Supplementary Material
Satellite Mapping of PM2.5 Episodes in the Wintertime San Joaquin Valley: A "Static" Model Using Column Water Vapor

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Included below are three portions of a poster presented by Michael Shook at the American Geophysical Union (Shook et al., 2013) soon after the DISCOVER-AQ measurements in California. That work gave a syncretic overview of many trace species measurement besides water vapor which motivated our investigation, as described in Section 1.1.. First, there is an acknowledgement of the many authors contributing measurements. Second, there is an explanation of methods of estimating a characteristic mixed layer height as observed of airplane measurements. Third, there are graphs of vertical profiles normalized by average tracer concentration and also by the depth of the mixed layer. The commonalities and some differences of the first tracer shown (water vapor) and the last (particulate scattering).

A43A-0228: Daily Evolution of Boundary Layer Properties based on NASA DISCOVER-AQ Airborne Profiles over the California San Joaquin Valley

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- BLHT assessment was based on the P-3B aircraft observations, primarily of meteorological parameters
- Primary criteria for BLHT identification include a sharp change from constant to increasing potential temperature (i.e. theta) with increasing height and a distinct trend change in temperature and relative humidity vertical profiles.
- If necessary, BLHTs were refined using vertical profiles of trace gas concentrations and aerosol properties.
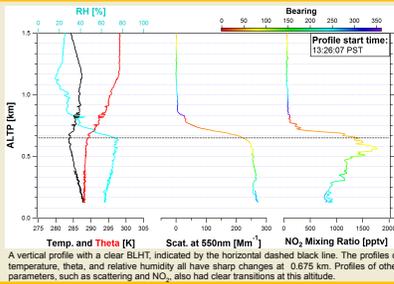
A vertical profile with a clear BLHT, indicated by the horizontal dashed black line. The profiles of temperature, theta, and relative humidity all have sharp changes at 0.675 km. Profiles of other parameters, such as scattering and NO_2, also had clear transitions at this altitude.

For some profiles, the BLHT could not be identified.
These cases usually had one of three problems:
- Suspected BLHT was near or below the bottom of the profile
- Suspected BLHT was between the bottom of a spiral and the top of a missed approach
- Aircraft was not able to complete a spiral due to visibility issues

These issues happened most frequently on the first circuit of the day (in the morning when BLHTs are very low) and on the last two days of the mission (when fog or low cloud decks were present). Profiles where the BLHT was not identified were removed from further analysis. In total, 119 of the 170 profiles had clear BLHTs.

To more clearly identify trends in BLHT from day to day across the campaign, profiles were separated by starting time into three groups: 0800-1030, 1030-1300, and 1300-1600 PST. These times loosely correspond to the start and end times of the three circuits. The distributions of the BLHTs in these time intervals were then analyzed. The distributions and time series of the BLHTs for each interval is shown below, along with an example profile from that interval. Constituent vertical profiles are colored by bearing from center of spiral.

Morning Profiles (0800-1030 LT)
- Morning BLHTs were consistently low (about 0.35 km or less)
- Aircraft was often unable to get low enough to see a clear transition into the boundary layer; only 20 of 61 morning profiles had clear BLHTs
- Not enough sample points to know if high outliers were part of a second mode
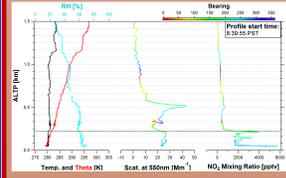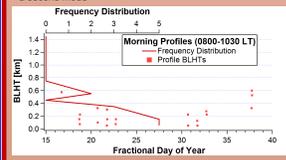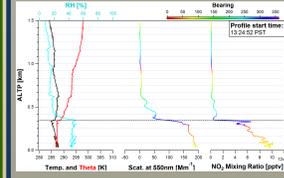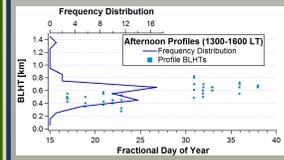
Midday Profiles (1030-1300 LT)
- Midday BLHTs were consistently between 0.2 and 0.6 km
- 47 of 53 midday profiles had clear BLHTs
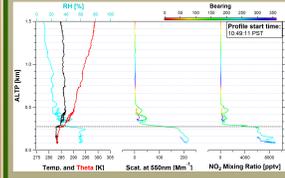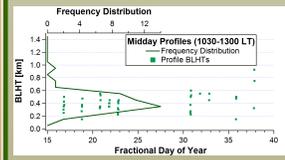
Afternoon Profiles (1300-1600 LT)
- Afternoon profile BLHTs seem to be bimodal
  - First half of the campaign: BLHTs from 0.3 to 0.6 km
  - Second half of the campaign: BLHTs from 0.5 to 0.7 km
- 52 of 56 afternoon profiles had clear BLHTs

To visualize BL variability and vertical gradients, composite profiles for eight different constituents were created. Constituents were chosen to represent a variety of lifetimes and production/removal processes.
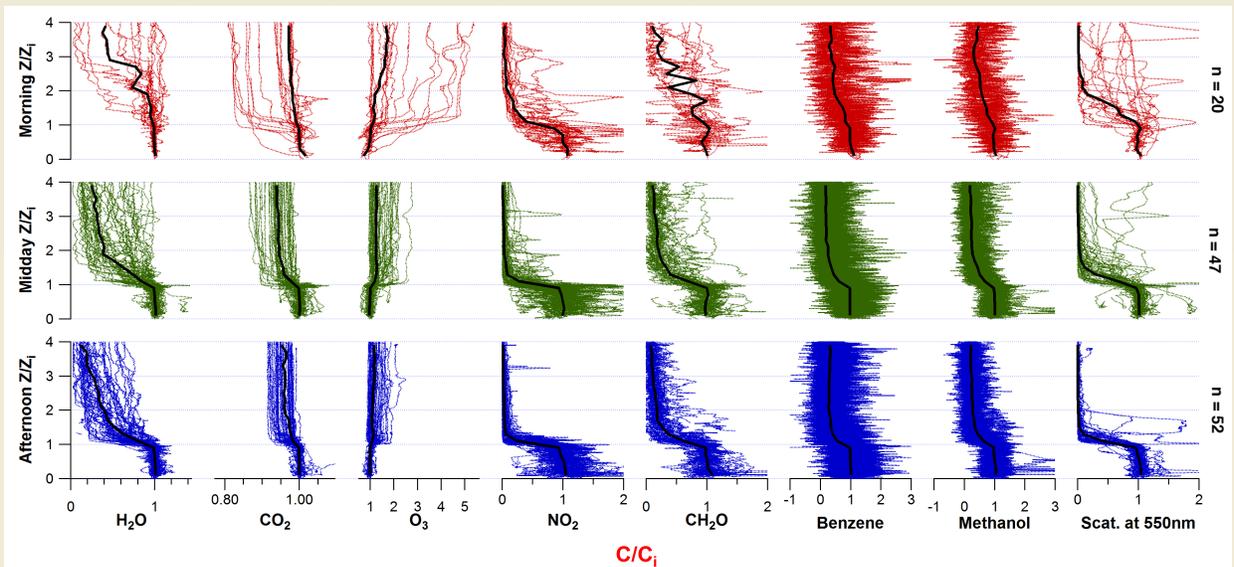
Composite profiles of different constituents scaled by the profile BLHT and the average concentration of the constituent within the boundary layer. The dotted, colored lines represent individual profiles, and the solid black lines represent the median profile for that constituent and time period.
Z = pressure altitude, Z_i = profile BLHT, C = constituent concentration, and C_i = average constituent concentration in the boundary layer