Regional Climate Forcing by Carbonaceous Aerosols: Relating Optical Properties to Chemical Composition to Improve Predictions

We gratefully acknowledge DOE-ASR funding; Ashley Williamson, Program Manager

Objectives

- Radiative forcing by carbonaceous aerosols is a largest sources of uncertainty in climate model
- They absorb and scatter sunlight to warm or cool the atmosphere depending on their Single Scatter Albedo, SSA = Scattering/(Scattering+Absorption)
- SSA is a complex function of the chemical composition and size of these aerosols. Models compute it from transport and chemistry of emissions with very idealized assumptions of optical properties. Unfortunately, these approximations are un-validated.
- We use our Arctic and Asia field data to relate aerosol chemistry to their optical properties
- Aerosol optical properties measured by our 3-wavelength photoacoustic spectrometer-PASS3

Chemical-Optical Relations

- SSA (405 nm) vs. OC/sulfate ratio and nitrate/sulfate ratio for pollution episodes 3-8. The composition charts are for high, medium, and low OC/sulfate pollution episode. High OC/sulfate results in low SSA at 405 nm implying “brown carbo-nitrate”
- Brown carbon absorbs more light in Blue-UV than soot
- SSA for high, medium, and low OC/sulfate episode. The darkening observed at 405 nm is due to enhanced absorption by OC or brown carbon
- Wavelength dependence of the Mass Absorption Coefficients (m2g) for black carbon (open circle) from laboratory studies and brown carbon (BC + OC)

ISDAC: Alaska 2008

PASS3 and Single Particle Laser Ablation Spectrometer (SPLAT) deployed on CONAIR in April 2008. On 19 April we interrogated a large biomass burning plume

Vertical Distribution of Optical Properties 4/19/08

- Vertical distribution of optical properties show pollution layers with alternating in high and low SSA. The extinction Angstrom exponent, measures its wavelength dependence and is high for small (combustion) and low for large particles (dust)
- Large transient (weeks) forcings from Arctic haze and long range pollution transport need to be included in climate models