Black Carbon from Biomass Burning

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Introduction

- **~50% Black Carbon (BC) is from Wildfire/Biomass Burning (BB) Globally**
  - Estimated to contribute ~0.6 W m^{-2} atmospheric warming globally

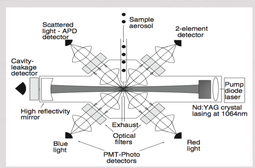
Las Conchas from the International Space Station

- Organic Aerosols co-emitted
  - OA can condense on and mix with BC, decreasing the total forcing
  - Reduction depends strongly on composition and mixing state
- **Global Atmospheric Forcing from Biomass Burning: 0.03 ± 0.12 W m^{-2}**
- Modeling and lab studies indicate
  - a BC core coated with a non-absorbing OA layer enhances absorption with a positive climate forcing
  - (Cross et al, 2010)
  - To date: not been observed in ambient (Cappa et al, 2012).

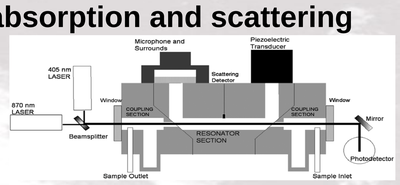
Instrumentation

- **Single Particle Soot Photometer (SP2): Direct, online measurement of BC mass**
  - Single particle incandescence and scattering

Schwarz, J.P., et al. JGR-A, 111, D16207, 2006.



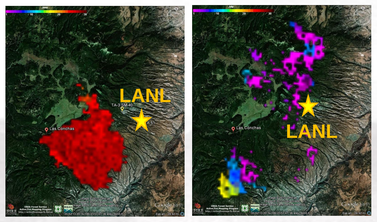
- **PhotoAcoustic Soot Spectrometer (PASS): Direct, online measurement of absorption and scattering**



  - 375, 405, 532, 781 nm wavelengths
  - Aerosol absorption coefficient (β_{abs})

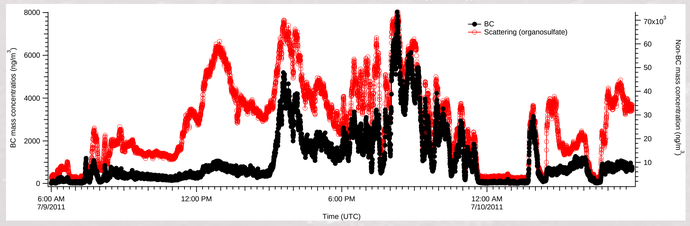
Fresh Las Conchas, 2011

- **2nd Largest NM Fire**
  - June-August 2011
  - ~160K acres
  - ~10 miles W of LANL
  - Lightning-caused
  - Fuel: litter/understory

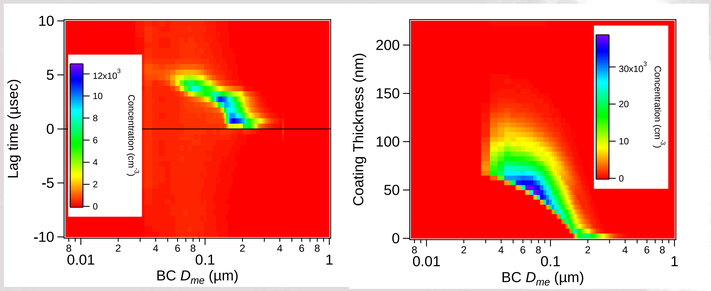


USDS MODIS Fire Burn Scars

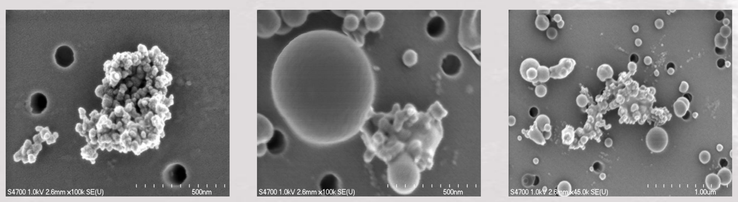
- Average Total $PM_{2.5(10)}$ = 94 (117) µg m^{-3}
  - Peaks up to 1400 µg m^{-3}
  - Prior Background Average = 15 (31) µg m^{-3}
    - **BC concentrations up to ~10 µg m^{-3}**
      - 10-100x forest background in CO
      - ~1-3 hours atmospheric aging



- **SP2 Coating Analysis**
  - **Time Lag and Thickness**
  - Fresh Las Conchas dominated by positive time lags, i.e. thickly coated BC
  - Minimal presence of nsBC defined as negative time lag BC (Sedlacek et al, 2012), observed in this near source BB

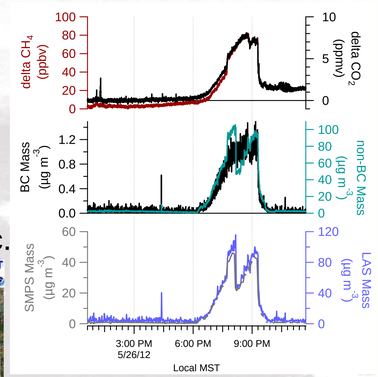


- **Scanning Electron Microscopy (SEM) Images**
  - Internal and external mixtures of BC, OA, tar balls
  - S. China, C. Mazzoleni, K. Gorkowski, A.C. Aiken, M.K. Dubey. submitted

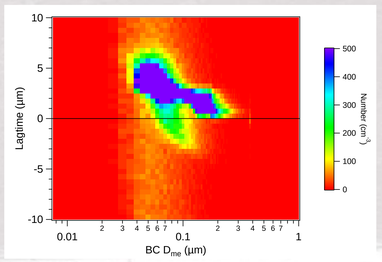


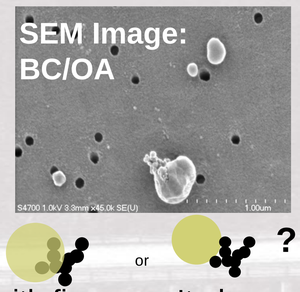
Aged Whitewater Baldy, 2012

- **Largest Fire in NM** History (May-July ‘12)
  - ~300K acres
  - 220 mi. SW of LANL
  - ~ 9 hrs atmos. aging
  - Lightning-caused
  - Fuel: mixed conifer, pine, juniper, grass, etc.

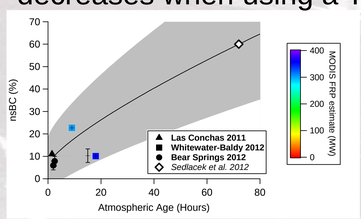


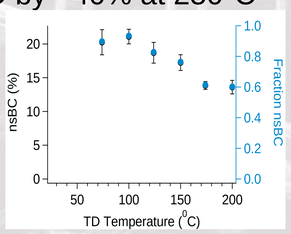
- **SP2 Coating: Near-Surface BC (nsBC)**
  - **Present in Aged BB plumes**



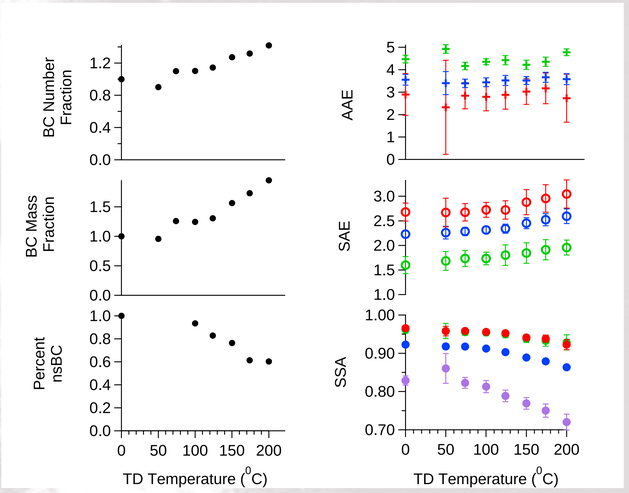


- nsBC may be correlated with fire age. It also decreases when using a TD by ~40% at 250^{0}C





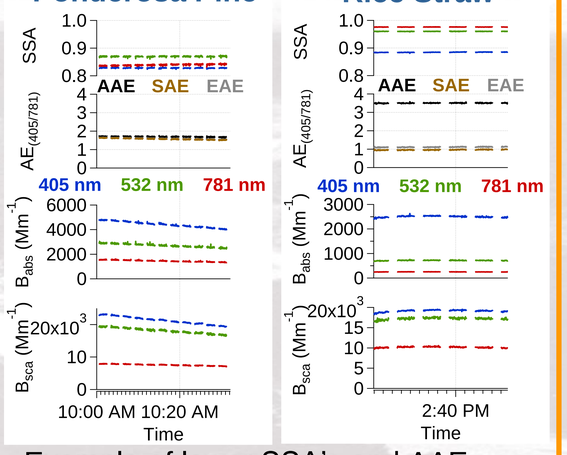
- **TD profiles for BC and Optical Properties**
  - SSA decreases the most @ 375 nm
  - SAE increases slightly with temperature



FLAME-IV

- Fire Lab at Missoula Expts. IV (Nov. ‘12)
- Fresh stack, **mixed room**, aged source

Ponderosa Pine **Rice Straw**



- Example of lower SSA’s and AAE (by ~2) for a conifer vs. a grass source

Conclusions

- BC mixing state investigated from the two largest fires in NM history
- A range of atmospherically aged BB BC was sampled (1-20 hours old)
- SP2 results are corroborated by SEM and energy dispersive spectroscopy (EDS) of single particles that show shifts in morphology
- Thermal denuding (TD) studies provide additional information on the nature of the OC and the BC coatings (not shown)
- Up to 23% of the internally mixed BC was nsBC in the older WB plumes
- For the plumes sampled the majority of the BC exhibits a core-shell coating structure for the range of aging times and conditions sampled here
- The nsBC fraction is smaller for the relatively fresh LC plume than aged WB
- When the TD was operated at 200^{0}C ~50% of the nsBC was removed
- A conceptual framework of increasing %nsBC with age was developed for the BB data shown here
- FLAME-IV data shows differing optical properties for different fuel types, e.g. conifer versus grass.

LA-UR—submitted to RLM