

A31C-3041: Comparing ground-based and airborne aerosol measurements during the DISCOVER-AQ Colorado field deployment



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Introduction and Overview of P-AQ CO

Understanding the relationship between airborne and ground-based measurements is one of the key questions that the DISCOVER-AQ series of field deployments hope to be able to answer. To address this question, the NASA P-3B systematically conducted vertical profiles over at least six ground sites sampling down to about 1000 feet above ground level (AGL). These data are combined with missed approaches at local airports which provide vertically resolved information between the lowest spiral altitude and the ground-based measurements. During the last DISCOVER-AQ field deployment (Denver, CO; July-August 2014), NASA Langley made aerosol measurements onboard both the NASA P-3B and a mobile laboratory. Coincident measurements included aerosol number concentration, size distributions, along with optical properties such as aerosol scattering, extinction, and hygroscopicity. Two ground sites were sampled, as well as several road trips to sample emissions from feedlots, oil/gas mining operations, and smoke from distant wildfires. We present a comparison between airborne and ground-based measurements made at the two ground sites. Most of the sampling was done in low aerosol concentration environments, away from local sources. Combined, the two ground sites provide at least 30 comparisons between airborne and ground-based aerosol measurements.

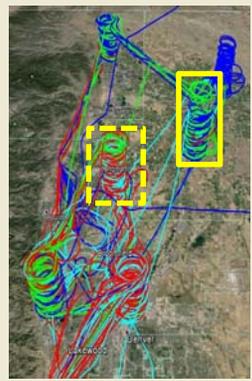
DISCOVER-AQ CO Overview

- The NASA P-3B was equipped with a complex suite of chemical and aerosol instruments
- A total of 214 spirals were done over 6 ground sites and 108 missed approaches were performed at nearby airports in order to extend the profiles down to the surface
- NASA Langley's Aerosol Research Group (LARGE) provided a coincident set of aerosol measurements to the ones they had on the NASA P-3B in a mobile laboratory (MACH-2)

Coincident LARGE aerosol measurements include:

Measured Parameter	P-3B Instruments	MACH-2 Mobile Lab Instruments
Aerosol Number Concentration (CN)	TSI-3025 (CN > 4 nm) TSI-3010 (CN > 10 nm)	TSI-3775 (CN > 4 nm)
Aerosol Particle Size	Scanning Mobility Particle Sizer (SMPS) (0.01-0.3 μm)	SMPS (0.008-0.3 μm)
	DMT Ultra-High Sensitivity Aerosol Spectrometer (UHSAS) (0.06-1.0 μm)	TSI Engine Exhaust Particle Sizer (EPPS) (0.006-0.52 μm)
	TSI Aerosol Particle Sizer (APS) 3321	APS 3321
Total (Dry & Wet) Scattering (450, 550, and 700 nm)	2 x TSI 3563 Nephelometers	2 x TSI 3563 Nephelometers
Aerosol Hygroscopicity	System humidifies aerosols to 80% RH	Scanning system switches between dry (< 40%), 60%, 70%, and 80% RH in steps
Aerosol Absorption	Radiance Research Particle Soot Absorption Photometers (PSAP) (467, 532, and 660 nm)	Thermo Multi-Angle Absorption Photometer (MAAP) (660 nm)

Composite Flight Track Map showing all the flight tracks at each of the 6 waypoints, highlighting the BAO Tower (yellow dashed box) and Platteville (yellow solid box) ground sites



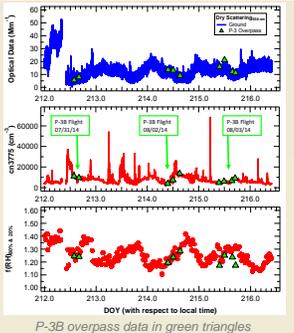
Summary and Future Directions

- ### Initial Summary of Preliminary Observations
- When the P-3B was able to descend into the mixed layer, the NASA LARGE ground based dry scattering measurements agreed very well with the airborne based optical data
 - The scanning humidifier system appears to agree better at the BAO tower ground site than at the Platteville ground site
 - The dry extinction appears to exhibit a slight offset compared to the dry scattering which cannot be attributed to aerosol absorption, requiring some future evaluation
 - The mean P-3B aerosol number concentrations agree well with the ground-based data
 - The ambient scattering values were nearly equal to the dry scattering values, due to the low relative humidity observed over the Front Range of Colorado
- ### Future Direction
- Submit data to the DISCOVER-AQ archive
 - Compare the size distributions from the ground and aircraft
 - Determine why the f(RH) data agrees better at the BAO Tower ground site than at Platteville
 - Add additional analysis prior to the DISCOVER-AQ Science Team Meeting in May

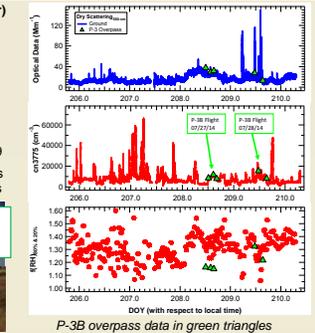
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Ground Site Location Info

- ### BAO Tower (Erie, CO, elev 1584 m)
- Located 25 miles North of Denver just west of I-25
 - 300m instrumented tower, operated by NOAA-ETL
 - Records data at 4 levels as well as on a moveable instrumented carriage
 - Spent 18 days parked next to the tower (see below)
 - Ground data showed excellent agreement with the airborne data
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- Collected data during 18 P-3B overpasses



- ### Platteville, CO (elev 1502.8 m, 37 mi NE of Denver)
- Area surrounded by fracking operations
 - Nearly vacant NOAA monitoring site
 - Spent a week there sampling (late on 24 July through morning of 31 July)
 - Highest aerosol scattering / extinction were in the morning and due to haze
 - Rain washed out the atmosphere late on DOY 209
 - Optical measurements and number concentrations show better agreement than the f(RH) calculations
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- Collected data during 6 P-3B overpasses

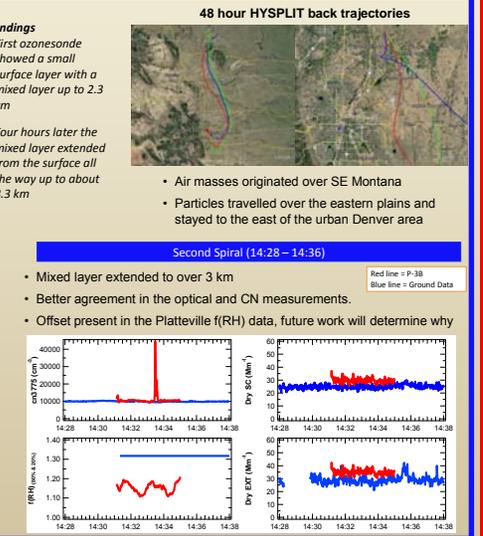


- ### Road Trips
- 24 July 2014
- Greeley, CO - sample feedlot emissions from pre-sunrise to lunch
 - Greeley, CO - early afternoon sampling of gas / oil open flaring (didn't see much)
 - Up to Wyoming sampling gas & oil fields
- 29 July 2014
- Quick trip to sample the Wiggins and Magnum feedlots
- 7 August 2014
- Wildfire smoke chasing - north to Cheyenne, west towards Salt Lake City, ending up in Idaho Falls as the forecasts evolved
- 8 August 2014
- Sawtooth National Forest & Sun Valley, ID for more smoke chasing from distant fires**
- 9 August 2014
- Return to BAO tower - mainly vehicle exhaust sampled, no smoke next morning



Platteville Overpass Example

- ### 07/27/14 - P-3B Science Flight 06
- Ground ops were located at Platteville
 - Penn State's group launched 2 balloons at 12:17 and 14:37
 - P-3B Made 3 Spirals (Local Time)
 - 12:09 - 12:16
 - 14:28 - 14:36
 - 16:02 - 16:08
 - Biomass burning aerosols aloft, but none mixed down to the surface
 - Possibility that the P-3B sampled their own exhaust (spike in CN)
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- Soundings
- First ozonsonde showed a small surface layer with a mixed layer up to 2.3 km
 - Four hours later the mixed layer extended from the surface all the way up to about 3.3 km
- HYSPLIT Back Traj.
- Air masses originated over SE Montana
 - Particles travelled over the eastern plains and stayed to the east of the urban Denver area



BAO Tower Overpass Example

- ### 08/02/14 - P-3B Sci Flights 10 (L1 & L2)
- Ground ops was located at BAO Tower
 - P-3B Made 3 Spirals (local times)
 - 09:18 - 09:35
 - 11:44 - 12:01
 - 14:54 - 15:11
 - In addition, missed approaches were made at the neighboring Parkland airstrip
 - Clearest aerosol levels morning of the campaign
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- Soundings (left)
- Mixed layer grew during the day, extending up to 3.5 km by the final spiral
 - Sampled air mass had subsided from the central plains
- HYSPLIT Back Traj. (right)
- 48 hours prior HYSPLIT suggest the air masses were at 2500 m AGL

