Chemical composition and optical properties of wildland and agricultural biomass burning particles measured downwind during BBOP study

Timothy Onasch[1], John Shilling[2], Arthur Sedlacek[3], Edward Fortner[1], Mikhail Pekour[2], Duli Chand[2], Andrew Freedman[1], Shan Zhou[4], S. Collier[4], Q. Zhang[4], Larry Kleinman[3], Joda Wormhoudt[1], Douglas Worsnop[1], Robert Yokelson[5], Kouji Adachi[6], Peter Buseck[7], Leah Williams[1]

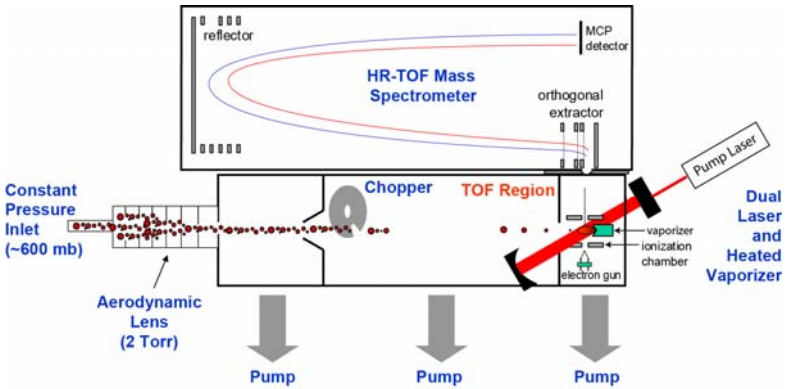
[1]Aerodyne Research Inc., Billerica, MA; [2]Pacific Northwest National Laboratory, Richland, WA; [3]University of California - Davis, Davis, CA; [4]Brookhaven National Laboratory, Upton, NY; [5]University of Montana, Missoula, MT; [6]Meteorological Research Institute, Japan; [7]Arizona State University, Tempe, AZ

DOE ASR and ARM funding

Chemical and Optical Measurements

Chemical & Physical Measurements	
NR-PM:	SP-AMS, TEM
rBC:	SP2, SP-AMS, TEM
Size:	UHSAS, PCASP, FIMS

Optical Measurements	
Extinction:	1-λ CAPS PMex (630 nm)
Scattering:	3-λ Nephelometer (450, 550, 700 nm)
Absorption:	1-λ PAS (355 nm)
	1-λ PTI (532 nm)
	3-λ PSAP (462, 523, 648 nm)



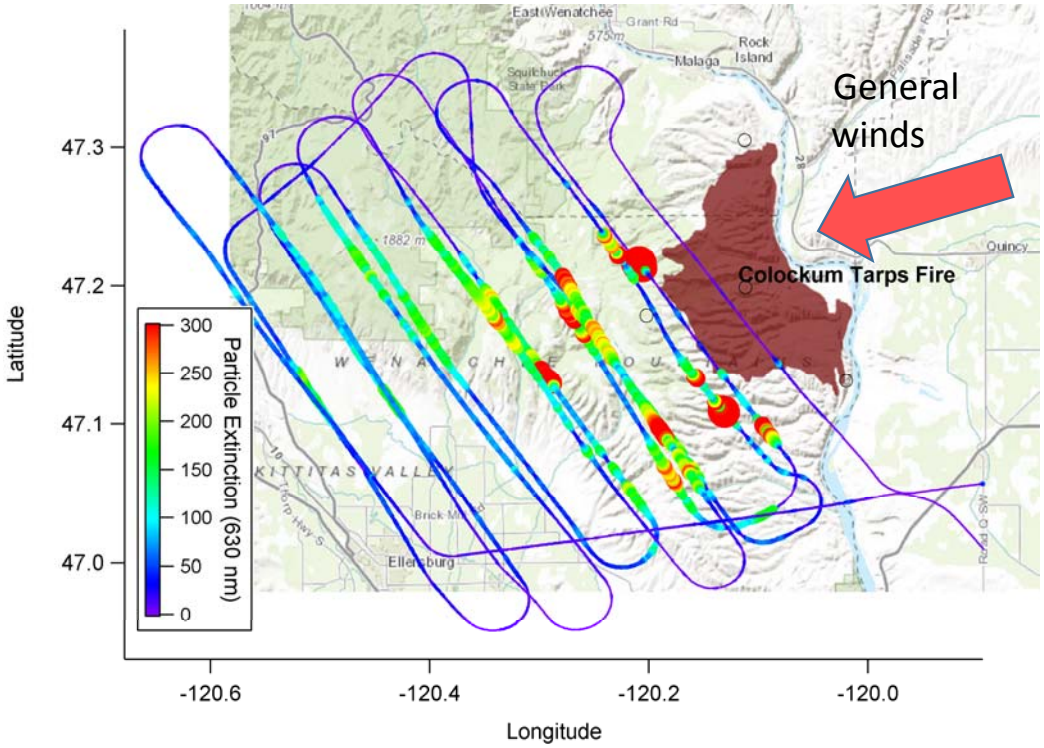
Soot Particle Aerosol Mass Spectrometer (SP-AMS)

SSA's derived from SCAT/EXT

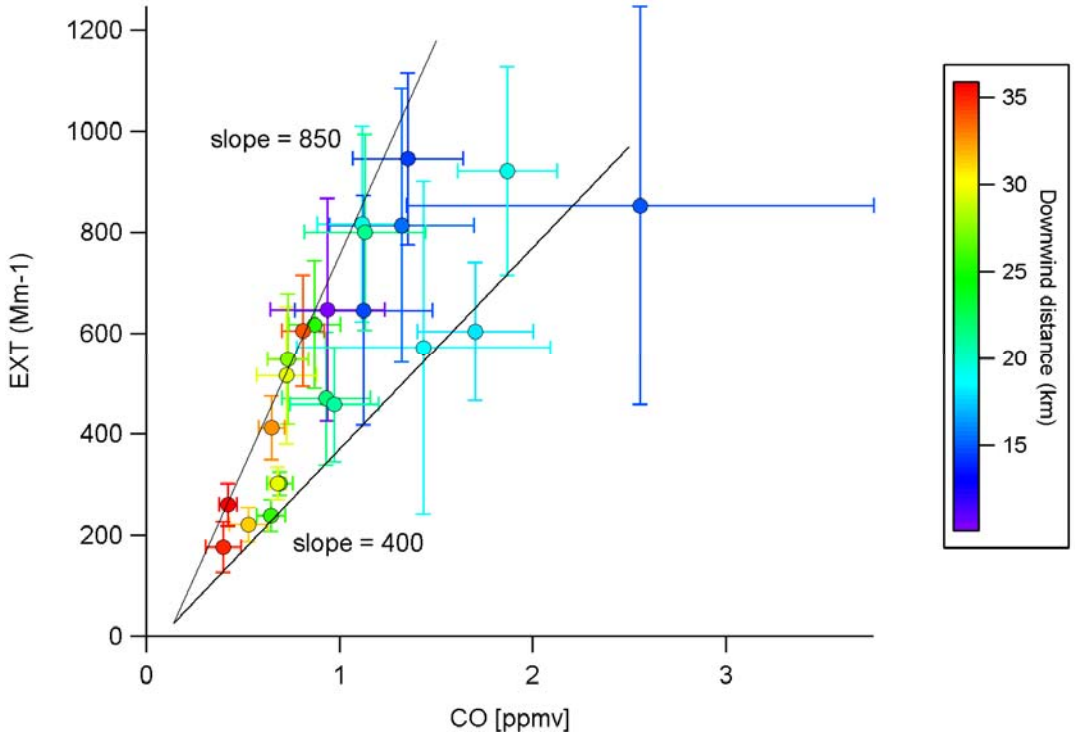
- EXT: CAPS PMex (630 nm)
- SCAT: NEPH (550 and 700 nm)
  - Interpolated at 630 nm using Angstrom coefficient

Colockum Tarps Fire (2nd flight July 30)

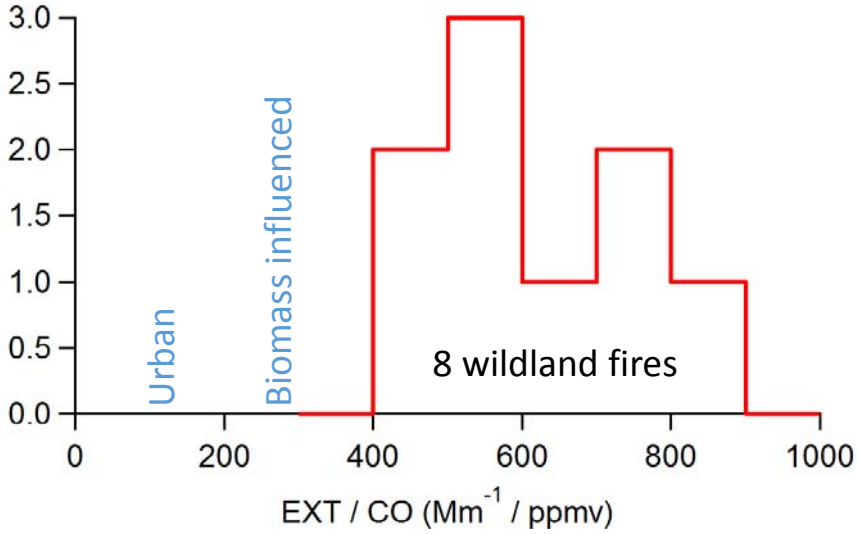
Extinction



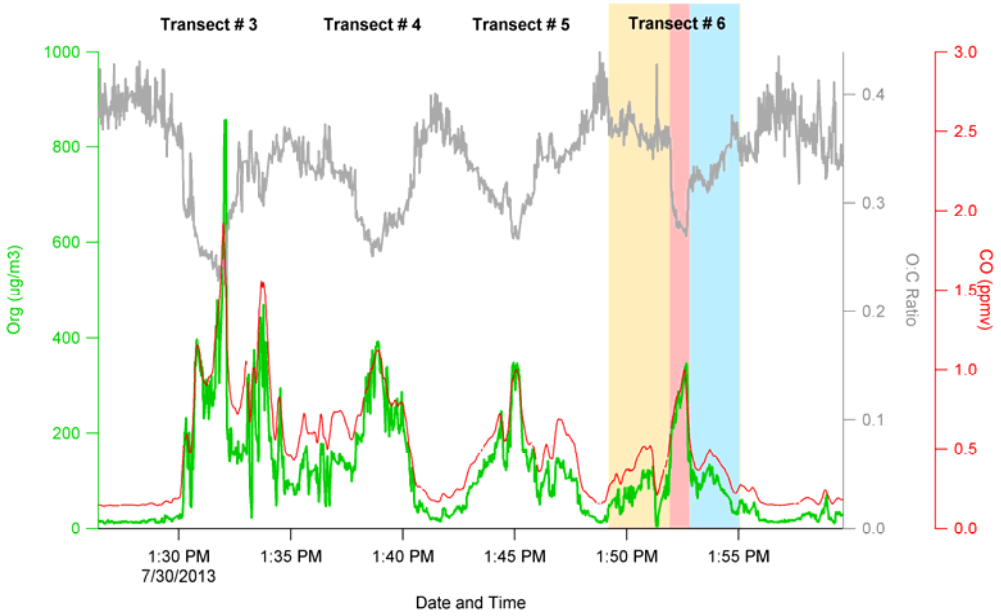
ΔExtinction / ΔCO

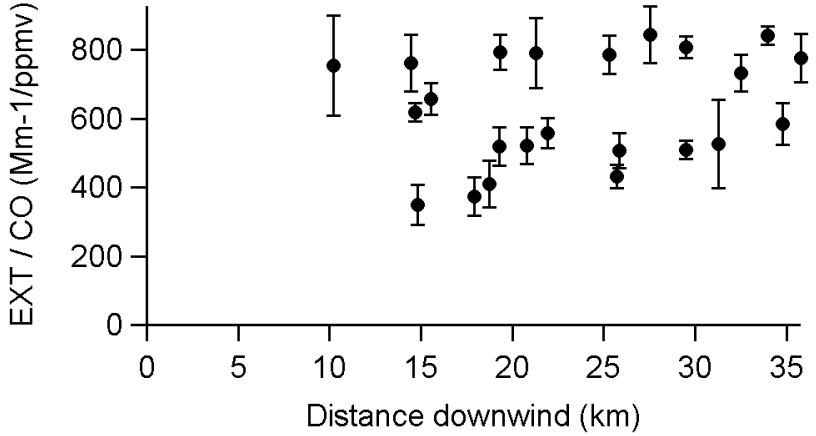


Dingle et al., 2016 ACPD



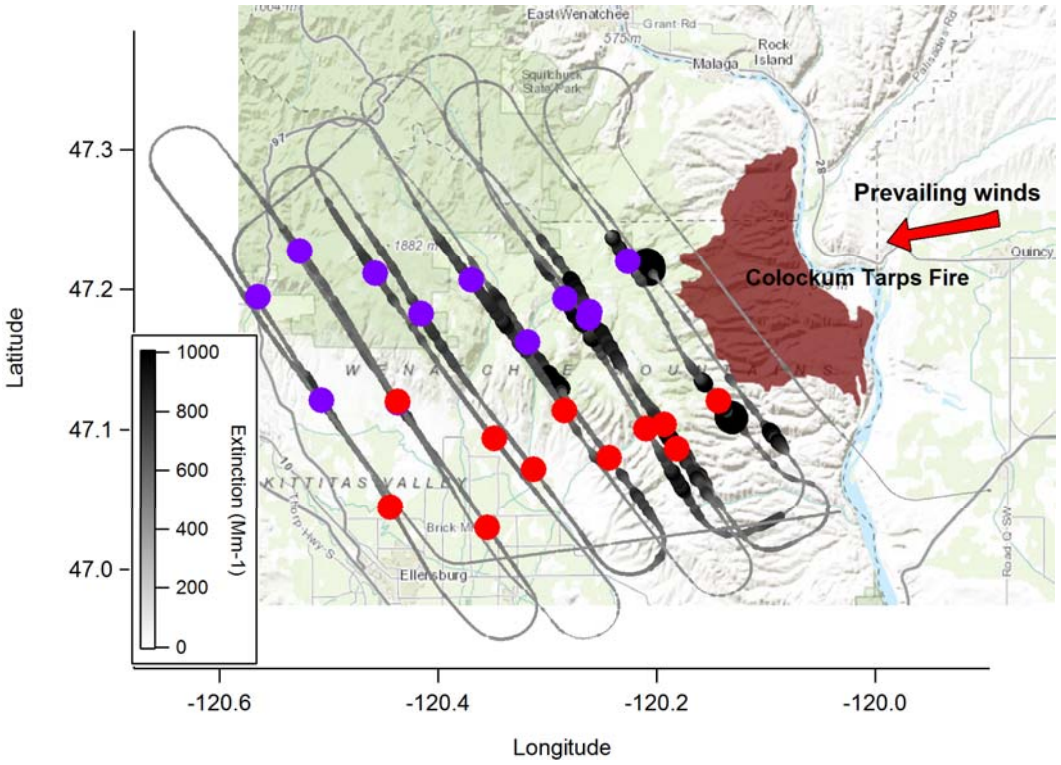
Transects downwind

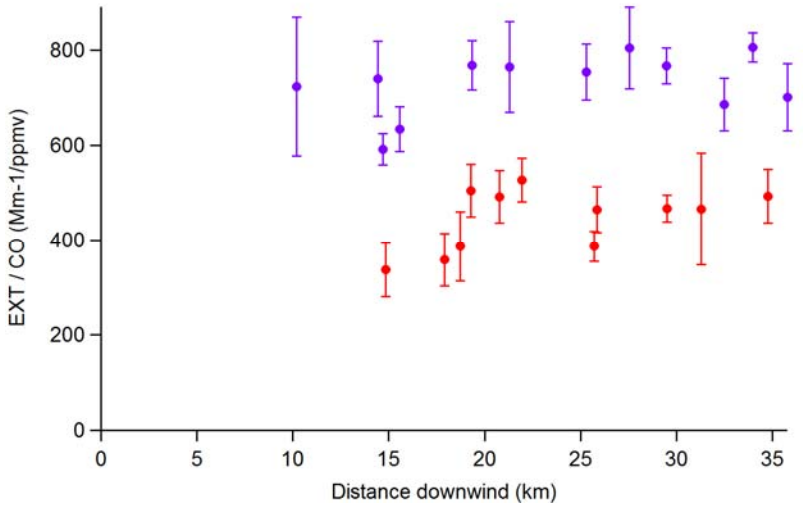




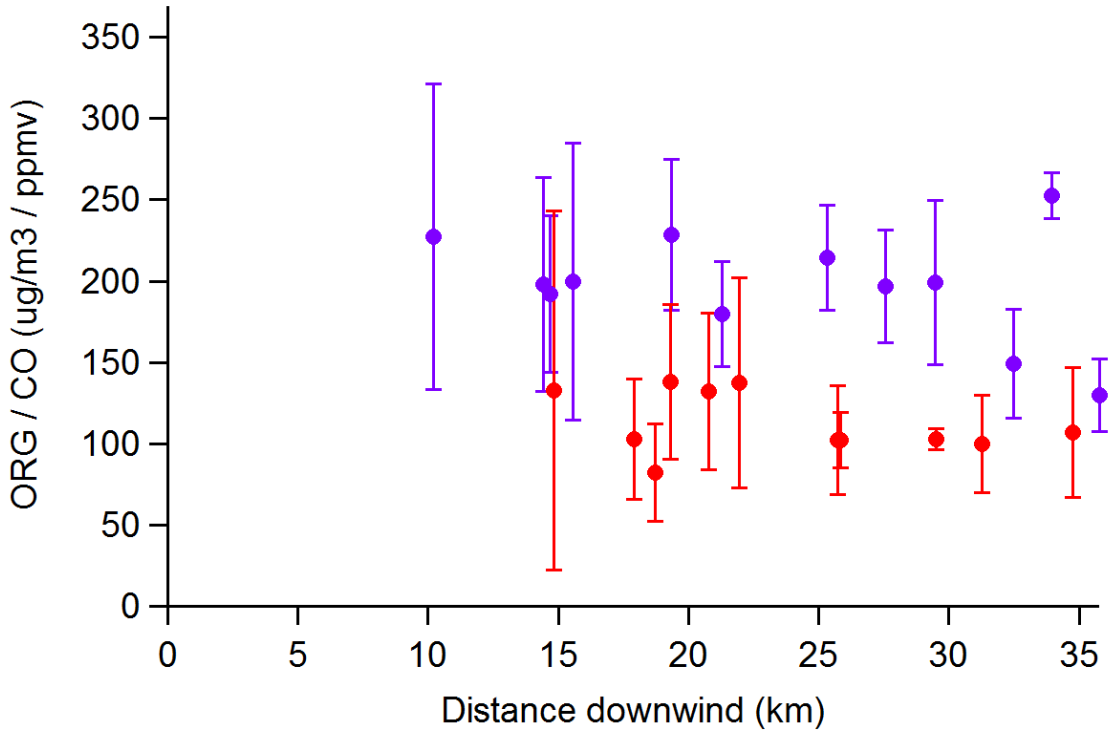
- Sampling different plumes during individual fire transect

Different burn conditions



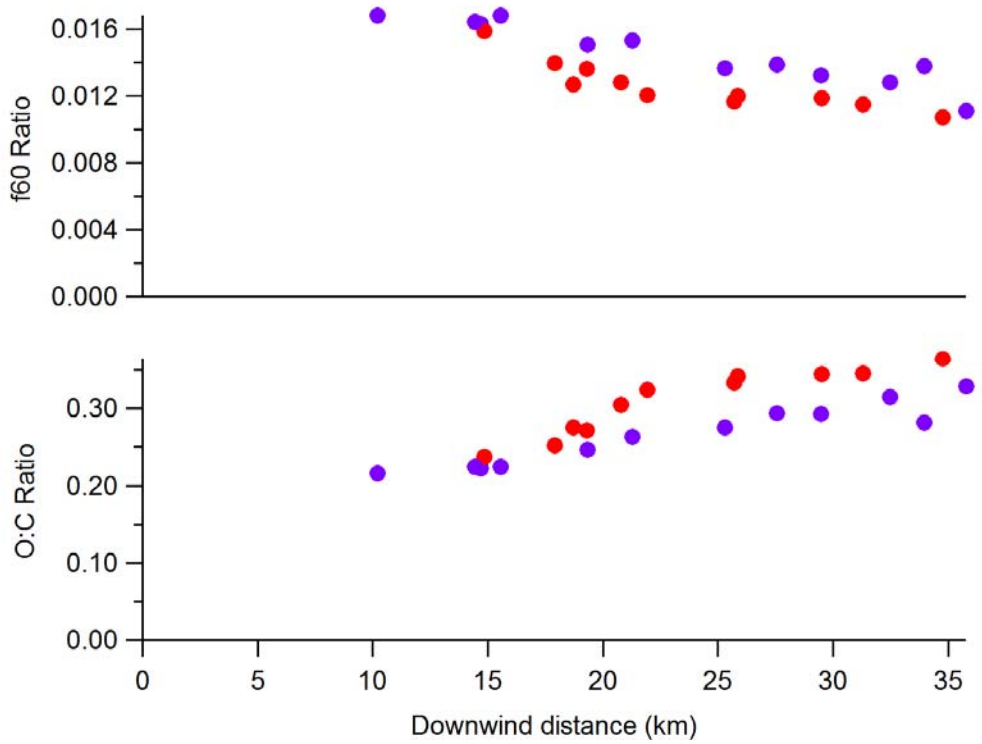


Downwind organic loadings



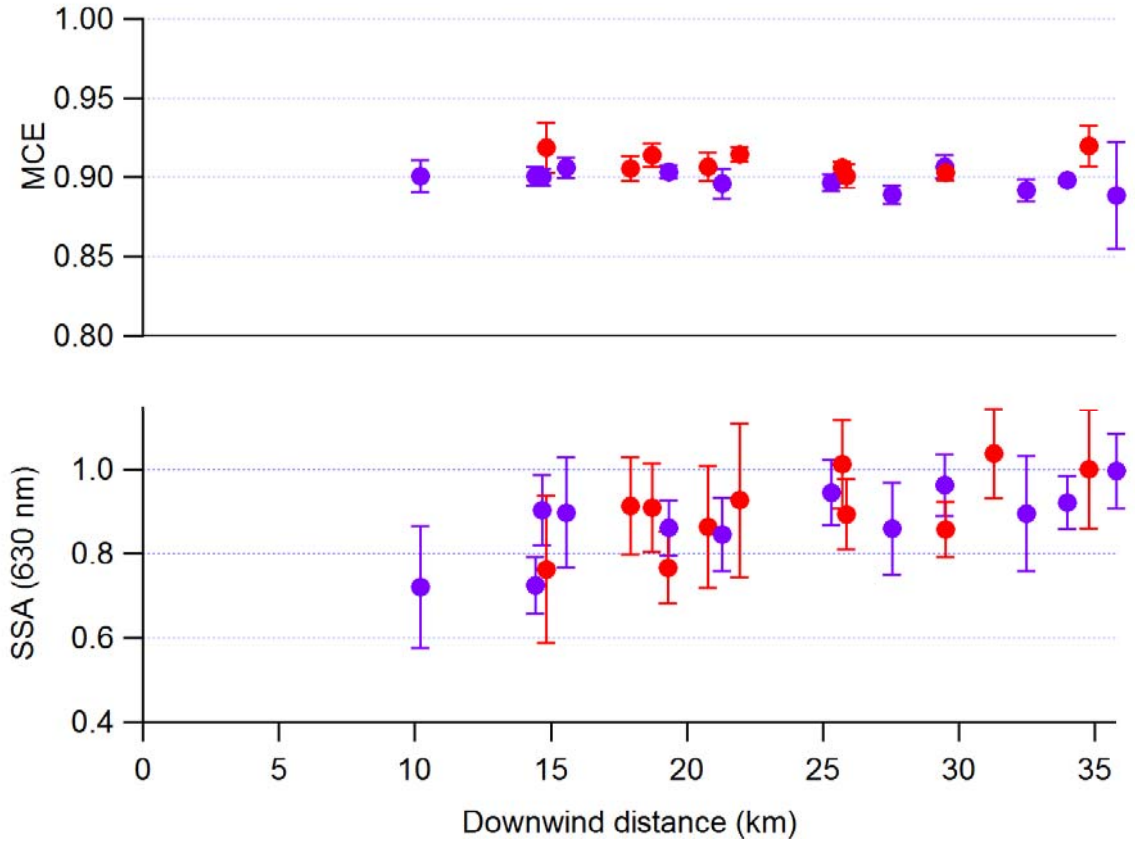
- ~ Constant ORG/CO
- Varying ORG/CO with burn condition

Downwind chemical changes



- f60 decreases with downwind distance
- O:C ratio increases with downwind distance

MCE and SSA measurements downwind

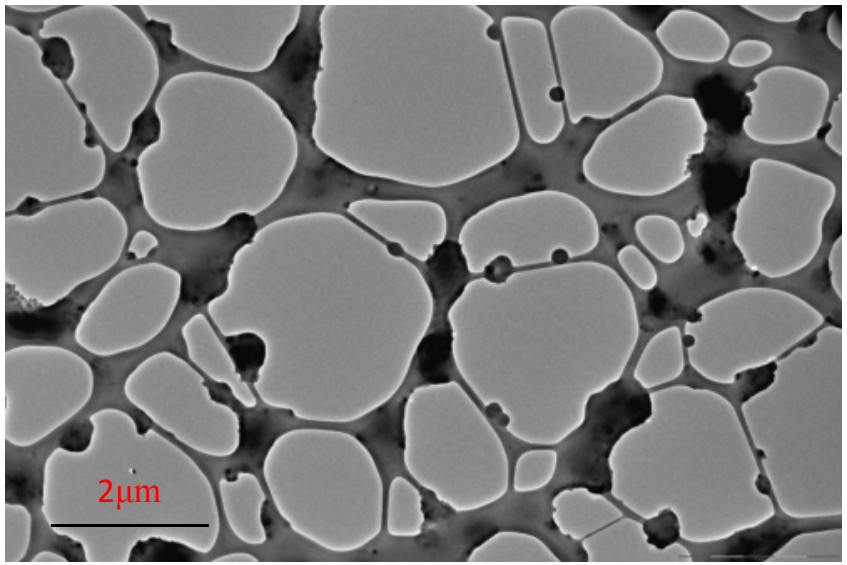


- Constant MCE
- Varying SSA with downwind transport

TEM observations downwind

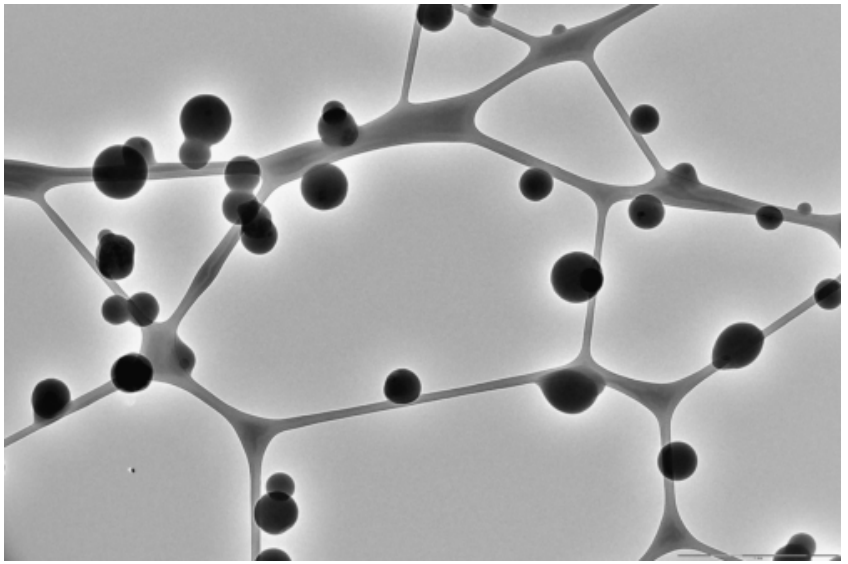
Fresh aerosol particles spread over the substrate

~0 hours



Aging results in highly spherical particles: Tar Balls

~2.5 hours



- Apparent loss of low viscous materials

Summary

- Rapid physical, chemical and optical changes in biomass burning particles measured downwind (< 3 hours) from wildland fires in Pacific Northwest.
  - Different burn conditions sampled during fire transects
- Organic aerosol loadings ([Org]/[CO]) appear to be relatively constant with time downwind suggesting that the competing evaporation of primary and condensation of secondary particulate material may be of similar order within the first few hours.
  - Whereas the [Org]/[CO] ratios are nearly constant, the chemical composition of the Org PM is rapidly changing, with the O:C and OM:OC increasing and primary components, such as anhydrosugar markers, decreasing.
  - TEM's observe apparent loss of low viscous PM and formation of tar balls; perhaps providing explanation for relatively constant organic aerosol loadings downwind.
  - SSA's increase downwind, indicating scattering increases faster than absorption (i.e., increase in aerosol mass, size, and/or real refractive index); potentially related to changes in organic aerosol chemistry

Acknowledgements

- Thanks to the G1 Flight Crew and Ground Crew and the other researchers on board for their help.
- Thanks to DOE Atmospheric System Research and ARM Climate Research Facility for funding and logistical support.