Assessment of Anthropogenic and Biomass Burning Impact on Aerosol Properties over California as Observed During ARCTAS/CARB

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DC-8 In Situ Payload - Aerosols

NASA Langley – Bruce Anderson

- Aerosol Concentration, Size Distributions, Optical Properties & Cloud Parameters

Georgia Institute of Technology – Rodney Weber

- Water Soluble Organic Carbon (PILS)

University of Colorado, Boulder – Jose Jimenez

- Sub-micron Cl, NH_4, NO_3, SO_4 and organics (AMS)

University of New Hampshire – Jack Dibb

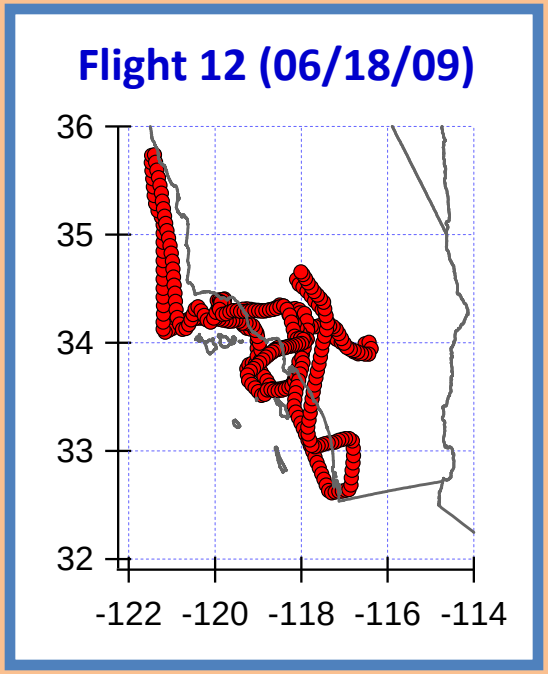
- Inorganic Composition (Filter & Mist Chamber)

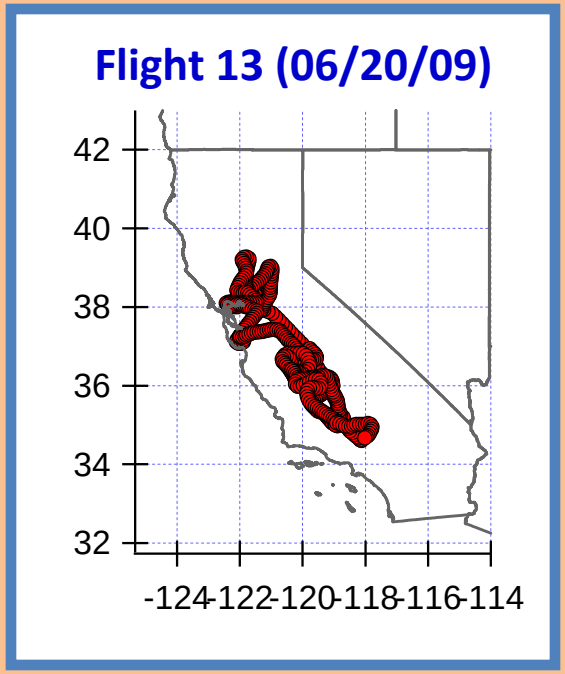
University of Tokyo – Yutaka Kondo

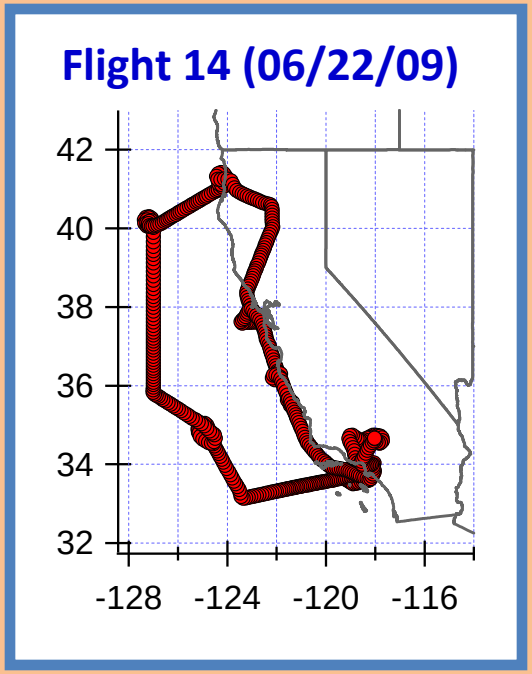
- Black Carbon Mass (SP^2)

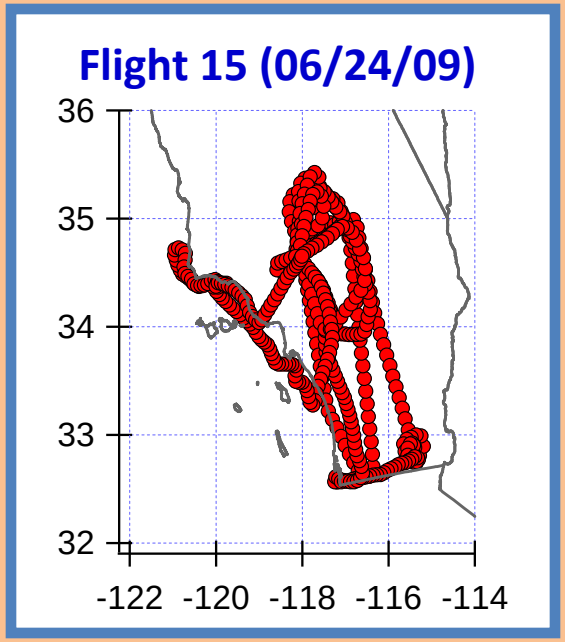
Goals: Characterize aerosols over California and their sources to assess the links between aerosol composition and optical properties.

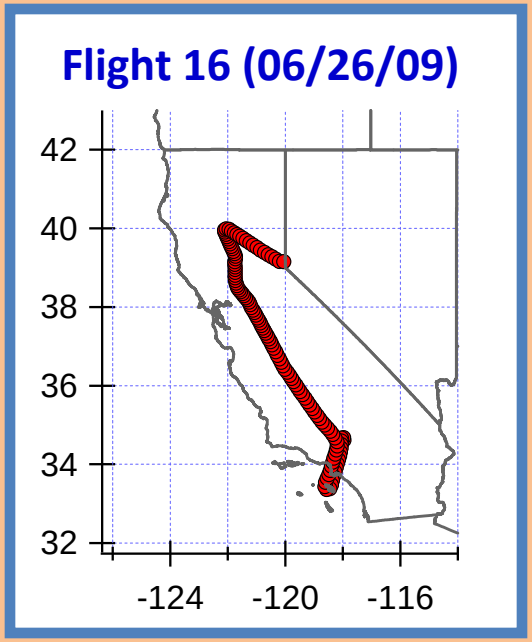
DC-8 CARB Flight Tracks (Flights 12-16)



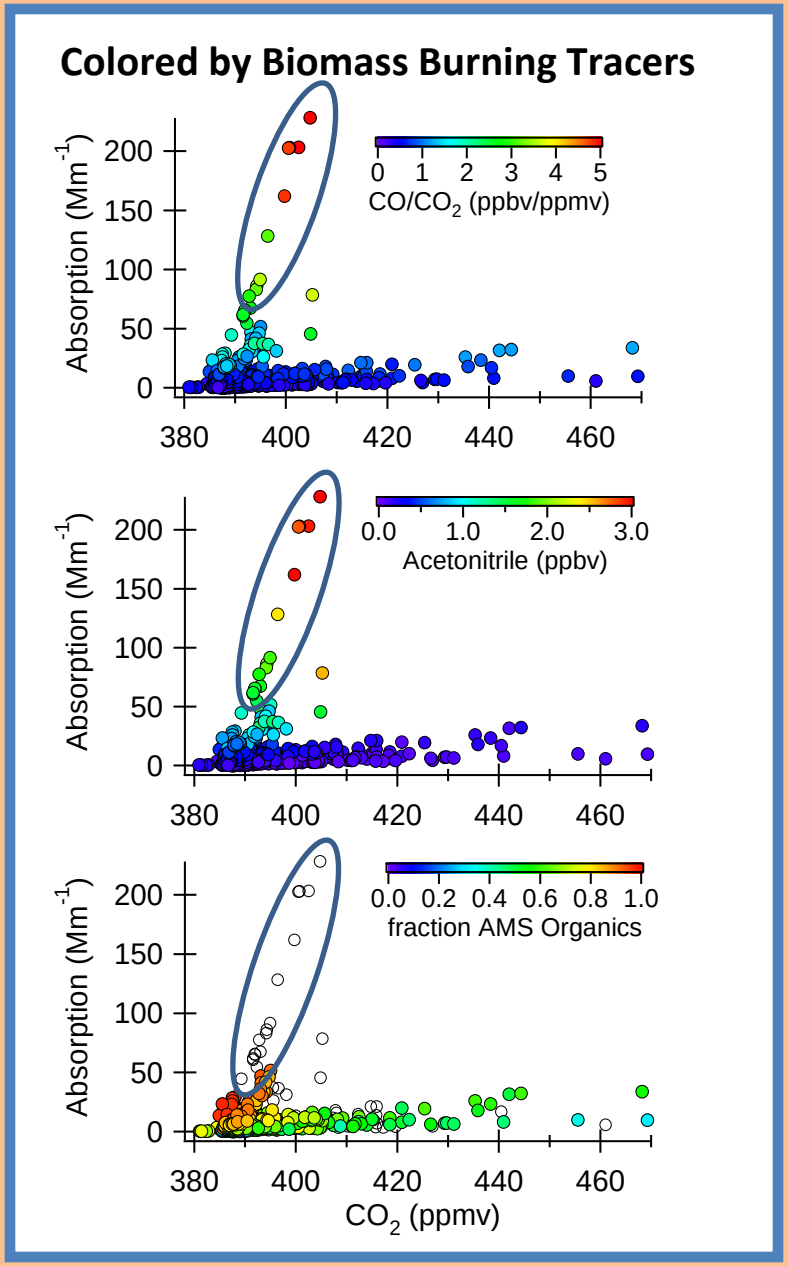


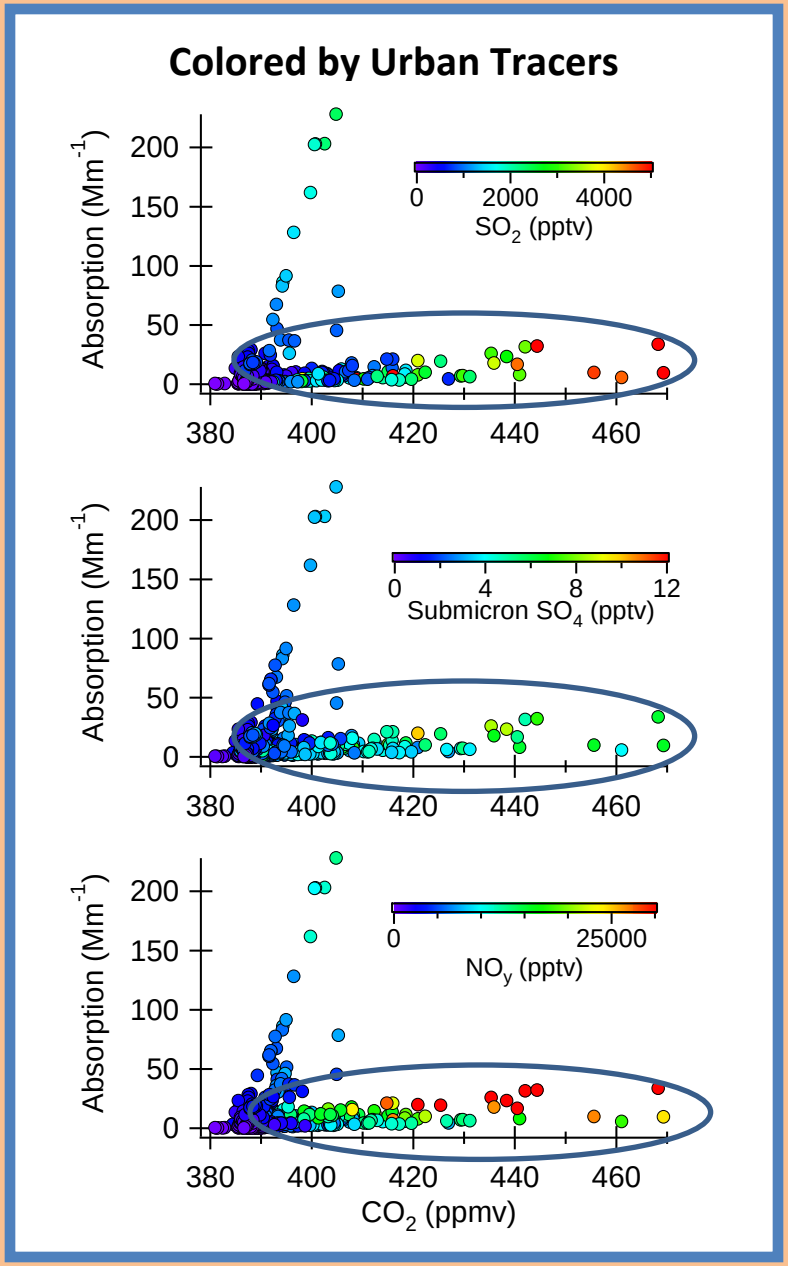




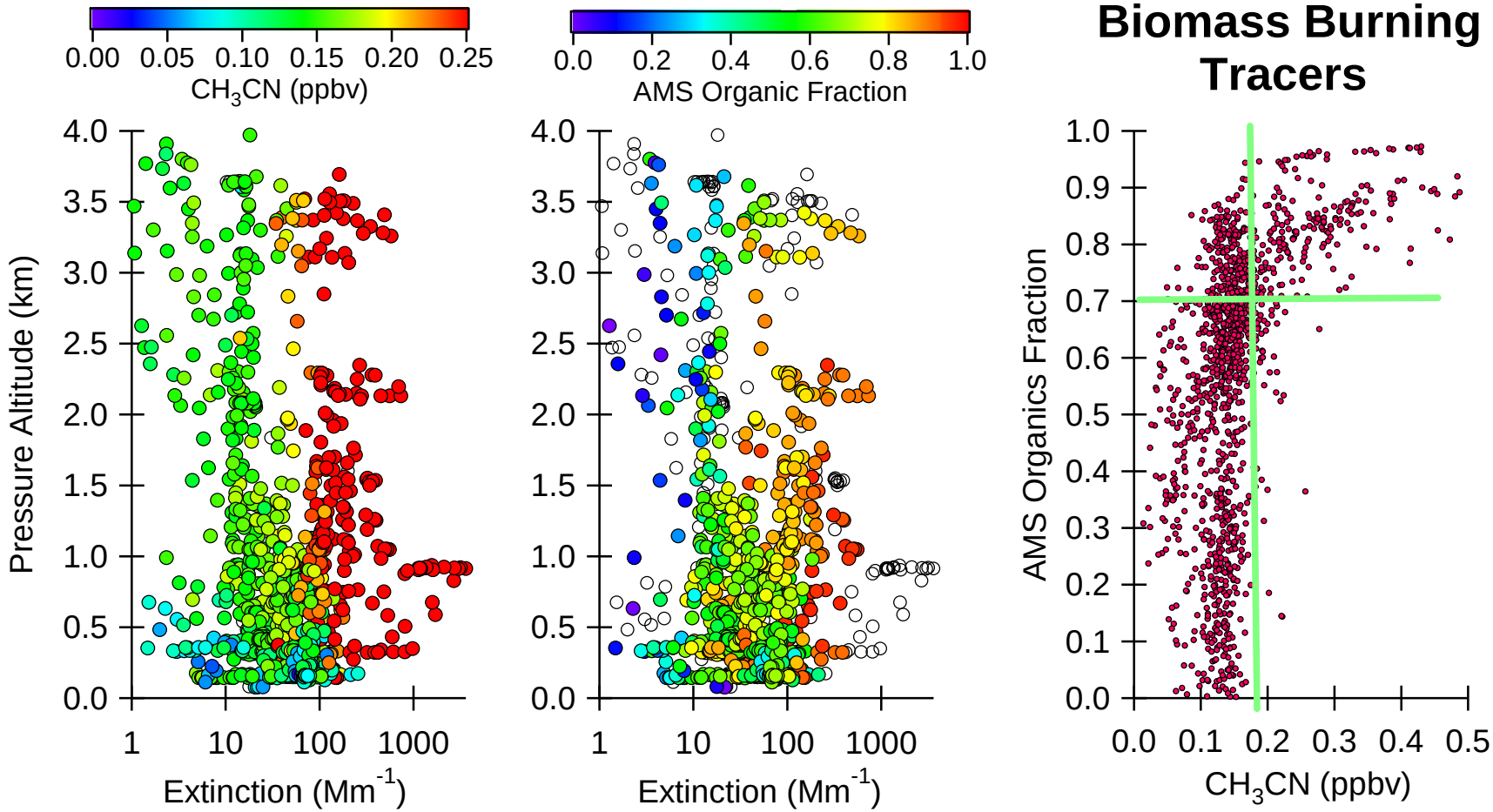


Summary of Aircraft Measurements





BB Encounters During ARCTAS-CA



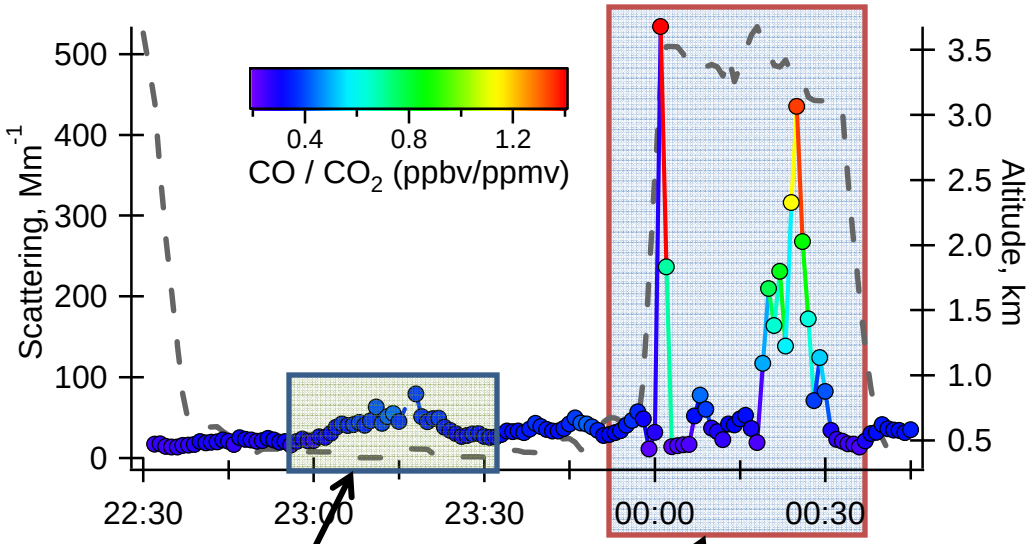
Biomass Burning Tracers

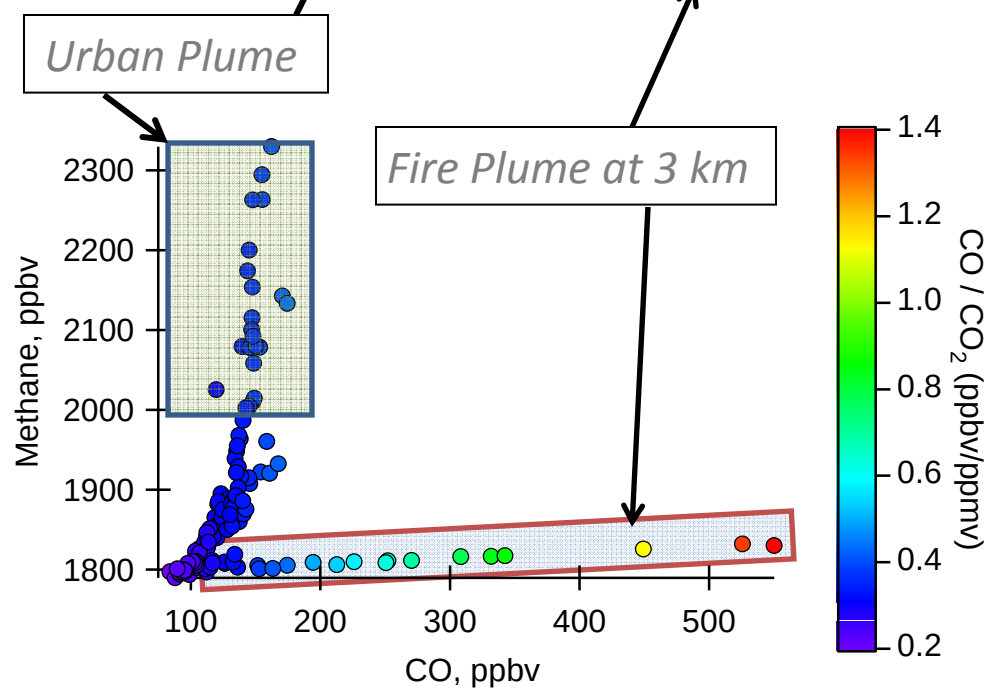
1. Acetonitrile (CH_3CN) (> 0.180 ppbv)
2. AMS Organic Fraction (= Organics/AMS Total Mass)

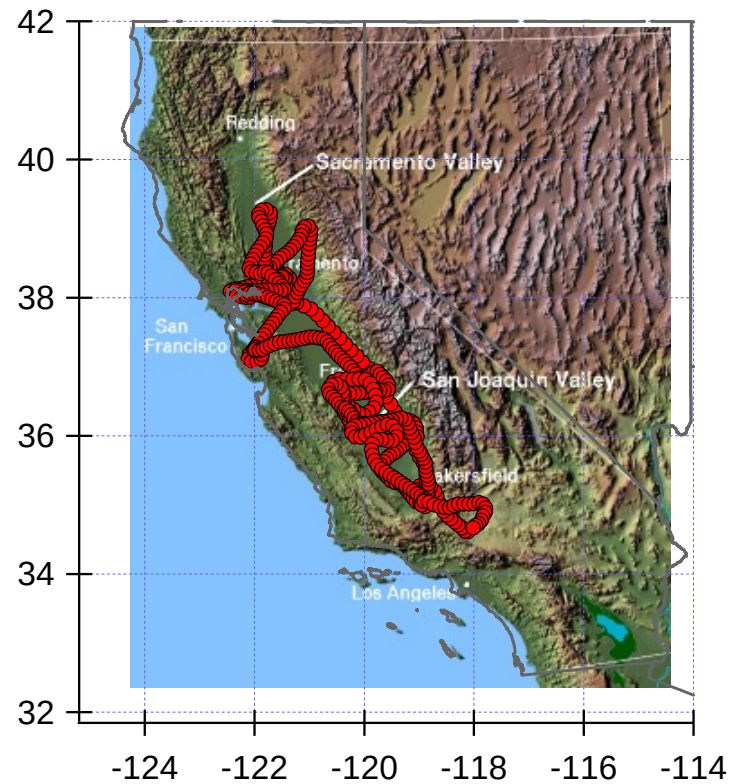
Observations

1. Extinction > 100 Mm^{-1} is almost entirely due to fire plumes
2. An AMS Organic Fraction of about 0.7 or higher parses the data much like CH_3CN > 0.180 ppbv.
3. BB Burning accounts for about 27% of the DC-8 ARCTAS-CA data

Central Valley Observations



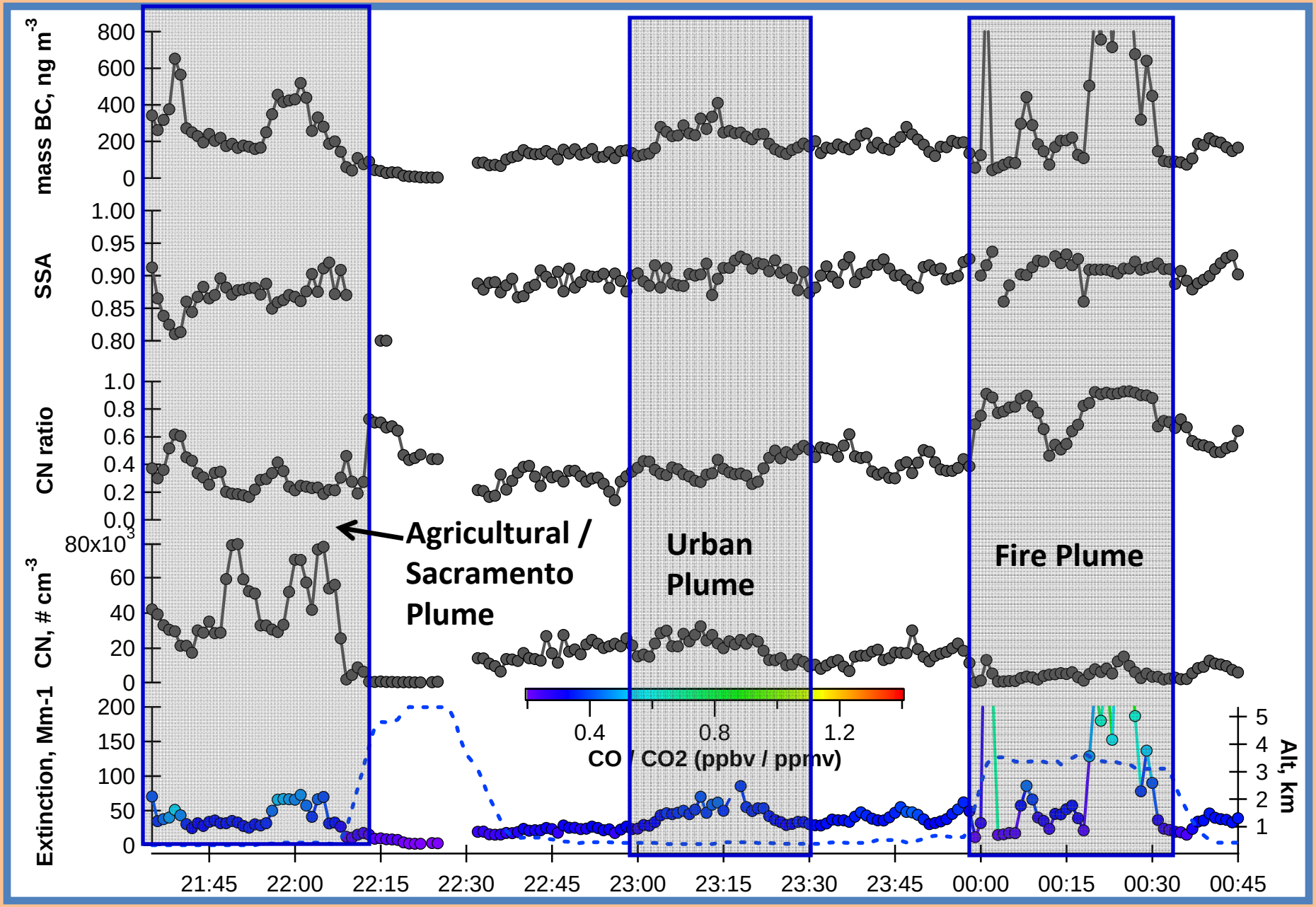




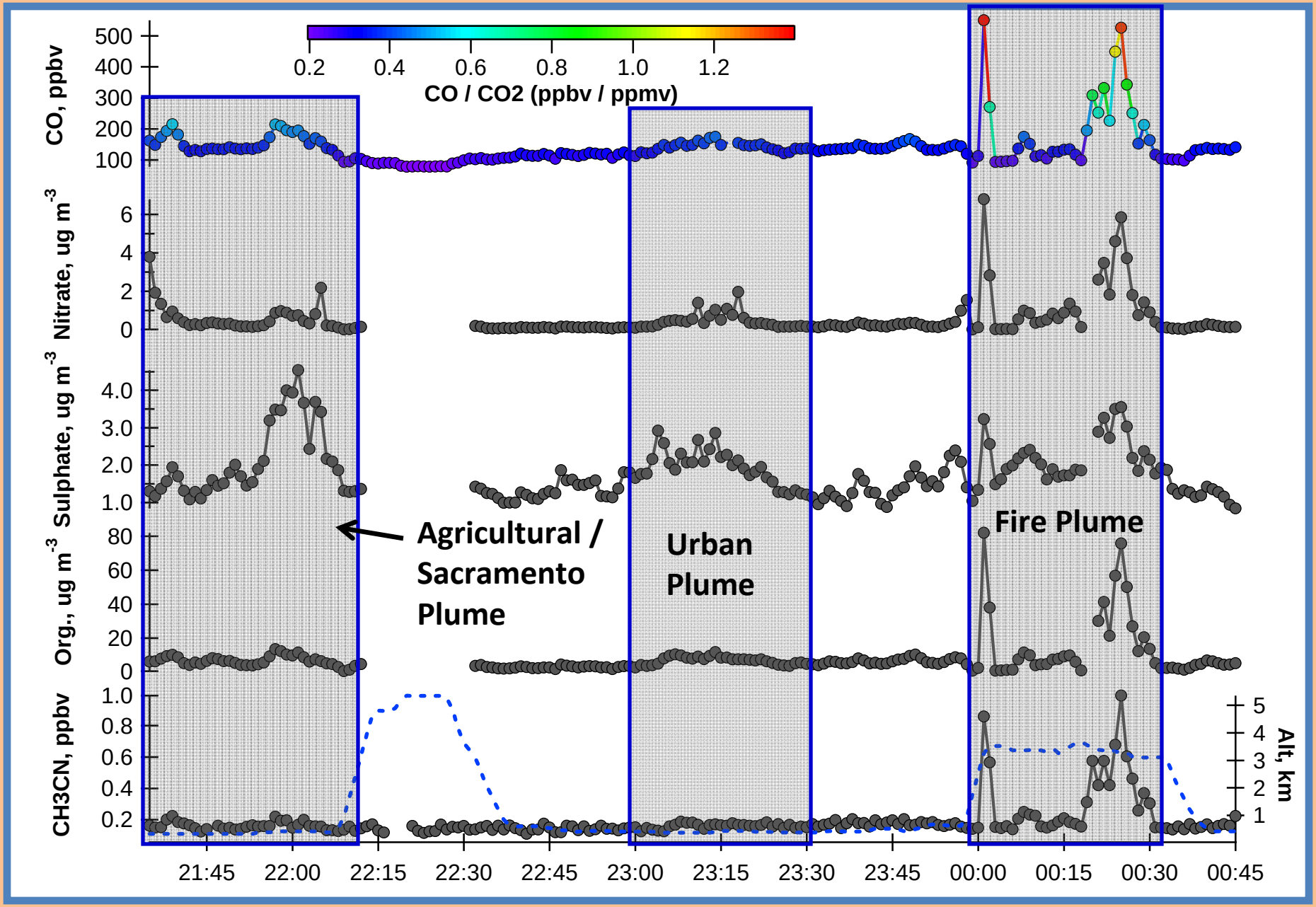
Aerosol Sources in the CV

- Biomass Burning
- Agricultural
- Urban (local sources e.g. Sacramento)
- Advected urban sources (e.g. LA)

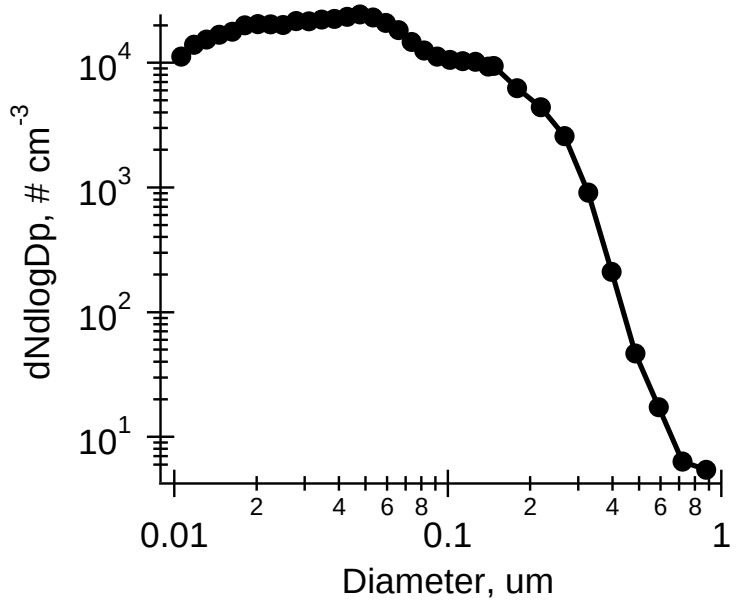
Central Valley Observations - Aerosols

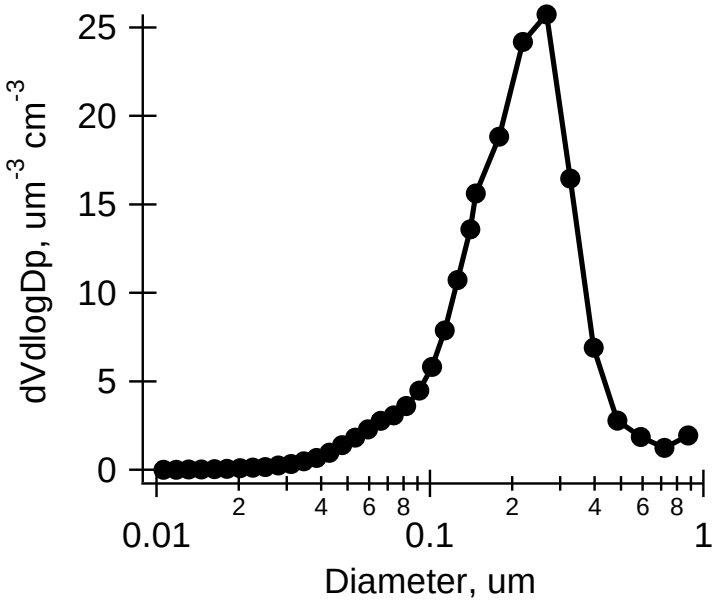


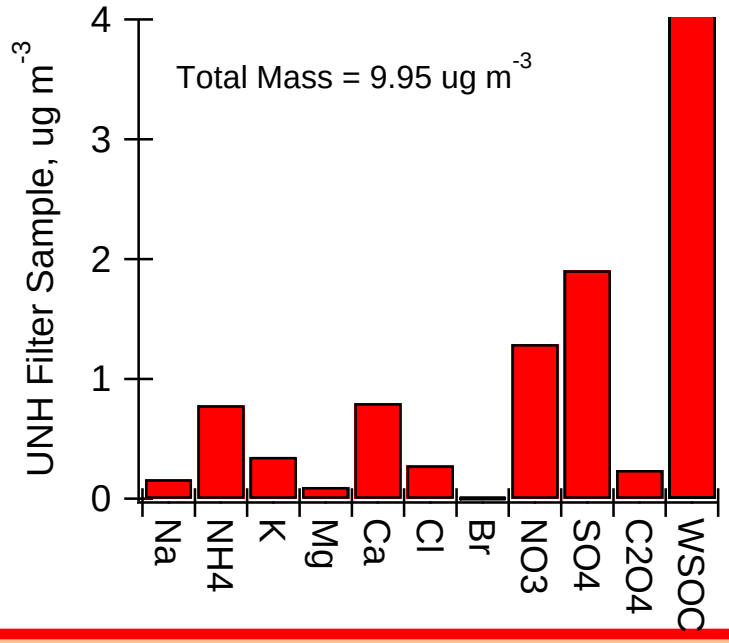
Central Valley Observations - Chemicals

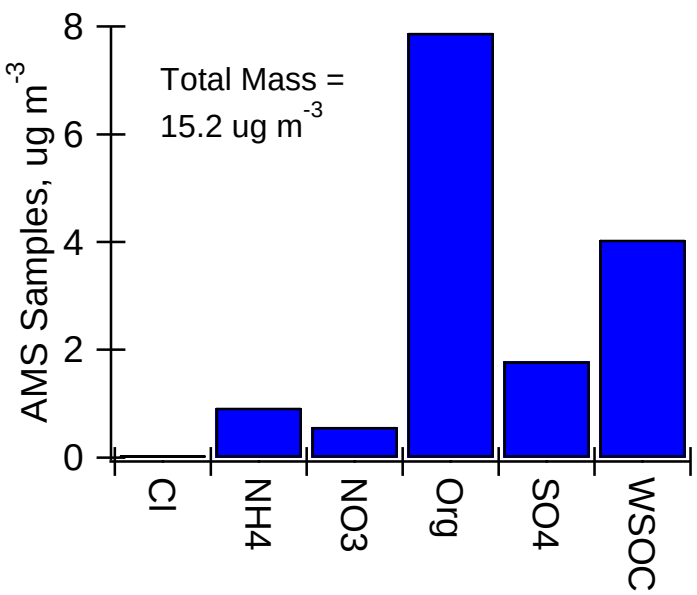


Central Valley Observations

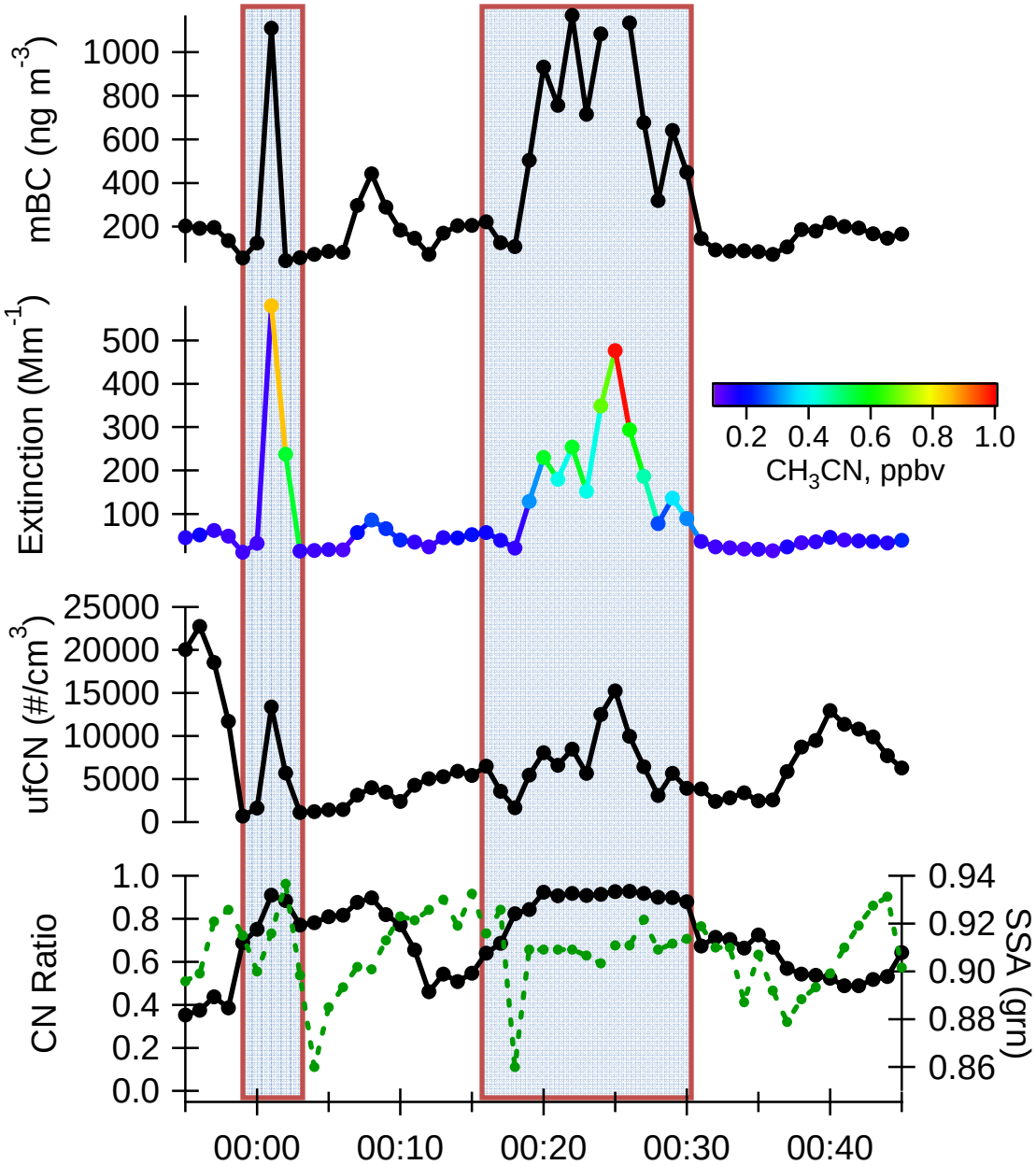


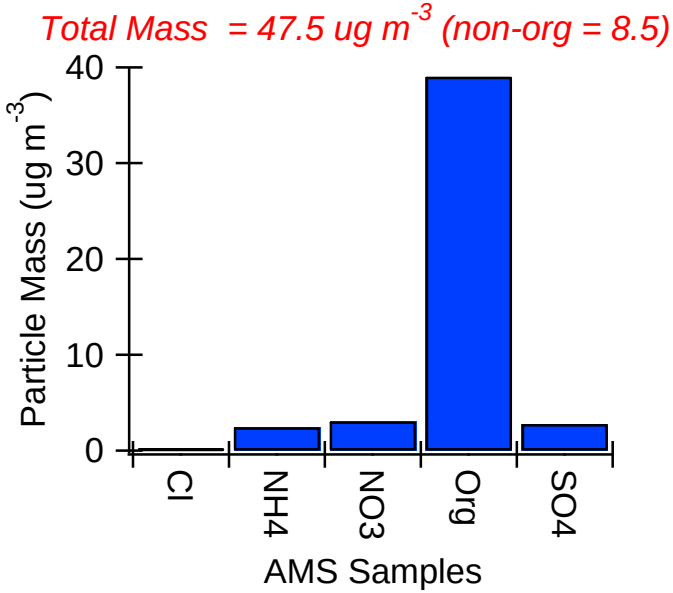






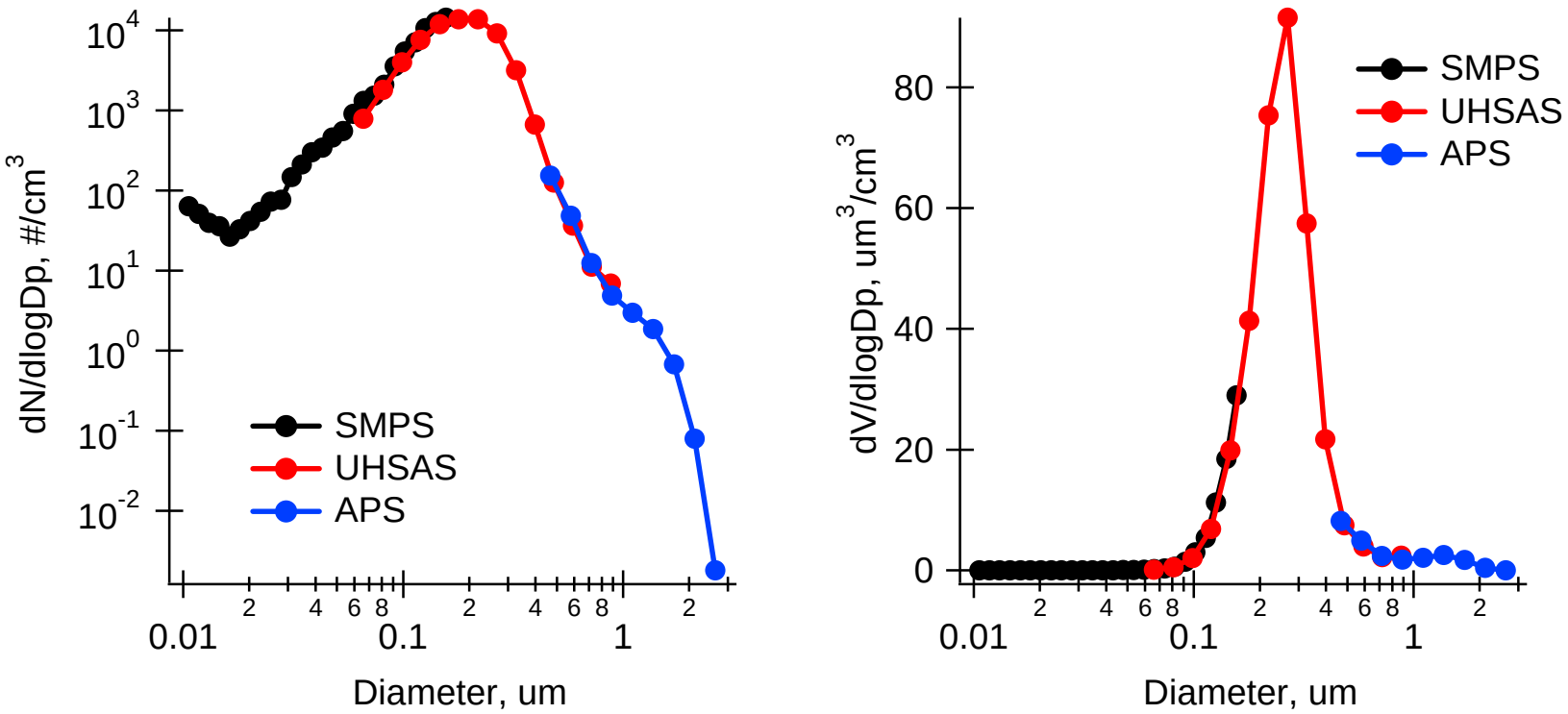
Fire Plume Encounter (06/20/09)





- no WSOC data
- AMS Organic/Total Mass = 0.82

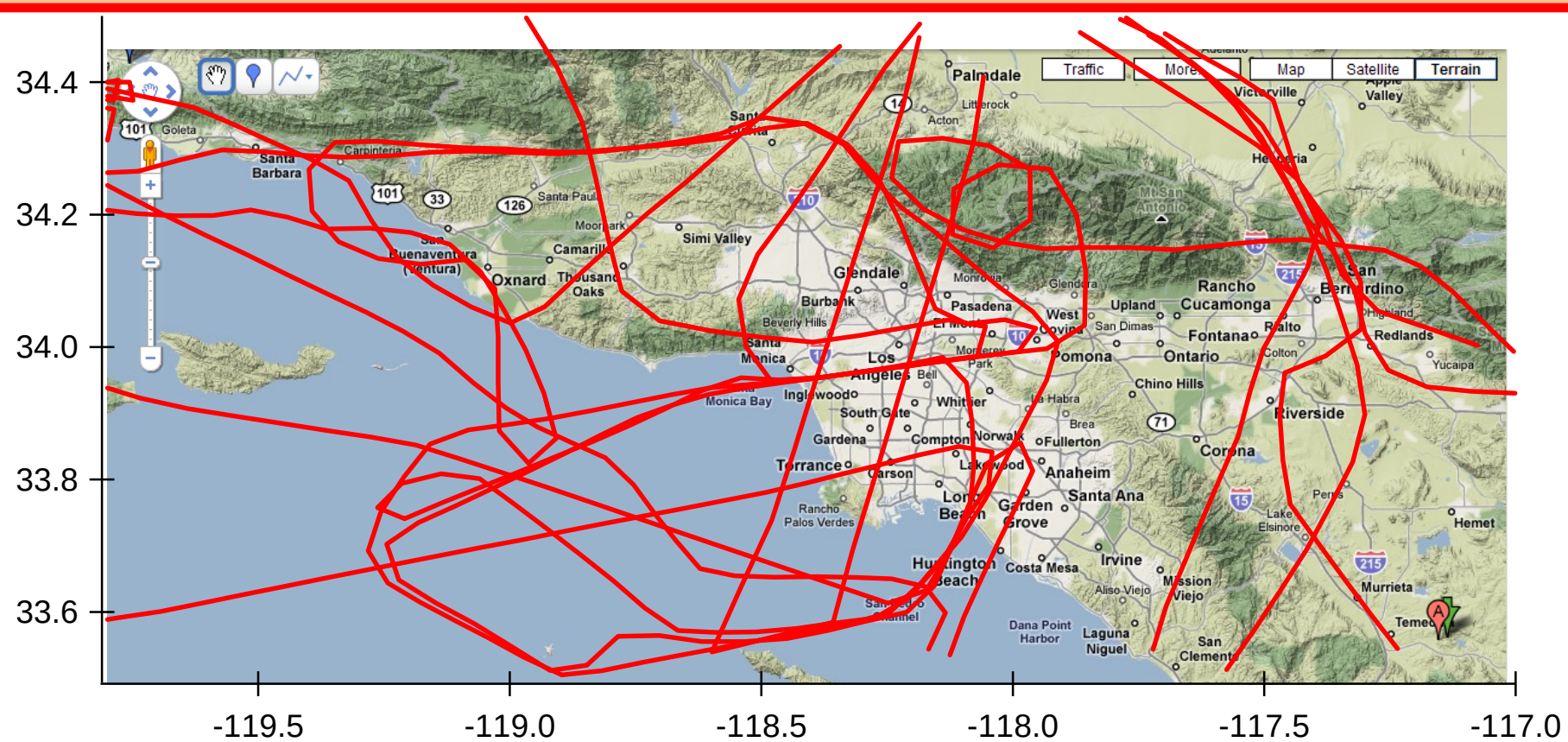
Fire Plume Encounter (06/20/09)



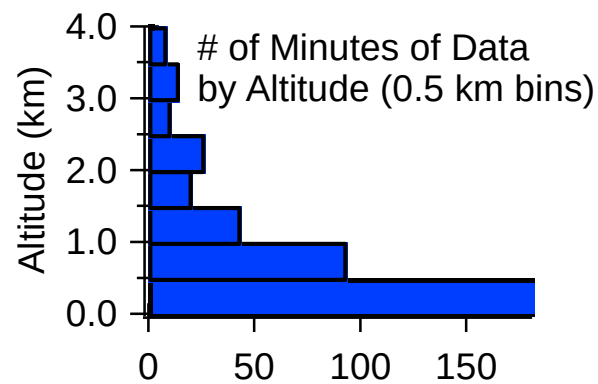
- APS diameters converted from aerodynamic to geometric diameter by a density of 1.85 g cm^{-3} and a shape factor of 1.04 [*Schmid et al., 2009*]

- Smoke particles are primarily submicron, with a GMD of 0.20 µm and a VMD of 0.30 µm

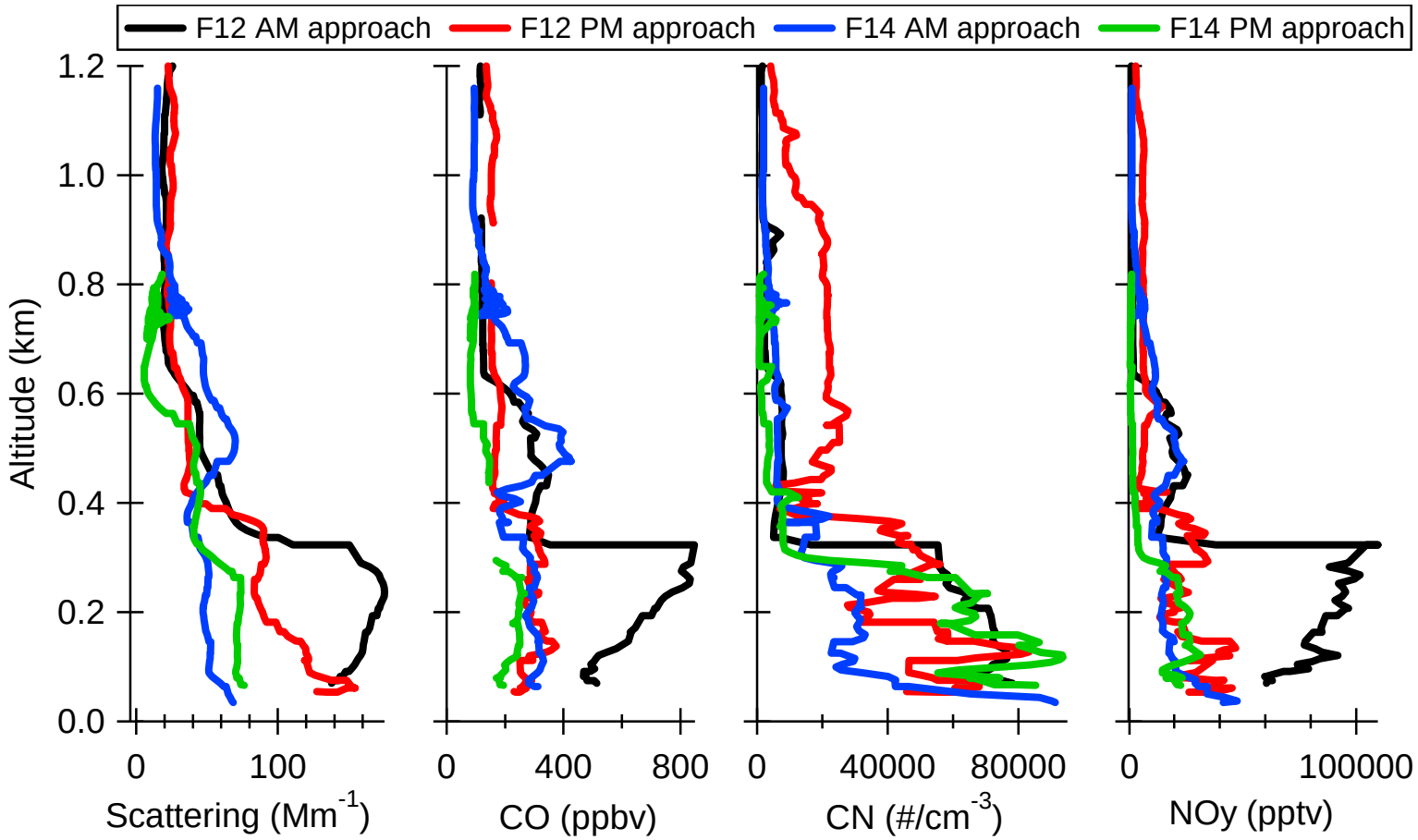
Los Angeles Basin Sampling



- 25% of the ARCTAS-CA data collected by the DC-8 was from within the LA Basin
- 4 missed approaches at LAX
- 4 traverses over Long Beach Harbor
- Sampling done throughout the day to study plume evolution



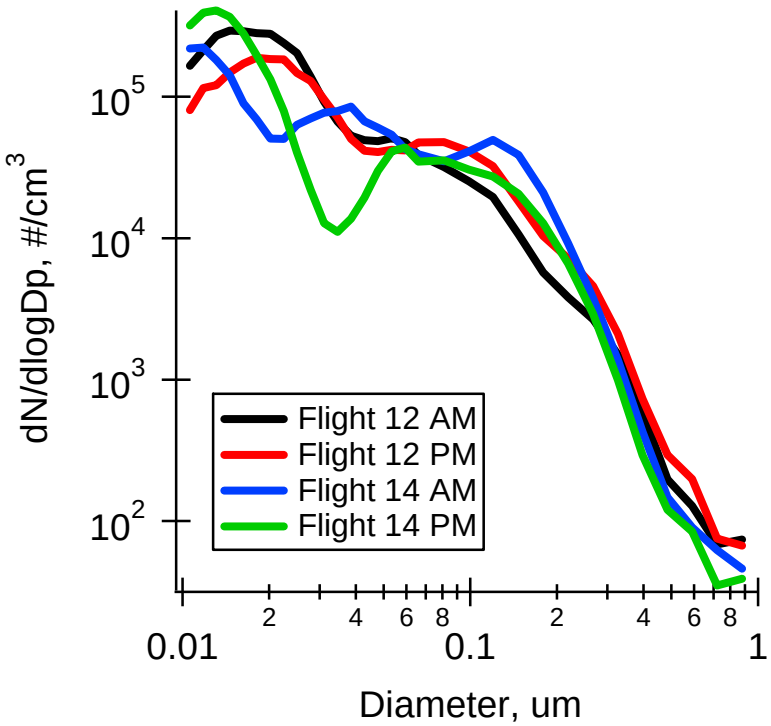
Los Angeles Airport Missed Approaches

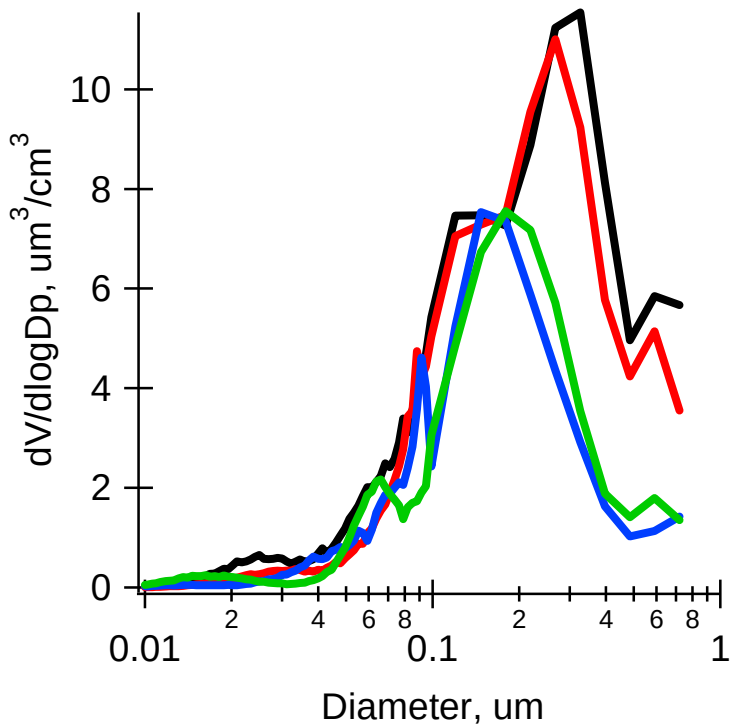


- Approaches made onshore to offshore
- 2 approaches made around 9:00 AM LT and 2 in the afternoon (1 PM and 5 PM LT)
- The weekday approaches (flight 12) showed a more polluted BL than the Sunday set (flight 14), as did the PM approaches

Case	Flight	UTC Time	Local Time	ML Top (km)	T (K)	P(mb)	WS (m/s)	WD (deg)
1	12	16:30	9:30	0.6	294	990	1.12	331 (NW)
2	12	19:50	12:50	0.7	294	998	5.20	265 (W)
3	14	16:00	9:00	0.6	297	998	1.12	135 (SE)
4	14	00:10	17:10	0.6	296	998	4.86	248 (WSW)

LAX Missed Approaches – Size Distributions

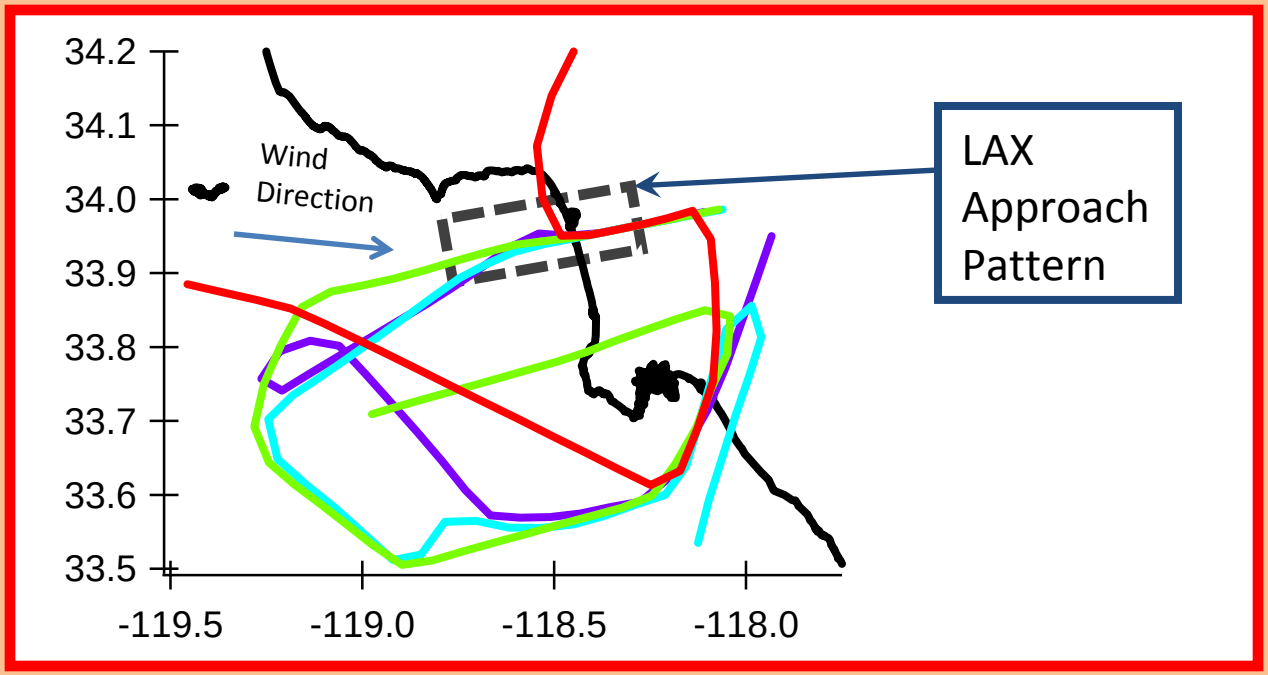


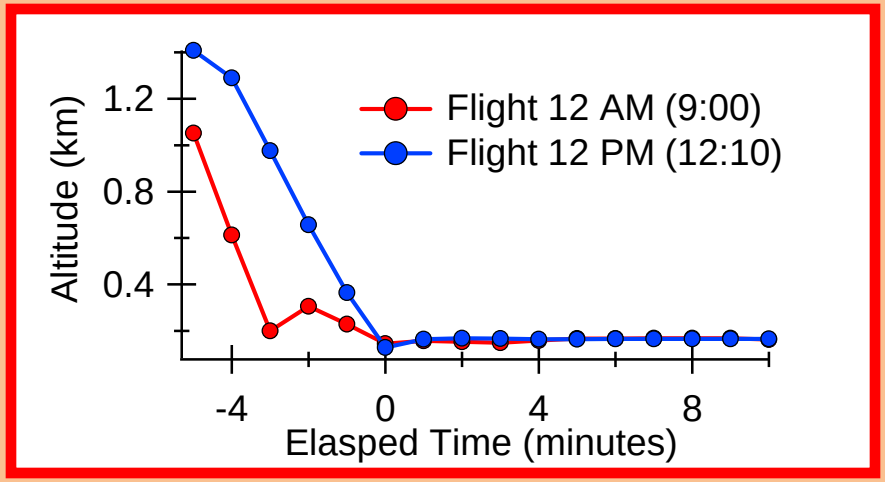


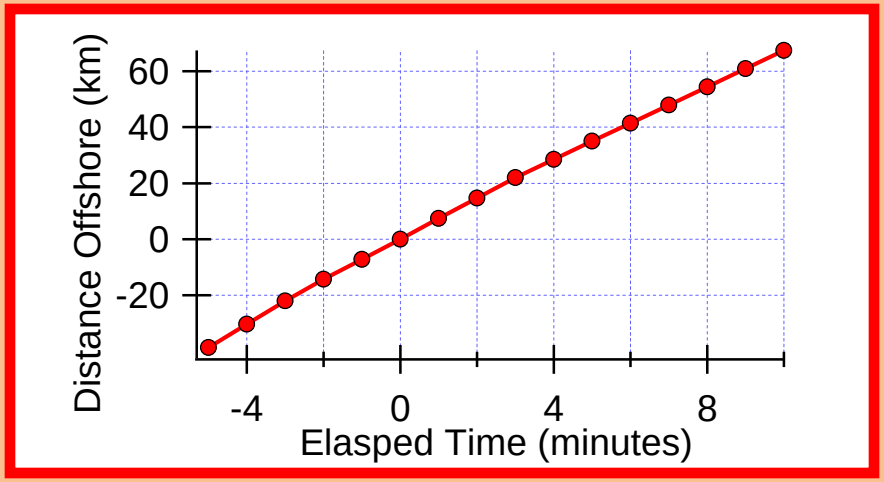
- The number SDs look pretty similar with an addition mode in the Flight 12 SDs around 0.02 um.
- The additional peak in the volume SD for the Flight 12 cases at 0.3 um is consistent with the increase in the extinction from the soundings and enhancement in anthropogenic tracers (e.g. sulfate, nitrate, and ammonium)

LAX Missed Approaches – Extent of Pollution

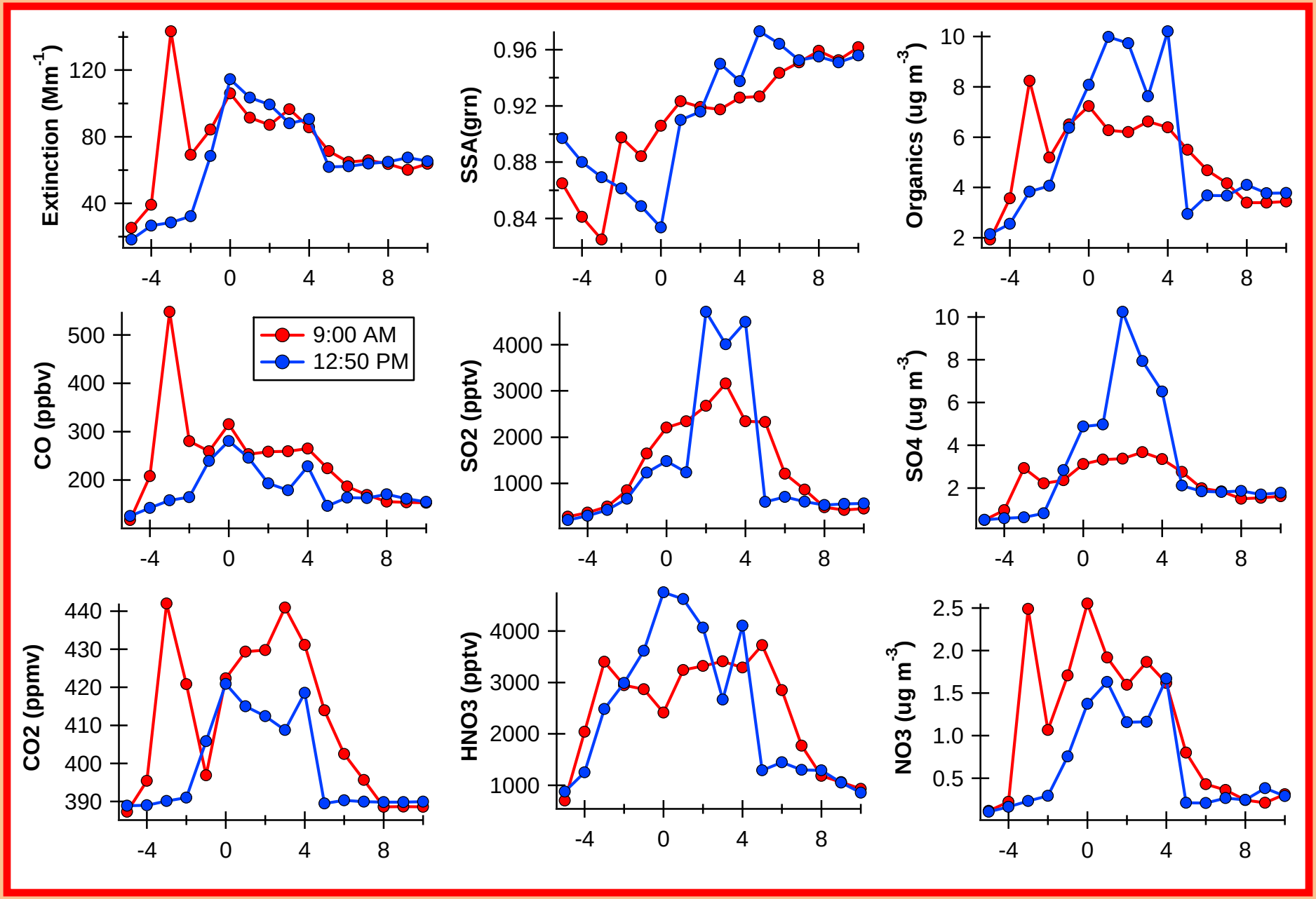
How far does the pollution from around LAX extend out into the Pacific?



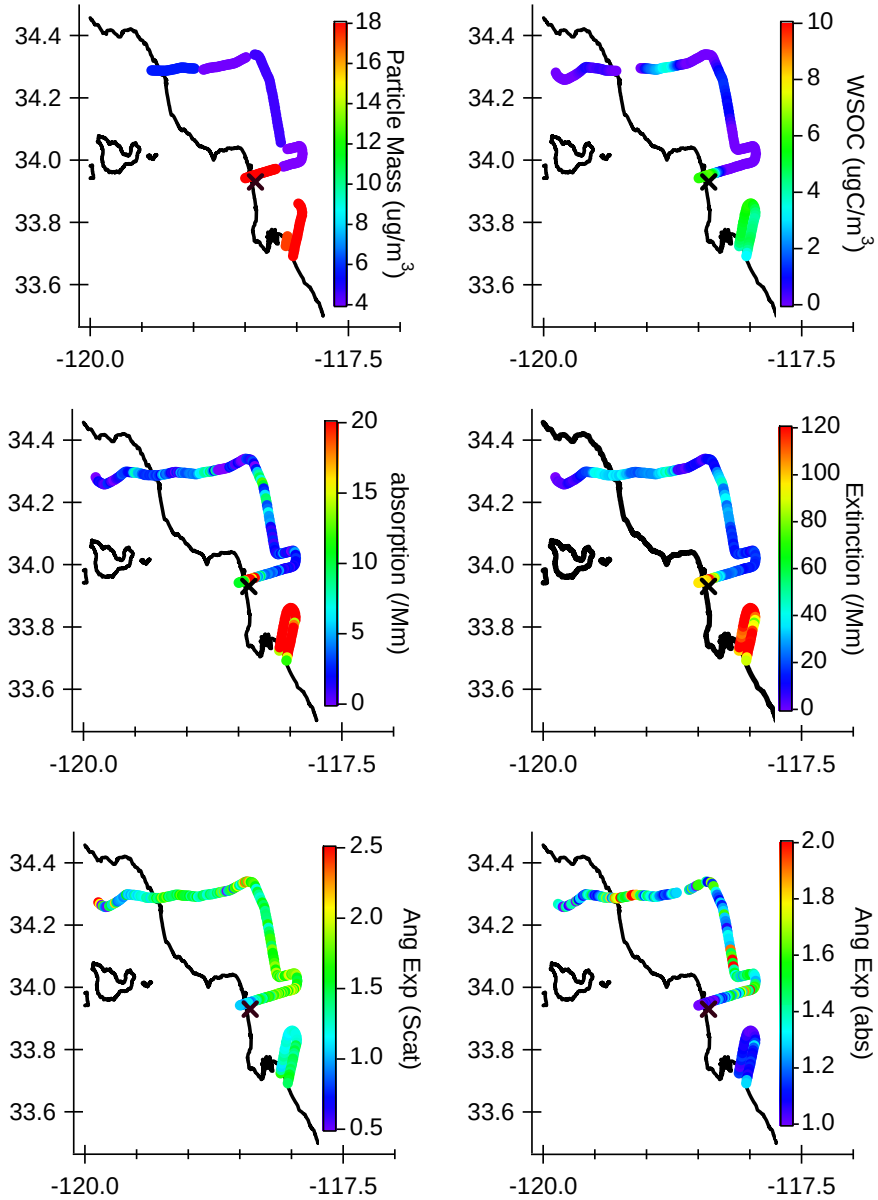


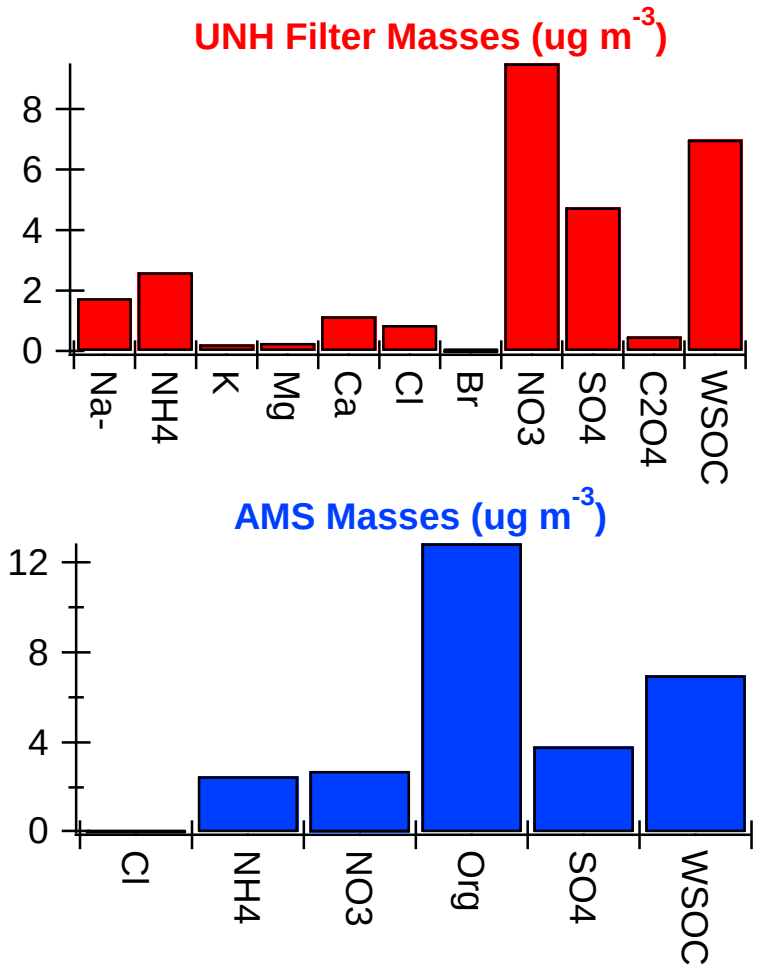


LAX Missed Approaches – Extent of Pollution



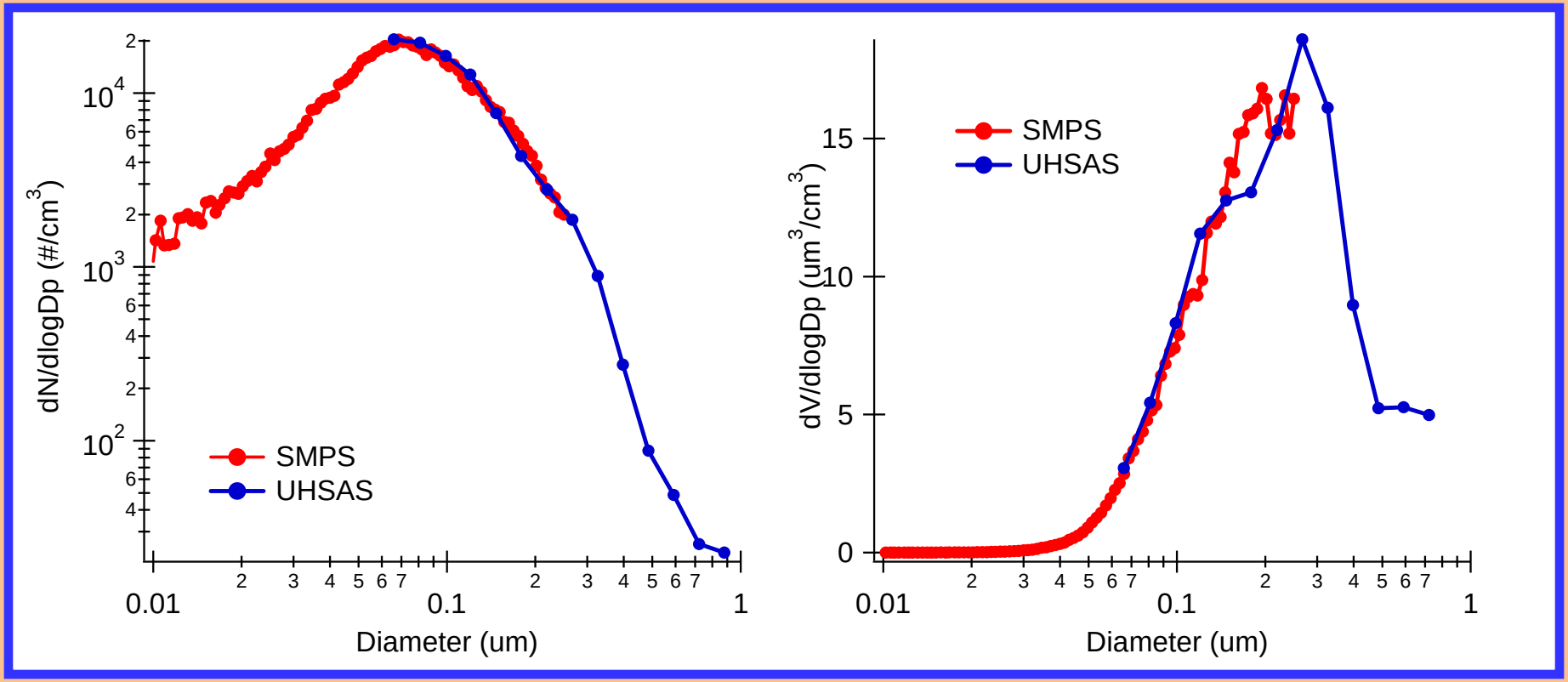
Long Beach Harbor Approaches





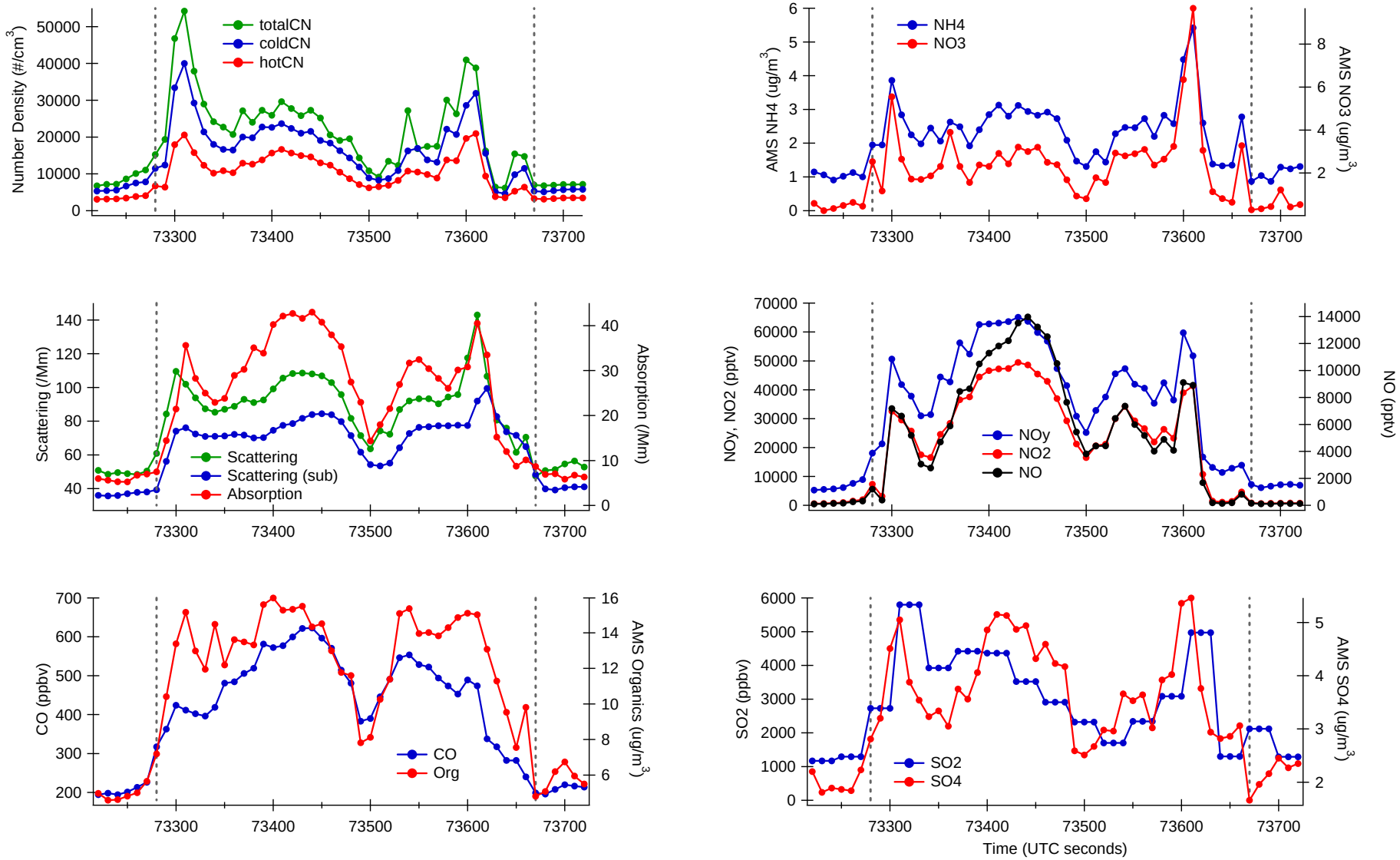
- *4 Passes (Flights 12 and 14)*
- *Example data from Flight 12*

Long Beach Harbor – Size Distributions

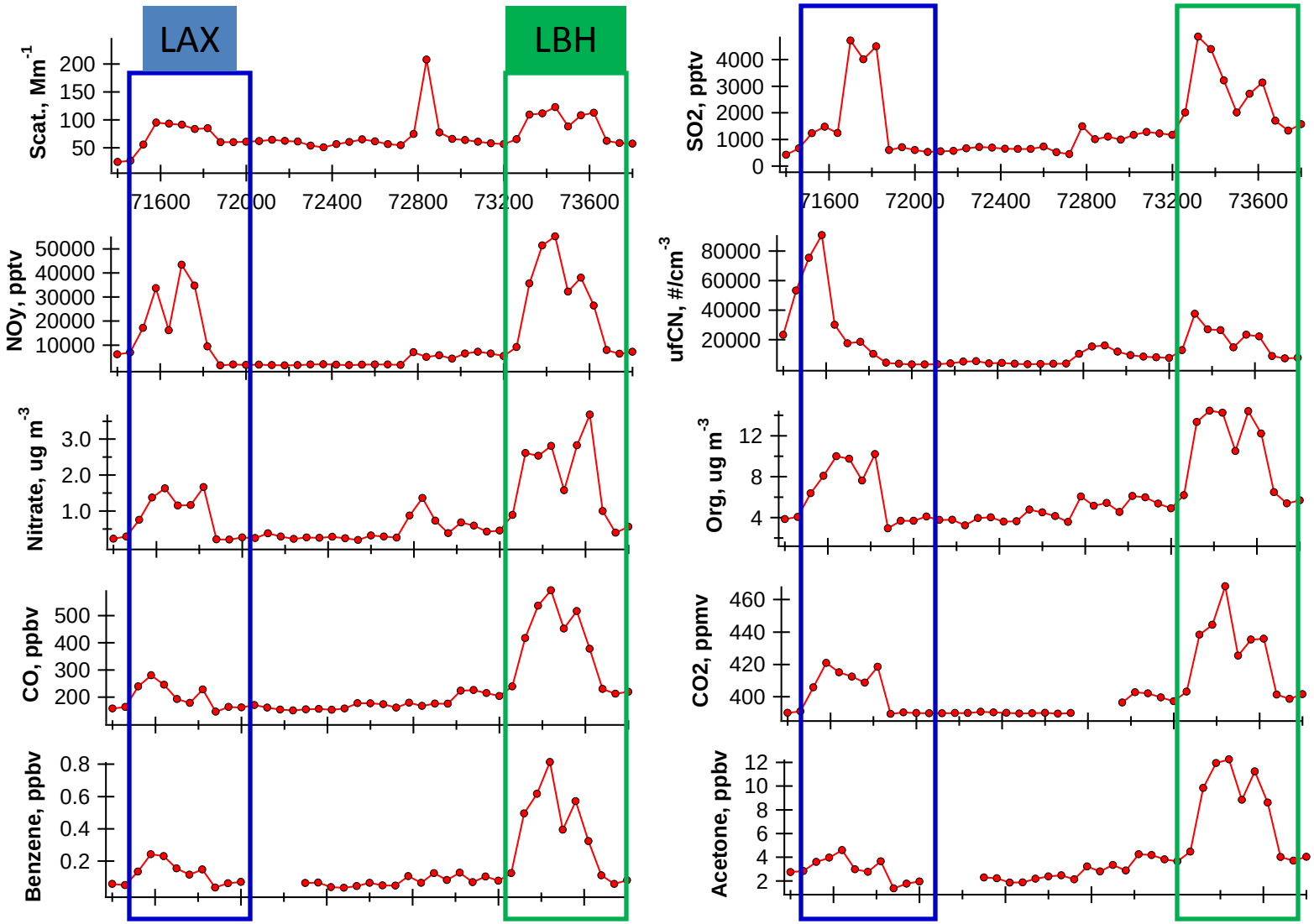


- The aerosols are primarily submicron, with a GMD of about 0.075 µm and a VMD of about 0.3 µm
- The size distributions of the other 3 passes through the Long Beach Harbor have a similar shape and peak.
- The peak in the volume distribution was about 1.5 times the magnitude of the LAX volume distribution and the number of particles < 0.1 µm was much less.

Long Beach Harbor – Time Series Plots



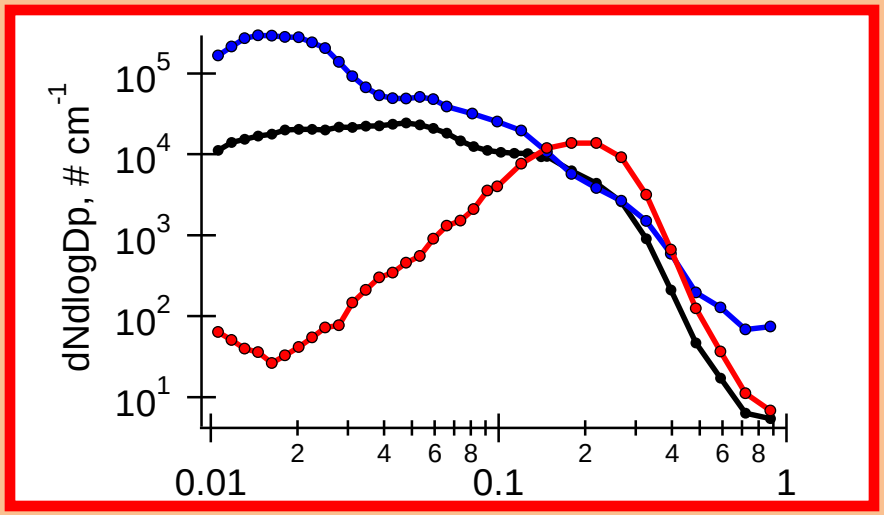
Comparing LAX and Long Beach Harbor

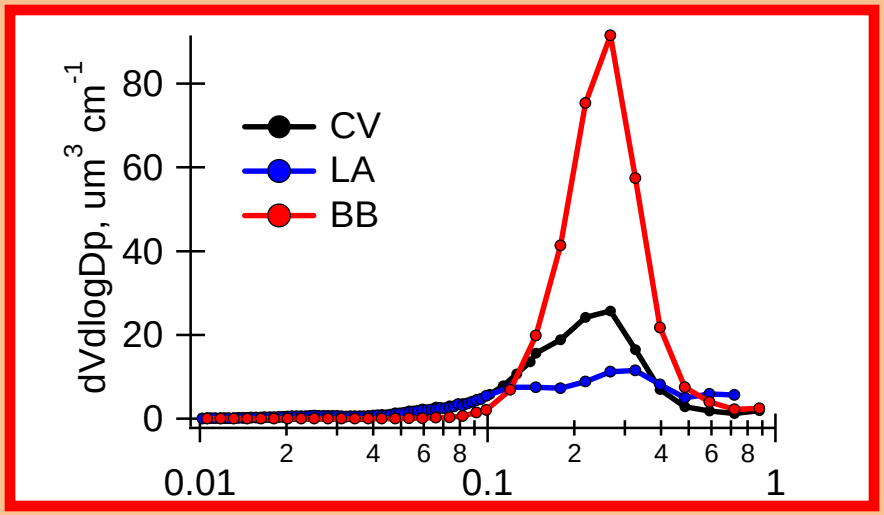


The Long Beach Harbor Data shows a greater enhancement in anthropogenic tracers than the LAX data

ARCTAS-CA Plume Summary

Biomass Burning	LAX	Long Beach Harbor	Central Valley
• CO = 284.2 ppbv	•CO = 344.5	• CO = 363.3	• CO = 141.7
• Extinction = 213 Mm^{-1}	• Extinction = 95.41	• Extinction = 102.9	• Extinction = 50.2
• CO/CO2 = 0.72	• CO/CO2 = 0.80	• CO/CO2 = 0.85	• CO/CO2 = 0.36
• SO_4 = 3.0 ug m^{-3}	• SO_4 = 6.10	• SO_4 = 6.0	• SO_4 = 3.0
• BC= 614.8 ng m^{-3}	• BC= 430.0	• BC= no data	• BC= 220.6
• CH3CN = 0.5 ppbv	• CH3CN = 0.11	• CH3CN = 0.18	• CH3CN = 0.2
• CN = 5.1e3 # cm^{-3}	• CN = 5.4e4	• CN =1.4e4	• CN = 1.27e4





Summary

- Majority of observed enhancements in aerosol extinction were associated with plumes from fires burning throughout California
- The aerosol loading and pollution buildup around LAX appears to show a dependence on the amount of air traffic, not necessarily the time of day or wind direction
- The Long Beach Harbor region shows high concentrations of anthropogenic pollutants, with levels greater than that of the LAX area
- The Central Valley was a complex mixture of urban and biomass burning airmasses during the summer of 2008

Acknowledgements

- Research funded by the NASA Tropospheric Chemistry Program
- ARCTAS Science Team
- California Air Resources Board