

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

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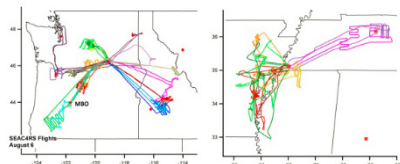


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Introduction and Methods

Biomass Burn Observation Project (BBOP)

A Department of Energy (DOE) sponsored study to measure wildland fires in the Pacific Northwest and prescribed agricultural burns in the Central Southeastern US from the DOE Gulfstream-1 aircraft platform over a four month period in 2013.



Wildland Fires:
Shrub, Forest
Urban: Seattle, Portland, Spokane
MBO: Fly overs
SEAC4RS: Joint mission

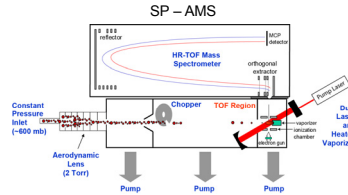
Prescribed Agricultural burns:
Rice, Soybean, Sorghum
Urban: Nashville, Memphis

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)

Chemical & Physical Measurements

NR-PM: SP-AMS, TEM
rBC: SP2, SP-AMS, TEM
Szie: UHSAS, PCASP, FIMS



Laboratory generated tar balls

Tar ball formation and evolution were clearly observed in BBOP samples examined using electron microscopy. We initiated a laboratory study of tar balls to examine chemical and optical properties to augment field observations.

Pyrolysis of pine needles/twigs

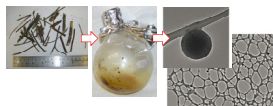
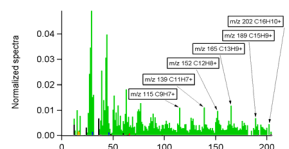


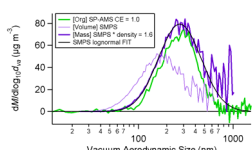
Exhibit low volatility

TBs slow to evaporate under TEM electron beam, similar to ambient collected TBs

Unsaturated hydrocarbon signals



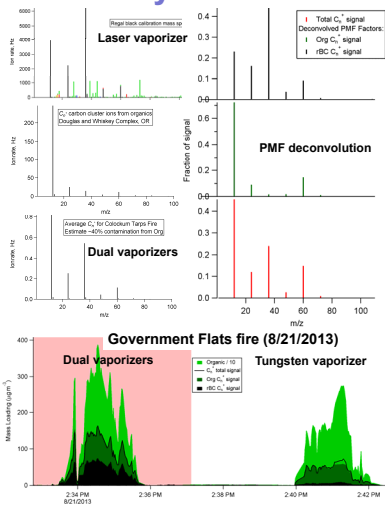
Measured quantitatively by AMS



Observed AMS collection efficiencies are between 0.5 and 1.0

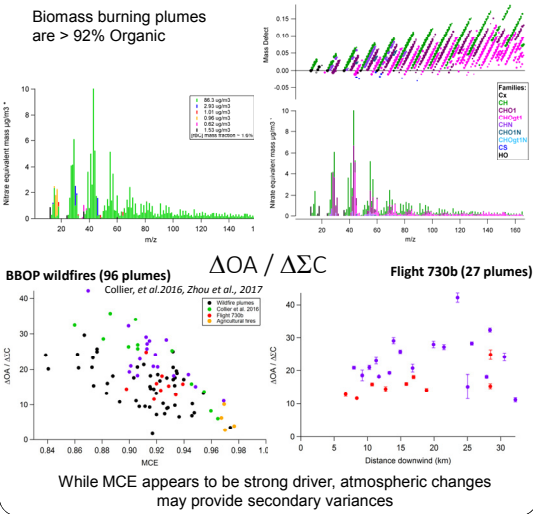
Chemical signals may be related to brown carbon absorption

Refractory black carbon

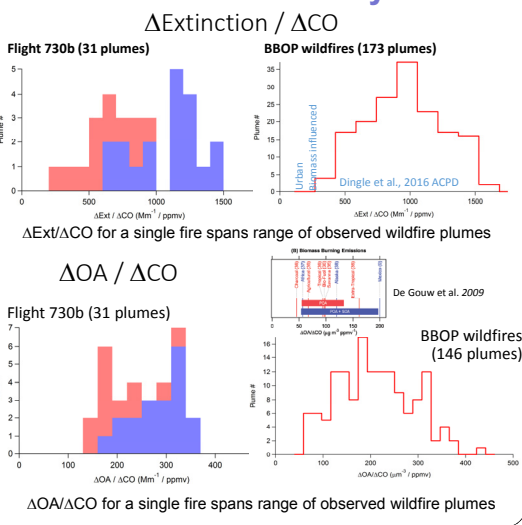


Nonrefractory composition

Biomass burning plumes are > 92% Organic



Measurement Variability

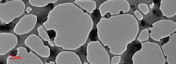


Evolution of biomass plumes



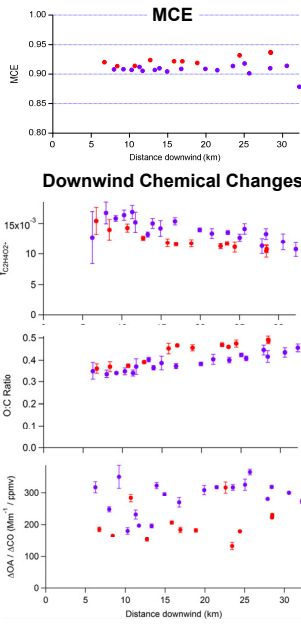
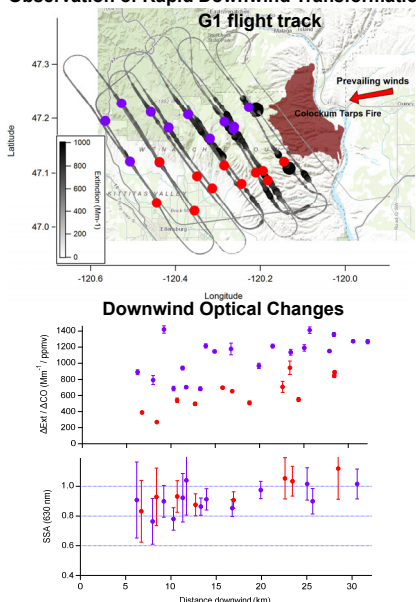
Tar ball formation

Fresh aerosol particles spread over the substrate



Aging results in highly spherical particles called Tar Balls

Observation of Rapid Downwind Transformations



Summary

- Rapid physical, chemical and optical changes in biomass burning particles measured downwind (< 3 hours) from wildland fires in Pacific Northwest.
- The chemical composition of OA is rapidly changing, with the O:C and OM:OC increasing and primary components decreasing.
- TEM's observe formation of tar balls.
- SP-AMS found to measure laboratory generated tar balls with high CE.
- SSA's increase downwind, indicating scattering increases faster than absorption
- 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.
- Variability in different burn plumes from one wildland fire similar to the variability in chemical and optical properties for all sampled wildland fires

Collier, et al. 2016, Zhou et al., 2017

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