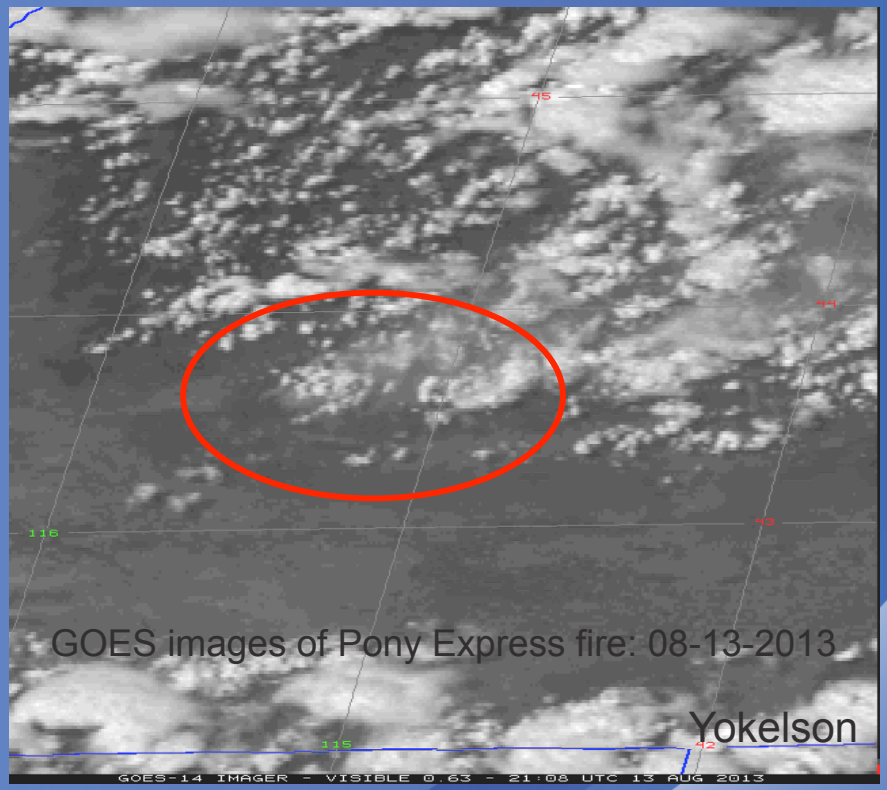
Biomass Burning Observation Project: BBOP

BBOP Team



GOES images of Pony Express fire: 08-13-2013

Yokelson

ASR Atmospheric System Research

BROOKHAVEN NATIONAL LABORATORY

a passion for discovery

ARM CLIMATE RESEARCH FACILITY

The University of Montana

ASU

DRI Desert Research Institute

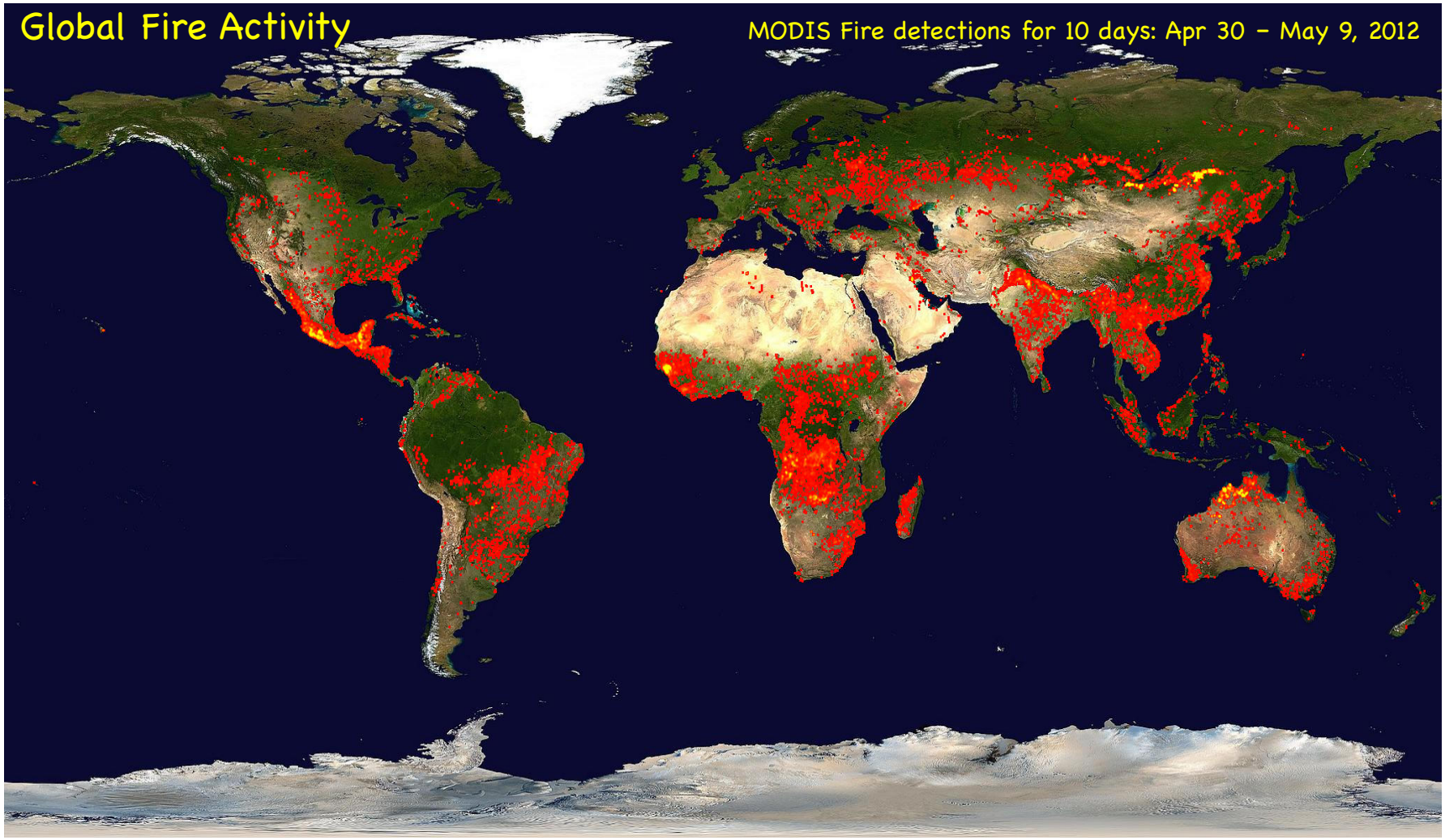
AERODYNE RESEARCH Inc.

NEVADA

Pacific Northwest NATIONAL LABORATORY

Office of Science U.S. DEPARTMENT OF ENERGY

Biomass Burning

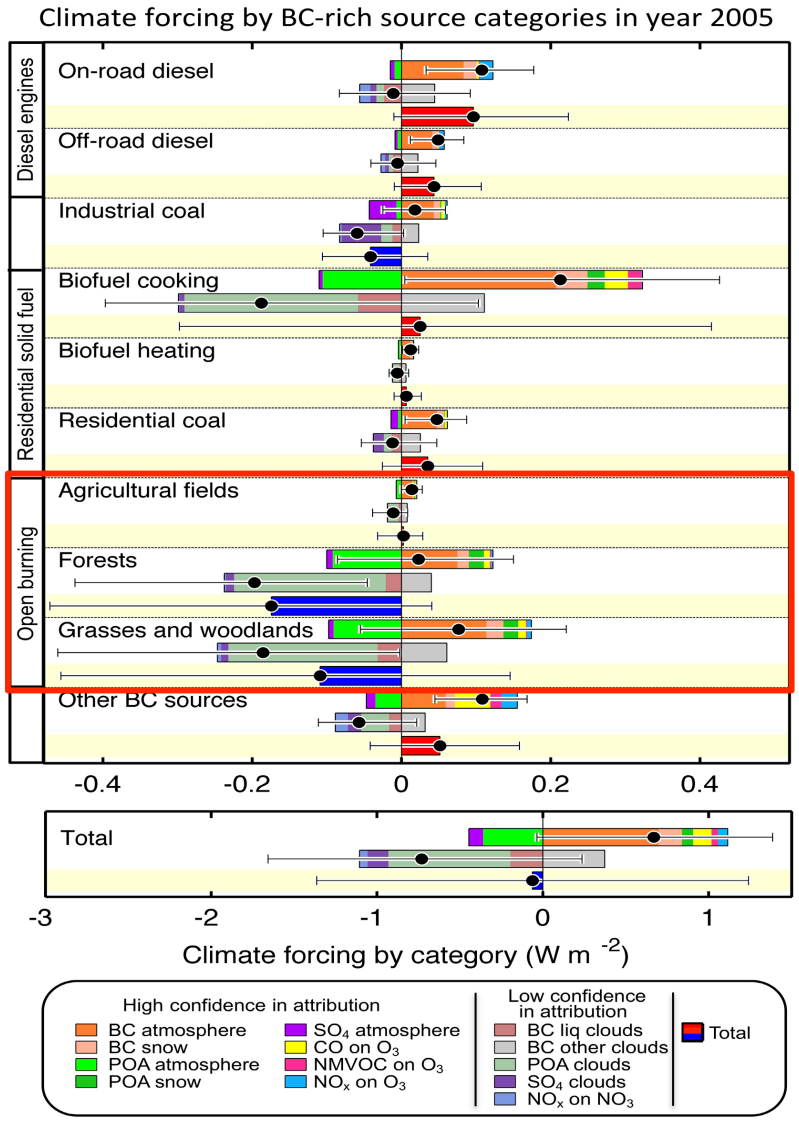


C. Ichoku and R. Kahn

Biomass Burn Aerosols

- Black carbon exerts positive aerosol forcing (warming) - second only to CO_2
- BB is a significant source of brown carbon (BrC)
  - Exhibits pronounced λ dependence in absorption
  - Role as CCN (in contrast to nascent BC)
- Aerosol type can vary
  - Flaming phase favors BC production
  - Smoldering phase favors organic aerosol
  - Fuel source
- Total climate forcing due to BB is estimated to be:
  -0.11 (-0.46 to +0.15) W m^{-2} (Bond et al. 2013)

  Uncertainly reflects knowledge gaps in BC-cloud interactions & BC interactions with co-emitted organic carbon



Bond et al. 2013

Radiative Forcing Contribution of Biomass Burn (BB) Aerosols

Scientific Challenge:

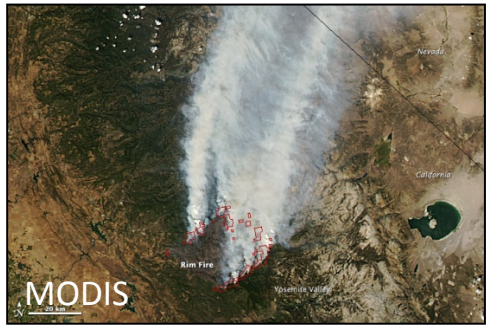
To understand and quantify the role of BB in aerosol forcing (heating/cooling)

- *Investigate the **evolution** of chemical, hydroscopic, microphysical, and optical properties of biomass burn aerosols in the near field*

*What is the **minimum knowledge** needed to accurately parameterize the contribution of biomass burn aerosols to radiative forcing?*

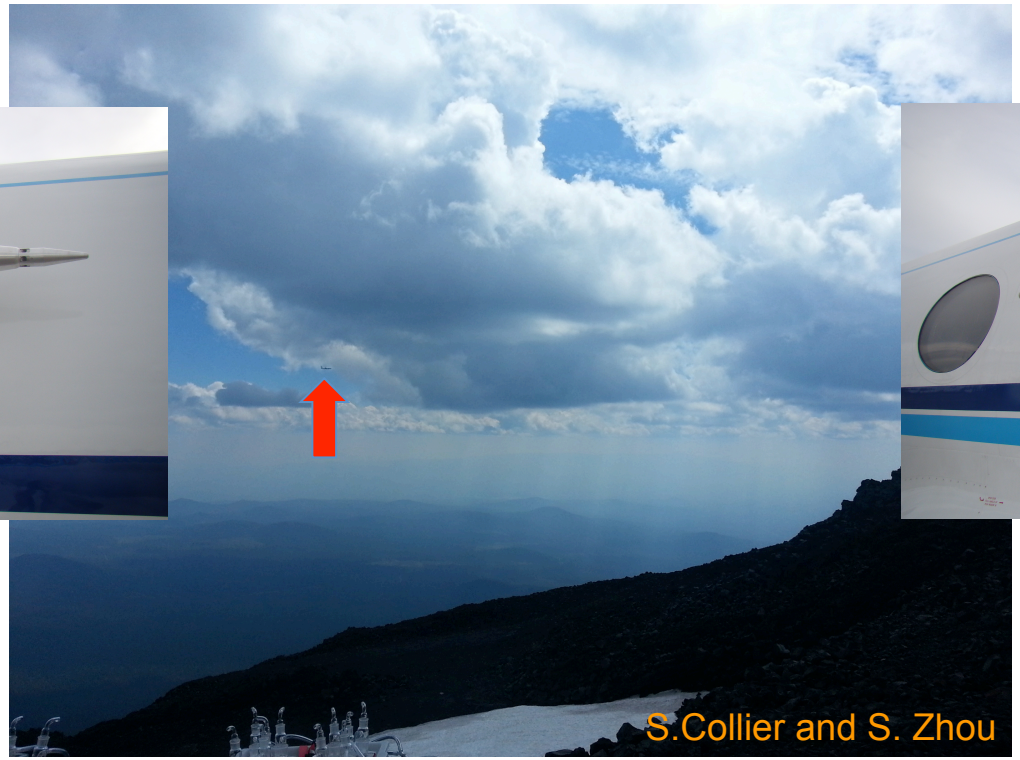
Laboratory scale

Near-field scale



Meso scale

G-1 Platform

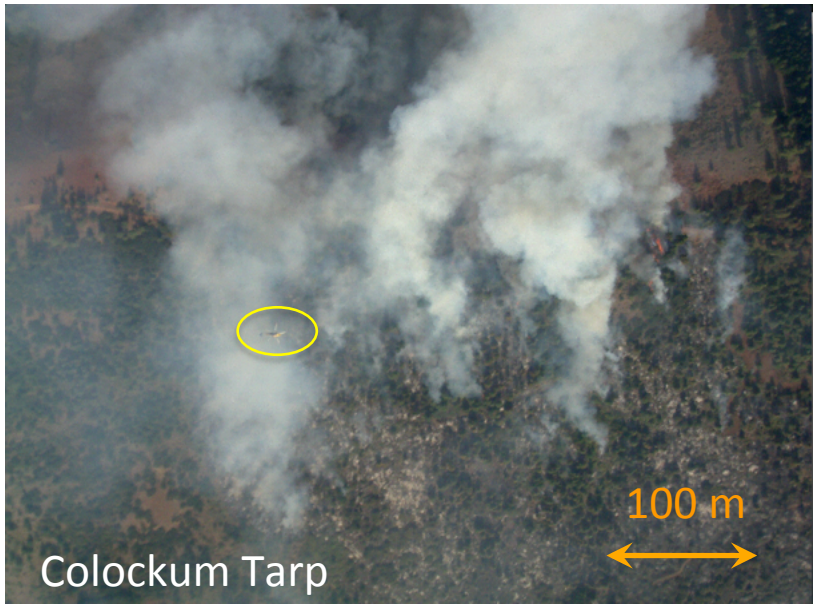


Scenes from BBOP: Wildfires

G1 was outfitted with two cameras: forward-looking and Nadar

Government Flats fire (2013-08-21) was one of largest fire sampled during BBOP. Over the course of 24-hrs fire increased by > 2800 acres & eventually consumed over 11,500 acres.

Forward-looking



Nadar

Org loading: ~ mg/m^3
rBC loading: 10s-100s µg/m^3

Scenes from BBOP: Agricultural Burns

Agricultural burns provide distinct advantage of being a single source burn. However, fire lifetime *much* shorter duration than wildfires (< 30 minutes)

MODIS no help in identifying potential sites. Most efficient approach: fly high and look fires

2013-10-20: largest Ag-burn sampled.

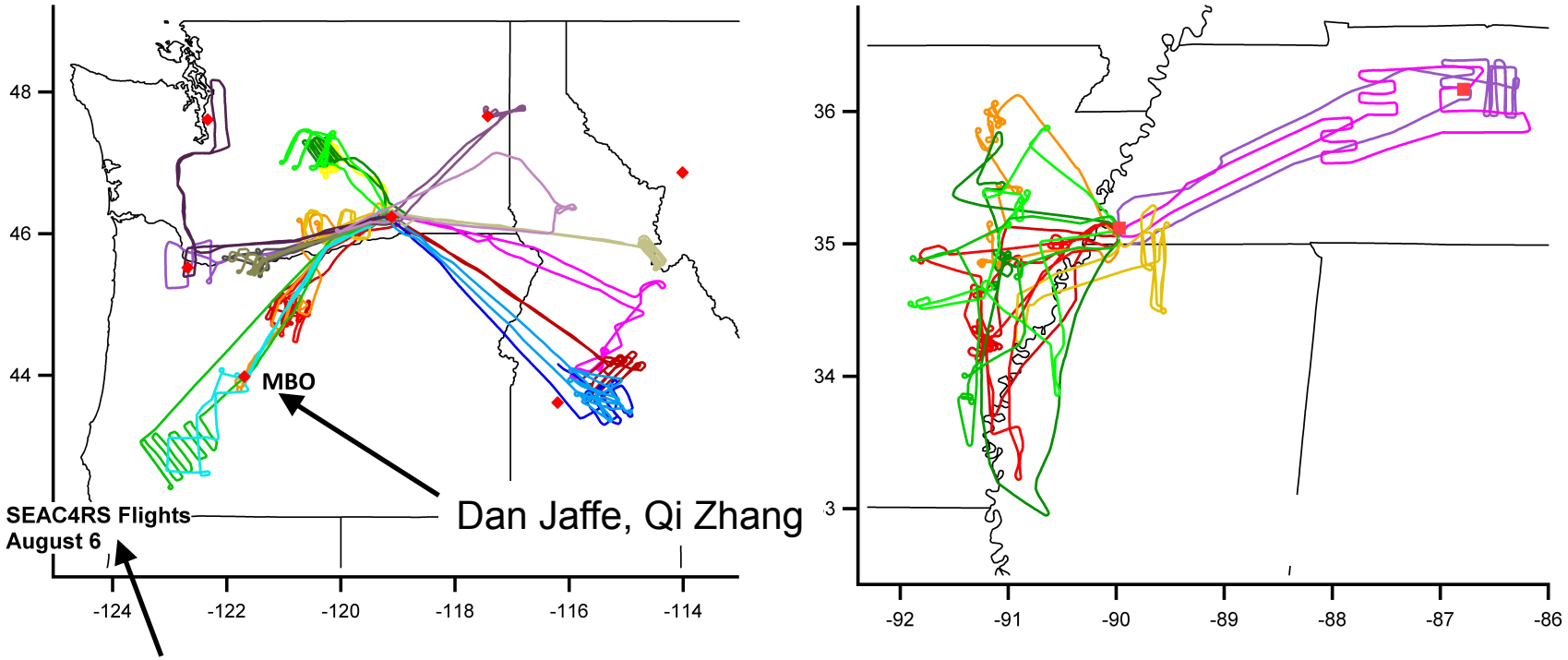
Forward-looking

Nadar

Flights (120 hours)

Wildland Fires: Shrub, Forest
Urban: Seattle (3), Portland (2), Spokane (2)
MBO (3)
SEAC4RS: Joint mission Aug., 6

Prescribed Agricultural burns: rice, soybean
Urban: Nashville (2), Memphis (2)



Dan Jaffe, Qi Zhang

Bob Yokelson, Rich Ferrare, Ralph Khan, Charles, Ichoku

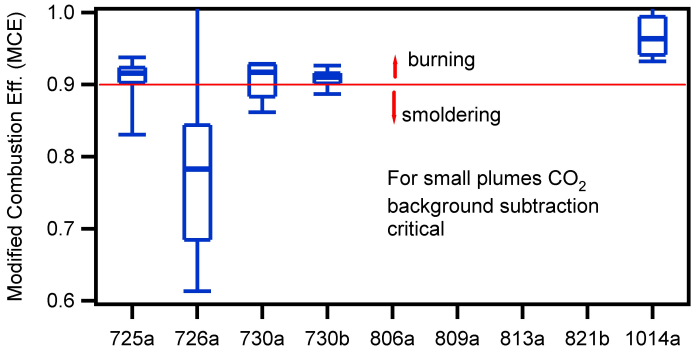
BBOP: Near-Field Evolution of Smoke Aerosol Properties

“28 Mile Marker” Fire sampled on 07-26-2013

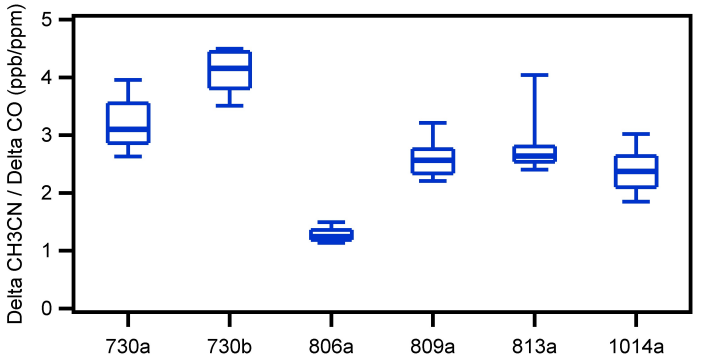
BBOP: Emission Factors

Parse Wildland Fire flights into Transects perpendicular to wind
Determine Delta X/Delta Y = (X-background)/(Y-background)

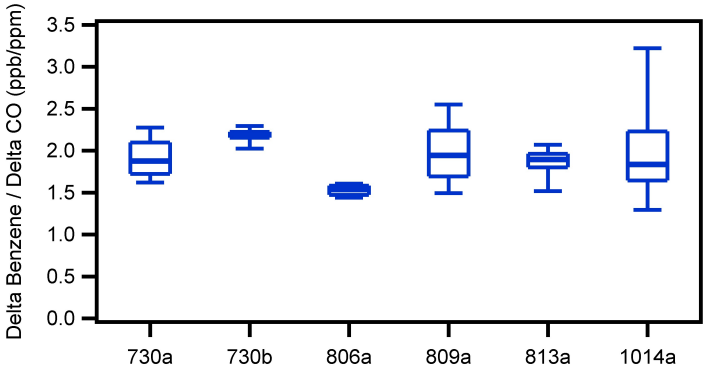
Instances of flaming conditions, but smoldering dominates



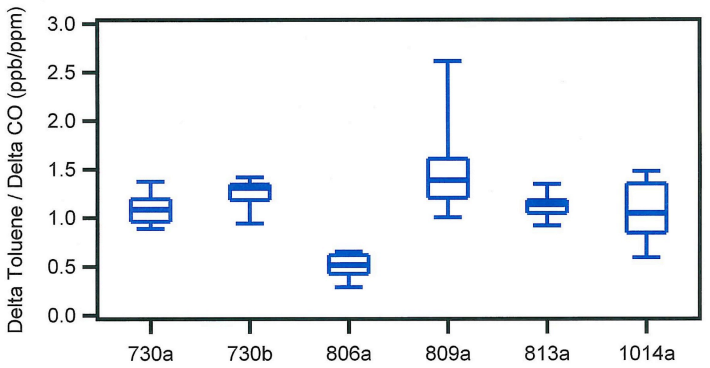
Emission Factors relative to CO



Emission Factors relative to CO



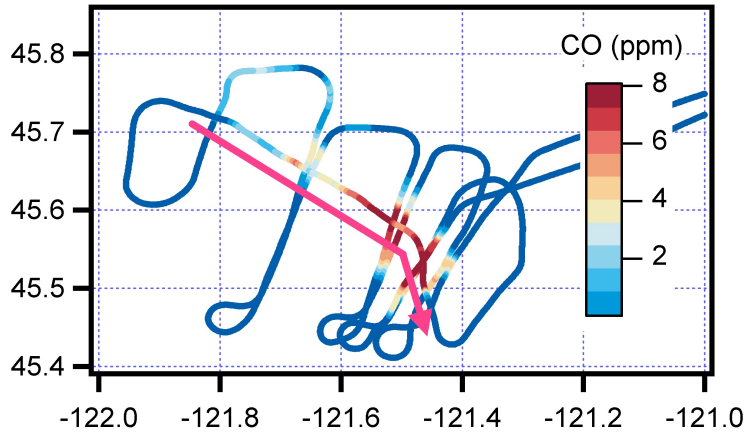
Toluene does not decrease with age – a surprise



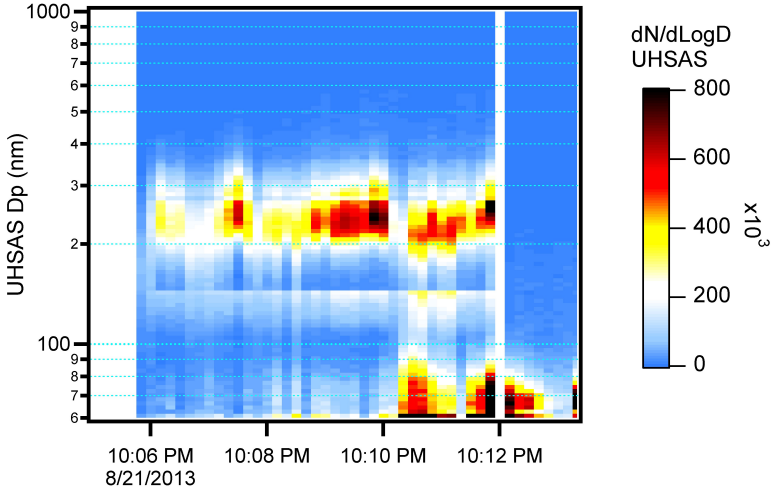
Plume Transects: Government Flats Fire

Largest fire sampled

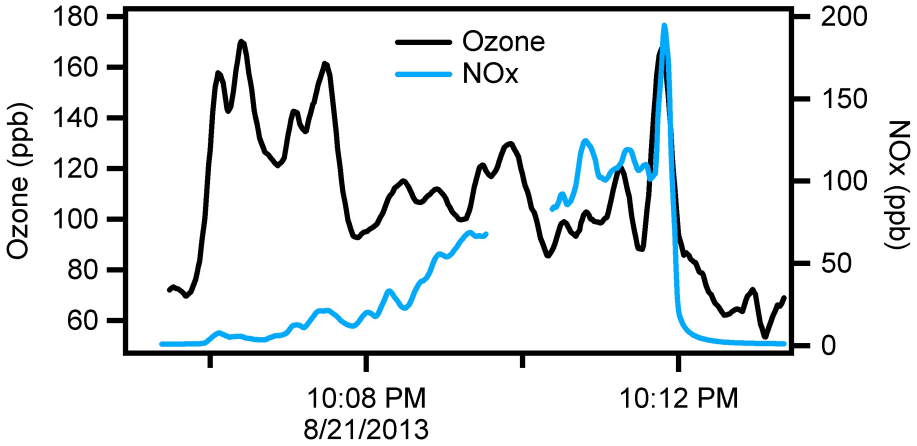
2.5 hours pseudo-Lagrangian transport



Aitken mode near fire

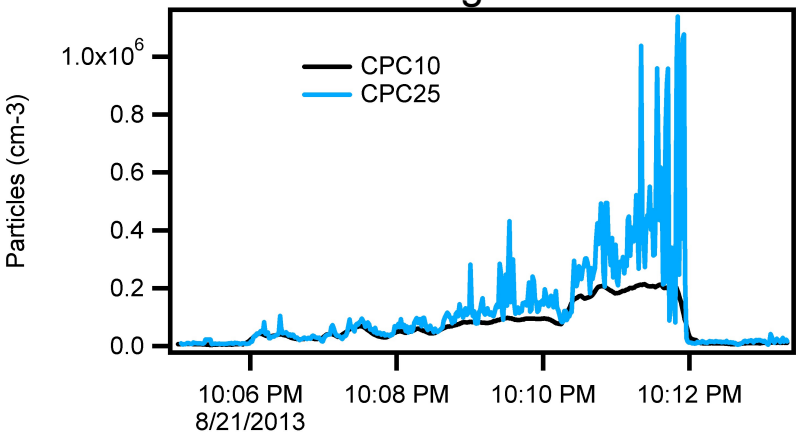


Very active photochemistry



>10^6 particles (cm^{-3}) near fire

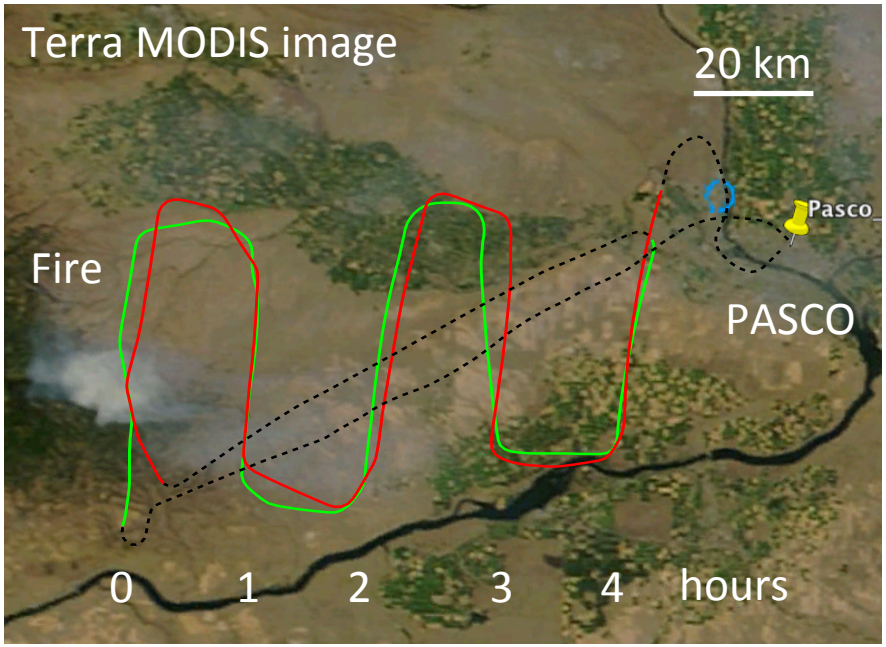
Half-life for coagulation < 1 hr

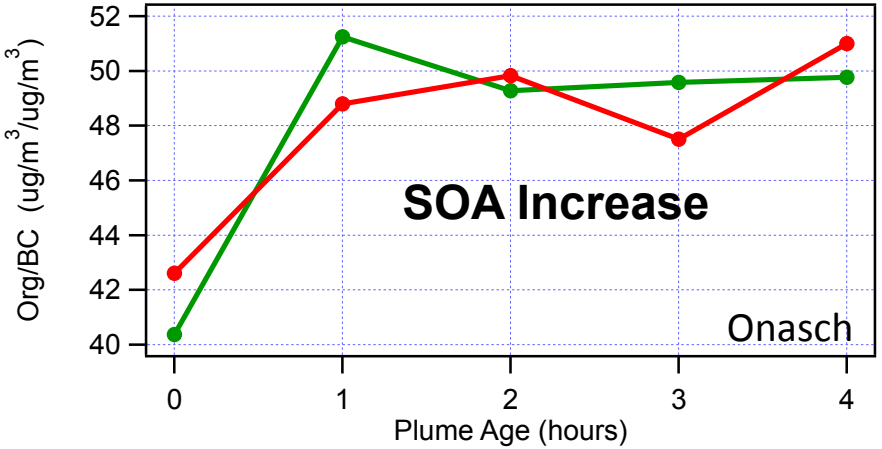


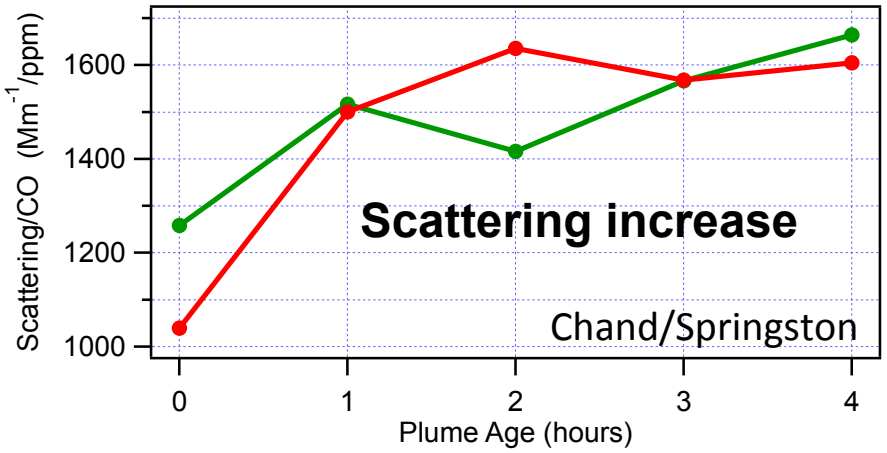
BBOP: Near-Field Evolution of Scattering & SOA

"28 Mile Marker" Fire sampled at source and 1, 2, 3, 4 hour downwind

Targeted 07-26-2013





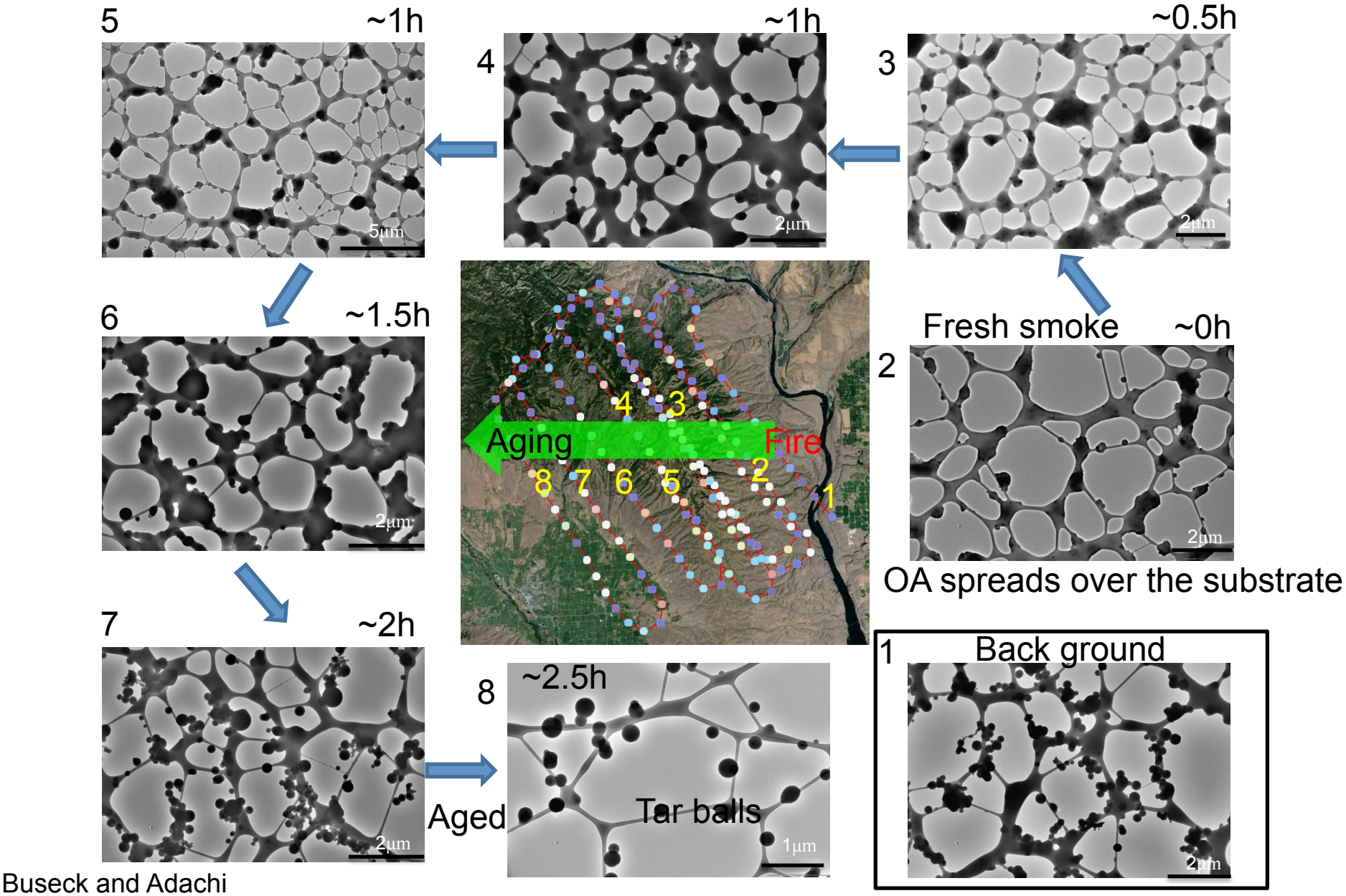


Repeatable

Rapid increase within 1st hour in SOA (25%) and scattering (50%)

AERODYNE RESEARCH Inc.

TEM: Evolution of Organic Aerosols to Tar Balls



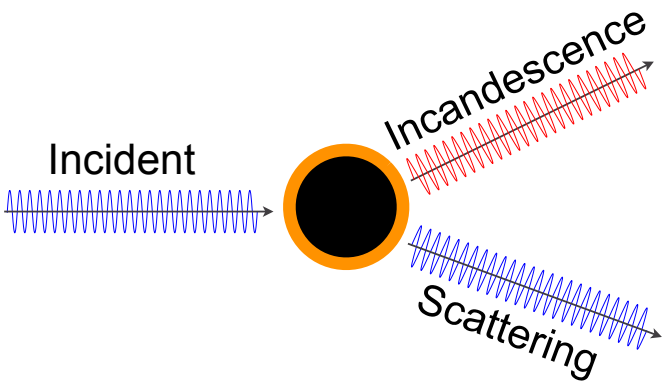
Buseck and Adachi

BBOP: Near-Field Evolution of rBC Mixing State

"Colockum Tarp" Fire sampled at source and 1 - 5 hours downwind

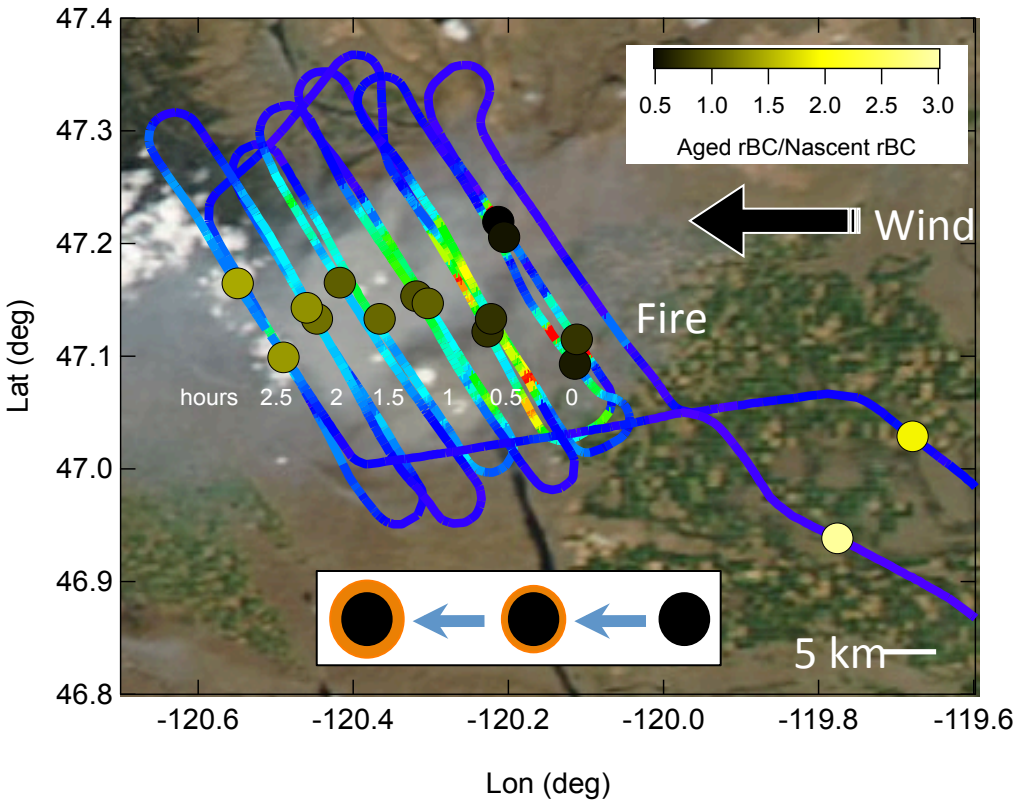
Targeted on 2013-07-30

Single Particle Soot photometer



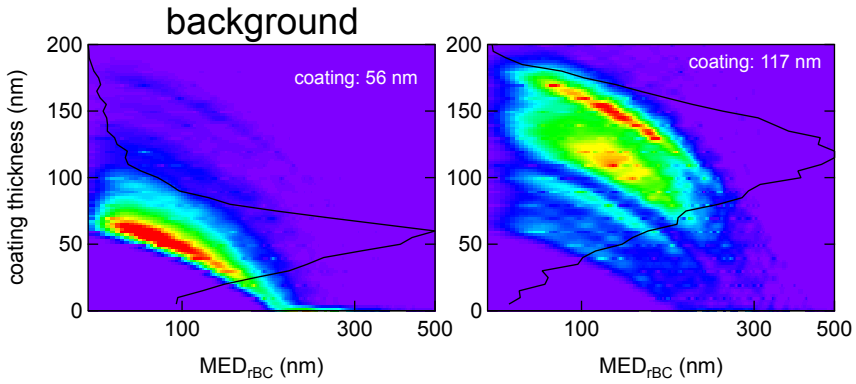
Probe mixing state:

- Incandescence amplitude:
  rBC core
- Scattering amplitude:
  rBC core + coating



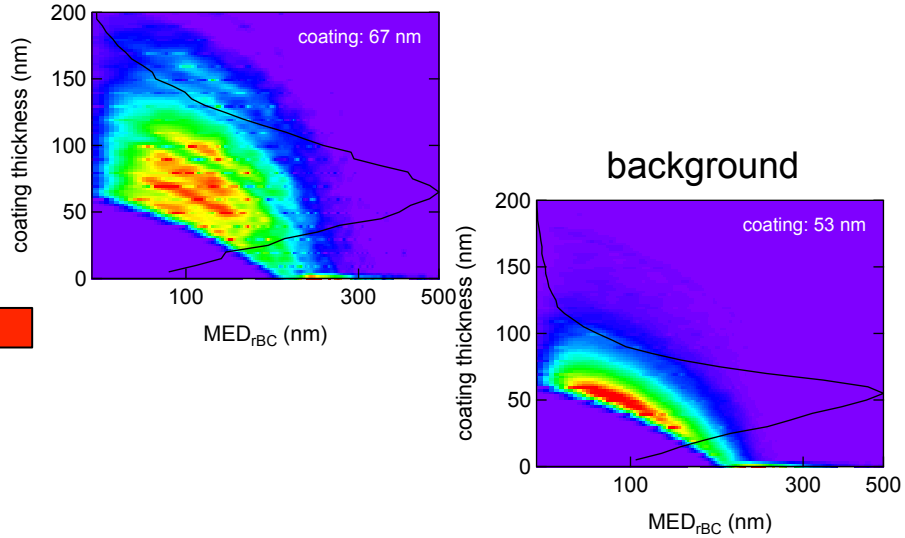
Rapid increase in fraction thickly coated rBC

Fuel Source Dependence on rBC 'Coating Thickness'?



$\Phi_{aged/nascent}$ = 4.9

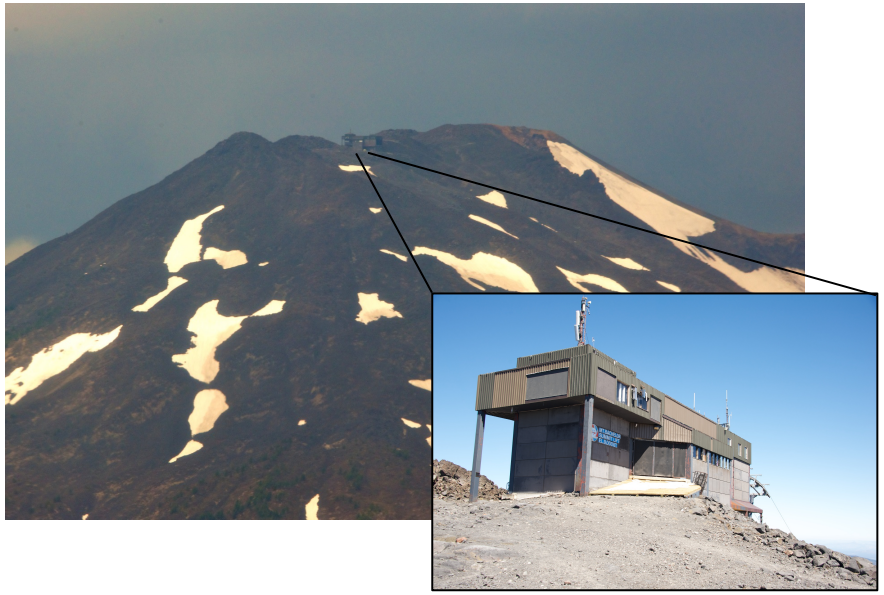
Scat mode: 395 nm



$\Phi_{aged/nascent}$ = 2.8

Scat mode: 275 nm

BBOP: Collaborations



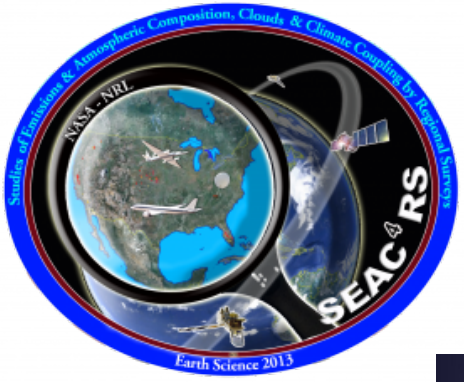
Mount Bachelor Observatory (MBO)
Dan Jaffe (U. Washington)
Lat: 43.979 N / Long: 121.687 W
Elevation: 9000 Ft a.s.l. (2.7 km)

- Core measurements:
- CO, CO2, H2O, Scat, Abs, Hg

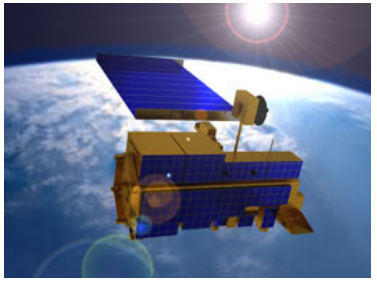
Qi Zhang (U. California/Davis)

- HR-AMS and SMPS

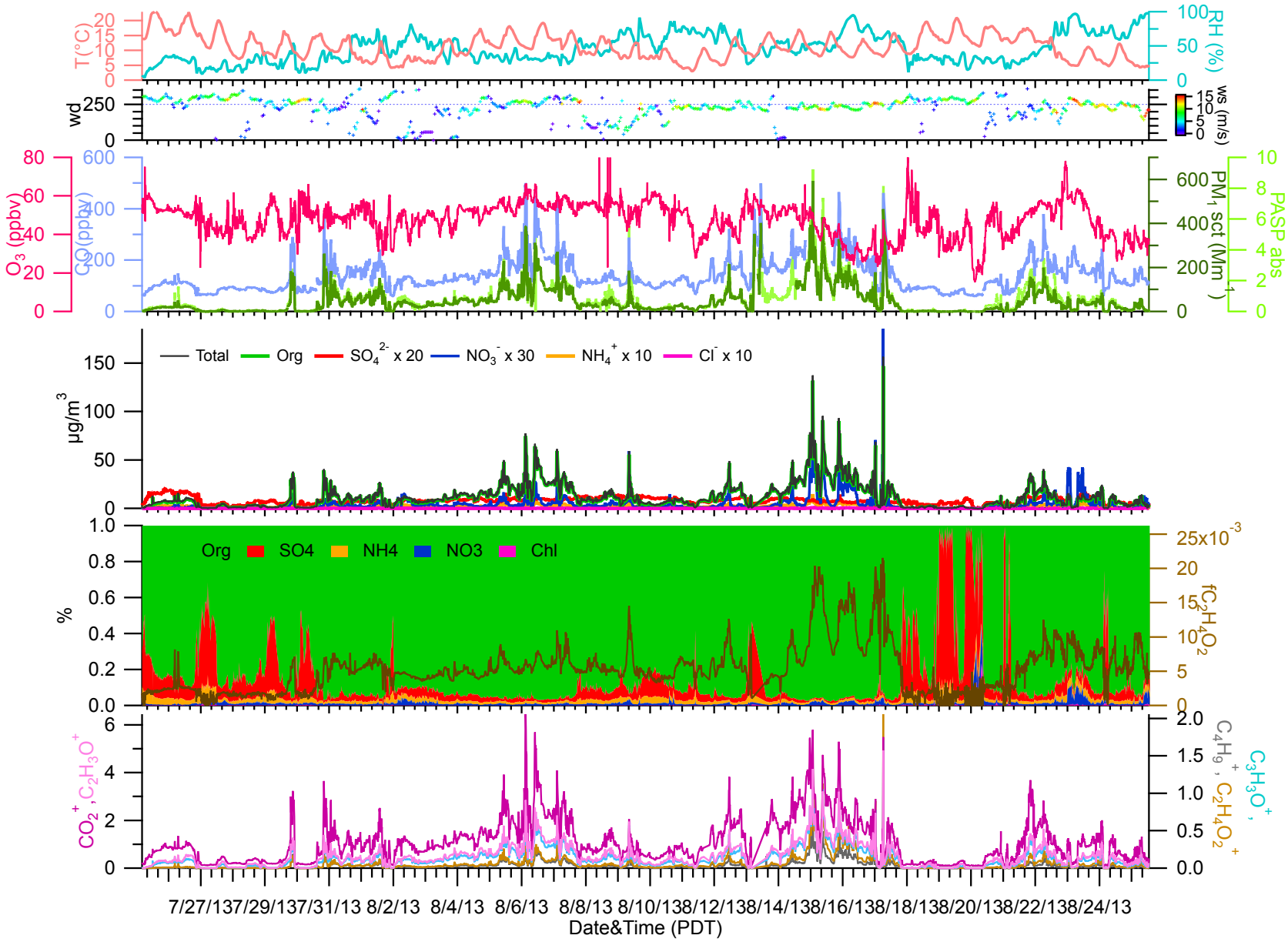
Studies of Emissions & Atmospheric Composition, Clouds & Climate Coupling by Regional Surveys (SEAC4RS) - Coordinated flight on August 6, 2013



Several missions coincided with over flights of Aqua and/or Terra
BBOP will provide *in situ* measurements for satellite retrievals

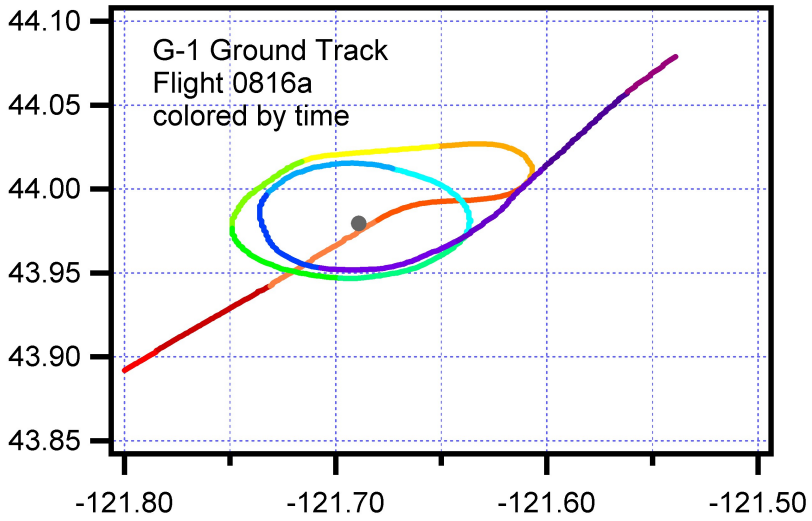


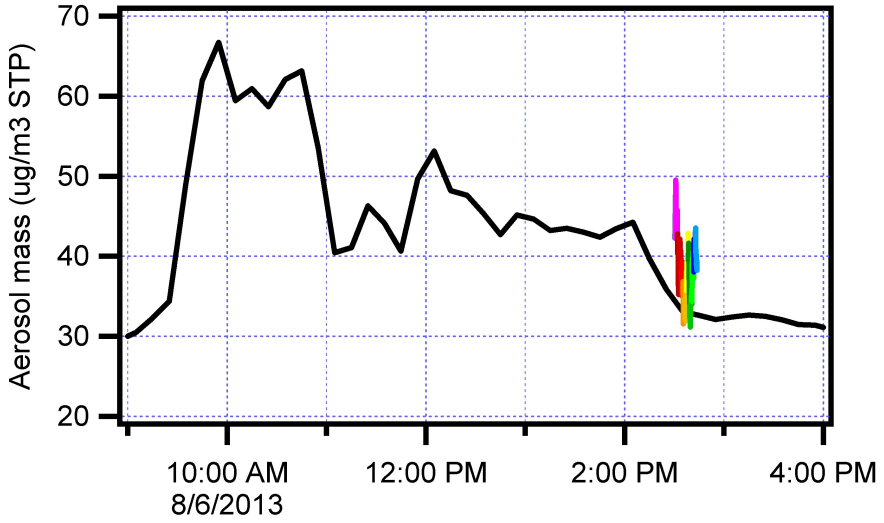
BBOP: Mount Bachelor Observatory

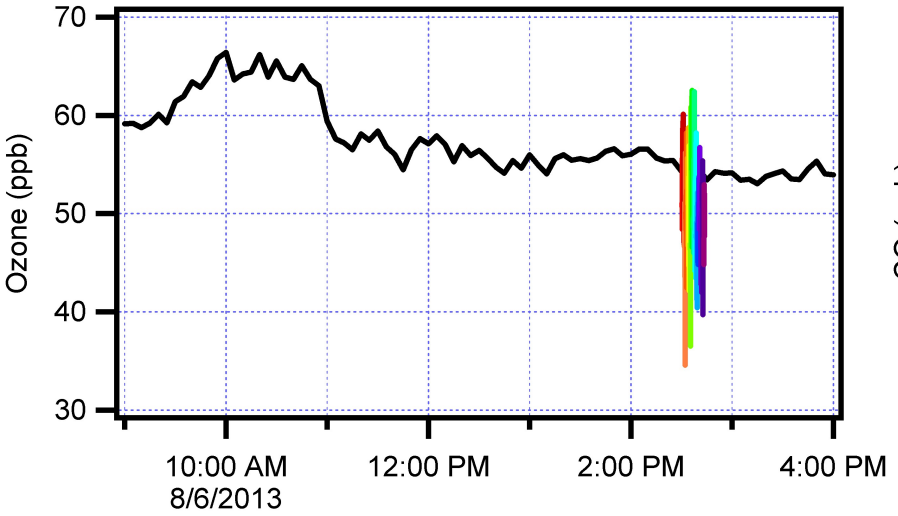


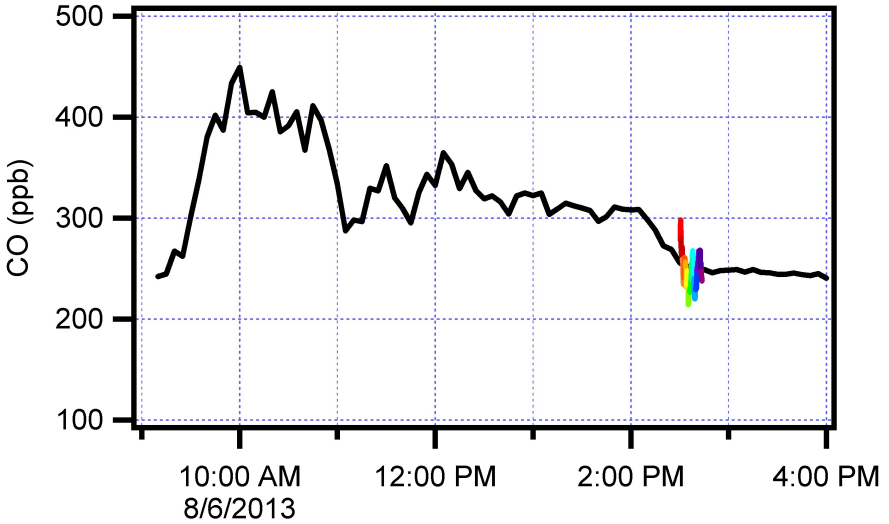
BBOP: Mount Bachelor Observatory

MBO—G1 intercomparison is just getting underway



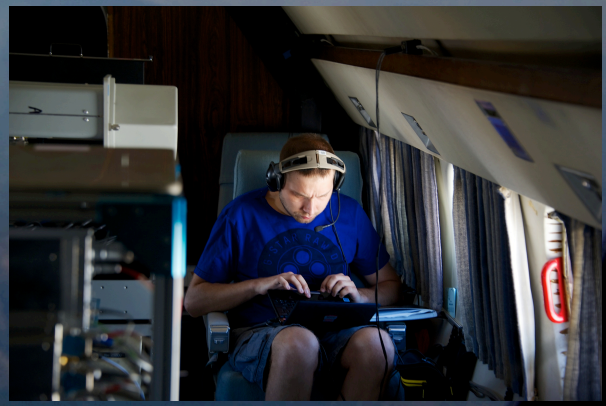






U. Washington/ (Wigder, Jaffe); U. C./Davis (Collier, Zhou, Zhang)

Big Thanks to all that made BBOP a success!



ARM CLIMATE RESEARCH FACILITY

ASR Atmospheric System Research