |
| | 15.504 | 0.11 | 0.42 | 0.27 | 0.16 | 0.01 | 0.01 | 0.03 | 0.16 |
| | 12.981 | 0.07 | 0.33 | 0.25 | 0.12 | 0.02 | 0.02 | 0.02 | 0.12 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 15.505 | 0.09 | 0.36 | 0.31 | 0.11 | 0.02 | 0.02 | 0.04 | 0.19 |
| | 13.252 | 0.02 | 0.17 | 0.16 | 0.07 | 0.01 | 0.01 | 0.01 | 0.05 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| July-1 2007 | 12.975 | 0.13 | 0.38 | 0.16 | 0.10 | 0.00 | 0.02 | 0.02 | 0.29 |
| | 15.570 | 0.17 | 0.81 | 0.22 | 0.16 | 0.01 | 0.01 | 0.03 | 0.44 |
| | 13.075 | 0.08 | 0.45 | 0.11 | 0.06 | 0.01 | 0.02 | 0.02 | 0.24 |
| | 15.616 | 0.17 | 1.68 | 0.26 | 0.13 | 0.01 | 0.02 | 0.04 | 0.81 |
| | 13.041 | 0.13 | 1.24 | 0.24 | 0.08 | 0.04 | 0.01 | 0.04 | 0.58 |
| | 15.647 | 0.08 | 0.90 | 0.22 | 0.07 | 0.02 | 0.01 | 0.03 | 0.55 |
| July-2 2007 | 15.520 | 0.41 | 0.90 | 0.26 | 0.33 | 0.01 | 0.02 | 0.05 | 0.45 |
| | 13.214 | 0.34 | 1.00 | 0.28 | 0.34 | 0.01 | 0.03 | 0.05 | 0.34 |
| | 15.504 | 0.53 | 1.25 | 0.36 | 0.44 | 0.01 | 0.02 | 0.07 | 0.57 |
| | 12.981 | 0.32 | 0.79 | 0.23 | 0.27 | 0.01 | 0.03 | 0.04 | 0.31 |
| | 15.505 | 0.69 | 1.79 | 0.42 | 0.57 | 0.01 | 0.04 | 0.09 | 0.72 |
| | 13.252 | 0.08 | 0.31 | 0.10 | 0.10 | 0.01 | 0.01 | 0.01 | 0.08 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| July-1 2007 | 12.975 | 0.03 | 0.06 | 0.02 | 0.02 | 0.002 | 0.003 | 0.005 | 0.12 |
| | 15.570 | 0.02 | 0.07 | 0.04 | 0.03 | 0.0001 | 0.006 | 0.005 | 0.14 |
| | 13.075 | 0.02 | 0.06 | 0.01 | 0.01 | 0.002 | 0.007 | 0.004 | 0.10 |
| | 15.616 | 0.03 | 0.12 | 0.03 | 0.01 | 0.003 | 0.004 | 0.006 | 0.18 |
| | 13.041 | 0.02 | 0.12 | 0.05 | 0.01 | 0.02 | 0.001 | 0.008 | 0.14 |
| | 15.647 | 0.02 | 0.09 | 0.03 | 0.003 | 0.02 | 0 | 0.006 | 0.16 |
| July-2 2007 | 15.520 | 0.09 | 0.07 | 0.04 | 0.05 | 0.002 | 0.004 | 0.007 | 0.12 |
| | 13.214 | 0.12 | 0.11 | 0.06 | 0.07 | 0.002 | 0.008 | 0.01 | 0.10 |
| | 15.504 | 0.13 | 0.09 | 0.07 | 0.07 | 0.003 | 0.005 | 0.01 | 0.15 |
| | 12.981 | 0.07 | 0.07 | 0.03 | 0.04 | 0 | 0.008 | 0.009 | 0.10 |
| | 15.505 | 0.19 | 0.17 | 0.08 | 0.11 | 0.002 | 0.008 | 0.01 | 0.22 |
| | 13.252 | 0.009 | 0.02 | 0.02 | 0.005 | 0.001 | 0.004 | 0.001 | 0.02 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Aug.-1 2007 | 10.481 | 0.02 | 0.07 | 0.80 | 0.01 | 0.26 | 0.05 | 0.01 | 0.10 |
| | 13.310 | 0.00 | 0.04 | 1.16 | 0.02 | 0.36 | 0.12 | 0.01 | 0.06 |
| | 15.226 | 0.00 | 0.06 | 1.50 | 0.04 | 0.47 | 0.12 | 0.01 | 0.06 |
| | 13.293 | 0.00 | 0.04 | 0.90 | 0.02 | 0.29 | 0.09 | 0.00 | 0.05 |
| | 15.150 | 0.00 | 0.05 | 0.90 | 0.03 | 0.30 | 0.07 | 0.01 | 0.06 |
| | 13.371 | 0.00 | 0.04 | 0.58 | 0.01 | 0.16 | 0.15 | 0.00 | 0.05 |
| Aug.-2 2007 | 14.967 | 0.00 | 0.03 | 1.42 | 0.02 | 0.47 | 0.11 | 0.01 | 0.05 |
| | 13.660 | 0.00 | 0.11 | 2.36 | 0.02 | 0.82 | 0.16 | 0.00 | 0.03 |
| | 15.018 | 0.00 | 0.03 | 1.28 | 0.02 | 0.43 | 0.11 | 0.00 | 0.04 |
| | 13.643 | 0.00 | 0.02 | 1.67 | 0.01 | 0.58 | 0.12 | 0.00 | 0.03 |
| | 15.173 | 0.00 | 0.04 | 1.27 | 0.01 | 0.44 | 0.08 | 0.00 | 0.04 |
| | 13.589 | -0.01 | 0.05 | 2.49 | 0.02 | 0.89 | 0.09 | 0.00 | 0.02 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Aug.-1 2007 | 10.481 | 0.03 | 0.31 | 0.14 | 0.07 | 0.01 | 0.00 | 0.01 | 0.10 |
| | 13.310 | 0.09 | 0.34 | 0.22 | 0.14 | 0.02 | 0.01 | 0.02 | 0.10 |
| | 15.226 | 0.13 | 0.59 | 0.22 | 0.26 | 0.01 | 0.01 | 0.03 | 0.10 |
| | 13.293 | 0.07 | 0.29 | 0.16 | 0.14 | 0.01 | 0.01 | 0.02 | 0.07 |
| | 15.150 | 0.08 | 0.23 | 0.12 | 0.13 | 0.00 | 0.01 | 0.01 | 0.05 |
| | 13.371 | 0.03 | 0.22 | 0.12 | 0.08 | 0.01 | 0.01 | 0.01 | 0.06 |
| Aug.-2 2007 | 14.967 | 0.01 | 0.32 | 0.18 | 0.08 | 0.02 | 0.01 | 0.01 | 0.08 |
| | 13.660 | 0.01 | 0.23 | 0.31 | 0.11 | 0.05 | 0.01 | 0.02 | 0.07 |
| | 15.018 | 0.01 | 0.27 | 0.14 | 0.09 | 0.01 | 0.01 | 0.01 | 0.05 |
| | 13.643 | 0.01 | 0.16 | 0.16 | 0.07 | 0.02 | 0.01 | 0.01 | 0.04 |
| | 15.173 | 0.01 | 0.21 | 0.13 | 0.08 | 0.01 | 0.01 | 0.01 | 0.03 |
| | 13.589 | 0.01 | 0.14 | 0.19 | 0.06 | 0.05 | 0.01 | 0.01 | 0.03 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Aug.-1 2007 | 10.481 | 0.13 | 0.40 | 0.13 | 0.12 | 0.00 | 0.00 | 0.02 | 0.18 |
| | 13.310 | 0.48 | 0.86 | 0.25 | 0.40 | 0.01 | 0.01 | 0.05 | 0.31 |
| | 15.226 | 1.00 | 1.19 | 0.35 | 0.75 | 0.01 | 0.02 | 0.09 | 0.40 |
| | 13.293 | 0.22 | 0.38 | 0.14 | 0.20 | 0.01 | 0.01 | 0.03 | 0.15 |
| | 15.150 | 0.41 | 0.37 | 0.16 | 0.28 | 0.01 | 0.01 | 0.03 | 0.15 |
| | 13.371 | 0.12 | 0.48 | 0.10 | 0.11 | 0.01 | 0.01 | 0.02 | 0.30 |
| Aug.-2 2007 | 14.967 | 0.08 | 0.72 | 0.16 | 0.11 | 0.01 | 0.01 | 0.02 | 0.29 |
| | 13.660 | 0.18 | 1.06 | 0.25 | 0.27 | 0.02 | 0.03 | 0.04 | 0.28 |
| | 15.018 | 0.05 | 0.47 | 0.10 | 0.11 | 0.00 | 0.01 | 0.02 | 0.17 |
| | 13.643 | 0.04 | 0.40 | 0.10 | 0.11 | 0.01 | 0.01 | 0.01 | 0.09 |
| | 15.173 | 0.05 | 0.32 | 0.07 | 0.10 | 0.01 | 0.01 | 0.01 | 0.09 |
| | 13.589 | 0.05 | 0.42 | 0.11 | 0.11 | 0.02 | 0.02 | 0.02 | 0.08 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Aug.-1 2007 | 10.481 | 0.02 | 0.01 | 0.02 | 0.005 | 0.003 | 0.001 | 0.001 | 0.03 |
| | 13.310 | 0.12 | 0.04 | 0.04 | 0.05 | 0.004 | 0.002 | 0.004 | 0.10 |
| | 15.226 | 0.26 | 0.08 | 0.07 | 0.1 | 0.004 | 0.004 | 0.01 | 0.11 |
| | 13.293 | 0.04 | 0.02 | 0.02 | 0.02 | 0.003 | 0.002 | 0.002 | 0.06 |
| | 15.150 | 0.07 | 0.04 | 0.03 | 0.04 | 0.003 | 0.002 | 0.003 | 0.05 |
| | 13.371 | 0.03 | 0.05 | 0.03 | 0.008 | 0.000 | 0.002 | 0.002 | 0.16 |
| Aug.-2 2007 | 14.967 | 0.01 | 0.03 | 0.02 | 0.001 | 0.002 | 0.001 | 0.0003 | 0.06 |
| | 13.660 | 0.07 | 0.2 | 0.05 | 0.03 | 0.001 | 0.003 | 0.004 | 0.14 |
| | 15.018 | 0.01 | 0.03 | 0.02 | 0.003 | 0.003 | 0.001 | 0.0004 | 0.05 |
| | 13.643 | 0.01 | 0.05 | 0.02 | 0.007 | 0.002 | 0.002 | 0.00001 | 0.03 |
| | 15.173 | 0.02 | 0.03 | 0.01 | 0.005 | 0.005 | 0.001 | 0.0007 | 0.04 |
| | 13.589 | 0.03 | 0.1 | 0.03 | 0.03 | 0.002 | 0.002 | 0.002 | 0.05 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Sep.-1 2007 | 13.535 | 0.00 | 0.05 | 0.67 | 0.01 | 0.26 | 0.02 | 0.00 | 0.01 |
| | 14.555 | 0.00 | 0.01 | 1.97 | 0.01 | 0.72 | 0.05 | 0.00 | 0.01 |
| | 13.718 | 0.00 | 0.01 | 0.44 | 0.01 | 0.15 | 0.08 | 0.00 | 0.00 |
| | 14.583 | 0.01 | 0.02 | 2.36 | 0.01 | 0.85 | 0.11 | 0.00 | 0.02 |
| | 13.737 | 0.00 | 0.10 | 2.18 | 0.01 | 0.81 | 0.10 | 0.00 | 0.01 |
| | 14.836 | 0.01 | 0.05 | 0.73 | 0.02 | 0.26 | 0.12 | 0.00 | 0.02 |
| Sep.-2 2007 | 13.556 | 0.01 | 0.02 | 0.24 | 0.01 | 0.09 | 0.03 | 0.00 | 0.01 |
| | 14.398 | 0.00 | 0.02 | 0.54 | 0.01 | 0.21 | 0.05 | 0.00 | 0.01 |
| | 14.297 | 0.00 | 0.07 | 0.40 | 0.00 | 0.14 | 0.05 | 0.00 | 0.01 |
| | 14.351 | 0.00 | 0.02 | 1.97 | 0.01 | 0.71 | 0.10 | 0.00 | 0.01 |
| | 14.337 | 0.01 | 0.12 | 1.58 | 0.01 | 0.58 | 0.15 | 0.00 | 0.01 |
| | 14.416 | 0.00 | 0.03 | 1.90 | 0.02 | 0.68 | 0.15 | 0.00 | 0.01 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Sep.-1 2007 | 13.535 | 0.00 | 0.01 | 0.10 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 |
| | 14.555 | 0.00 | 0.04 | 0.17 | 0.06 | 0.03 | 0.00 | 0.00 | 0.00 |
| | 13.718 | 0.01 | 0.01 | 0.07 | 0.04 | 0.00 | 0.01 | 0.00 | 0.01 |
| | 14.583 | 0.00 | 0.07 | 0.24 | 0.07 | 0.05 | 0.01 | 0.00 | 0.01 |
| | 13.737 | 0.00 | 0.04 | 0.45 | 0.04 | 0.13 | 0.02 | 0.01 | 0.04 |
| | 14.836 | 0.00 | 0.01 | 0.05 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 |
| Sep.-2 2007 | 13.556 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| | 14.398 | 0.00 | 0.09 | 0.02 | 0.01 | 0.00 | 0.01 | 0.00 | 0.03 |
| | 14.297 | 0.01 | 0.04 | 0.09 | 0.00 | 0.02 | 0.03 | 0.00 | 0.01 |
| | 14.351 | 0.00 | 0.08 | 0.19 | 0.05 | 0.04 | 0.01 | 0.01 | 0.02 |
| | 14.337 | 0.02 | 0.11 | 0.39 | 0.02 | 0.10 | 0.05 | 0.01 | 0.03 |
| | 14.416 | 0.00 | 0.11 | 0.26 | 0.04 | 0.05 | 0.04 | 0.01 | 0.02 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Sep.-1 2007 | 13.535 | 0.03 | 0.05 | 0.03 | 0.04 | -0.01 | 0.06 | 0.01 | 0.01 |
| | 14.555 | 0.05 | 0.28 | 0.08 | 0.13 | 0.00 | 0.03 | 0.01 | 0.02 |
| | 13.718 | 0.07 | 0.15 | 0.04 | 0.09 | -0.02 | 0.05 | 0.01 | 0.03 |
| | 14.583 | 0.07 | 0.40 | 0.13 | 0.17 | 0.00 | 0.03 | 0.02 | 0.07 |
| | 13.737 | 0.04 | 0.23 | 0.08 | 0.06 | 0.00 | 0.05 | 0.01 | 0.06 |
| | 14.836 | 0.01 | 0.04 | 0.03 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 |
| Sep.-2 2007 | 13.556 | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.06 | 0.00 | 0.01 |
| | 14.398 | 0.01 | 0.23 | 0.04 | 0.01 | 0.00 | 0.02 | 0.01 | 0.10 |
| | 14.297 | 0.04 | 0.05 | 0.03 | 0.01 | 0.00 | 0.05 | 0.01 | 0.05 |
| | 14.351 | 0.04 | 0.23 | 0.09 | 0.10 | 0.00 | 0.02 | 0.01 | 0.05 |
| | 14.337 | 0.08 | 0.22 | 0.09 | 0.07 | 0.00 | 0.06 | 0.02 | 0.12 |
| | 14.416 | 0.05 | 0.64 | 0.12 | 0.09 | 0.01 | 0.04 | 0.02 | 0.20 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Sep.-1 2007 | 13.535 | 0.01 | 0.01 | 0.02 | 0.02 | 0 | 0.01 | 0.002 | 0.008 |
| | 14.555 | 0.02 | 0.03 | 0.03 | 0.04 | 0 | 0.005 | 0.002 | 0.009 |
| | 13.718 | 0.02 | 0.02 | 0.02 | 0.03 | 0 | 0.01 | 0.004 | 0.02 |
| | 14.583 | 0.03 | 0.04 | 0.07 | 0.04 | 0 | 0.006 | 0.005 | 0.05 |
| | 13.737 | 0.02 | 0.11 | 0.03 | 0.03 | 0 | 0.01 | 0.007 | 0.10 |
| | 14.836 | 0.007 | 0.01 | 0.01 | 0.003 | 5.E-05 | 0.003 | 0.002 | 0.03 |
| Sep.-2 2007 | 13.556 | 0.005 | 0 | 0.02 | 0.002 | 0 | 0.01 | 0.001 | 0.01 |
| | 14.398 | 0.009 | 0.04 | 0.02 | 0.003 | 0.0004 | 0.005 | 0.003 | 0.05 |
| | 14.297 | 0.01 | 0.004 | 0.01 | 0.004 | 0 | 0.01 | 0.003 | 0.02 |
| | 14.351 | 0.01 | 0.03 | 0.04 | 0.02 | 0.006 | 0.005 | 0.004 | 0.02 |
| | 14.337 | 0.04 | 0.05 | 0.05 | 0.02 | 0 | 0.03 | 0.01 | 0.13 |
| | 14.416 | 0.03 | 0.18 | 0.04 | 0.01 | 0.0002 | 0.02 | 0.008 | 0.16 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Oct.-1 2007 | No data | | | | | | | | |
| | 14.071 | 0.00 | 0.02 | 6.90 | 0.02 | 2.51 | 0.25 | 0.00 | 0.02 |
| | 14.615 | 0.00 | 0.03 | 3.34 | 0.01 | 1.12 | 0.10 | 0.00 | 0.00 |
| | 14.079 | 0.00 | 0.01 | 4.74 | 0.01 | 1.64 | 0.17 | 0.00 | 0.01 |
| | 14.664 | 0.00 | 0.02 | 6.32 | 0.02 | 2.10 | 0.19 | 0.00 | 0.01 |
| | No data | | | | | | | | |
| Oct.-2 2007 | 13.631 | 0.01 | 0.02 | 14.32 | 0.06 | 4.69 | 0.63 | 0.01 | 0.03 |
| | 14.322 | 0.01 | 0.01 | 7.84 | 0.04 | 2.79 | 0.28 | 0.01 | 0.03 |
| | 14.379 | 0.01 | 0.04 | 4.63 | 0.02 | 1.63 | 0.19 | 0.00 | 0.01 |
| | 13.836 | 0.01 | 0.01 | 3.57 | 0.04 | 1.23 | 0.12 | 0.00 | 0.02 |
| | 14.857 | 0.01 | 0.03 | 5.45 | 0.03 | 2.05 | 0.19 | 0.00 | 0.03 |
| | 13.857 | 0.01 | 0.03 | 13.30 | 0.05 | 4.66 | 0.47 | 0.01 | 0.04 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Oct.-1 2007 | No data | | | | | | | | |
| | 14.071 | 0.00 | 0.05 | 2.32 | 0.03 | 0.75 | 0.09 | 0.01 | 0.02 |
| | 14.615 | 0.00 | 0.01 | 0.81 | 0.00 | 0.29 | 0.02 | 0.00 | 0.01 |
| | 14.079 | 0.00 | 0.00 | 1.22 | 0.01 | 0.42 | 0.03 | 0.00 | 0.01 |
| | 14.664 | 0.00 | 0.01 | 2.21 | 0.02 | 0.72 | 0.04 | 0.01 | 0.02 |
| | No data | | | | | | | | |
| Oct.-2 2007 | 13.631 | 0.01 | 0.27 | 4.18 | 0.15 | 1.25 | 0.17 | 0.03 | 0.06 |
| | 14.322 | 0.00 | 0.18 | 1.57 | 0.22 | 0.38 | 0.06 | 0.02 | 0.04 |
| | 14.379 | 0.01 | 0.13 | 1.15 | 0.11 | 0.28 | 0.04 | 0.03 | 0.03 |
| | 13.836 | 0.10 | 0.25 | 0.66 | 0.27 | 0.11 | 0.02 | 0.02 | 0.02 |
| | 14.857 | 0.03 | 0.19 | 2.00 | 0.14 | 0.62 | 0.03 | 0.02 | 0.03 |
| | 13.857 | 0.01 | 0.11 | 5.35 | 0.16 | 1.76 | 0.15 | 0.06 | 0.06 |

| sampling | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| period | PC | 10>d>2.5 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Oct.-1 2007 | No data | | | | | | | | |
| | 14.071 | 0.01 | 0.19 | 0.18 | 0.05 | 0.03 | 0.03 | 0.01 | 0.03 |
| | 14.615 | 0.00 | 0.02 | 0.14 | 0.01 | 0.03 | 0.02 | 0.00 | 0.01 |
| | 14.079 | 0.00 | 0.05 | 0.24 | 0.01 | 0.08 | 0.01 | 0.00 | 0.01 |
| | 14.664 | 0.01 | 0.12 | 0.28 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 |
| | No data | | | | | | | | |
| Oct.-2 2007 | 13.631 | 0.15 | 1.27 | 0.51 | 0.48 | 0.04 | 0.04 | 0.06 | 0.18 |
| | 14.322 | 0.49 | 1.41 | 0.40 | 0.77 | 0.03 | 0.04 | 0.08 | 0.11 |
| | 14.379 | 0.25 | 0.82 | 0.24 | 0.41 | 0.02 | 0.04 | 0.05 | 0.07 |
| | 13.836 | 0.79 | 0.72 | 0.30 | 0.70 | 0.01 | 0.03 | 0.07 | 0.06 |
| | 14.857 | 0.35 | 0.88 | 0.38 | 0.51 | 0.03 | 0.04 | 0.06 | 0.07 |
| | 13.857 | 0.11 | 1.29 | 0.49 | 0.49 | 0.04 | 0.04 | 0.07 | 0.13 |

| sampling | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| period | PC | d>10 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Oct.-1 2007 | No data | | | | | | | | |
| | 14.071 | 0.04 | 0.06 | 0.06 | 0.03 | 0.01 | 0.02 | 0.001 | 0.01 |
| | 14.615 | 0.01 | 0.01 | 0.04 | 0.008 | 0.02 | 0.006 | 0.001 | 0.009 |
| | 14.079 | 0.004 | 0 | 0.04 | 0.001 | 0.02 | 0.003 | 0 | 0.004 |
| | 14.664 | 0.01 | 0.03 | 0.05 | 0.02 | 0.02 | 0.003 | 0.0006 | 0.008 |
| | No data | | | | | | | | |
| Oct.-2 2007 | 13.631 | 0.06 | 0.27 | 0.07 | 0.09 | 0.0005 | 0.01 | 0.01 | 0.05 |
| | 14.322 | 0.14 | 0.24 | 0.07 | 0.13 | 0.01 | 0.009 | 0.01 | 0.05 |
| | 14.379 | 0.07 | 0.14 | 0.04 | 0.08 | 0 | 0.008 | 0.007 | 0.03 |
| | 13.836 | 0.12 | 0.06 | 0.04 | 0.08 | 0.002 | 0.007 | 0.006 | 0.02 |
| | 14.857 | 0.13 | 0.22 | 0.1 | 0.14 | 0.002 | 0.01 | 0.01 | 0.03 |
| | 13.857 | 0.06 | 0.27 | 0.07 | 0.10 | 0.004 | 0.009 | 0.01 | 0.04 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Nov.-1 2007 | 15.046 | 0.01 | 0.03 | 3.51 | 0.02 | 1.25 | 0.19 | 0.00 | 0.02 |
| | 13.840 | 0.01 | 0.01 | 2.16 | 0.02 | 0.77 | 0.09 | 0.00 | 0.02 |
| | 14.880 | 0.00 | 0.01 | 2.46 | 0.02 | 0.87 | 0.10 | 0.00 | 0.01 |
| | 13.640 | 0.01 | 0.01 | 3.29 | 0.06 | 1.14 | 0.10 | 0.01 | 0.03 |
| | 15.096 | 0.01 | 0.05 | 3.50 | 0.03 | 1.34 | 0.15 | 0.00 | 0.02 |
| | 13.658 | 0.01 | 0.04 | 4.36 | 0.06 | 1.59 | 0.16 | 0.01 | 0.03 |
| Nov.-2 2007 | 12.844 | 0.02 | 0.12 | 14.34 | 0.08 | 5.07 | 0.99 | 0.03 | 0.17 |
| | 13.462 | 0.02 | 0.17 | 16.05 | 0.12 | 5.72 | 0.96 | 0.05 | 0.16 |
| | 15.183 | 0.01 | 0.08 | 13.11 | 0.08 | 4.76 | 0.91 | 0.03 | 0.08 |
| | 13.445 | 0.02 | 0.15 | 11.42 | 0.12 | 3.88 | 0.67 | 0.06 | 0.20 |
| | No data | | | | | | | | |
| | 13.490 | 0.02 | 0.03 | 12.55 | 0.08 | 4.34 | 0.96 | 0.03 | 0.10 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Nov.-1 2007 | 15.046 | 0.05 | 0.16 | 0.92 | 0.12 | 0.27 | 0.05 | 0.02 | 0.03 |
| | 13.840 | 0.02 | 0.13 | 0.31 | 0.12 | 0.04 | 0.01 | 0.01 | 0.02 |
| | 14.880 | 0.18 | 0.23 | 0.39 | 0.22 | 0.07 | 0.02 | 0.02 | 0.03 |
| | 13.640 | 0.23 | 0.35 | 0.35 | 0.34 | 0.03 | 0.02 | 0.03 | 0.03 |
| | 15.096 | 0.09 | 0.27 | 0.60 | 0.22 | 0.11 | 0.03 | 0.03 | 0.03 |
| | 13.658 | 0.09 | 0.32 | 0.42 | 0.28 | 0.05 | 0.02 | 0.03 | 0.02 |
| Nov.-2 2007 | 12.844 | 0.04 | 0.25 | 1.70 | 0.07 | 0.50 | 0.09 | 0.03 | 0.14 |
| | 13.462 | 0.05 | 0.29 | 3.64 | 0.10 | 1.05 | 0.16 | 0.06 | 0.23 |
| | 15.183 | 0.04 | 0.38 | 3.95 | 0.09 | 1.23 | 0.17 | 0.06 | 0.21 |
| | 13.445 | 0.01 | 0.32 | 1.83 | 0.10 | 0.45 | 0.07 | 0.05 | 0.22 |
| | No data | | | | | | | | |
| | 13.490 | 0.05 | 0.25 | 2.34 | 0.12 | 0.61 | 0.13 | 0.05 | 0.19 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Nov.-1 2007 | 15.046 | 0.15 | 0.41 | 0.20 | 0.24 | 0.00 | 0.01 | 0.02 | 0.05 |
| | 13.840 | 0.24 | 0.28 | 0.16 | 0.25 | 0.01 | 0.01 | 0.02 | 0.03 |
| | 14.880 | 0.75 | 0.57 | 0.23 | 0.62 | 0.01 | 0.02 | 0.07 | 0.06 |
| | 13.640 | 1.30 | 0.92 | 0.36 | 1.06 | 0.01 | 0.04 | 0.11 | 0.07 |
| | 15.096 | 0.73 | 0.94 | 0.30 | 0.74 | 0.02 | 0.03 | 0.09 | 0.06 |
| | 13.658 | 0.81 | 1.13 | 0.31 | 0.85 | 0.01 | 0.03 | 0.09 | 0.06 |
| Nov.-2 2007 | 12.844 | 0.16 | 0.90 | 0.35 | 0.20 | 0.05 | 0.03 | 0.06 | 0.36 |
| | 13.462 | 0.21 | 2.61 | 0.87 | 0.38 | 0.10 | 0.04 | 0.13 | 0.87 |
| | 15.183 | 0.36 | 2.05 | 1.07 | 0.33 | 0.13 | 0.05 | 0.14 | 0.89 |
| | 13.445 | 0.43 | 2.52 | 0.93 | 0.49 | 0.07 | 0.03 | 0.15 | 0.98 |
| | No data | | | | | | | | |
| | 13.490 | 0.36 | 2.72 | 0.85 | 0.59 | 0.08 | 0.05 | 0.13 | 0.73 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Nov.-1 2007 | 15.046 | 0.02 | 0.05 | 0.06 | 0.03 | 0.002 | 0.006 | 0.007 | 0.04 |
| | 13.840 | 0.05 | 0.02 | 0.02 | 0.03 | 0.003 | 0.004 | 0.004 | 0.03 |
| | 14.880 | 0.22 | 0.08 | 0.06 | 0.16 | 0 | 0.008 | 0.01 | 0.04 |
| | 13.640 | 0.26 | 0.1 | 0.07 | 0.19 | 0.007 | 0.01 | 0.02 | 0.04 |
| | 15.096 | 0.18 | 0.1 | 0.06 | 0.14 | 0.002 | 0.009 | 0.016 | 0.04 |
| | 13.658 | 0.18 | 0.1 | 0.05 | 0.10 | 0.007 | 0.005 | 0.01 | 0.04 |
| Nov.-2 2007 | 12.844 | 0.10 | 0.2 | 0.07 | 0.06 | 0.02 | 0.009 | 0.02 | 0.15 |
| | 13.462 | 0.15 | 0.4 | 0.11 | 0.11 | 0.02 | 0.007 | 0.03 | 0.23 |
| | 15.183 | 0.30 | 0.5 | 0.19 | 0.21 | 0.01 | 0.01 | 0.04 | 0.28 |
| | 13.445 | 0.17 | 0.3 | 0.12 | 0.12 | 0.01 | 0.01 | 0.02 | 0.18 |
| | No data | | | | | | | | |
| | 13.490 | 0.20 | 0.6 | 0.12 | 0.20 | 0.02 | 0.01 | 0.03 | 0.17 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Dec.-1 2007 | 13.296 | 0.01 | 0.11 | 4.18 | 0.08 | 1.53 | 0.51 | 0.01 | 0.06 |
| | 15.328 | 0.05 | 0.37 | 5.06 | 0.06 | 1.95 | 0.67 | 0.01 | 0.06 |
| | 13.329 | 0.02 | 0.12 | 4.27 | 0.06 | 1.68 | 0.58 | 0.01 | 0.07 |
| | 15.315 | 0.02 | 0.13 | 2.89 | 0.05 | 1.05 | 0.44 | 0.01 | 0.04 |
| | 13.318 | 0.01 | 0.09 | 1.75 | 0.05 | 0.59 | 0.19 | 0.01 | 0.04 |
| | 15.394 | 0.01 | 0.07 | 1.40 | 0.03 | 0.47 | 0.27 | 0.01 | 0.04 |
| Dec.-2 2007 | 13.300 | 0.02 | 0.06 | 2.32 | 0.05 | 0.82 | 0.19 | 0.01 | 0.05 |
| | 15.353 | 0.03 | 0.25 | 2.11 | 0.03 | 0.72 | 0.41 | 0.01 | 0.06 |
| | 13.334 | 0.02 | 0.14 | 2.53 | 0.08 | 0.90 | 0.29 | 0.02 | 0.07 |
| | 15.352 | 0.03 | 0.12 | 2.40 | 0.05 | 0.80 | 0.37 | 0.02 | 0.13 |
| | 13.316 | 0.03 | 0.12 | 2.85 | 0.10 | 0.94 | 0.23 | 0.03 | 0.09 |
| | 15.431 | 0.02 | 0.07 | 5.64 | 0.06 | 2.08 | 0.37 | 0.02 | 0.11 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Dec.-1 2007 | 13.296 | 0.01 | 0.25 | 1.26 | 0.21 | 0.34 | 0.05 | 0.02 | 0.05 |
| | 15.328 | 0.02 | 0.22 | 1.75 | 0.09 | 0.59 | 0.09 | 0.02 | 0.04 |
| | 13.329 | 0.01 | 0.15 | 1.41 | 0.12 | 0.45 | 0.07 | 0.02 | 0.05 |
| | 15.315 | 0.02 | 0.17 | 0.82 | 0.09 | 0.25 | 0.04 | 0.02 | 0.04 |
| | 13.318 | 0.01 | 0.12 | 0.37 | 0.09 | 0.10 | 0.02 | 0.01 | 0.02 |
| | 15.394 | 0.01 | 0.10 | 0.27 | 0.08 | 0.07 | 0.02 | 0.01 | 0.03 |
| Dec.-2 2007 | 13.300 | 0.04 | 0.23 | 0.25 | 0.16 | 0.03 | 0.01 | 0.01 | 0.03 |
| | 15.353 | 0.04 | 0.30 | 0.35 | 0.12 | 0.09 | 0.04 | 0.02 | 0.05 |
| | 13.334 | 0.01 | 0.21 | 0.24 | 0.13 | 0.05 | 0.02 | 0.01 | 0.03 |
| | 15.352 | 0.07 | 0.26 | 0.31 | 0.17 | 0.07 | 0.02 | 0.02 | 0.04 |
| | 13.316 | 0.14 | 0.41 | 0.30 | 0.30 | 0.03 | 0.02 | 0.03 | 0.04 |
| | 15.431 | 0.03 | 0.31 | 1.40 | 0.20 | 0.40 | 0.07 | 0.03 | 0.06 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Dec.-1 2007 | 13.296 | 0.23 | 0.99 | 0.25 | 0.47 | 0.03 | 0.03 | 0.05 | 0.08 |
| | 15.328 | 0.07 | 0.71 | 0.23 | 0.20 | 0.06 | 0.04 | 0.04 | 0.14 |
| | 13.329 | 0.05 | 0.71 | 0.16 | 0.24 | 0.03 | 0.02 | 0.03 | 0.11 |
| | 15.315 | 0.10 | 0.55 | 0.17 | 0.22 | 0.03 | 0.02 | 0.03 | 0.11 |
| | 13.318 | 0.09 | 0.40 | 0.13 | 0.18 | 0.02 | 0.02 | 0.02 | 0.07 |
| | 15.394 | 0.06 | 0.33 | 0.10 | 0.11 | 0.03 | 0.02 | 0.02 | 0.10 |
| Dec.-2 2007 | 13.300 | 0.52 | 0.77 | 0.19 | 0.56 | 0.02 | 0.03 | 0.06 | 0.10 |
| | 15.353 | 0.25 | 0.87 | 0.20 | 0.33 | 0.03 | 0.07 | 0.07 | 0.17 |
| | 13.334 | 0.22 | 1.02 | 0.18 | 0.46 | 0.02 | 0.03 | 0.05 | 0.10 |
| | 15.352 | 0.43 | 0.84 | 0.20 | 0.50 | 0.03 | 0.03 | 0.07 | 0.18 |
| | 13.316 | 0.91 | 1.04 | 0.29 | 0.86 | 0.03 | 0.04 | 0.09 | 0.12 |
| | 15.431 | 0.30 | 1.26 | 0.38 | 0.58 | 0.04 | 0.04 | 0.08 | 0.19 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Dec.-1 2007 | 13.296 | 0.05 | 0.10 | 0.02 | 0.04 | 0.01 | 0.007 | 0.004 | 0.02 |
| | 15.328 | 0.03 | 0.17 | 0.03 | 0.01 | 0.02 | 0.02 | 0.008 | 0.08 |
| | 13.329 | 0.02 | 0.10 | 0.03 | 0.01 | 0.02 | 0.009 | 0.005 | 0.06 |
| | 15.315 | 0.03 | 0.10 | 0.02 | 0.01 | 0.02 | 0.01 | 0.007 | 0.06 |
| | 13.318 | 0.02 | 0.07 | 0.02 | 0.01 | 0.02 | 0.01 | 0.005 | 0.05 |
| | 15.394 | 0.01 | 0.05 | 0.01 | 0.004 | 0.01 | 0.008 | 0.004 | 0.04 |
| Dec.-2 2007 | 13.300 | 0.13 | 0.10 | 0.03 | 0.09 | 0.004 | 0.008 | 0.006 | 0.04 |
| | 15.353 | 0.10 | 0.12 | 0.04 | 0.06 | 0.001 | 0.02 | 0.01 | 0.09 |
| | 13.334 | 0.08 | 0.14 | 0.03 | 0.08 | 0.008 | 0.01 | 0.009 | 0.06 |
| | 15.352 | 0.11 | 0.12 | 0.04 | 0.08 | 0.01 | 0.01 | 0.01 | 0.10 |
| | 13.316 | 0.16 | 0.09 | 0.04 | 0.1 | 0.002 | 0.008 | 0.009 | 0.05 |
| | 15.431 | 0.11 | 0.21 | 0.06 | 0.1 | 0.01 | 0.01 | 0.02 | 0.12 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Jan.-1 2008 | 15.100 | 0.03 | 0.45 | 6.65 | 0.05 | 2.43 | 0.62 | 0.02 | 0.09 |
| | 13.478 | 0.03 | 0.32 | 7.44 | 0.10 | 2.64 | 0.99 | 0.02 | 0.09 |
| | 10.159 | 0.02 | 0.42 | 5.93 | 0.08 | 2.15 | 0.91 | 0.02 | 0.09 |
| | 13.497 | 0.04 | 0.77 | 7.94 | 0.14 | 2.81 | 1.50 | 0.05 | 0.22 |
| | 8.098 | 0.05 | 1.15 | 11.06 | 0.17 | 3.88 | 2.28 | 0.04 | 0.23 |
| | 11.115 | 0.03 | 0.31 | 10.60 | 0.14 | 3.80 | 1.51 | 0.02 | 0.11 |
| Jan.-2 2008 | 14.977 | 0.02 | 0.13 | 3.48 | 0.07 | 1.18 | 0.45 | 0.01 | 0.07 |
| | 13.615 | 0.03 | 0.13 | 5.06 | 0.09 | 1.94 | 0.31 | 0.02 | 0.08 |
| | 15.048 | 0.02 | 0.13 | 4.98 | 0.09 | 1.77 | 0.50 | 0.01 | 0.08 |
| | 13.639 | 0.01 | 0.05 | 3.12 | 0.02 | 1.12 | 0.21 | 0.01 | 0.04 |
| | 15.034 | 0.02 | 0.13 | 3.72 | 0.02 | 1.43 | 0.23 | 0.00 | 0.02 |
| | 13.696 | 0.01 | 0.08 | 1.70 | 0.02 | 0.63 | 0.16 | 0.00 | 0.02 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Jan.-1 2008 | 15.100 | 0.02 | 0.29 | 1.76 | 0.09 | 0.59 | 0.09 | 0.02 | 0.05 |
| | 13.478 | 0.00 | 0.11 | 0.89 | 0.05 | 0.29 | 0.06 | 0.01 | 0.04 |
| | 10.159 | 0.01 | 0.14 | 0.73 | 0.06 | 0.24 | 0.04 | 0.01 | 0.04 |
| | 13.497 | 0.00 | 0.12 | 0.53 | 0.04 | 0.18 | 0.04 | 0.01 | 0.05 |
| | 8.098 | 0.01 | 0.35 | 1.23 | 0.07 | 0.42 | 0.09 | 0.02 | 0.12 |
| | 11.115 | 0.00 | 0.21 | 1.45 | 0.07 | 0.48 | 0.09 | 0.02 | 0.10 |
| Jan.-2 2008 | 14.977 | 0.02 | 0.38 | 0.60 | 0.20 | 0.15 | 0.03 | 0.02 | 0.04 |
| | 13.615 | 0.00 | 0.35 | 0.90 | 0.23 | 0.21 | 0.03 | 0.03 | 0.05 |
| | 15.048 | 0.01 | 0.23 | 1.64 | 0.15 | 0.51 | 0.06 | 0.02 | 0.04 |
| | 13.639 | 0.00 | 0.03 | 0.77 | 0.02 | 0.27 | 0.02 | 0.01 | 0.02 |
| | 15.034 | 0.00 | 0.07 | 0.80 | 0.01 | 0.31 | 0.02 | 0.00 | 0.02 |
| | 13.696 | 0.00 | 0.04 | 0.26 | 0.00 | 0.10 | 0.01 | 0.00 | 0.01 |

| sampling | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| period | PC | 10>d>2.5 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Jan.-1 2008 | 15.100 | 0.07 | 0.80 | 0.25 | 0.23 | 0.05 | 0.02 | 0.04 | 0.16 |
| | 13.478 | 0.02 | 0.75 | 0.16 | 0.16 | 0.04 | 0.02 | 0.03 | 0.16 |
| | 10.159 | 0.03 | 0.47 | 0.13 | 0.13 | 0.03 | 0.02 | 0.02 | 0.11 |
| | 13.497 | 0.03 | 0.97 | 0.14 | 0.11 | 0.07 | 0.03 | 0.03 | 0.27 |
| | 8.098 | 0.12 | 2.09 | 0.30 | 0.13 | 0.14 | 0.06 | 0.07 | 0.71 |
| | 11.115 | 0.03 | 1.84 | 0.27 | 0.15 | 0.13 | 0.04 | 0.05 | 0.52 |
| Jan.-2 2008 | 14.977 | 0.22 | 1.23 | 0.29 | 0.50 | 0.04 | 0.03 | 0.06 | 0.16 |
| | 13.615 | 0.14 | 1.62 | 0.34 | 0.62 | 0.04 | 0.03 | 0.07 | 0.12 |
| | 15.048 | 0.08 | 0.93 | 0.44 | 0.36 | 0.06 | 0.03 | 0.05 | 0.12 |
| | 13.639 | 0.01 | 0.08 | 0.15 | 0.02 | 0.05 | 0.01 | 0.01 | 0.03 |
| | 15.034 | 0.01 | 0.06 | 0.17 | 0.03 | 0.04 | 0.01 | 0.01 | 0.03 |
| | 13.696 | 0.00 | 0.08 | 0.10 | 0.01 | 0.05 | 0.01 | 0.00 | 0.02 |

| sampling | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| period | PC | d>10 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Jan.-1 2008 | 15.100 | 0.03 | 0.20 | 0.04 | 0.03 | 0.017 | 0.009 | 0.008 | 0.05 |
| | 13.478 | 0.02 | 0.19 | 0.03 | 0.02 | 0.02 | 0.008 | 0.008 | 0.06 |
| | 10.159 | 0.02 | 0.13 | 0.02 | 0.01 | 0.03 | 0.008 | 0.007 | 0.06 |
| | 13.497 | 0.04 | 0.68 | 0.04 | 0.01 | 0.05 | 0.02 | 0.02 | 0.28 |
| | 8.098 | 0.13 | 1.8 | 0.1 | 0.02 | 0.07 | 0.04 | 0.03 | 0.82 |
| | 11.115 | 0.05 | 1.1 | 0.07 | 0.02 | 0.04 | 0.02 | 0.02 | 0.50 |
| Jan.-2 2008 | 14.977 | 0.04 | 0.17 | 0.03 | 0.05 | 0.02 | 0.007 | 0.007 | 0.08 |
| | 13.615 | 0.04 | 0.19 | 0.03 | 0.06 | 0.02 | 0.009 | 0.007 | 0.05 |
| | 15.048 | 0.03 | 0.17 | 0.04 | 0.04 | 0.02 | 0.008 | 0.009 | 0.06 |
| | 13.639 | 0.009 | 0.05 | 0.04 | 0.003 | 0.02 | 0.006 | 0.004 | 0.04 |
| | 15.034 | 0.009 | 0.05 | 0.08 | 0.004 | 0.04 | 0.007 | 0.003 | 0.03 |
| | 13.696 | 0.007 | 0.06 | 0.02 | 0.004 | 0.02 | 0.004 | 0.003 | 0.03 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Feb.-1 2008 | 10.473 | 0.04 | 0.35 | 3.3 | 0.07 | 1.2 | 0.60 | 0.01 | 0.08 |
| | 13.785 | 0.02 | 0.12 | 3.2 | 0.06 | 1.1 | 0.46 | 0.02 | 0.08 |
| | 14.865 | 0.03 | 0.36 | 1.5 | 0.09 | 0.44 | 0.56 | 0.01 | 0.05 |
| | 13.793 | 0.02 | 0.15 | 1.7 | 0.04 | 0.60 | 0.30 | 0.03 | 0.09 |
| | 13.039 | 0.03 | 0.37 | 2.7 | 0.08 | 0.94 | 0.63 | 0.02 | 0.10 |
| | 13.877 | 0.01 | 0.17 | 3.8 | 0.05 | 1.4 | 0.54 | 0.03 | 0.11 |
| Feb.-2 2008 | 14.003 | 0.03 | 0.15 | 2.8 | 0.08 | 0.91 | 0.33 | 0.04 | 0.10 |
| | 14.658 | 0.02 | 0.15 | 4.6 | 0.05 | 1.7 | 0.39 | 0.02 | 0.08 |
| | 13.988 | 0.02 | 0.11 | 6.2 | 0.08 | 2.3 | 0.41 | 0.03 | 0.09 |
| | 14.673 | 0.02 | 0.13 | 6.2 | 0.05 | 2.3 | 0.42 | 0.01 | 0.06 |
| | 13.988 | 0.03 | 0.16 | 9.2 | 0.11 | 3.4 | 0.52 | 0.02 | 0.08 |
| | 14.690 | 0.04 | 0.31 | 6.5 | 0.06 | 2.5 | 0.52 | 0.02 | 0.08 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Feb.-1 2008 | 10.473 | 0.02 | 0.26 | 0.72 | 0.06 | 0.25 | 0.04 | 0.02 | 0.05 |
| | 13.785 | 0.006 | 0.03 | 0.47 | 0.04 | 0.15 | 0.02 | 0.009 | 0.03 |
| | 14.865 | 0.006 | 0.06 | 0.23 | 0.03 | 0.07 | 0.02 | 0.008 | 0.02 |
| | 13.793 | 0.005 | 0.04 | 0.10 | 0.009 | 0.04 | 0.007 | 0.005 | 0.02 |
| | 13.039 | 0.007 | 0.08 | 0.45 | 0.03 | 0.15 | 0.02 | 0.009 | 0.03 |
| | 13.877 | 0.005 | 0.04 | 0.63 | 0.02 | 0.22 | 0.03 | 0.007 | 0.03 |
| Feb.-2 2008 | 14.003 | 0.006 | 0.14 | 0.25 | 0.08 | 0.04 | 0.01 | 0.01 | 0.03 |
| | 14.658 | 0.02 | 0.15 | 1.3 | 0.10 | 0.41 | 0.04 | 0.02 | 0.04 |
| | 13.988 | 0.005 | 0.09 | 1.3 | 0.10 | 0.39 | 0.04 | 0.02 | 0.04 |
| | 14.673 | 0.01 | 0.16 | 2.3 | 0.10 | 0.72 | 0.07 | 0.02 | 0.04 |
| | 13.988 | 0.004 | 0.07 | 2.3 | 0.10 | 0.72 | 0.06 | 0.02 | 0.03 |
| | 14.690 | 0.01 | 0.16 | 2.7 | 0.06 | 0.92 | 0.08 | 0.02 | 0.05 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Feb.-1 2008 | 10.473 | 0.07 | 0.78 | 0.33 | 0.18 | 0.06 | 0.04 | 0.06 | 0.28 |
| | 13.785 | 0.009 | 0.25 | 0.14 | 0.10 | 0.02 | 0.01 | 0.02 | 0.07 |
| | 14.865 | 0.03 | 0.17 | 0.08 | 0.05 | 0.02 | 0.02 | 0.02 | 0.06 |
| | 13.793 | 0.007 | 0.09 | 0.03 | 0.02 | 0.01 | 0.007 | 0.009 | 0.04 |
| | 13.039 | 0.02 | 0.23 | 0.09 | 0.05 | 0.02 | 0.02 | 0.02 | 0.09 |
| | 13.877 | 0.009 | 0.19 | 0.08 | 0.06 | 0.03 | 0.01 | 0.01 | 0.06 |
| Feb.-2 2008 | 14.003 | 0.05 | 0.26 | 0.08 | 0.12 | 0.005 | 0.01 | 0.01 | 0.05 |
| | 14.658 | 0.05 | 0.43 | 0.20 | 0.17 | 0.02 | 0.02 | 0.02 | 0.06 |
| | 13.988 | 0.05 | 0.46 | 0.19 | 0.19 | 0.02 | 0.02 | 0.03 | 0.06 |
| | 14.673 | 0.07 | 0.58 | 0.30 | 0.24 | 0.04 | 0.02 | 0.03 | 0.07 |
| | 13.988 | 0.04 | 0.64 | 0.27 | 0.26 | 0.02 | 0.02 | 0.03 | 0.07 |
| | 14.690 | 0.03 | 0.37 | 0.26 | 0.11 | 0.04 | 0.02 | 0.03 | 0.10 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Feb.-1 2008 | 10.473 | 0.04 | 0.29 | 0.17 | 0.05 | 0.06 | 0.02 | 0.02 | 0.15 |
| | 13.785 | 0.009 | 0.07 | 0.02 | 0.008 | 0.009 | 0.005 | 0.007 | 0.05 |
| | 14.865 | 0.02 | 0.08 | 0.02 | 0.007 | 0.01 | 0.01 | 0.009 | 0.06 |
| | 13.793 | 0.009 | 0.05 | 0.01 | 0.003 | 0.01 | 0.008 | 0.006 | 0.04 |
| | 13.039 | 0.02 | 0.11 | 0.02 | 0.008 | 0.01 | 0.01 | 0.01 | 0.08 |
| | 13.877 | 0.009 | 0.08 | 0.02 | 0.006 | 0.009 | 0.006 | 0.005 | 0.04 |
| Feb.-2 2008 | 14.003 | 0.01 | 0.03 | 0.01 | 0.008 | 0.005 | 0.005 | 0.004 | 0.03 |
| | 14.658 | 0.02 | 0.06 | 0.03 | 0.01 | 0.004 | 0.007 | 0.005 | 0.04 |
| | 13.988 | 0.02 | 0.06 | 0.03 | 0.02 | 0.01 | 0.009 | 0.006 | 0.04 |
| | 14.673 | 0.04 | 0.10 | 0.04 | 0.04 | 0.01 | 0.01 | 0.007 | 0.04 |
| | 13.988 | 0.02 | 0.10 | 0.04 | 0.04 | 0.009 | 0.006 | 0.006 | 0.04 |
| | 14.690 | 0.02 | 0.09 | 0.03 | 0.01 | 0.01 | 0.009 | 0.010 | 0.06 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Mar.-1 2008 | 14.220 | 0.04 | 0.49 | 17 | 0.17 | 6.1 | 1.09 | 0.05 | 0.22 |
| | 11.658 | 0.02 | 0.29 | 10 | 0.23 | 3.6 | 0.91 | 0.03 | 0.15 |
| | 14.240 | 0.02 | 0.18 | 8.9 | 0.15 | 3.2 | 0.61 | 0.03 | 0.11 |
| | 14.037 | 0.02 | 0.24 | 7.5 | 0.11 | 2.8 | 0.77 | 0.02 | 0.12 |
| | 14.254 | 0.01 | 0.21 | 5.4 | 0.11 | 2.1 | 0.45 | 0.02 | 0.10 |
| | 13.198 | 0.02 | 0.35 | 5.4 | 0.18 | 1.8 | 0.93 | 0.03 | 0.13 |
| Mar.-2 2008 | 9.410 | 0.04 | 0.62 | 7.2 | 0.16 | 2.6 | 1.5 | 0.04 | 0.16 |
| | 14.452 | 0.03 | 0.28 | 7.2 | 0.21 | 2.7 | 1.0 | 0.05 | 0.18 |
| | 12.122 | 0.03 | 0.45 | 5.5 | 0.14 | 2.0 | 1.2 | 0.03 | 0.15 |
| | 13.940 | 0.02 | 0.27 | 7.1 | 0.17 | 2.7 | 1.2 | 0.03 | 0.13 |
| | 14.194 | 0.04 | 0.17 | 4.0 | 0.12 | 1.4 | 0.52 | 0.04 | 0.18 |
| | 11.911 | 0.02 | 0.13 | 7.1 | 0.09 | 2.7 | 0.77 | 0.02 | 0.09 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Mar.-1 2008 | 14.220 | 0.0002 | 0.18 | 1.3 | 0.09 | 0.36 | 0.06 | 0.03 | 0.11 |
| | 11.658 | 0.04 | 0.42 | 0.89 | 0.20 | 0.21 | 0.04 | 0.03 | 0.10 |
| | 14.240 | 0.04 | 0.44 | 0.63 | 0.25 | 0.09 | 0.03 | 0.03 | 0.08 |
| | 14.037 | 0.008 | 0.39 | 0.75 | 0.20 | 0.18 | 0.03 | 0.03 | 0.07 |
| | 14.254 | 0.007 | 0.09 | 0.22 | 0.05 | 0.05 | 0.009 | 0.009 | 0.03 |
| | 13.198 | 0.01 | 0.20 | 0.32 | 0.11 | 0.08 | 0.02 | 0.01 | 0.04 |
| Mar.-2 2008 | 9.410 | 0.01 | 0.28 | 0.66 | 0.18 | 0.17 | 0.04 | 0.02 | 0.07 |
| | 14.452 | 0.003 | 0.14 | 0.48 | 0.12 | 0.12 | 0.03 | 0.02 | 0.04 |
| | 12.122 | 0.01 | 0.19 | 0.41 | 0.11 | 0.11 | 0.03 | 0.02 | 0.05 |
| | 13.940 | 0.005 | 0.09 | 0.61 | 0.12 | 0.16 | 0.05 | 0.02 | 0.05 |
| | 14.194 | 0.009 | 0.10 | 0.48 | 0.06 | 0.13 | 0.03 | 0.02 | 0.05 |
| | 11.911 | 0.009 | 0.10 | 0.81 | 0.12 | 0.21 | 0.04 | 0.02 | 0.06 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | m$^3$ | Cl$^-$ | NO$^{3-}$ | SO$_4^{2-}$ | Na$^+$ | NH$_4^+$ | K$^+$ | Mg$^{2+}$ | Ca$^{2+}$ |
| Mar.-1 2008 | 14.220 | 0.06 | 1.8 | 0.45 | 0.39 | 0.05 | 0.03 | 0.08 | 0.36 |
| | 11.658 | 0.27 | 1.5 | 0.44 | 0.51 | 0.03 | 0.03 | 0.08 | 0.30 |
| | 14.240 | 0.73 | 2.1 | 0.62 | 0.98 | 0.03 | 0.04 | 0.13 | 0.34 |
| | 14.037 | 0.13 | 1.8 | 0.42 | 0.58 | 0.05 | 0.04 | 0.09 | 0.28 |
| | 14.254 | 0.02 | 0.51 | 0.12 | 0.17 | 0.01 | 0.01 | 0.02 | 0.08 |
| | 13.198 | 0.10 | 0.71 | 0.20 | 0.25 | 0.03 | 0.02 | 0.04 | 0.15 |
| Mar.-2 2008 | 9.410 | 0.09 | 1.1 | 0.26 | 0.37 | 0.04 | 0.04 | 0.06 | 0.20 |
| | 14.452 | 0.02 | 1.3 | 0.26 | 0.42 | 0.03 | 0.04 | 0.06 | 0.21 |
| | 12.122 | 0.06 | 0.69 | 0.17 | 0.23 | 0.03 | 0.03 | 0.05 | 0.17 |
| | 13.940 | 0.02 | 0.91 | 0.22 | 0.29 | 0.03 | 0.04 | 0.05 | 0.18 |
| | 14.194 | 0.05 | 0.32 | 0.13 | 0.13 | 0.01 | 0.03 | 0.03 | 0.12 |
| | 11.911 | 0.04 | 0.89 | 0.24 | 0.27 | 0.02 | 0.04 | 0.05 | 0.18 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | m$^3$ | Cl$^-$ | NO$^{3-}$ | SO$_4^{2-}$ | Na$^+$ | NH$_4^+$ | K$^+$ | Mg$^{2+}$ | Ca$^{2+}$ |
| Mar.-1 2008 | 14.220 | 0.03 | 0.31 | 0.05 | 0.07 | 0.01 | 0.007 | 0.01 | 0.05 |
| | 11.658 | 0.07 | 0.21 | 0.06 | 0.06 | 0.01 | 0.01 | 0.01 | 0.07 |
| | 14.240 | 0.21 | 0.28 | 0.09 | 0.18 | 0.01 | 0.01 | 0.02 | 0.07 |
| | 14.037 | 0.08 | 0.25 | 0.05 | 0.07 | 0.01 | 0.01 | 0.02 | 0.10 |
| | 14.254 | 0.01 | 0.10 | 0.03 | 0.02 | 0.01 | 0.005 | 0.006 | 0.04 |
| | 13.198 | 0.03 | 0.12 | 0.04 | 0.02 | 0.01 | 0.008 | 0.008 | 0.06 |
| Mar.-2 2008 | 9.410 | 0.05 | 0.27 | 0.06 | 0.03 | 0.02 | 0.02 | 0.02 | 0.15 |
| | 14.452 | 0.04 | 0.44 | 0.05 | 0.04 | 0.02 | 0.02 | 0.02 | 0.21 |
| | 12.122 | 0.04 | 0.17 | 0.05 | 0.02 | 0.02 | 0.01 | 0.01 | 0.14 |
| | 13.940 | 0.04 | 0.42 | 0.05 | 0.03 | 0.02 | 0.02 | 0.02 | 0.20 |
| | 14.194 | 0.05 | 0.13 | 0.06 | 0.03 | 0.01 | 0.02 | 0.01 | 0.11 |
| | 11.911 | 0.05 | 0.34 | 0.07 | 0.04 | 0.02 | 0.02 | 0.02 | 0.17 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Apr.-1 2008 | 13.910 | 0.01 | 0.19 | 2.4 | 0.03 | 0.82 | 0.34 | 0.01 | 0.04 |
| | 4.698 | 0.009 | 0.10 | 2.4 | 0.04 | 0.85 | 0.26 | 0.009 | 0.04 |
| | 13.971 | 0.008 | 0.20 | 1.9 | 0.02 | 0.69 | 0.19 | 0.005 | 0.03 |
| | 14.691 | 0.01 | 0.07 | 3.7 | 0.04 | 1.3 | 0.34 | 0.008 | 0.04 |
| | 13.956 | 0.02 | 0.30 | 2.6 | 0.03 | 0.97 | 0.27 | 0.004 | 0.02 |
| | 14.206 | 0.01 | 0.10 | 4.2 | 0.05 | 1.5 | 0.50 | 0.01 | 0.05 |
| Apr.-2 2008 | 14.915 | 0.005 | 0.05 | 2.1 | 0.02 | 0.79 | 0.23 | 0.003 | 0.02 |
| | 13.729 | 0.009 | 0.21 | 2.6 | 0.03 | 1.0 | 0.32 | 0.002 | 0.02 |
| | 14.890 | 0.006 | 0.06 | 2.5 | 0.03 | 0.97 | 0.32 | 0.007 | 0.03 |
| | 13.758 | 0.01 | 0.24 | 1.3 | 0.02 | 0.54 | 0.18 | 0.007 | 0.03 |
| | 14.915 | 0.008 | 0.07 | 2.1 | 0.04 | 0.75 | 0.25 | 0.006 | 0.04 |
| | 13.799 | 0.007 | 0.18 | 2.3 | 0.03 | 0.86 | 0.31 | 0.008 | 0.06 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Apr.-1 2008 | 13.910 | 0.01 | 0.08 | 0.29 | 0.03 | 0.09 | 0.03 | 0.008 | 0.02 |
| | 4.698 | 0.004 | 0.04 | 0.24 | 0.02 | 0.08 | 0.02 | 0.006 | 0.02 |
| | 13.971 | 0.005 | 0.2 | 0.48 | 0.02 | 0.18 | 0.03 | 0.009 | 0.02 |
| | 14.691 | 0 | 0.03 | 0.42 | 0.03 | 0.12 | 0.03 | 0.006 | 0.02 |
| | 13.956 | 0.004 | 0.1 | 0.55 | 0.02 | 0.20 | 0.03 | 0.007 | 0.02 |
| | 14.206 | 0 | 0.06 | 0.52 | 0.04 | 0.17 | 0.04 | 0.008 | 0.03 |
| Apr.-2 2008 | 14.915 | 0 | 0.03 | 0.15 | 0.02 | 0.04 | 0.01 | 0.003 | 0.02 |
| | 13.729 | 0.0006 | 0.06 | 0.27 | 0.02 | 0.10 | 0.02 | 0.002 | 0.01 |
| | 14.890 | 0.0001 | 0.02 | 0.13 | 0.02 | 0.03 | 0.01 | 0.001 | 0.008 |
| | 13.758 | 0.003 | 0.1 | 0.15 | 0.02 | 0.04 | 0.02 | 0.006 | 0.02 |
| | 14.915 | 0 | 0.02 | 0.12 | 0.01 | 0.04 | 0.01 | 0.002 | 0.01 |
| | 13.799 | 0 | 0.04 | 0.16 | 0.02 | 0.05 | 0.02 | 0.003 | 0.02 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Apr.-1 2008 | 13.910 | 0.04 | 0.2 | 0.06 | 0.06 | 0.004 | 0.03 | 0.01 | 0.08 |
| | 4.698 | 0.007 | 0.2 | 0.04 | 0.03 | 0.005 | 0.01 | 0.009 | 0.10 |
| | 13.971 | 0.02 | 0.2 | 0.06 | 0.04 | 0.007 | 0.02 | 0.007 | 0.04 |
| | 14.691 | 0.009 | 0.2 | 0.08 | 0.07 | 0.01 | 0.02 | 0.01 | 0.05 |
| | 13.956 | 0.01 | 0.2 | 0.06 | 0.03 | 0.003 | 0.03 | 0.01 | 0.06 |
| | 14.206 | 0.02 | 0.5 | 0.10 | 0.07 | 0.03 | 0.04 | 0.03 | 0.13 |
| Apr.-2 2008 | 14.915 | 0.005 | 0.2 | 0.05 | 0.05 | 0.01 | 0.02 | 0.009 | 0.05 |
| | 13.729 | 0.01 | 0.2 | 0.06 | 0.06 | 0.01 | 0.02 | 0.01 | 0.05 |
| | 14.890 | 0.009 | 0.2 | 0.06 | 0.05 | 0.01 | 0.01 | 0.01 | 0.05 |
| | 13.758 | 0.032 | 0.2 | 0.05 | 0.04 | 0.005 | 0.03 | 0.02 | 0.07 |
| | 14.915 | 0.003 | 0.2 | 0.04 | 0.03 | 0.01 | 0.02 | 0.008 | 0.05 |
| | 13.799 | 0.007 | 0.2 | 0.05 | 0.03 | 0.02 | 0.01 | 0.01 | 0.09 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| Apr.-1 2008 | 13.910 | 0.02 | 0.1 | 0.03 | 0.01 | 0.008 | 0.01 | 0.006 | 0.05 |
| | 4.698 | 0.03 | 0.2 | 0.04 | 0.02 | 0.01 | 0.01 | 0.01 | 0.12 |
| | 13.971 | 0.006 | 0.05 | 0.01 | 0.006 | 0.006 | 0.008 | 0.004 | 0.05 |
| | 14.691 | 0.009 | 0.1 | 0.03 | 0.01 | 0.01 | 0.01 | 0.006 | 0.06 |
| | 13.956 | 0.002 | 0.07 | 0.03 | 0.003 | 0.01 | 0.008 | 0.004 | 0.05 |
| | 14.206 | 0.02 | 0.3 | 0.04 | 0.01 | 0.02 | 0.02 | 0.01 | 0.13 |
| Apr.-2 2008 | 14.915 | 0.002 | 0.05 | 0.02 | 0.005 | 0.01 | 0.006 | 0.002 | 0.04 |
| | 13.729 | 0.006 | 0.1 | 0.02 | 0.009 | 0.009 | 0.009 | 0.006 | 0.08 |
| | 14.890 | 0.006 | 0.09 | 0.02 | 0.008 | 0.008 | 0.008 | 0.004 | 0.05 |
| | 13.758 | 0.01 | 0.07 | 0.03 | 0.008 | 0.005 | 0.01 | 0.006 | 0.06 |
| | 14.915 | 0.003 | 0.06 | 0.02 | 0.005 | 0.008 | 0.007 | 0.004 | 0.05 |
| | 13.799 | 0.007 | 0.1 | 0.04 | 0.006 | 0.01 | 0.009 | 0.006 | 0.08 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 1.0>d | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| May -1 2008 | 13.492 | 0.009 | 0.02 | 0.48 | 0.01 | 0.17 | 0.05 | 0.004 | 0.008 |
| | 15.137 | 0.006 | 0.02 | 0.61 | 0.008 | 0.23 | 0.04 | 0.003 | 0.01 |
| | 13.540 | 0.01 | 0.08 | 0.43 | 0.01 | 0.16 | 0.08 | 0.003 | 0.02 |
| | 15.133 | 0.01 | 0.02 | 2.2 | 0.02 | 0.766 | 0.09 | 0.004 | 0.03 |
| | 13.519 | 0.006 | 0.05 | 1.2 | 0.01 | 0.43 | 0.04 | 0.0008 | 0.01 |
| | 15.215 | 0.006 | 0.02 | 1.3 | 0.02 | 0.44 | 0.06 | 0.002 | 0.02 |
| May -2 2008 | 13.299 | 0.008 | 0.04 | 1.2 | 0.01 | 0.43 | 0.09 | 0.002 | 0.02 |
| | 15.395 | 0.006 | 0.04 | 3.3 | 0.04 | 1.1 | 0.18 | 0.007 | 0.04 |
| | 13.229 | 0.006 | 0.10 | 1.9 | 0.01 | 0.69 | 0.10 | 0.001 | 0.01 |
| | 15.461 | 0.005 | 0.04 | 3.3 | 0.03 | 1.1 | 0.15 | 0.004 | 0.03 |
| | 13.279 | 0.009 | 0.07 | 2.1 | 0.02 | 0.73 | 0.09 | 0.0009 | 0.01 |
| | 15.456 | 0.007 | 0.03 | 4.8 | 0.04 | 1.7 | 0.20 | 0.006 | 0.03 |

| sampling period | total volume | major soluble ions (ug $m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 2.5>d>1.0 | | | | | | | |
| | $m^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| May -1 2008 | 13.492 | 0.02 | 0.07 | 0.35 | 0.03 | 0.07 | 0.01 | 0.01 | 0.04 |
| | 15.137 | 0.02 | 0.03 | 0.11 | 0.02 | 0.03 | 0.006 | 0.004 | 0.02 |
| | 13.540 | 0.007 | 0.05 | 0.05 | 0.01 | 0.01 | 0.01 | 0.003 | 0.02 |
| | 15.133 | 0.004 | 0.06 | 0.14 | 0.03 | 0.033 | 0.01 | 0.003 | 0.02 |
| | 13.519 | 0.004 | 0.05 | 0.09 | 0.02 | 0.02 | 0.005 | 0.001 | 0.01 |
| | 15.215 | 0.01 | 0.13 | 0.12 | 0.06 | 0.01 | 0.01 | 0.004 | 0.02 |
| May -2 2008 | 13.299 | 0.01 | 0.11 | 0.25 | 0.03 | 0.04 | 0.01 | 0.009 | 0.04 |
| | 15.395 | 0.02 | 0.29 | 0.35 | 0.13 | 0.03 | 0.02 | 0.02 | 0.07 |
| | 13.229 | 0.01 | 0.13 | 0.39 | 0.04 | 0.10 | 0.02 | 0.01 | 0.05 |
| | 15.461 | 0.02 | 0.26 | 0.52 | 0.13 | 0.07 | 0.02 | 0.02 | 0.08 |
| | 13.279 | 0.02 | 0.15 | 0.50 | 0.06 | 0.08 | 0.02 | 0.02 | 0.07 |
| | 15.456 | 0.02 | 0.36 | 0.48 | 0.19 | 0.05 | 0.02 | 0.03 | 0.07 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | 10>d>2.5 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| May -1 2008 | 13.492 | 0.03 | 0.09 | 0.06 | 0.02 | 0 | 0.02 | 0.01 | 0.02 |
| | 15.137 | 0.03 | 0.15 | 0.04 | 0.01 | 0.005 | 0.03 | 0.01 | 0.04 |
| | 13.540 | 0.02 | 0.09 | 0.03 | 0.02 | 0.003 | 0.01 | 0.009 | 0.04 |
| | 15.133 | 0.02 | 0.35 | 0.08 | 0.07 | 0.009 | 0.03 | 0.02 | 0.06 |
| | 13.519 | 0.03 | 0.26 | 0.06 | 0.06 | 0.01 | 0.04 | 0.009 | 0.04 |
| | 15.215 | 0.09 | 0.41 | 0.10 | 0.16 | 0.005 | 0.04 | 0.02 | 0.06 |
| May -2 2008 | 13.299 | 0.04 | 0.24 | 0.08 | 0.04 | 0.003 | 0.01 | 0.02 | 0.07 |
| | 15.395 | 0.27 | 0.92 | 0.25 | 0.29 | 0.01 | 0.04 | 0.05 | 0.22 |
| | 13.229 | 0.05 | 0.38 | 0.10 | 0.08 | 0.01 | 0.03 | 0.02 | 0.10 |
| | 15.461 | 0.19 | 0.98 | 0.25 | 0.25 | 0.01 | 0.04 | 0.05 | 0.22 |
| | 13.279 | 0.18 | 0.93 | 0.22 | 0.15 | 0.02 | 0.04 | 0.12 | 0.18 |
| | 15.456 | 0.34 | 1.6 | 0.37 | 0.52 | 0.03 | 0.05 | 0.09 | 0.30 |

| sampling period | total volume | major soluble ions (ug m$^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC | d>10 | | | | | | | |
| | m$^3$ | $Cl^-$ | $NO^{3-}$ | $SO_4^{2-}$ | $Na^+$ | $NH_4^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ |
| May -1 2008 | 13.492 | 0.01 | 0.03 | 0.02 | 0.02 | 0 | 0.02 | 0.0005 | 0.005 |
| | 15.137 | 0.01 | 0.03 | 0.02 | 0.01 | 0.002 | 0.01 | 0.003 | 0.02 |
| | 13.540 | 0.03 | 0.09 | 0.04 | 0.01 | 0.0006 | 0.02 | 0.009 | 0.10 |
| | 15.133 | 0.02 | 0.12 | 0.03 | 0.01 | 0.005 | 0.008 | 0.005 | 0.07 |
| | 13.519 | 0.02 | 0.08 | 0.03 | 0.02 | 0.006 | 0.009 | 0.003 | 0.04 |
| | 15.215 | 0.03 | 0.07 | 0.02 | 0.03 | 0.003 | 0.007 | 0.003 | 0.04 |
| May -2 2008 | 13.299 | 0.01 | 0.06 | 0.03 | 0.006 | 0.003 | 0.006 | 0.005 | 0.06 |
| | 15.395 | 0.09 | 0.14 | 0.05 | 0.05 | 0.005 | 0.009 | 0.01 | 0.10 |
| | 13.229 | 0.008 | 0.06 | 0.02 | 0.006 | 0.0006 | 0.005 | 0.003 | 0.05 |
| | 15.461 | 0.06 | 0.14 | 0.03 | 0.03 | 0 | 0.009 | 0.008 | 0.09 |
| | 13.279 | 0.12 | 0.49 | 0.04 | 0.02 | 0.004 | 0.01 | 0.09 | 0.11 |
| | 15.456 | 0.13 | 0.33 | 0.07 | 0.07 | 0.004 | 0.01 | 0.03 | 0.16 |

Table B-3 Carbonaceous Aerosol Concentration Data from July 2007 to May 2008

| sampling period | total volume | OC | | | EC | | |
|---|---|---|---|---|---|---|---|
| | QF | 10>d>2.5 | 2.5>d>1.0 | 1.0>d | 10>d>2.5 | 2.5>d>1.0 | 1.0>d |
| | m$^3$ | ug m$^{-3}$ | ug m$^{-3}$ | ug m$^{-3}$ | ug m$^{-3}$ | ug m$^{-3}$ | ug m$^{-3}$ |
| July-1 2007 | 12.975 | 1.28 | 0.52 | 1.31 | 0.12 | 0.05 | 0.66 |
| | 15.570 | 1.26 | 0.69 | 0.90 | 0.02 | 0.05 | 0.51 |
| | 13.075 | 1.49 | 0.80 | 1.25 | 0.01 | 0.16 | 0.45 |
| | 15.616 | 1.20 | 0.32 | 0.74 | 0.00 | 0.07 | 0.46 |
| | 13.041 | 1.33 | 0.61 | 2.14 | 0.06 | 0.10 | 1.12 |
| | 15.647 | 0.88 | 0.40 | 0.54 | 0.09 | 0.07 | 0.47 |
| July-2 2007 | 14.706 | 1.08 | 0.36 | 1.34 | 0.00 | 0.06 | 0.60 |
| | 12.554 | 0.91 | 0.42 | 2.03 | 0.01 | 0.05 | 0.68 |
| | 14.807 | 0.86 | 0.37 | 1.47 | 0.00 | 0.04 | 0.55 |
| | 12.432 | 1.30 | 0.28 | 1.83 | 0.01 | 0.11 | 0.51 |
| | 14.769 | 1.16 | 0.39 | 1.82 | 0.00 | 0.18 | 0.63 |
| | 12.544 | 0.50 | 0.16 | 0.84 | 0.01 | 0.04 | 0.26 |
| Aug.-1 2007 | 10.114 | 0.66 | 0.00 | 4.37 | 0.08 | 0.00 | 1.02 |
| | 13.242 | 1.03 | 0.44 | 2.02 | 0.00 | 0.16 | 0.89 |
| | 15.302 | 1.58 | 0.53 | 1.63 | 0.00 | 0.13 | 0.73 |
| | 13.110 | 0.52 | 0.52 | 1.57 | 0.05 | 0.05 | 0.39 |
| | 15.137 | 0.65 | 0.18 | 0.73 | 0.04 | 0.04 | 0.25 |
| | 13.351 | 0.79 | 0.49 | 2.47 | 0.10 | 0.13 | 0.90 |
| Aug.-2 2007 | 15.047 | 0.78 | 0.50 | 0.61 | 0.00 | 0.16 | 0.29 |
| | 13.726 | 1.23 | 0.56 | 1.09 | 0.01 | 0.15 | 0.71 |
| | 14.962 | 0.50 | 0.33 | 1.12 | 0.05 | 0.06 | 0.47 |
| | 13.627 | 0.61 | 0.26 | 1.53 | 0.01 | 0.03 | 0.64 |
| | 15.027 | 0.57 | 0.20 | 1.38 | 0.07 | 0.03 | 0.55 |
| | 13.593 | 0.90 | 0.73 | 3.42 | 0.04 | 0.14 | 0.73 |

| sampling period | total volume | OC | | | EC | | |
|---|---|---|---|---|---|---|---|
| | QF | 10>d>2.5 | 2.5>d>1.0 | 1.0>d | 10>d>2.5 | 2.5>d>1.0 | 1.0>d |
| | m$^3$ | ug m$^{-3}$ | ug m$^{-3}$ | ug m$^{-3}$ | ug m$^{-3}$ | ug m$^{-3}$ | ug m$^{-3}$ |
| Sep.-1 2007 | 13.585 | 2.05 | 0.20 | 0.78 | 0.11 | 0.04 | 0.30 |
| | 14.557 | 0.93 | 0.15 | 0.90 | 0.04 | 0.04 | 0.48 |
| | 13.718 | 1.74 | 0.49 | 1.51 | 0.21 | 0.14 | 0.77 |
| | 14.576 | 1.28 | 0.33 | 1.04 | 0.17 | 0.05 | 0.53 |
| | 13.729 | 1.94 | 0.67 | 1.65 | 0.18 | 0.22 | 0.89 |
| | 14.808 | 0.59 | 0.85 | 1.77 | 0.11 | 0.13 | 0.75 |
| Sep.-2 2007 | 13.595 | 1.23 | 0.06 | 1.02 | 0.10 | 0.08 | 0.13 |
| | 14.400 | 0.85 | 0.22 | 1.20 | 0.07 | 0.08 | 0.36 |
| | 14.286 | 1.29 | 0.14 | 1.37 | 0.22 | 0.08 | 0.37 |
| | 14.352 | 0.55 | 0.57 | 1.81 | 0.05 | 0.06 | 0.48 |
| | 14.279 | 1.61 | 0.92 | 1.77 | 0.37 | 0.54 | 1.30 |
| | 14.328 | 1.21 | 1.22 | 3.36 | 0.18 | 0.27 | 1.47 |
| Oct.-1 2007 | No data | | | | | | |
| | 14.094 | 1.15 | 1.44 | 2.45 | 0.14 | 0.37 | 0.97 |
| | 14.574 | 0.77 | 0.65 | 1.38 | 0.08 | 0.16 | 0.70 |
| | 13.972 | 0.69 | 0.87 | 1.60 | 0.13 | 0.13 | 0.74 |
| | 14.597 | 0.76 | 0.92 | 1.12 | 0.19 | 0.24 | 0.76 |
| | No data | | | | | | |
| Oct.-2 2007 | 14.344 | 1.76 | 2.84 | 5.12 | 0.10 | 0.73 | 2.16 |
| | 14.154 | 0.83 | 1.62 | 2.74 | 0.18 | 0.39 | 1.37 |
| | 14.219 | 1.35 | 1.17 | 3.16 | 0.05 | 0.26 | 1.39 |
| | 13.683 | 0.94 | 0.48 | 1.54 | 0.10 | 0.13 | 0.55 |
| | 14.740 | 1.10 | 1.18 | 1.84 | 0.26 | 0.58 | 1.41 |
| | 13.743 | 1.85 | 2.43 | 3.03 | 0.12 | 0.65 | 1.61 |

| sampling period | total volume | OC | | | EC | | |
|---|---|---|---|---|---|---|---|
| | QF | 10>d>2.5 | 2.5>d>1.0 | 1.0>d | 10>d>2.5 | 2.5>d>1.0 | 1.0>d |
| | $m^3$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ |
| Nov.-1 2007 | 14.792 | 0.88 | 1.22 | 2.05 | 0.06 | 0.25 | 1.15 |
| | 13.555 | 0.51 | 0.44 | 1.00 | 0.01 | 0.02 | 0.35 |
| | 14.750 | 0.56 | 0.62 | 1.03 | 0.01 | 0.08 | 0.52 |
| | 13.638 | 0.74 | 0.48 | 1.79 | 0.00 | 0.06 | 0.47 |
| | 15.122 | 0.95 | 0.90 | 1.53 | 0.02 | 0.16 | 0.74 |
| | 13.649 | 0.76 | 0.56 | 1.47 | 0.01 | 0.08 | 0.45 |
| Nov.-2 2007 | 15.258 | 2.64 | 3.40 | 6.29 | 0.04 | 0.62 | 2.35 |
| | 13.438 | 1.92 | 2.96 | 4.53 | 0.28 | 0.74 | 1.74 |
| | 15.265 | 3.44 | 4.01 | 6.16 | 0.08 | 0.84 | 2.54 |
| | 13.429 | 1.63 | 2.13 | 4.04 | 0.02 | 0.34 | 1.37 |
| | | | | | | | |
| | 13.452 | 1.57 | 2.58 | 4.69 | 0.12 | 0.70 | 1.69 |
| Dec.-1 2007 | 13.276 | 1.55 | 1.87 | 6.15 | 0.10 | 0.41 | 2.09 |
| | 15.356 | 1.48 | 2.71 | 5.89 | 0.00 | 0.57 | 2.74 |
| | 13.350 | 1.74 | 2.40 | 6.65 | 0.00 | 0.40 | 2.53 |
| | 15.302 | 1.20 | 1.69 | 5.30 | 0.04 | 0.36 | 1.91 |
| | 13.338 | 1.61 | 1.61 | 3.05 | 0.06 | 0.20 | 1.14 |
| | 15.359 | 1.68 | 2.02 | 4.77 | 0.01 | 0.38 | 1.84 |
| Dec.-2 2007 | 13.352 | 1.53 | 0.82 | 3.49 | 0.00 | 0.13 | 0.86 |
| | 15.338 | 1.94 | 1.63 | 3.75 | 0.38 | 0.39 | 2.03 |
| | 13.292 | 1.37 | 1.34 | 4.14 | 0.00 | 0.30 | 1.44 |
| | 15.334 | 1.49 | 1.45 | 4.63 | 0.00 | 0.24 | 1.92 |
| | 13.287 | 1.72 | 1.19 | 1.93 | 0.08 | 0.32 | 0.64 |
| | 15.464 | 1.54 | 1.76 | 3.22 | 0.00 | 0.36 | 1.41 |

| sampling period | total volume | OC | | | EC | | |
|---|---|---|---|---|---|---|---|
| | QF | 10>d>2.5 | 2.5>d>1.0 | 1.0>d | 10>d>2.5 | 2.5>d>1.0 | 1.0>d |
| | $m^3$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ |
| Jan.-1 2008 | 15.382 | 1.49 | 2.63 | 4.42 | 0.31 | 0.60 | 3.34 |
| | 13.508 | 1.65 | 2.82 | 8.44 | 0.19 | 0.68 | 3.17 |
| | 15.219 | 2.33 | 3.24 | 7.86 | 0.08 | 0.69 | 3.60 |
| | 13.411 | 2.68 | 3.31 | 11.36 | 0.11 | 0.92 | 4.23 |
| | 15.143 | 3.55 | 6.88 | 12.16 | 0.51 | 1.41 | 6.76 |
| | 13.524 | 2.56 | 4.51 | 10.25 | 0.36 | 1.15 | 3.87 |
| Jan.-2 2008 | 14.813 | 1.30 | 1.44 | 4.78 | 0.12 | 0.31 | 1.87 |
| | 13.465 | 1.16 | 1.82 | 2.53 | 0.04 | 0.35 | 0.83 |
| | 14.855 | 1.46 | 2.07 | 5.60 | 0.00 | 0.47 | 2.50 |
| | 13.539 | 1.07 | 0.86 | 2.77 | 0.03 | 0.12 | 1.01 |
| | 14.994 | 0.93 | 1.27 | 2.48 | 0.07 | 0.23 | 1.23 |
| | 13.714 | 1.16 | 1.00 | 4.26 | 0.18 | 0.07 | 1.07 |
| Feb.-1 2008 | 14.838 | 2.63 | 3.72 | 9.34 | 0.16 | 0.65 | 4.14 |
| | 13.697 | 1.15 | 1.90 | 7.16 | 0.12 | 0.29 | 2.18 |
| | 14.863 | 1.22 | 1.58 | 8.59 | 0.00 | 0.43 | 2.65 |
| | 13.785 | 1.06 | 1.12 | 4.85 | 0.03 | 0.33 | 1.59 |
| | 14.862 | 2.07 | 3.10 | 8.62 | 0.00 | 0.43 | 3.01 |
| | 13.874 | 1.31 | 2.39 | 8.05 | 0.04 | 0.60 | 2.37 |
| Feb.-2 2008 | 13.994 | 0.88 | 0.95 | 4.14 | 0.11 | 0.33 | 1.49 |
| | 14.776 | 0.92 | 1.68 | 4.05 | 0.03 | 0.26 | 1.51 |
| | 13.928 | 0.75 | 1.56 | 4.50 | 0.05 | 0.39 | 1.41 |
| | 14.649 | 0.91 | 2.30 | 4.46 | 0.01 | 0.40 | 1.67 |
| | 13.936 | 0.82 | 2.10 | 4.76 | 0.06 | 0.58 | 1.34 |
| | 14.631 | 1.17 | 2.47 | 5.97 | 0.00 | 0.64 | 2.91 |

| sampling period | total volume | OC | | | EC | | |
|---|---|---|---|---|---|---|---|
| | QF | 10>d>2.5 | 2.5>d>1.0 | 1.0>d | 10>d>2.5 | 2.5>d>1.0 | 1.0>d |
| | $m^3$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ |
| Mar.-1 2008 | 14.117 | 1.67 | 3.33 | 8.16 | 0.26 | 1.09 | 3.03 |
| | 14.259 | 1.73 | 2.80 | 6.97 | 0.03 | 0.61 | 2.37 |
| | 14.054 | 1.14 | 2.01 | 6.93 | 0.09 | 0.55 | 2.10 |
| | 14.318 | 1.68 | 2.68 | 9.45 | 0.06 | 0.95 | 3.47 |
| | 14.197 | 1.54 | 2.15 | 7.50 | 0.22 | 0.64 | 1.84 |
| | 14.424 | 2.19 | 2.60 | 10.00 | 0.00 | 0.76 | 3.13 |
| Mar.-2 2008 | 14.067 | 2.54 | 4.39 | 14.23 | 0.04 | 0.99 | 4.46 |
| | 14.286 | 2.21 | 3.18 | 10.83 | 0.06 | 0.57 | 3.26 |
| | 14.347 | 2.27 | 3.86 | 11.56 | 0.26 | 0.97 | 4.08 |
| | 14.029 | 2.10 | 4.41 | 15.43 | 0.17 | 0.83 | 3.63 |
| | 14.160 | 1.42 | 2.03 | 5.25 | 0.26 | 0.29 | 2.02 |
| | 14.507 | 1.56 | 3.15 | 9.06 | 0.27 | 0.72 | 2.94 |
| Apr.-1 2008 | 13.875 | 1.84 | 1.91 | 4.86 | 0.29 | 0.59 | 1.94 |
| | 14.649 | 0.99 | 1.71 | 5.77 | 0.05 | 0.23 | 1.67 |
| | 14.076 | 1.05 | 1.13 | 2.06 | 0.06 | 0.19 | 0.73 |
| | 14.623 | 1.30 | 1.71 | 4.33 | 0.08 | 0.26 | 1.32 |
| | 14.029 | 1.87 | 2.30 | 4.10 | 0.15 | 0.59 | 1.44 |
| | 14.768 | 2.34 | 2.69 | 7.38 | 0.18 | 0.54 | 2.14 |
| Apr.-2 2008 | 15.049 | 1.24 | 1.52 | 4.84 | 0.07 | 0.19 | 0.96 |
| | 13.799 | 1.27 | 2.25 | 4.87 | 0.10 | 0.35 | 1.35 |
| | 14.819 | 1.18 | 1.62 | 5.61 | 0.07 | 0.23 | 1.20 |
| | 13.750 | 1.32 | 1.21 | 2.78 | 0.09 | 0.18 | 0.83 |
| | 14.829 | 1.14 | 1.44 | 4.93 | 0.07 | 0.37 | 1.25 |
| | 13.726 | 1.46 | 1.57 | 5.19 | 0.01 | 0.22 | 1.55 |

| sampling period | total volume | OC | | | EC | | |
|---|---|---|---|---|---|---|---|
| | QF | 10>d>2.5 | 2.5>d>1.0 | 1.0>d | 10>d>2.5 | 2.5>d>1.0 | 1.0>d |
| | $m^3$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ | ug $m^{-3}$ |
| May -1 2008 | 13.490 | 1.77 | 0.47 | 0.47 | 0.13 | 0.10 | 0.01 |
| | 15.052 | 1.44 | 0.44 | 1.26 | 0.16 | 0.11 | 0.35 |
| | 13.506 | 0.58 | 0.35 | 2.11 | 0.02 | 0.02 | 0.37 |
| | 15.059 | 1.57 | 0.58 | 2.72 | 0.06 | 0.16 | 0.88 |
| | 13.422 | 1.82 | 0.49 | 1.12 | 0.09 | 0.00 | 0.06 |
| | 15.087 | 1.42 | 0.68 | 1.70 | 0.04 | 0.12 | 0.73 |
| May -2 2008 | 13.303 | 0.87 | 0.53 | 1.34 | 0.00 | 0.10 | 0.21 |
| | 15.432 | 1.41 | 0.71 | 1.92 | 0.00 | 0.05 | 0.49 |
| | 13.240 | 0.94 | 0.68 | 0.99 | 0.01 | 0.23 | 0.29 |
| | 15.328 | 1.27 | 0.68 | 1.56 | 0.00 | 0.21 | 0.71 |
| | 13.251 | 1.36 | 0.31 | 0.72 | 0.00 | 0.08 | 0.34 |
| | 15.402 | 1.66 | 0.72 | 2.08 | 0.00 | 0.07 | 0.63 |

# APPENDIX C: Soil Sample Data

Table C-1 The concentration of compounds in soil samples (%w/w)

| Compound Formula | Concentration (% w/w) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Fe_2O_3$ | $SiO_2$ | $Na_2O$ | MgO | $Al_2O_3$ | $P_2O_5$ | $SO_3$ | Cl | $K_2O$ | CaO | Others |
| Sample1 | 0.7999 | 63.66 | 0.106 | 0.0462 | 3.668 | 0.041 | 0.208 | 0.14 | 0.0749 | 0.0685 | 31.188 |
| Sample2 | 0.7916 | 62.91 | 0.107 | 0.0438 | 3.677 | 0.042 | 0.201 | 0.138 | 0.0752 | 0.067 | 31.947 |
| Sample3 | 0.8092 | 64.44 | 0.111 | 0.0413 | 3.704 | 0.043 | 0.194 | 0.142 | 0.0725 | 0.0687 | 30.374 |
| Sample4 | 0.827 | 62.33 | 0.144 | 0.0318 | 3.51 | 0.0611 | 0.313 | 0.122 | 0.0444 | 0.046 | 32.571 |
| Sample5 | 0.834 | 62.71 | 0.141 | 0.0319 | 3.455 | 0.0604 | 0.276 | 0.122 | 0.0434 | 0.0423 | 32.284 |
| Sample6 | 0.8569 | 62.53 | 0.14 | 0.0316 | 3.496 | 0.0635 | 0.258 | 0.13 | 0.0434 | 0.0448 | 32.406 |
| Sample7 | 0.7073 | 68.05 | 0.122 | 0.0473 | 2.541 | 0.0765 | 0.206 | 0.118 | 0.0498 | 0.0726 | 28.01 |
| Sample8 | 0.7023 | 68.33 | 0.119 | 0.0484 | 2.557 | 0.0705 | 0.165 | 0.119 | 0.048 | 0.0751 | 27.766 |
| Sample9 | 0.7016 | 68.48 | 0.111 | 0.0452 | 2.521 | 0.0711 | 0.165 | 0.122 | 0.0479 | 0.0734 | 27.662 |
| Sample10 | 1.127 | 59.28 | 0.137 | 0.0464 | 5.402 | 0.025 | 0.227 | 0.12 | 0.0648 | 0.0481 | 33.523 |
| Sample11 | 1.138 | 59.73 | 0.126 | 0.0506 | 5.507 | 0.027 | 0.175 | 0.123 | 0.0643 | 0.0492 | 33.01 |
| Sample12 | 1.137 | 59.9 | 0.101 | 0.038 | 5.425 | 0.022 | 0.137 | 0.144 | 0.064 | 0.0471 | 32.985 |

# VITAE

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Publication list

1. Conference presentation
   - Chotpitayasunon, J., Tsuruta, H., Thana, B. and Vijarnwannaluk S. Atmospheric Aerosol Properties at the Observatory for Atmospheric Research at Phimai, Thailand. 6th Asian Aerosol Conference. Bangkok, Nov. 24-27, 2009.
   - Chotpitayasunon, J., Tsuruta, H., Thana, B. and Vijarnwannaluk S. Relationship between Atmospheric Aerosol Compositions and Aerosol Emission Sources in Phimai, Nakhon Ratchasima. The 6th Kasetsart University Kamphang Saen Campus Conference. Nakhon Pathom, Dec. 8-9, 2009.
2. Proceeding
   - Tsuruta, H., Chotpitayasunon, J., Thana B., Khatri. P., Takamura, T., Hayasaka, T. and Nakajima, T. Characterization of atmospheric aerosols at the Observatory for Atmospheric Research at Phimai, Thailand, a Station of SKYNET. The 14th CEReS Symposium and SKYNET workshop on "Remote Sensing of the Atmosphere for Better Understanding of Climate Change". (2008): 22-25.
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