

# Atmospheric Aerosol Research

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# An Overview of Hand held Sun Photometer Measurements of Atmospheric Aerosols at Xavier University of Louisiana

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## Abstract

The effects of aerosols on the atmosphere, climate, and public health are among the central topics in current environmental research. Aerosol particles scatter and absorb solar and terrestrial radiation, they are involved in the formation of clouds and precipitation as cloud condensation and ice nuclei, and they affect the abundance and distribution of atmospheric trace gases by chemical reactions and other multiphase processes. Moreover, airborne particles play an important role in the spreading of biological organisms, reproductive materials, and pathogens and they can cause or enhance respiratory, cardiovascular, infectious, and allergic diseases. In this study we use a Globe hand held sun photometer to measure seasonal variations (Sept '17 –March 18") of atmospheric aerosol particles at our study site. We compare our AOT calculations with the Globe calculations. The symbol for AOT is  $\tau$ .

## Motivation

Measurements of aerosol optical thickness at more than one wavelength allow us to calculate the Angstrom exponents and turbidity parameters of the atmosphere. These parameters provide important information about the concentration, size distribution, and variability of aerosols in the atmosphere. This information is needed for climate studies, for comparison with satellite data, and to predict and to identify the source and cause of the aerosols.



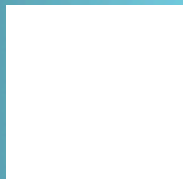
$V_0$  is the calibration constant of sun photometer  
 $R$  is the earth-sun distance expressed in astronomical units  
 $V$  and  $V_{dark}$  are the sunlight and dark voltages from sun photometer  
 $a_{0\lambda}$  is the contribution to optical thickness of Rayleigh scattering of light in the atmosphere  
 $P$  is the station pressure at the time of measurement  
 $P_0$  is the standard sea level atmospheric pressure  
 $M$  is the relative air mass ( $m=1/\sin(\text{solar elevation angle})$ )

## Technique

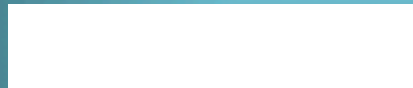
### Aerosol Optical Thickness

Optical thickness is a measure of the amount of direct Sunlight reaching a detector that respond to a single Wavelength of light. Optical thickness is affected by many factors including scattering by aerosols. The portion of Optical thickness which is due to aerosols is called Aerosol Optical Thickness (AOT)

Measurement of AOT  $\tau_{\lambda_1}$  and  $\tau_{\lambda_2}$  were taken at two different wavelengths  $\lambda_1$  (505nm) and  $\lambda_2$ (625nm). The Angstrom exponent  $\alpha$  is given by



The Angstrom exponent is inversely related to the average size of the particles in the aerosols

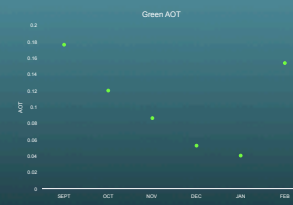
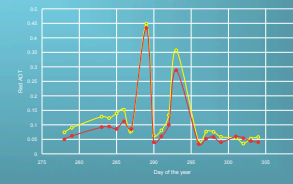
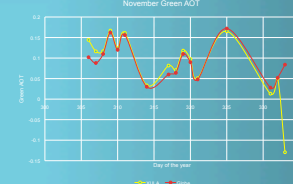
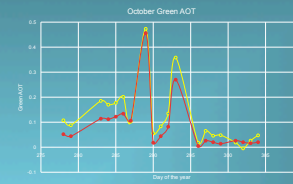


$\beta$  is the Angstrom's turbidity coefficient and describes The general haziness of the atmosphere.

## Results

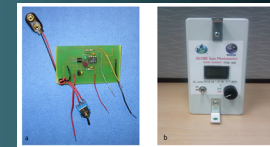


## Results



## Equipment Used

### Sun photometer( measuring AOT)



Basic circuit of sun photometer

Fully assembled sun photometer

## Future Plans

### Anderson Cascade impactor

- ✦ Air samples are collected using an ACI
- ✦ Freshly cleaved HOPG substrates are placed on 4 of the 8 Stages of ACI
- ✦ ACI is run for at least 2 hrs.
- ✦ The HOPG samples are kept in a clean environment before AFM analysis

### Single particle analysis with AFM

- ✦ The Samples are then analyzed using AFM
- ✦ Morphology and particle sizes are deduced from the AFM images
- ✦ Sizes are then compared with those obtained

## Acknowledgement

- ✦ This project was supported By DOD ARO grant #W911NF-15-1-0510.

### References:

1. Angström, A., On the atmospheric transmission of sun radiation and on dust in the air. Geografis Annal., 2,156-166.
2. Ackerman, A. S., O. B. Toon, D. E. Stevens, A. J. Heymsfield, V. Ramanathan and E. J. Welton (2000), Reduction of tropical cloudiness by soot, Science, 288, 1042–1047.
3. Ackerman, T. P. and O. B. Toon (1981), Absorption of visible radiation in the atmosphere containing mixtures of absorbing and nonabsorbing particles, Appl. Opt., 20, 3661–3667.

# Aerosols

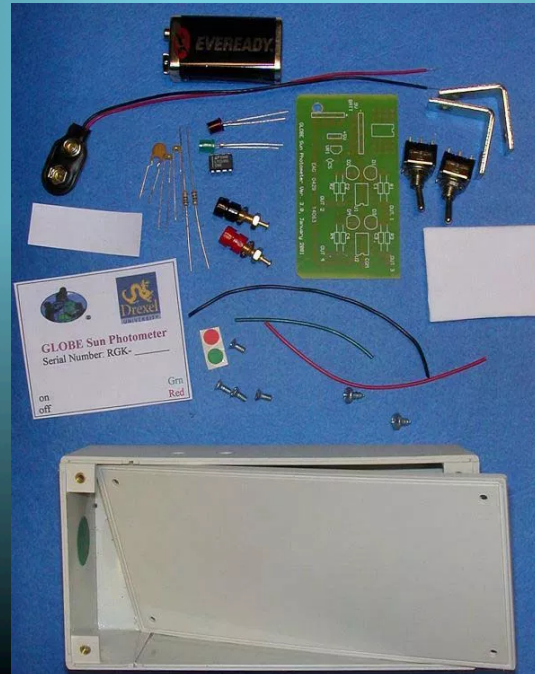
- An **aerosol** is a suspension of fine solid particles or liquid droplets, in air or another gas. **Aerosols** can be natural or anthropogenic.





# Data Collection

- During school:
  - Solar noon collections
- Over the summer:
  - 9am, 11am, 1pm, 3pm, 5pm



# Analyzation

Please note that this web page is the old version of the NOAA Solar Calculator. Back when this calculator was first created, we decided to use a non-standard definition of longitude and time zone, to make coordinate entry less awkward. So on this page, both longitude and time zone are defined as positive to the west, instead of the international standard of positive to the east of the Prime Meridian.

We maintain this page as a courtesy to those people who, for whatever reason, prefer the old calculator. For the rest of you, we encourage you to instead [click here to try the updated version of NOAA's Solar Calculator](#).

City:	Lat	Long	Time Zone
New Orleans, LA	29° 57' 0\"/>		

Calculate Solar Position

Latitude Altitude (minutes):	Solar Declination (degrees)	Solar Azimuth:	Solar Elevation:	zenith of solar zenith angle:
0.04	23.37	200.94	12.84	0

Azimuth is measured in degrees clockwise from north.  
Elevation is measured in degrees up from the horizon.  
As of 8/23 both report data in astronomical units.

$$P = \frac{P}{P_o} \quad P_o = 1013.2$$

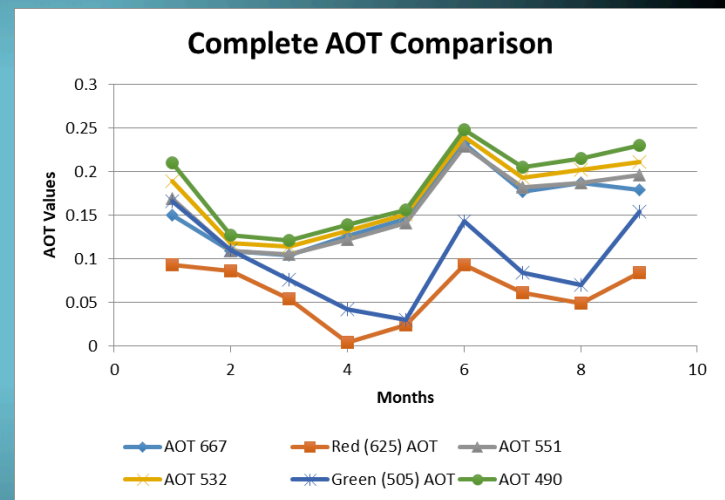
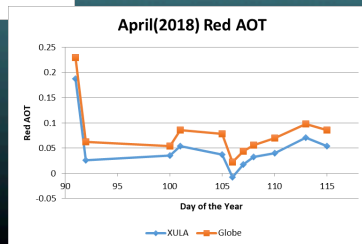
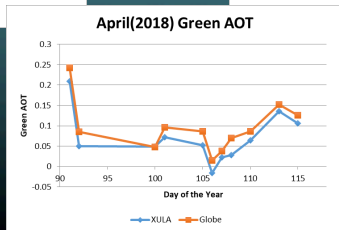
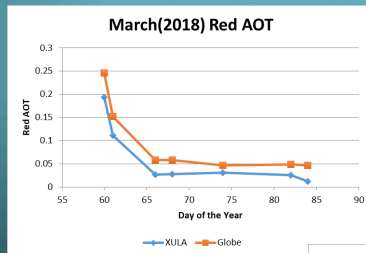
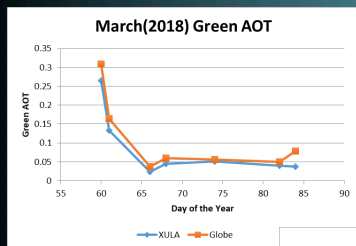
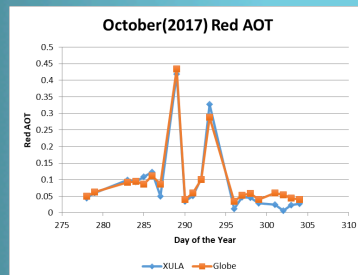
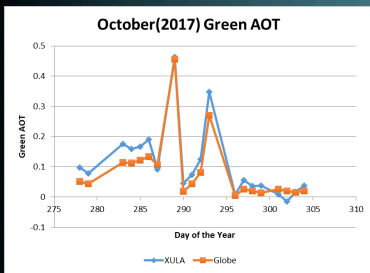
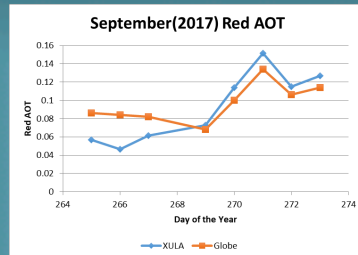
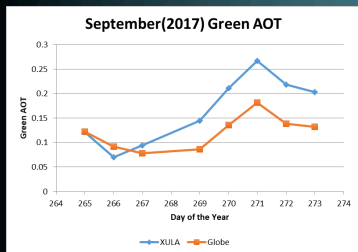
$$m = \frac{1}{\sin(\text{solar elevation})}$$

$$R = \frac{(1 - [?]^2)}{(1 + [?] (360 \times \text{day of the year} / 365))}$$

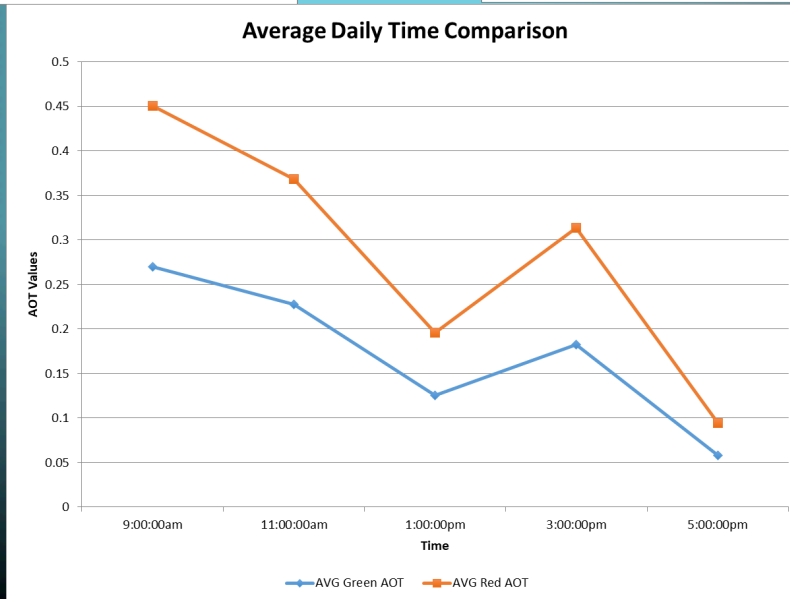
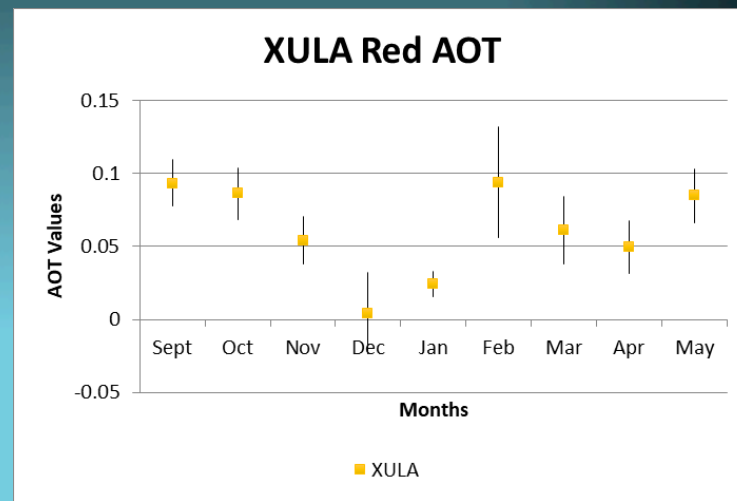
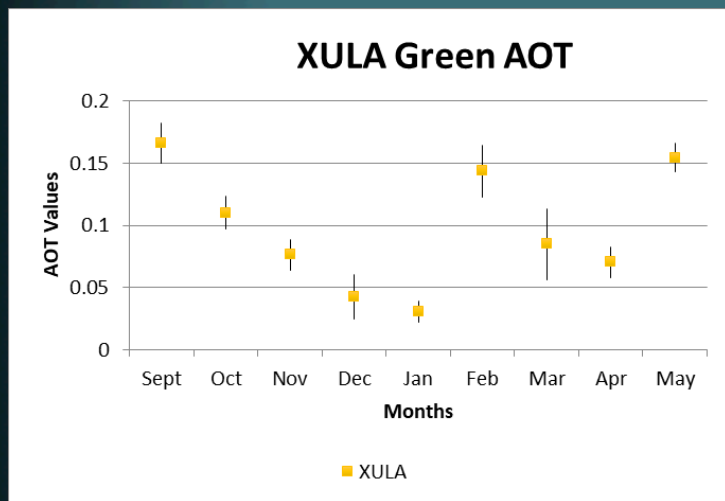
$$[?] = 0.0167$$

# Globe Comparison

# Aeronet



# End Results



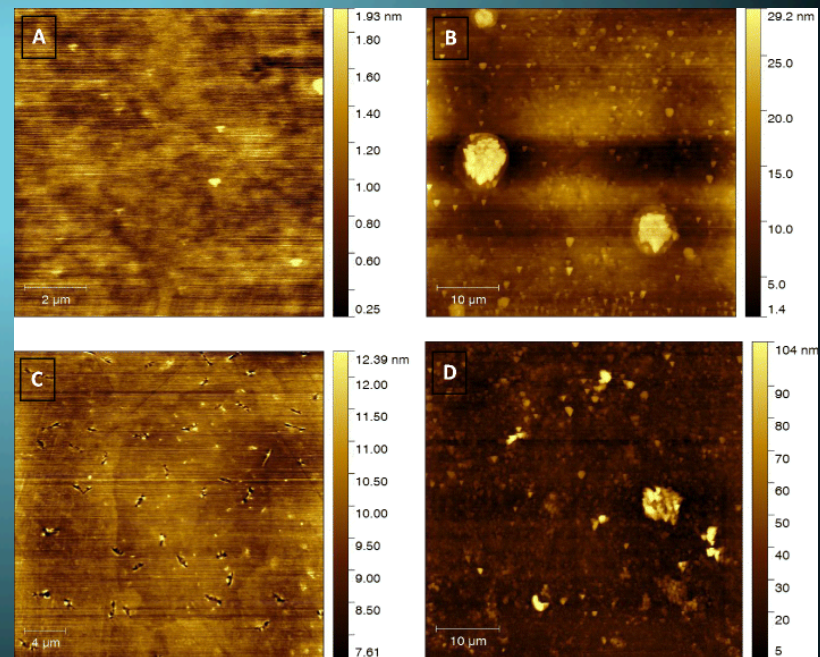


# Future

- Anderson cascade impactor



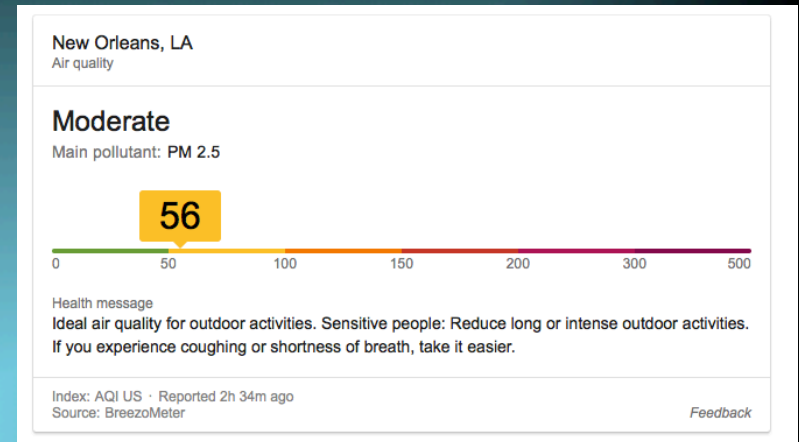
- Single particle analysis with AFM machine





# AQI

- Measures particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide and Ozone
- Ranges from 0 to 500



AQI	Pollution Level	Health Implications
0 - 50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk
51 - 100	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
101 - 150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
151 - 200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects
201 - 300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.
301 - 500	Hazardous	Health alert: everyone may experience more serious health effects