From the Atmosphere to the Classroom

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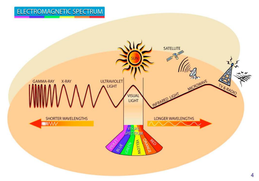
Introduction

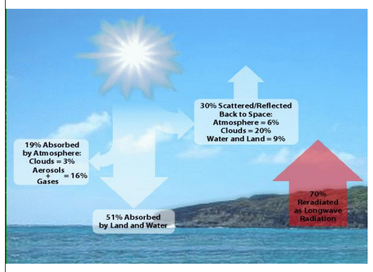
The purpose of this research project was to investigate how an instrument works, what type of data it gathers, what is needed to compare the data to a reliable source, and to determine if an instrument is valid. Each part of the project uncovered another layer of content that needed to be studied. I wanted to see what knowledge and skills are necessary to successfully bring building and using scientific instruments into a an educational environment.

Science Content in Classrooms

Beginning this project I looked at the science content students would bring into an experience to develop an instrument. Based on state standards all children by grade 8 have a basic working knowledge of the role of the sun on Earth, how it interacts with the atmosphere and what happens when sunlight hits different particles.

"Electromagnetic Spectrum"

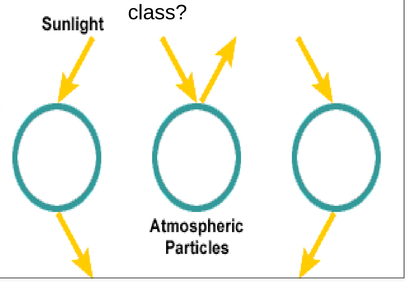




Students understand the EM contains a range of light wavelengths that vary in intensity.

So why is this interaction with particles important? How can students study it? How can they be active learners in a science class?

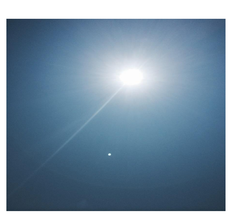
The wavelengths of the light and their intensity can tell scientists quite a bit about the particle types in the atmosphere. The amount of light that is absorbed or scattered is being studied by NASA and other national space agencies.



Examples of data collected

Date 05/05/2014
Picture Time 14:17:31 UTC
Data Time 14:16:36 UTC
Red Dark .006
Red Light .631
Barometric Pressure 1016.5 mb
AOT .6515
AOT ozone corrected .6215

Date 06/17/2014
Picture Time 16:18:24 UTC
Data Time 16:17:20
Red Dark .009
Red Light 1.183
Barometric Pressure 1019.8 mb
AOT .26
AOT ozone corrected .2326

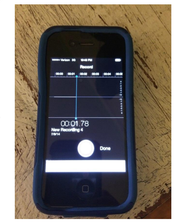


The GLOBE instrument measures at two wavelength channels, 505nm and 625 nm.

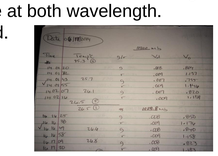
From the Atmosphere to the Classroom

In the winter, spring and early summer of 2014 over 600 measurements were taken with the GLOBE sun photometer. Upon gathering the data it was recorded and calculated. During this time multiple instruments were used to gather data.

GLOBE sun photometer measures the amount of sun reaching the instrument. It uses a green and red LED light as a sunlight detector. When light shines on the LED, a small current is produced. The electronics inside the instrument amplify the current and a voltage is converted.

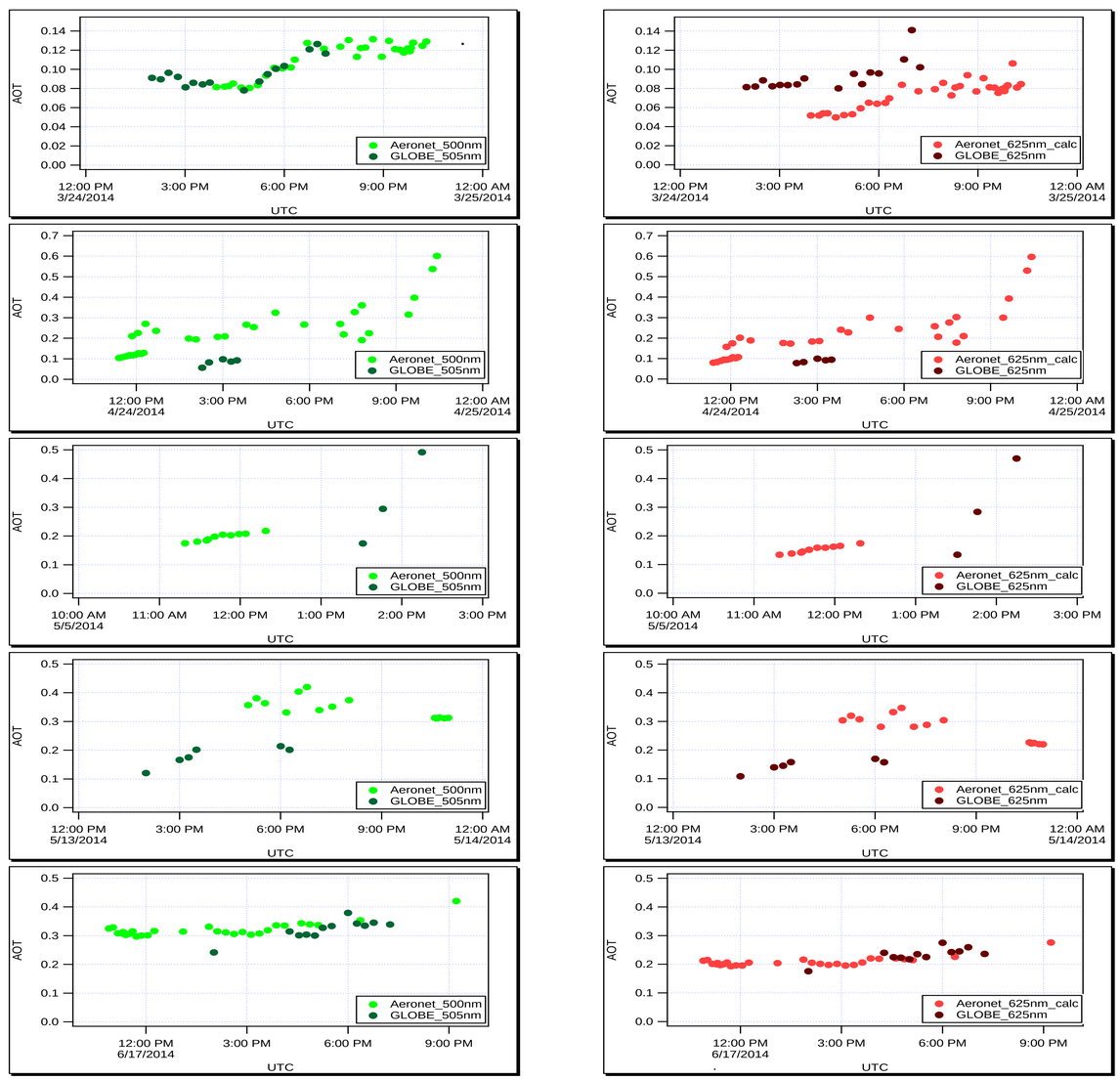


GLOBE sun photometer was verbally recorded into an app on an iPhone. The data included time, ambient temperature of the photometer and the voltage readings at for 500nm and 625nm wavelength including dark voltage at both wavelength. Three trials were done for each 15 minute time period.



Data from the voice recordings was recorded into a lab book. This has been integral in cross referencing data from the iPhone and the Brooks Spreadsheet. Within this spreadsheet the primary calculations were done for aerosol optical thickness, AOT.

GLOBE and AERONET AOT comparison from 3/24/14 to 6/17/14



GLOBE Data was collected on sunny, cloudless days at NASA Langley Research Center in Hampton, Virginia. Comparison data was provided by the AERONET network located at the CAPABLE site approximately one kilometer from collection site.

Calculating AOT for GLOBE

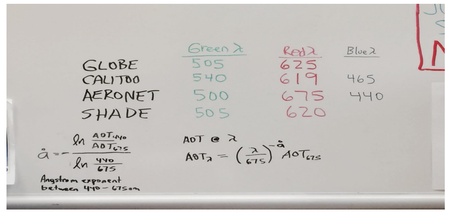
The formulas below are used to calculate AOT from the voltage readings produced by the GLOBE photometer.

$$AOT = \frac{[\ln(V_o/R^2) - \ln(V - V_{dark}) - a_r\,(p/p_o)m]}{m}$$

$$R = \frac{(1-\varepsilon^2)}{[1+\varepsilon\cos(360^0 \bullet d/365)]}$$

V_o= Calibration constant for each channel
R= Earth-Sun distance
ε= Eccentricity
d= Day of year (Julian Day)
V= Voltage readings obtained with photometer
V_{dark}= Dark voltage readings obtained with photometer
a_r= Rayleigh scattering coefficient for each channel
P=Pressure at location and time of readings
P_o= Standard sea-level atmospheric pressure
m= air mass

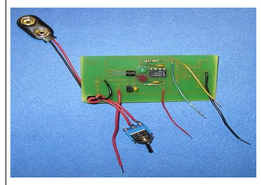
To calculate the AOT between instruments measuring with different wavelengths, it is necessary to calculate and use the Angstrom exponent.



Building the GLOBE Photometer

Printed circuit board- front and back

LEDs-green/red, op amp



Battery connector, switch, wires

Battery, temperature sensor

I will need to learn the function of each part, learn to solder and the flow of the schematic. From this I want to see how we can integrate this building process Into an educational environment.

Acknowledgements

I would like to thank Dr. Margaret Pippin. Additionally, I would like to thank the following LaRC interns for their support and patience: Robert Bujosa, Stephen Haggard, Cara Moulton and Maricely Ramirez Hernandez.

References

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