The Effects of Long-Range Transport of Agricultural Smoke on AOD in Houston, TX
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Motivation
Measuring surface level particulate concentrations remains a challenge for Earth-observing satellites due to:
1) Variability in aerosol vertical distribution, and
2) The effects of aerosol composition and hygroscopicity on optical properties.

The correlation between aerosol optical depth (AOD) measured by satellites and ground-level aerosol loading (PM2.5) can be hindered by the presence of pollution in the free troposphere. During September 2013 transported smoke from agricultural fires was transported to Houston, TX, increasing aerosol optical depths in the region. This aged smoke can be compared to fresher smoke measured:
- During SEAC4RS - eight agricultural smoke plumes
- Over Georgia during a DISCOVER-AQ transit flight

Conclusions & Future Work
Transported smoke measured during four flights (Sept. 4, 6, 13 and 14):
- No smoke measured at ground level
- AOD-to-PM higher than expected

Aerosol aging:
- Increases SSA due to secondary aerosol formation
- Increases smoke hygroscopicity by 45% (and thus increases AOD more than fresh smoke would)

Agricultural Fires:
- Lower modified combustion efficiencies than other types of fires (smoldering fires) resulting in high particulate emissions & lower SSA

Smoke Properties
Aged agricultural smoke plumes measured over Houston can be compared to:
- Fresh agricultural smoke plumes encountered during SEAC4RS
- An agricultural fire sampled extensively in Georgia during a transit flight (below)

SEAC4RS & ARCTAS Biomass Burning
Smoke measured by both the HSRL and in situ measurements:
- Highest loadings in the north of the flight region
- Back trajectory for layer aloft from a region of agricultural fires

DISCOVER-AQ
Driving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality is a multi-year project aimed at understanding the variables that affect remote sensing measurements in U.S. urban areas. Four campaigns were performed in regions with differing aerosol composition and meteorology:

Maryland
- Aerosol was composed of a mixture of organics and ammonium sulfate
- Aerosol present in a well-mixed deep haze layer (~7500 ft)

California
- Primarily ammonium nitrate aerosol
- Contained in a very shallow boundary layer (~2000 ft) except for the last two flights

AOD-to-PM correlation is dependent on the height of the haze layer (boundary + residual) with Maryland having a higher ratio than measured during California.

AOD-to-PM2.5:
- Flight day particulate mass varied between 6 & 11 μg/m³ (top left)
- Ambient AOD (measured by the P-3B) was more variable (top right): between 0.06 (Sept 26th) & 0.32 (Sept 14th)
- No correlation between ambient AOD and particulate mass (right)

Results from Previous Campaigns
- Maryland: AOD-to-PM2.5 correlation is dependent on the height of the haze layer (boundary + residual) with Maryland having a higher ratio than measured during California.
- California: primarily ammonium nitrate aerosol contained in a very shallow boundary layer (~2000 ft) except for the last two flights

DISCOVER-AQ Texas
- 8 Flights between Sept. 4th and 26th, 2013
- P-3B aircraft
- Repetitive flight plans - 24 spirals (1,500-15,000 ft above ground level) over 9 ground sites
- In situ measurements of aerosols & trace gases
  - Aerosol number concentration, scattering, absorption, size & composition (by SP2 and PILS; particle into liquid sampler)
  - B-200 aircraft (30,000 ft)
- High Resolution Spectral Lidar (HSRL)
  - Sampling of agricultural fires during transit flight

Smoke Transport
In Situ Measurements
- In Situ Measurements
  - September 13th: Smoke measured by both the HSRL and in situ measurements
  - Highest loadings in the north of the flight region
  - Back trajectory for layer aloft from a region of agricultural fires

Dust Aerosol Source Identification Experiment (DASIE) - DASIE-3:
- Aerosol measurements included:
  - Optical Properties (Nephelometer & PSAP)
  - Size (UHSAS, SMPS & APS)
  - Composition (PILS) & Hygroscopicity

In Situ Measurements
- September 13th: Smoke measured by both the HSRL and in situ measurements
  - Highest loadings in the north of the flight region
  - Back trajectory for layer aloft from a region of agricultural fires

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