SEAC4RS Aerosol Overview and Vertical Transport Mechanisms

PALMS Single-Particle Composition

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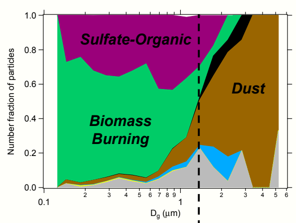
Vertical Transport of Dust

Biomass Burning as a Dust source

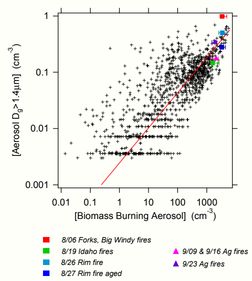
Size spectrum of aerosol composition inside BB plumes



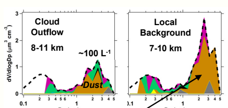
Fine mode mostly Biomass Burning particles and Sulfate-Organic particles

Coarse mode mostly Mineral Dust

Correlation of BB aerosol and Coarse aerosol concentrations

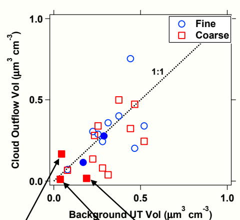


Deep Convection as a Dust source



Background UT coarse aerosol volume often higher than cloud outflow

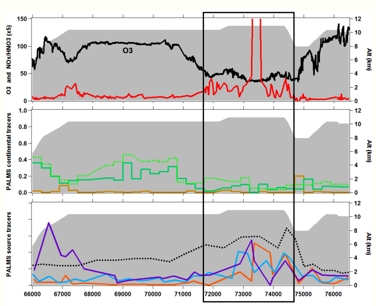
DC3 Summary of Outflow Encounters



SEAC4RS continental convection: coarse mode enhanced x4

SEAC4RS marine convection: very clean, coarse mode absent in outflow

Outflow from North American Monsoon – 8/26 case



Identify clear sky outflow

use NOx/HNO3 as primary outflow indicator

Aerosol tracers for continental convection

low Org:Sulf ratio
low Biomass Burning aerosol
low Dust

Cloud processing and marine tracers

high MSA = marine air
high H-MSA = cloud processing
high acidity = cloud processing
high methyl nitrate (WAS) = marine air

- 8/08 and 8/26 DC8 NAM outflow cases (9-11 km) suggest marine origin
- Consistent with HYSPLIT trajectories
- Dust not enhanced in NAM outflow

Key Messages

- *Fire plumes are a significant source of Mineral Dust to the free troposphere*
- *Continental convection also lofts Dust, may enhance UT conc on a regional scale*
- *Biomass Burning aerosol composition and hygroscopic properties are systematically different for Wild vs Ag fires. Aerosol evolve to become more hygroscopic.*
- *The SEAC4RS aerosol environment was similar to DC3 but with higher loading in the lower troposphere and a cleaner UT. Much lower coarse mode Dust throughout.*

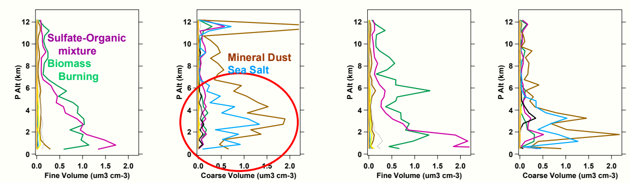
Aerosol Composition Overview

PALMS + LARGE = Size-resolved Composition

Clouds and strong fire plumes excluded

Sulfate-Organic mixture, Biomass Burning, Mineral Dust, Sea Salt, EC, Meteoric, Oil Combustion

DC3 — *Western US* / *Eastern US*



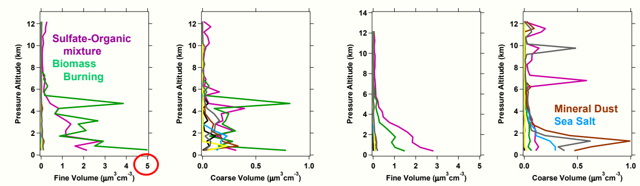
Biomass Burning Particles dominate throughout UT

Coarse aerosol is mostly Dust, some Sea Salt

Similar to West. Biomass Burning goes to higher altitudes

Similar to West. Less Dust in UT.

SEAC4RS — *Western US* / *Eastern US*



Biomass Burning Particles dominate lower trop. lower trop. vol x3 higher than DC3. Very clean UT.

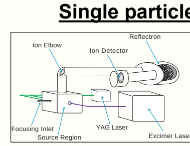
Coarse aerosol a mixture, low volume. Much lower Dust than DC3.

Much lower Biomass Burning

Low volume, mostly Dust.

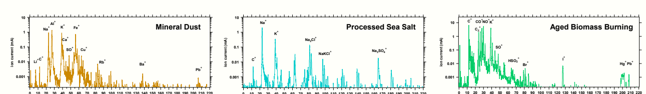
PALMS Single-Particle Composition

Single particle size and chemical composition



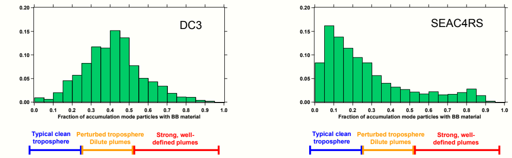
1. Sample aerosol particles
2. Particle detection: Nd:YAG laser 532nm
3. Evaporation & ionization: UV Excimer laser 193nm
4. Time-of-flight mass spec

- 1 mass spectrum (+ or –) per particle
- aerodynamic particle size: ~0.2 – 5 µm
- data rate ≤ 10Hz
- Can run autonomously



Biomass Burning Aerosol

Sampling Frequency of Biomass Burning Particles



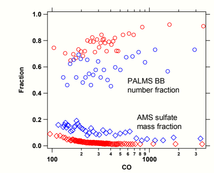
BB aerosol were enhanced >80% of flight time

BB aerosol were enhanced <50% of flight time

Plume Chemistry and Hygroscopicity

Data sorted for plumes only: Wild Fires, Ag Fires

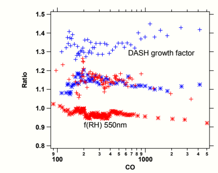
Chemical properties in BB plumes



Ag fire plumes contain relatively fewer BB particles, but they are more sulfate-rich

Bulk sulfate content is also higher

Hygroscopicity in BB plumes



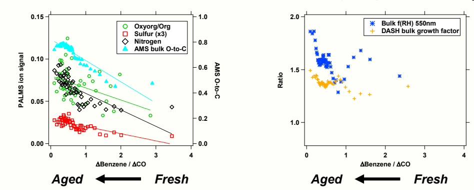
Ag fire plumes are more hygroscopic: f(RH) wet/dry scattering ratio and wet/dry growth factor

How Aging Changes Chemistry and Hygroscopicity

Data sorted for moderately-to-highly BB-influenced air (CH_3CN> 20 pptv)

DC3

Chemical evolution of BB particles / *Bulk hygroscopicity evolution*



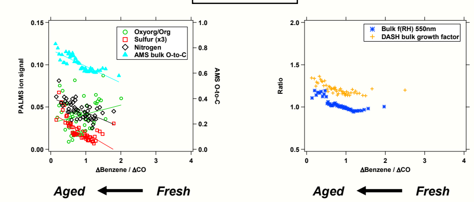
Use photochemical clock to infer age: ΔBenzene / ΔCO

Other indicators work, eg, ΔAPAN / Δacetonitrile

Selecting only BB particles… Secondary species and organic oxidation increase with photochemical time

Bulk aerosol hygroscopicity increases over time. …Not just due to dilution… BB particle number fraction is fairly constant (not shown).

SEAC4RS



f(RH) much lower for SEAC4RS ???