The Attributes and Associated Air Mass History of Fine Particles Observed at a Rural-Urban Site in the Mid-Atlantic Region

Megan Payne[1], Dr. Everette Joseph[1], and Dr. Jose Fuentes[2]
Howard University[1] and Penn State University[2]

Introduction

The limited knowledge of how clouds and aerosols influence the climate through interaction with radiative and hydrological processes is the largest source of uncertainty in estimates of global climate change by numerical models. A key challenge is how to assess and quantify the temporal and spatial variability of the aerosol direct and indirect effects on cloud and precipitation. Comprehensive and accurate observations on a regional scale of aerosol chemical and physical properties and their influences on cloud microphysical and precipitation processes are needed to constraint numerical models

Toward this end, NASA, Penn State University, and Howard University, have deployed a suit of in situ and remotely sensed observations of cloud, aerosol, and precipitation properties at the Howard University Beltsville Campus – a rural-urban field site in the Mid-Atlantic.

A detailed assessment of the attributes of aerosols observed at the site on multiple time scales is a perquisite to this research. During August 2009 continuous in situ aerosol sampling was initiated at the site. Preliminary results are presented below of concentrations and size characteristics of fine aerosols and associated air mass history that were observed.

Site

- HUBC is located ~12 miles NE of Washington D.C. and ~22 miles SW of Baltimore, MD.
- The facility is on about 110 acres in Beltsville, MD, nestled in suburban Maryland. The Beltsville Campus is in a rural location with no more than 5% of land area used by buildings and development.
- The campus houses a large set of instruments including, water vapor Raman Lidar, spectral and broadband radiometers, radiosonde/ozonesonde sounding system, 31 m flux and meteorological tower, gas analyzers and aerosol particle samplers

Method

Instrumentation

These instruments were deployed to look at size distribution characteristics in Beltsville, MD and chemical composition of aerosols.

- Aerosol Mass Spectrometer (AMS)
- Ultra-High Sensitivity Aerosol Spectrometer (UHSAS)

Meteorological Outlook for Cases

July 20, 2009- July 21, 2009

- Stagnant and variable winds from the S-SW. At 15Z became E.
- Eastern wind aided in transport of Marine/Atlantic air
- Low Pressure over Delmarva restricted large production of aerosols on July 21.
- Slight enhancement of concentrations towards end of July 21due to wind from NE.

August 2, 2009- August 4, 2009

- Wind from S-SW allowed for production/transport
- August 2 at 9Z recorded thunderstorm shut down production of aerosols and allowed for scavenging of aerosols by precipitation
- August 3 at 6Z there was a cold frontal passage with decreasing concentration till 9Z
- Before cold front there was S wind, then N wind, back to S-SE later in the day
- August 4 at 6Z was S wind, switched to S-SW at 16Z with little transport and production due to lingering cloud and haze cover.

Synoptic Picture

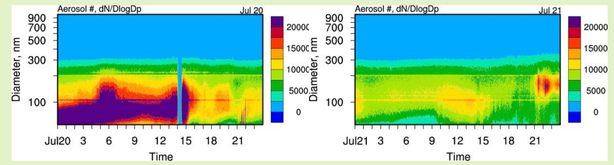
Northern	Southern	Eastern

For Northern flow our region will be dominated by a High pressure in Ohio River Valley or SW Pennsylvania with clockwise flow around the High bringing cleaner, smaller concentrations of aerosols. For Southern flow, there is a High pressure in the Southeast and depending on the region the High depends on the intensity of aerosols concentrations in our region. For Eastern flow, there typically is a low pressure system moving up the coast moving counter-clockwise into our region. This is of importance since there is a more marine component to the air mass that could affect the types of aerosols seen at Beltsville.

Data

Aerosol Concentration with Time

Case #1



Case #2

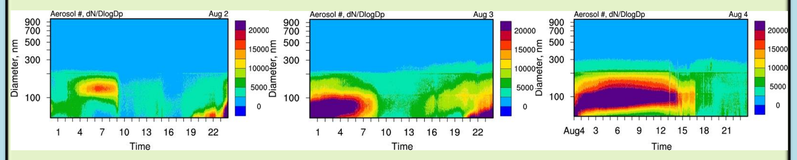


Figure 1: These plots display the number concentration of aerosols as a function of time and diameter (nm). Plotting these images allows to show the evolution of aerosol growth and events with time and how they change is diameter. Using the synoptic overview on how these regimes differ meteorologically, they can be categorized into different regimes of air mass.

AMS Chemical Composition

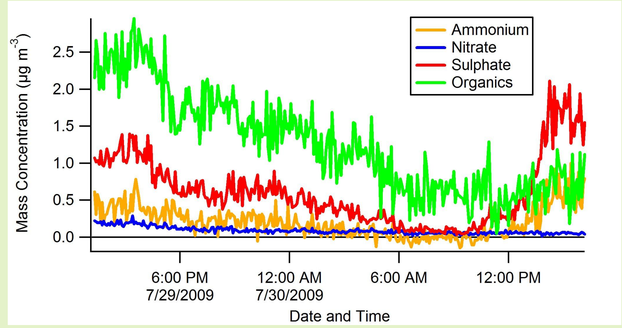


Figure 2: This plot shows a one and half day time series mass concentration plot of different chemical compositions found in Beltsville, MD for July 29 through July 30, 2009. It is evident that our region sees a large concentration of organic/biogenic material. Some other compositions are nitrates, sulphates, and ammonium. During the whole event there is a downward trend of decreasing concentrations for all compositions until 9:00AM on July 30, 2009 there is a shift from predominately organic to high concentrated Sulfate. There is also an increase in Ammonium. This switch is associated with a directional change in air mass from South-Southwesterly flow to a more continental, Northerly flow.

Conclusions

1. Flow from the North cleans out aerosol concentrations with less polluted air mass.
2. Flow from the South allows for the production of aerosols and leads to large concentrations of small aerosols.
3. Maine air sources have an easterly component and tend to be less concentrated than other air masses.
4. Composition of aerosols are just as dependent on air mass type as concentration.
5. There are organic/biogenic aerosols and secondary organic aerosols, such as Sulfate.

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