Pre-GLORY Assessment of Aerosol Characteristics

Project Goals

- To develop the initial protocol for GLORY ground-truth validation at the student/ educational level.
- To ascertain pre-GLORY "baseline" aerosol characteristics for the NY region.

Abstract

NASA has tentative plans to launch the GLORY satellite in 2008 that will measure atmospheric aerosols and pollutants. The study of aerosols is very important because aerosols have both cooling and heating effects on earth's climate. The cooling effect that aerosols have on the surface of the Earth is known as direct climate forcing. This is due to the direct reflection of radiation from the sun. Aerosols also have an effect on the radiative properties of Earth's cloud cover, known as indirect climate forcing. Although scientists are studying the properties of aerosols, not much is known about them. Through this investigation, data is being collected and analyzed to help locate regional aerosol trends, and use devices that measure Aerosol Optical Thickness to validate other instruments.

The Polarimeter on the GLORY satellite has the ability to measure aerosols by looking at light reflectance, which can help identify concentrations of different types of aerosol in the air. Ultimately, sifting through data retrieved on particle concentration and Aerosol Optical thickness from land-based instruments will allow for the recognition of trends. This will define "baseline" aerosol characteristics in the New York region that can be used for validation purposes. Comparisons between urban and rural areas have also been made.

Another aspect of this project is developing an initial protocol for the GLORY ground-truth validation. By comparing GLOBE sunphotometer data to AOT data from other instruments, the accuracy of the sunphotometers can be analyzed. After tests have been completed to make sure the instruments have been calibrated correctly, a protocol for accurate readings by high school and middle school students can be created. These instruments will be distributed to students around the world to take readings of Aerosol Optical Thickness as part of the satellite validation plan.

GLORY Mission

The GLORY satellite will feature an instrument to measure atmospheric aerosols and man-made pollutants in the atmosphere.
The on-board instruments are:

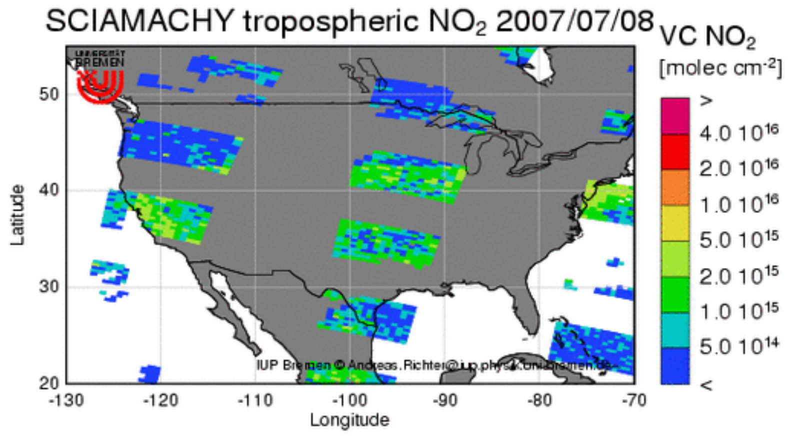
-Aerosol Polarimetry Sensor (APS) which will collect global aerosol data based on measurements of light reflected within the solar reflective spectral region of Earth's atmosphere.

-Total Irradiance Monitor (TIM); collects measurements of total solar irradiance (TSI), (the amount of solar radiation in the Earth's atmosphere over a period of time).

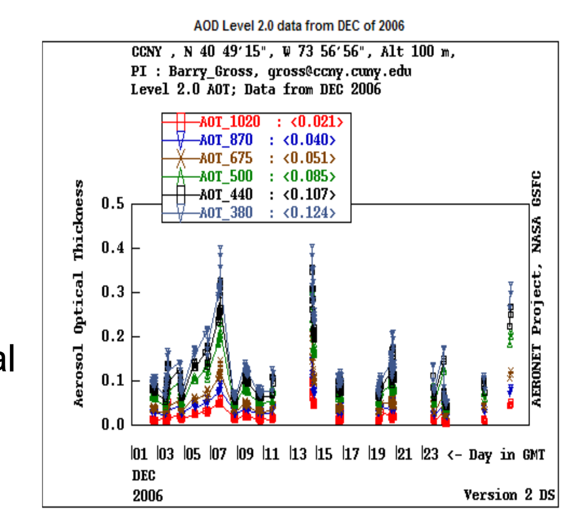
Looking at Aerosol Concentration and Distribution

SCIAMACHY (***SC**anning **I**maging **A**bsorption Spectro**M**eter for **A**tmospheric **CH**artograph**Y***)

SCIAMACHY tropospheric NO_2 2007/07/08

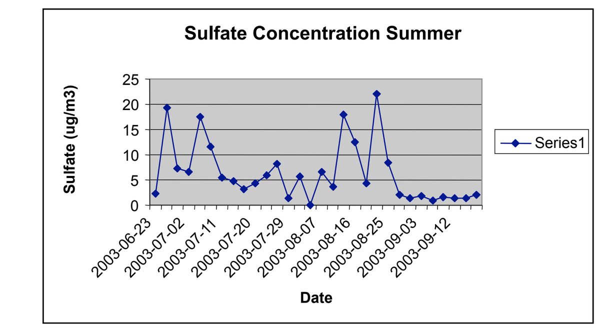


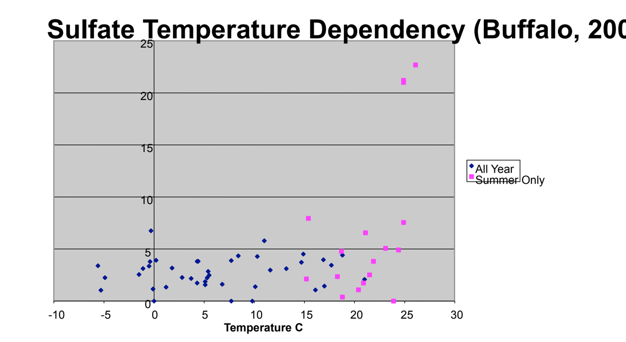
- **Multifilter Rotating Shadowband Radiometer**
  - Takes spectral measurements of solar radiation
- **CIMEL**
  - Part of the AERONET program; remote sensing of Aerosol Optical Thickness

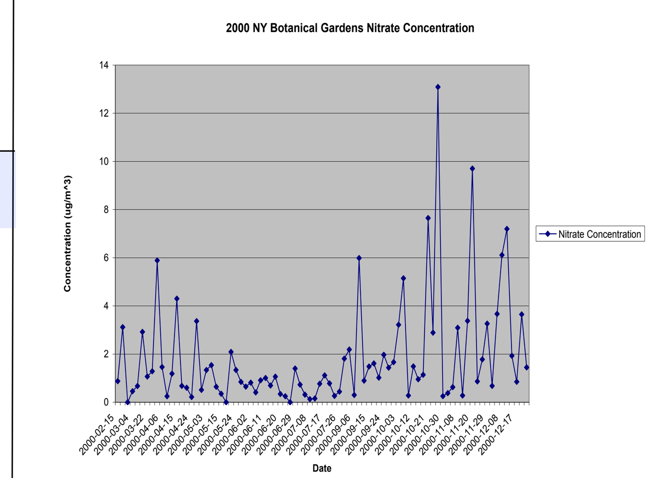


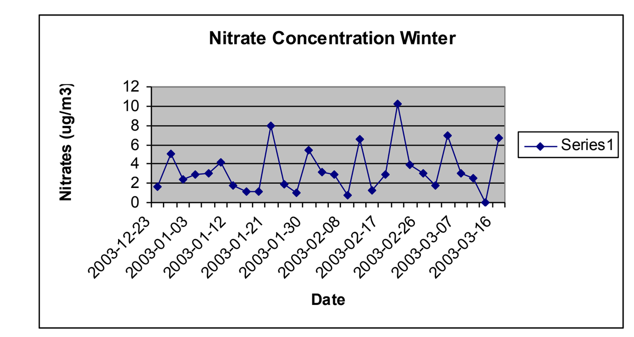
Sulfate and Nitrate Observations

Sulfates form when sulfur dioxide gets oxidized in the earth's atmosphere. It may be oxidized when it is in the gas phase or when it has dissolved in clouds. Sulfate formation is catalyzed by warm, humid conditions. Water vapor in the earth's atmosphere is necessary to oxidize the sulfur dioxide. As the amount of water vapor present increases, the amount and rate of oxidation will also increase. The earth's atmosphere is able to hold more water vapor as it heats up. Therefore more sulfates will form when the earth's atmosphere Is warmer.





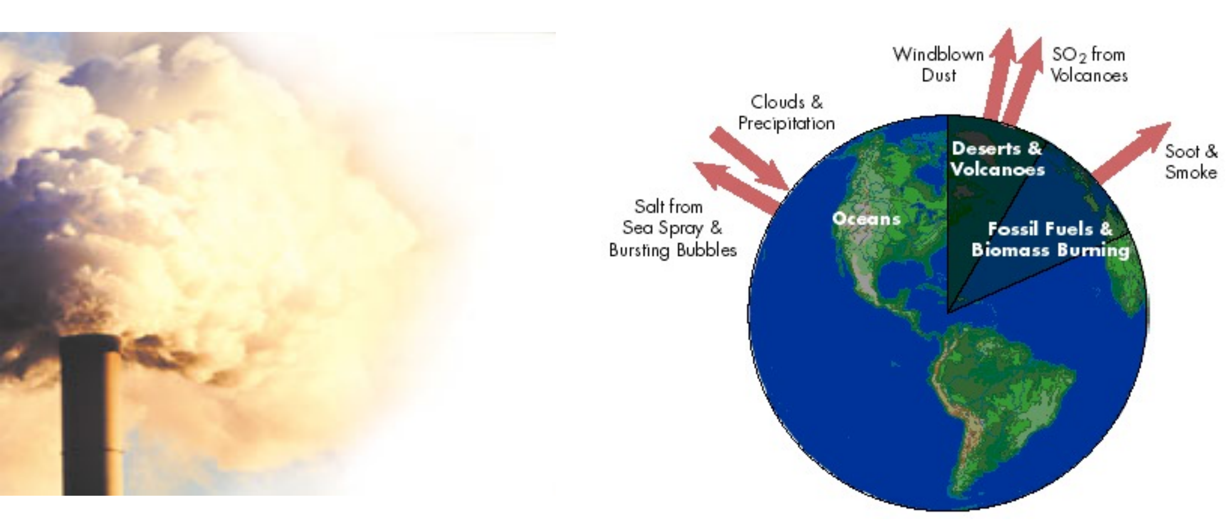




Nitrates begin as nitrous oxide and can be formed in two ways:
1) Cloud droplets containing Nitric Acid vapor evaporate leaving behind nitrates.
2) Nitric acid vapor sometimes changes phase together with ammonia, creating ammonium nitrate aerosol (NH4NO3).
Nitrate formation is also temperature dependent. During summer months when atmospheric temperature is high, Nitrous Oxide may combine with atmospheric oxygen, forming ozone. When the Nitrous Oxide is consumed to create ozone, it can no longer form nitrates. Since this process occurs mainly when the temperature is high, there will be less nitrates forming in earth's atmosphere.

What are Aerosols?

- Both natural and anthropogenic aerosols have many different effects on global climate, ecosystem development, and human health.
- Have both cooling effect (direct forcing) and heating effect (indirect forcing)
- Aerosols are solid and liquid particles suspended in gas.



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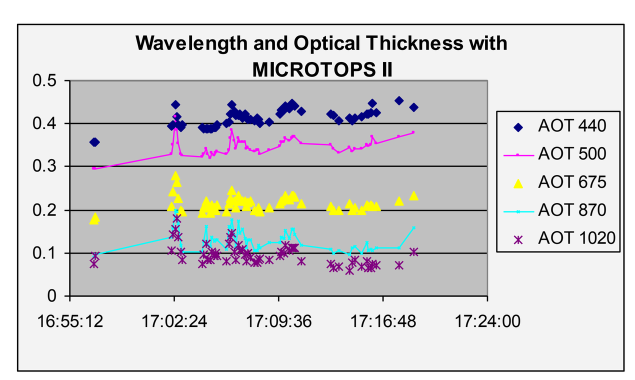
Handheld Sunphotometers

The MICROTOPS II is a hand-held multi-band sunphotometer that measures aerosol optical thickness at 1020nm.

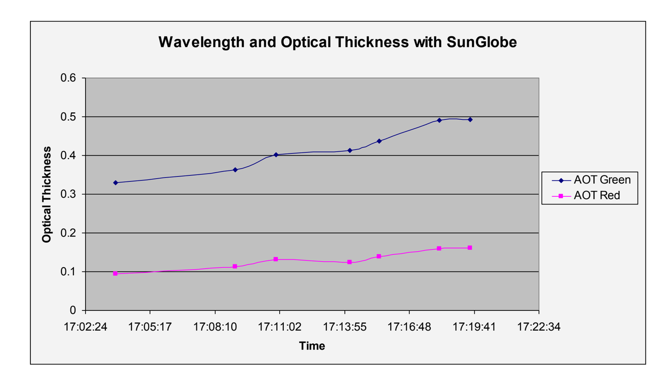


Comparison between the MICROTOPS and GLOBE Sunphotometers instrument calibration.

MICROTOPS II

GLOBE Sunphotometer

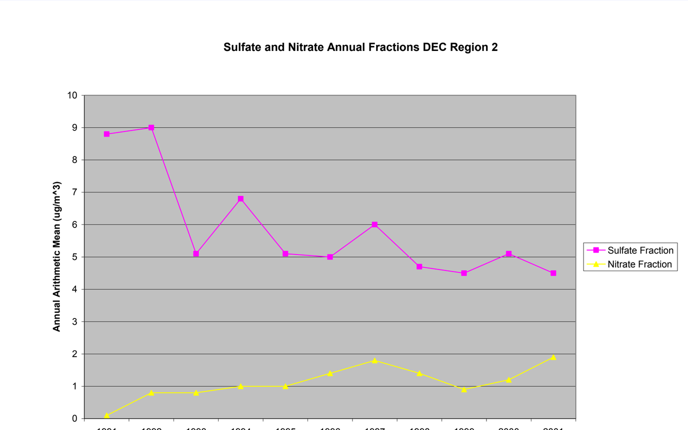
The GLOBE sun photometer uses a light emitting diode (LED) to detect the strength of the sun's light.



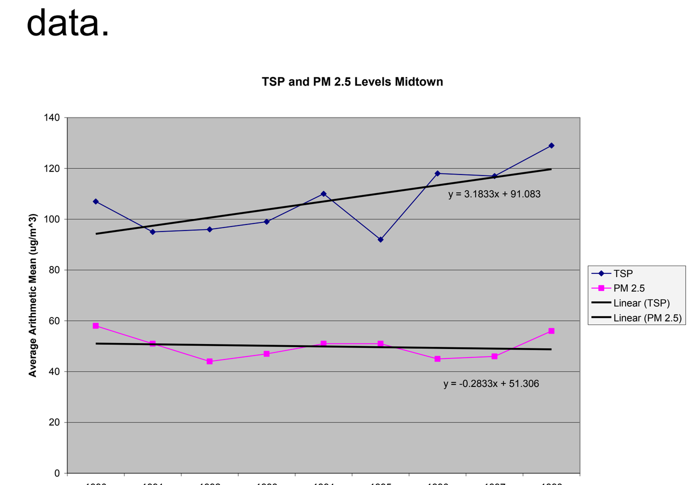
Both instruments measure AOT on different wavelengths.

A Closer Look at Suspended Particulates

The composition and deposition of aerosol in the air is important because it allows for further GLORY instrument validation. Photometers, Radiometers, and the CIMEL all give data on Aerosol Optical Thickness (AOT), but not individual particle information. The Polarimeter on GLORY will help take measurements that can provide speciation data.



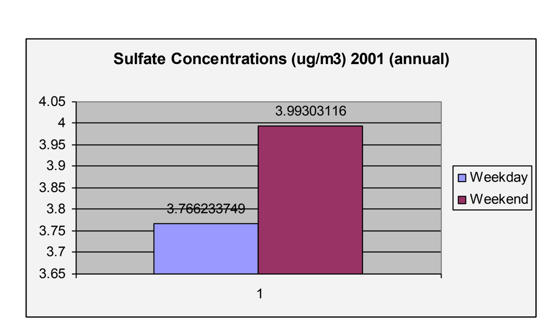
The DEC Provides data sets with information on total sulfate and Nitrate fractions in different New York State regions.

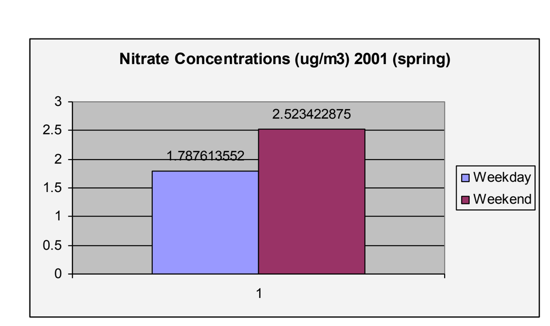


TSP = Total Suspended Particulates

PM 2.5 = Particulate Matter < 2.5 Microns (inhalable particulates)

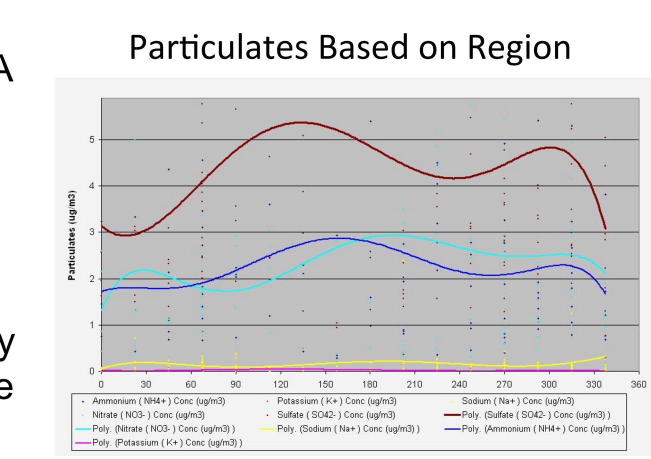
Regional analysis is important because it allows us to locate where different types of aerosols are being produced, and contributes information that can be looked at to discover reasons for these differences, based on chemical reactions and meteorological trends.

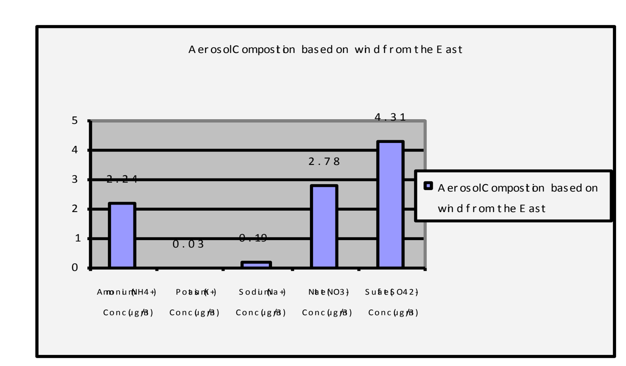


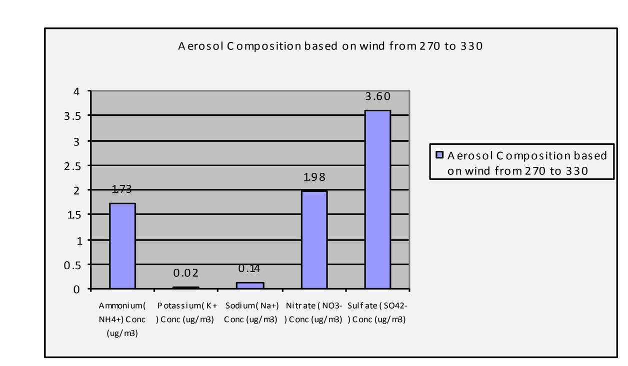


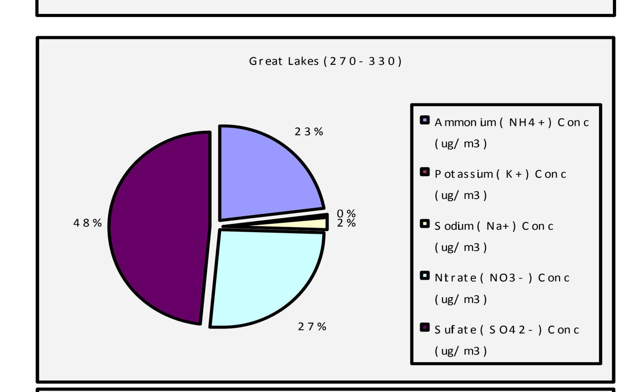
Wind Direction and Regional Trends

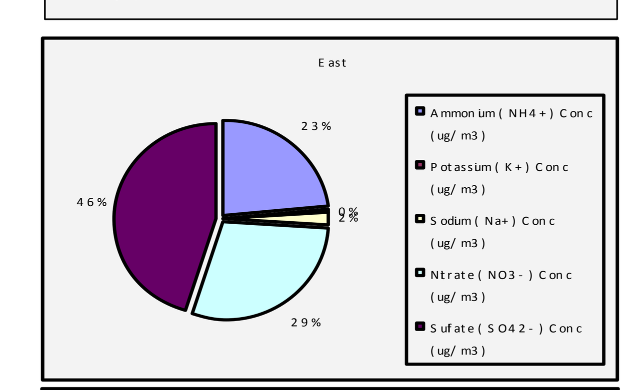
Aerosol composition can be different based on the source of the particulates. A region close to the ocean could be expected to have a larger amount of sodium while an area with farmlands would have a greater amount of nitrates. When comparing the regions throughout a 5 year long time period, there were very subtle differences in the composition. The differences in total volumes varied more than the breakdown compositions.

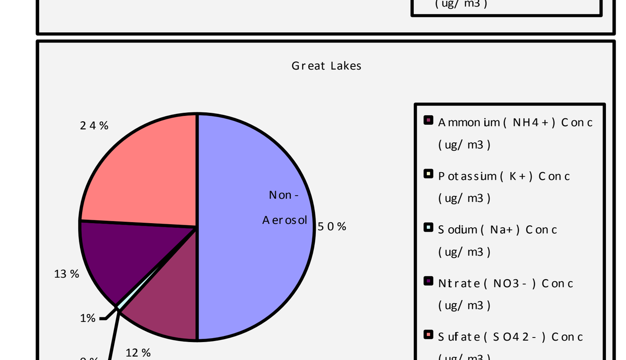


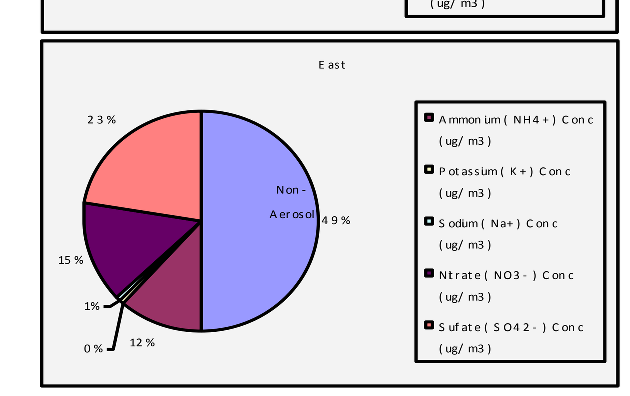












Future Work

•Designing educational modules/protocols for validation of the GLORY Mission
•Assessment of PM 2.5 Levels and Composition dependence on:
-Season
-Temperature
-Wind Speed
-Wind Direction
-Barometric Pressure