Optical Property Measurements of Urban and Regional Particulates Using the CAPS PM_{ex} Particle Extinction Monitor

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WHY

Instrumentation for the Measurement of Aerosol Optical Properties

- Simple in Operation
- Rugged
- Inexpensive Components
- Stable
- State-of-the Art Performance

HOW

Cavity Attenuation Phase Shift Extinction Spectrometer ($CAPS\ PM_{ex}$)

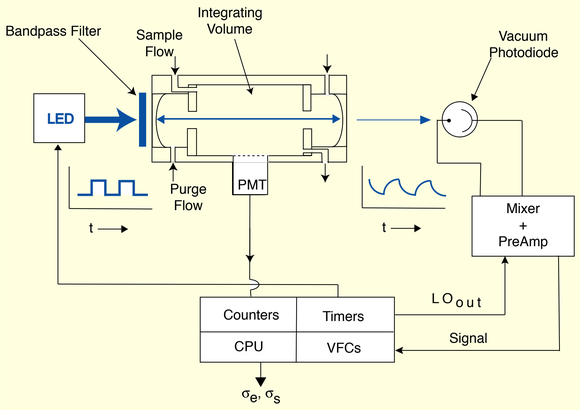
- Use Low-Loss Optical Cavity to Produce km Pathlengths
- Square Wave Modulate Light Souce
- Detect Distorted Waveform Emitted from Cavity
- Phase Shift Provides Information on Particle Extinction

$$\cot\vartheta = \cot\vartheta_0 + (c/2\pi f)\,\sigma_e$$

where ϑ = Measured Phase Shift
ϑ_0 = Phase Shift for Particle-Free Cell
f = Modulation Frequency
σ_e = Extinction

$CAPS\ PM_{ex}$ Particle Extinction Monitor

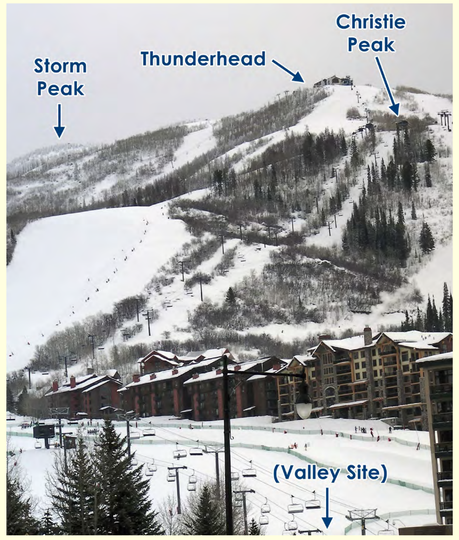
- Time Response ~1 s (10-90%)
- LOD (3σ, 1s) = 2 Mm^{-1}
- Rack Mount, 12 kg, 50 W, 0.85 l min^{-1} Flow



- Near-Confocal Optical Cavity
  25 cm Base Length
- Light Emitting Diode (LED) Light Source
  445 nm, 530 nm or 630 nm

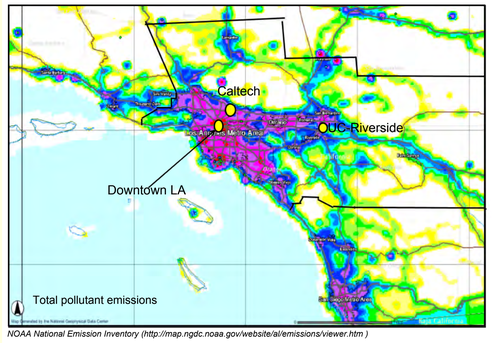
WHERE

StormVex Campaign
Steamboat Springs, CO



CalNex-LA Ground Site, Pasadena, CA

South Coast Air Basin: Emissions Map



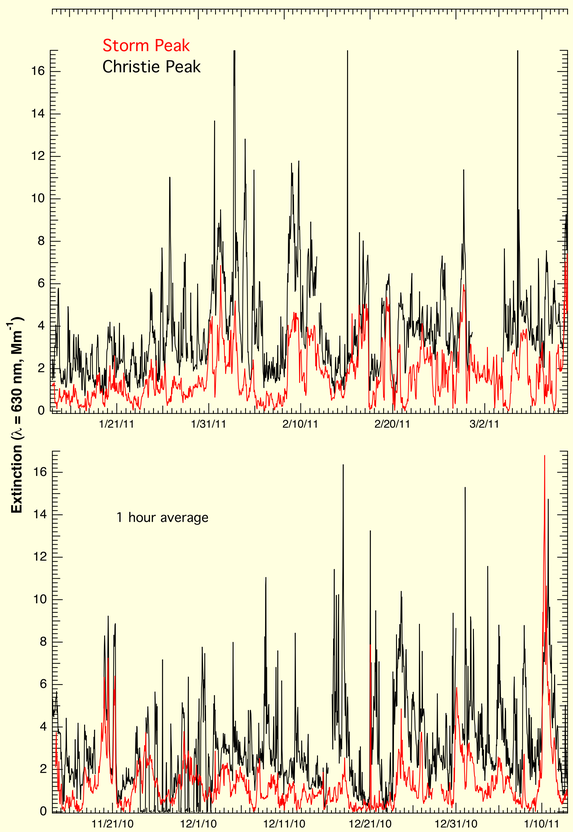
NOAA National Emission Inventory (http://map.ngdc.noaa.gov/website/al/emissions/viewer.htm)

StormVex Campaign

November 2010-April 20111

- Two Sites
  Storm Peak Laboratory (DRI) (alt. 3220 m)
  ARM AMF2 Deployment at Christie Peak (alt. 2440 m)

- Fully Instrumented for Particle Optical Property Measurement
  - Absorption (PSAP)
  - Scattering (Nephelometer)
  - **Extinction ($CAPS\ PM_{ex}$)**



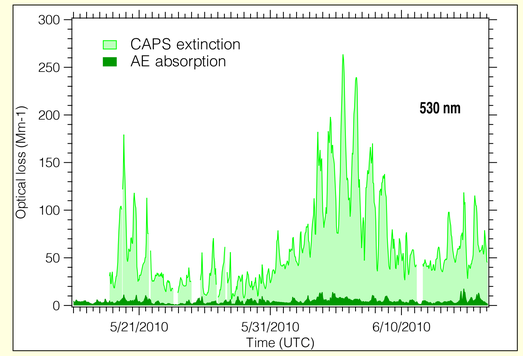
- Four Months of Continuous Data
  - Strong Correlation Between Sites
  - Occasional Local Events
    Snow Clearing Equipment
    Vehicular Traffic
  - Some Meteorological-Linked Events

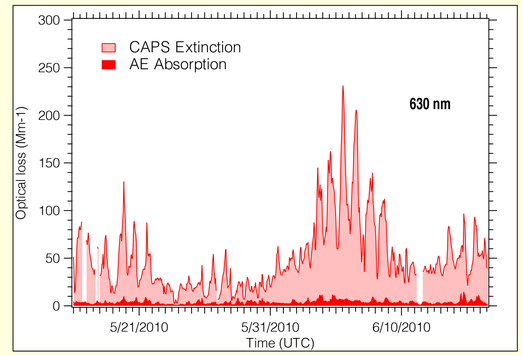
- Future Analysis
  - SSA at Both Sites
  - Effects of Meteorology (Thermal Inversion) on Loadings

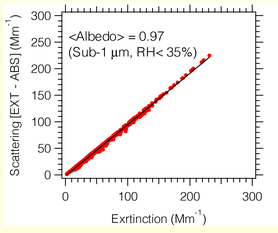
CALNEX CAMPAIGN

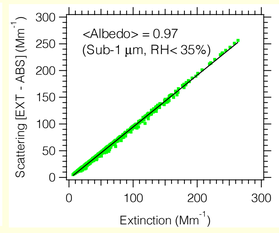
May-June, 2010

- Sub-1 µm Dried (RH < 35%) Particles
- Measure Extinction at ~ 530 nm and 630 nm
  Combine with Aetholometer Absorption Data
- Absorption Contributes Little to Total Extinction
  - <Albedo> = 0.97 ± 0.01









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