Characterization of North American Monsoon Outflow: DC-8 Profiling on August 16, 2013

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Introduction

- The North American Monsoon (NAM) is a persistent meteorological feature characterized by upper-level high pressure bringing rain to the SW-USA region in the early summer season.
- While the NAM is not as consistent or intense as the Indian monsoon, features observed during SEAC4RS may by analogous.
- Sampling on August 16, 2013 targeted NAM outflow while transiting east-to-west along the northern side of NAM circulation.

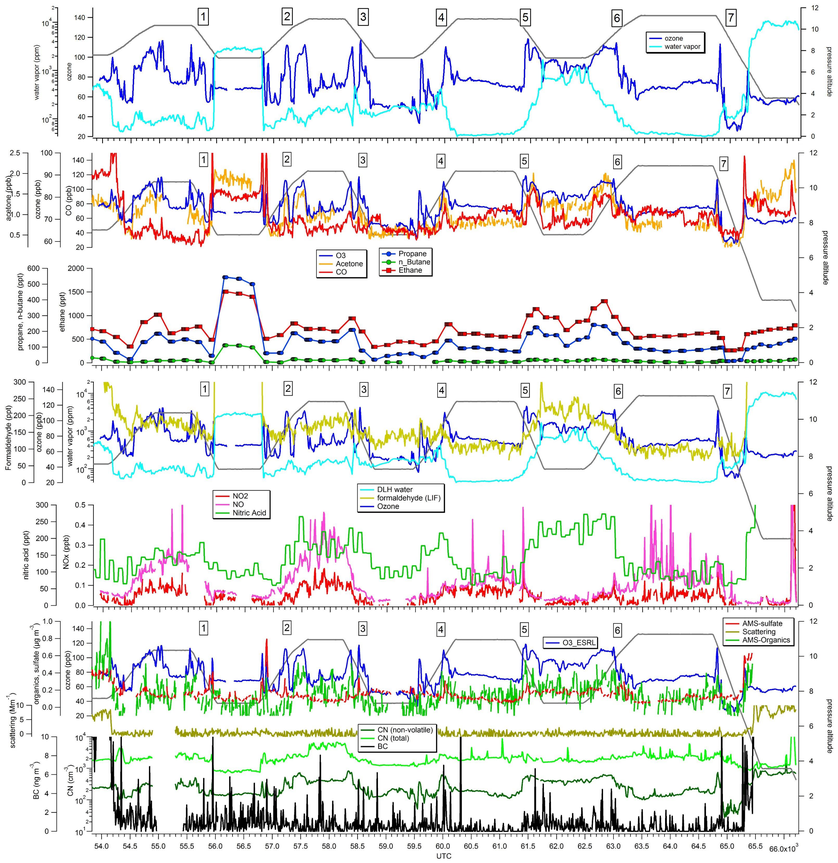
Objectives and Impacts

1. Identify aerosol and gas-phase markers for NAM outflow
2. Quantify the impact of injection and aging of pollutants to upper tropospheric composition

Conclusions

- Profiling in NAM outflow allowed identification of two distinct plumes from 7-11 km altitude.
- Each plume increased in age (up to 4 days old) toward the center of NAM circulation, with the lower-altitude plume being generally less aged.
- Upper-plume sampling had a source in Mexico, and a distinct chemical signature compared convection in AZ.
- Outflow aerosol was small (40-70nm), was consistent with urban sources, and lacked any observable coarse mode.

2. August 16, 2013 (RF-5)



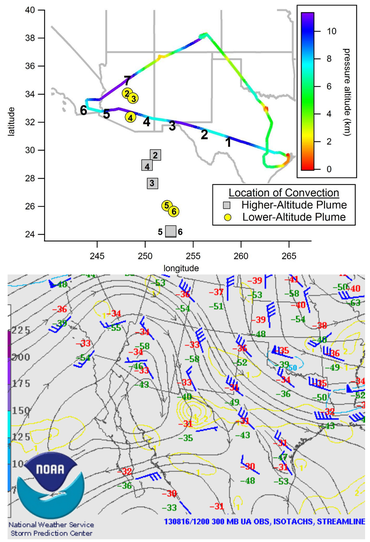
- Profiles are numbered and noted on map.
- Ozone variability suggests periodic sampling of NAM in each profile
- Water vapor is unlikely stratospheric air.

- Gas-phase pollutants are each elevated with high ozone plumes.
- CO, acetone, and ozone are generally positively correlated suggesting dominant tropospheric sources.

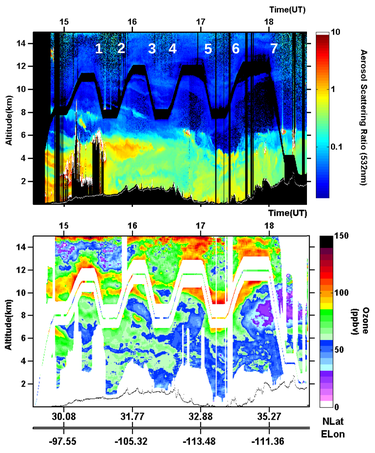
- Formaldehyde-water correlation suggests active photochemistry is occurring, especially in profiles 5+6.
- Highly variable NO due to lightning source.

- Aerosol scattering is negligible throughout region.
- Non-volatile particle concentrations are highly correlated with ozone.
- BC mass concentrations are very low; particles are likely too small to be detected by SP2.
- Organic and sulfate contribution is variable but often enhanced.

- Flight track for RF-5. Open numbers represent profiles. Boxes and circles are locations of convection for each profile



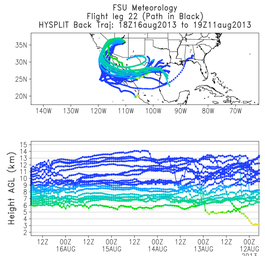
1. Meteorological and Flight Setup



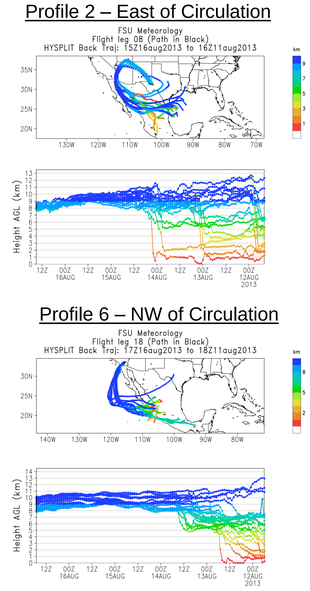
- 300mb streamlines show the center of NAM circulation south of profiles 4/5.
- Lidar shows complex layering of ozone in the region, some indication of aerosol structure above 7 km is observed.

- HYSPLIT back trajectories suggest that convection in Mexico is the source for all of the high-elevation plumes.
- Lower altitude plumes have sources in AZ.
- East of circulation, flow has wrapped around H-pressure
- Unique clean air was sampled in Profile-7 that had never encountered continental convection.

Profile 7 – Clean FT air

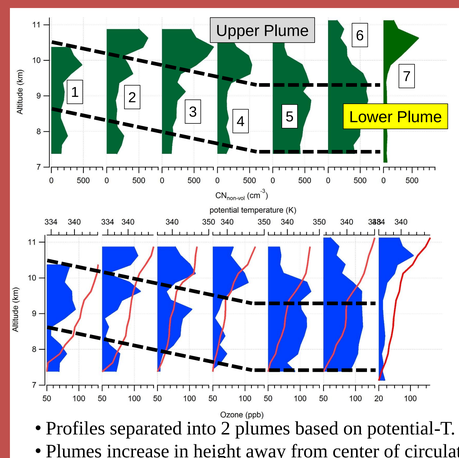


Profile 2 – East of Circulation



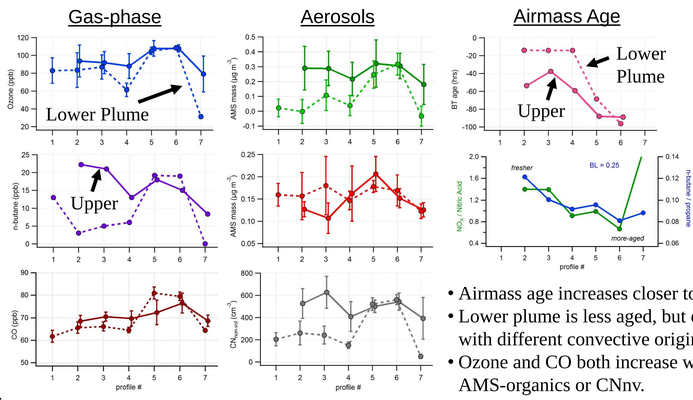
Profile 6 – NW of Circulation

3. Profiles: Aging and Source-region Comparison

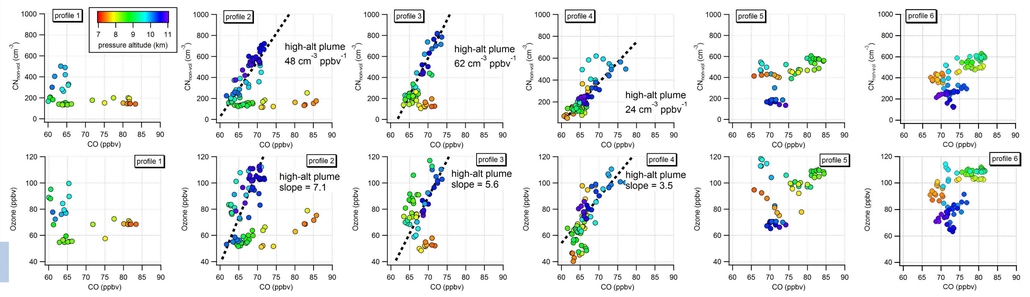


- Profiles separated into 2 plumes based on potential-T.
- Plumes increase in height away from center of circulation

Gas-phase / Aerosols / Airmass Age

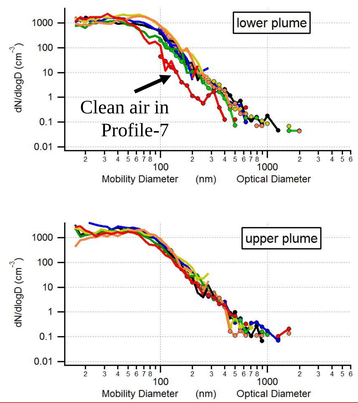


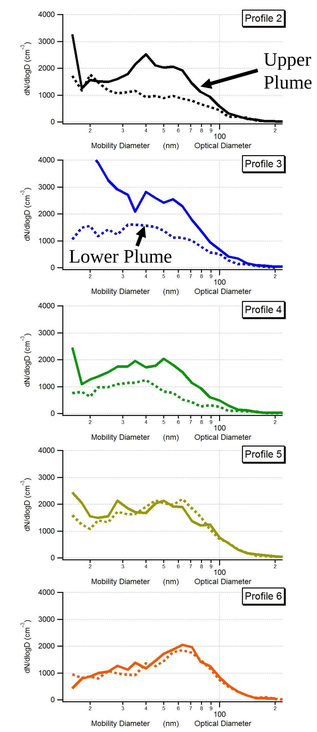
- Airmass age increases closer to center of circulation
- Lower plume is less aged, but chemistry is consistent with different convective origin.
- Ozone and CO both increase with age, no change in AMS-organics or CNnv.



- Ozone/CO are well correlated for fresher plumes, harder to interpret closer to center of circulation.
- CN_{nv}/CO ratios are more consistent with urban-anthropogenic sources of BC than with cruise-aircraft emissions.
- UTLS mixing of aircraft emissions is an unlikely source of NAM CN_{nv}

- Size distributions show a consistent peak in dN/dlogD at 40-70nm diameter.
- No clear trend in particle diameter is observed as plumes age.
- Lower-plume has consistently lower concentrations of 40-70 nm particles when convection is over AZ.





- No obvious transport of coarse-mode aerosol was observed in NAM outflow

Type	nonvolatile CN to CO	Mission	Notes
Wildfires - fresh	**20**	SEAC4RS	Rim Fire - within 1 day (RF09)
Wildfires - aged	**11**	SEAC4RS	Rim Fire - 1-2 days (RF10)
Clean Urban	**81**	DISCOVER-AQ	Baltimore below 1 km on days with low AOD
Polluted Urban	**40**	DISCOVER-AQ	Baltimore below 1 km on days with high AOD
Aircraft Emissions - Idle	**17-66**	AAFEX-1	JP8 Fuel, range of 1 to 30m data, 4-7% power
Aircraft Emissions - Cruise	**289-638**	AAFEX-1	JP8 Fuel, range of 1 to 30m data, 30-65% power
Aircraft Emissions - Take-Off	**654-1342**	AAFEX-1	JP8 Fuel, range of 1 to 30m data, 85-100% power