Using An Aethalometer to Determine Optical Absorption Features from Different Black Carbon Sources

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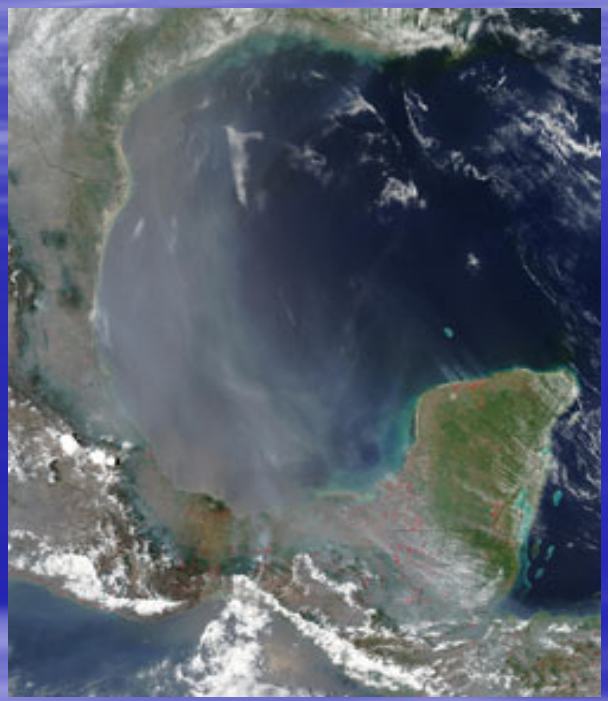
Background



NASA/ MODIS are credited for this satellite image of a large haze, smoke plume over the southern Texas, Gulf of Mexico and the Yucatan Peninsula (2).

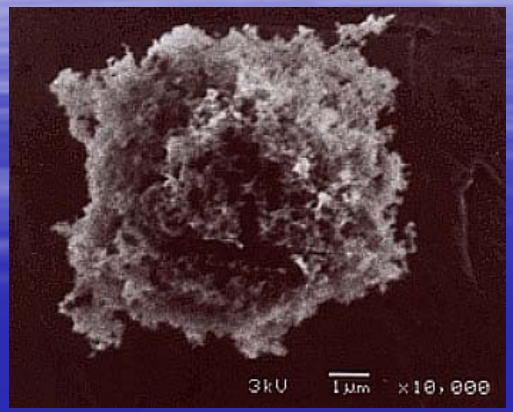
- Aerosol Impacts on Climate
  - Aerosols are introduced into the atmosphere as particulate matter.
  - Aerosol particle sizes of most importance range between 0.1μm-1μm.
  - A main source of black carbon is combustion derived.
  - Other sources include diesel exhaust from vehicles.

Background

Picture taken by NASA of a wheat field burning in progress (1).

- Biomass Burning:
  - Biomass burning further contributes to the gradual increase of black carbon aerosols in our atmosphere.
  - Refers to burning dead or living biological matter.
  - An example of this is when farmers burn fields after harvest.
  - Wheat, rice and corn fields are commonly burned.
  - Forest fires are also considered biomass burning.
  - Is a primary source of nitrogen oxides, carbon dioxide and hydrocarbons.

Black Carbon Aerosols



An electron Microscope Image of a Black Carbon Soot particle (4).

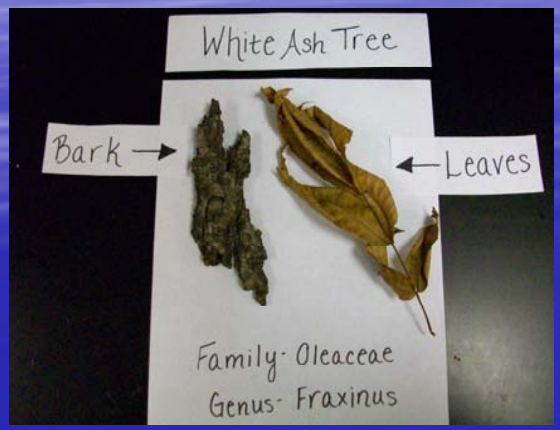
Soot being emitted from a diesel tanker (5).

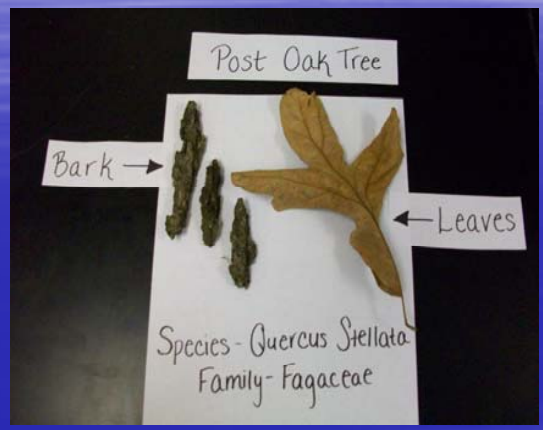
- Black Carbon derives from incomplete combustion of fossil fuels, biofuel, and biomass, and is emitted in both anthropogenic (from human influences) and naturally occurring soot (6).
- Black Carbon warms the planet by absorbing heat in the atmosphere and by reducing albedo (an object's ability to reflect sunlight, such as snow) (8).
- Black Carbon stays in the atmosphere for only several days to months, whereas CO_2 has an atmospheric lifetime of more than 100 years (6).
- Aerosols that contain black carbon both absorb and reflect incoming sunlight, therefore, these particles can exert a regional cooling influence on Earth's surface that is about 3 times greater than the warming effect of greenhouse gases (7).

Instruments

- Aethalometer
  - A piece of equipment that extracts air and measures the amount of black carbon in the air at 7 different wavelengths.
  - The 7 wavelengths are: 370 nm., 470 nm., 520 nm., 590 nm., 660 nm., 880 nm., and 950 nm.
  - In an indoor environment, the aethalometer monitors the smaller BC particles.
  - An example of this would be the diesel exhaust from buses into schools.

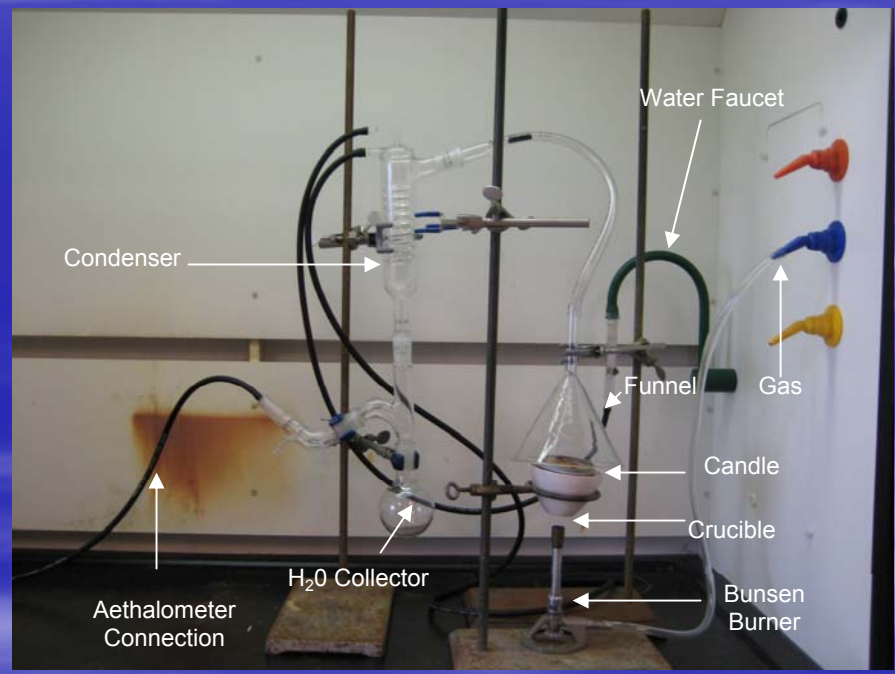
Burning Samples





The Combustion System

- After taking samples of lab air with the aethalometer, testing began on black carbon accumulations from individual burns.
- This system is connected to the aethalometer, so that the only air that is sampled is the air from the burning sample.
- This method serves as a substitute that helps show the direct effect of biomass burning
- The burning lasted between 20 minutes to an hour.



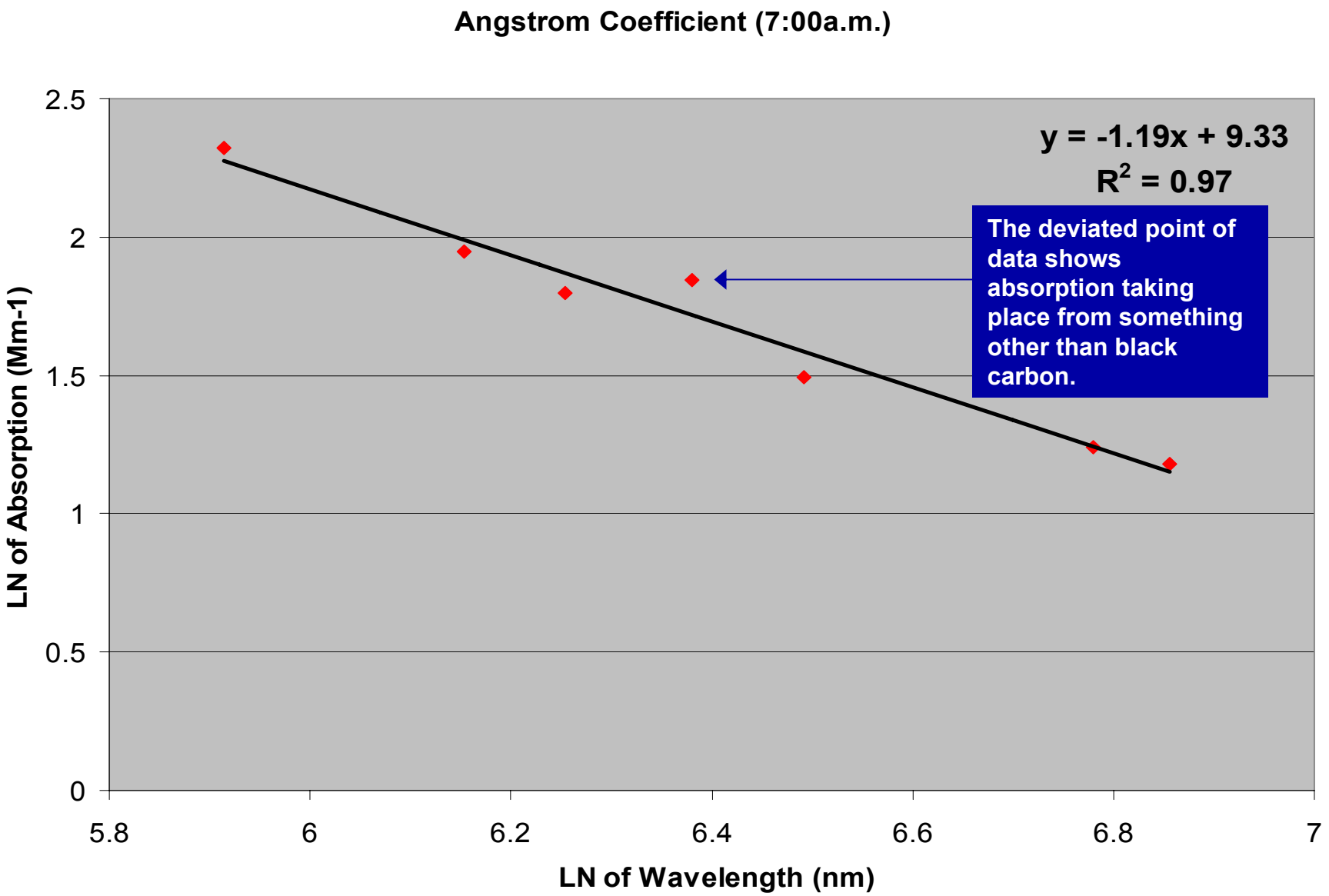
Analyzing the Data

- The data was collected on a floppy.
- The data is then analyzed and broken down into graphs.
- First, establish which hours of data will be the primary focus.
- Time focus: 12:00a.m., 7:00a.m., 12:00p.m. and 6:00p.m.
- The absorption, natural log of the wavelengths, and the natural log of the absorptions are calculated.
- This information is then formatted onto a graph, which displays a slope known as the Angstrom Coefficient ($A=\beta\lambda^{-\alpha}$).

Angström Coefficient Graphs

- Angstrom Coefficient-describes wavelength of aerosol absorbance.
- It means that there is something absorbing, which is why in most cases it will not reach the goal of 1.
- If the Angström coefficient slope is lower than 1, there are traces of inorganic dust particles present.
- If Angström coefficient slope is higher then 1, secondary organic particles, such as humic like substances, are present.

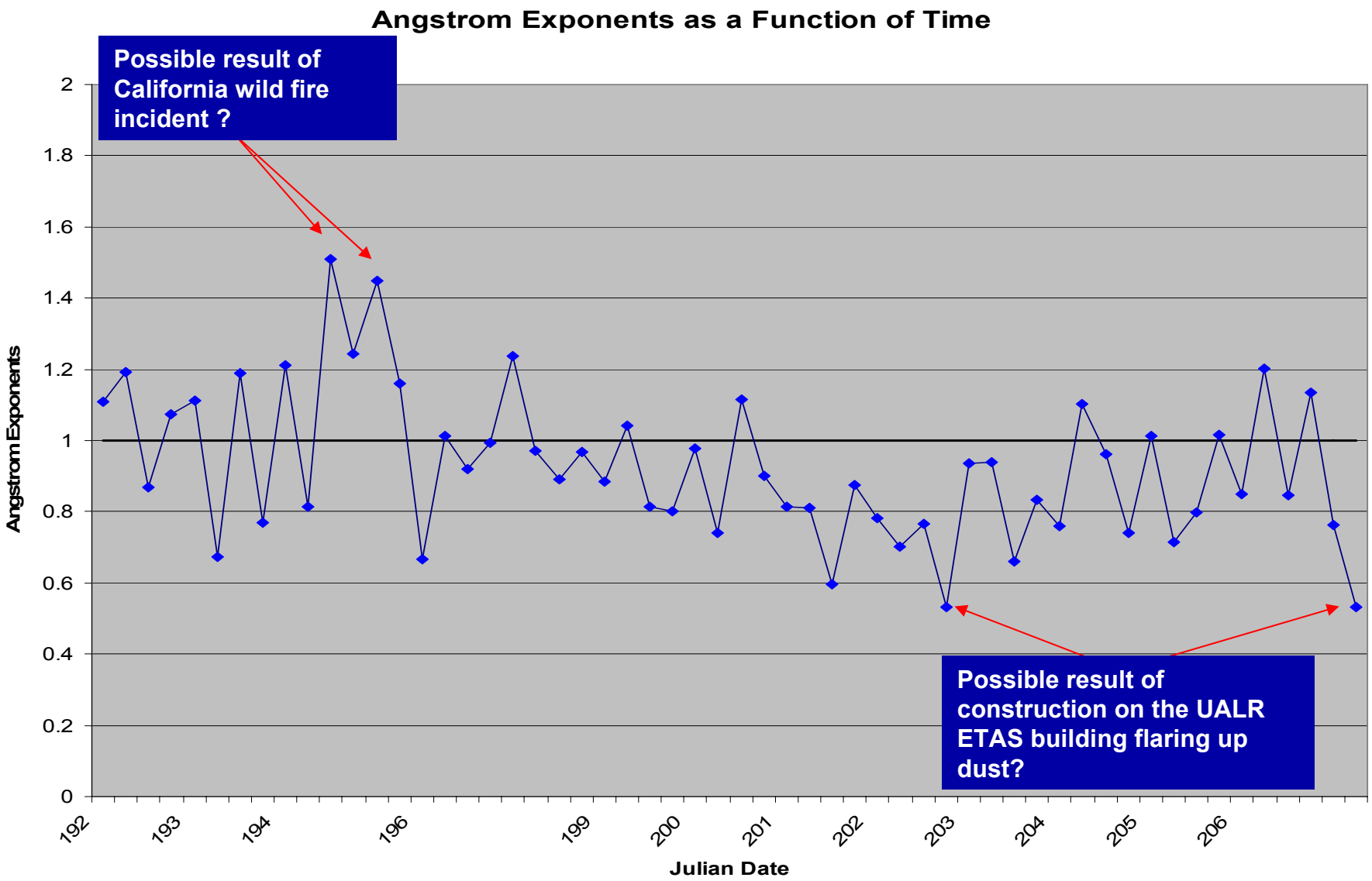
Angström Coefficient Graph



Angström Exponent as a Function of Time

- After finding the Angstrom exponents of each date and specific hours, all of the angstroms are then put together on a graph as a function of time.
- This is how we can gradually see an obvious pattern of black carbon peaks on certain days.

Angström Exponent as a Function of Time



Averages for the Burned Specimens

Burned Sample	Angstrom Coefficient	Alpha (α)
Unscented Candle	-0.86	0.72
Scented Vanilla Candle	-0.96	0.96
Scented Cinnamon Candle	-0.28	0.86
Post Oak Tree Leaf	-1.49	0.94

Future Works

- To use spectrophotometer which is an optical instrument
- measures properties of light over a light spectrum.
- This instrument analyzes the data on the entire UV- Visible wavelength range

Future Works

- UALR will be establishing an Atmospheric Observatory
- Compare indoor and outdoor aethalometer data.

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References

1. www.nasa.gov: *Goddard Space Flight Center*. Mike Bettwy. 2006. July 2008. <http://www.nasa.gov/environment/central_am_fires.html>.
2. www.nasa.gov: *Biomass burning and the Production of Greenhouse Gases- NASA Langley Research*. Joel S. Levine. 1994. July 2008. <http://www.nasa.gov/environment/central_am_fires.html>.
3. www.merriam.com: Webster's Online Dictionary- "Pollution". 2008. August 2008. <http://www.merriam.com/dictionary/pollution>
4. www.iarc.uaf.edu: *Wildfire Soot May Contribute to Melting Sea Ice and Glaciers in the Arctic*. Barbara Travis and Reginald R. Muskett. 2005. August 2008. <http://www.iarc.uaf.edu/wildlife_soot/index.php.html>
5. Wikipedia Encyclopedia: Keyword- "Soot". United States Environmental Protection Agency. 2008. August 2008. <www.wikipedia.org/>.
6. *Seven Nature Geoscience: Global and Regional Climate Changes Due to Black Carbon*. Ramanathan V., and G. Carmichael. March 23, 2008. p. 221-222.
7. *Unisci: Daily University Science News*. Mario Aguilara and Cindy Clark. 2001. August 2008. <http://www.unisci.com/stories/20013/0817013.html>.
8. Wikipedia Encyclopedia: Keyword- "Albedo". *Pavement Albedo.* Pon Brian. 2007. August 2008. <www.wikipedia.org/>.