Sources of High Aerosol Mass Loadings during the TexAQS II / GoMACCS Study

Presentation at the Austin Workshop
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Background:

- Some local sites (e.g., Clinton Dr) are close to “non-attainment” status for the NAAQS 24-hr (35 $\mu$g/m$^3$) and annual (15 $\mu$g/m$^3$) PM2.5 standards.

- The 2000 study did not include aerosol composition.

- The ship channel, Parish power plant, and urban area contribute to high aerosol volume.

- *Using only size distributions and $SO_2$, Brock et al. (2003) showed that aerosol growth rates downwind of the ship channel were larger than those downwind of the Parish power plant or predicted from sulfur oxidation rates.*
Houston Aerosol Processes

2006 Principle Findings:

- Plumes from the ship channel aerosol contains both sulfate and organic material, the Parish power plant produces mainly sulfate aerosol, and the urban aerosol is typically organic with a little sulfate.

- Sulfate formation rates are similar in ship channel and Parish power plant plumes.

- Slightly more secondary organic aerosol (SOA) relative to CO is formed downwind of the ship channel compared to the urban area.

- Processed air has $\Delta$(Organic Mass)/$\Delta$CO $\sim$0.1 $\mu$g/m$^3$/ppbv.

- No evidence of significant acid-catalyzed SOA.
Compact Time-of-Flight Aerosol Mass Spectrometer (C-ToF AMS)

Non-refractory
Sulfate
Nitrate
Ammonium
Organic

C-ToF AMS Total Mass Compared to Fine Particle Volume

Mostly within +/-20%, sometimes within +/-50%.

Ammonium+Sulfate Mass Fraction

10 s averages 10/6/06

\( \rho = 1.5 \)

Slope = 1.19

\( r^2 = 0.68 \)
perhaps add good comparison with PILS?
add volume size range

Flight Track on Oct. 6: Increased Aerosol Mass Downwind

AMS Total (μg/m³)

Latitude: 24 20 16 12
Longitude: -96.5 -96.0 -95.5 -95.0 -94.5

Wind Direction: 4-5 m/s
Sulfate Map: Increases Downwind of SO$_2$ Sources

plus various small sources in Houston
Sulfate Formation from SO$_2$

Large local SO$_2$ sources are the ship channel and Parish.
Within uncertainties (not shown), the rates downwind of Parish and the ship channel are probably similar.
Organics Map: Increases Downwind of VOC Sources

Texas City
Ship Channel
plus various small sources in Houston
Organic Aerosol at High Altitudes is Correlated with CO

Similar to 0.07 from NEAQS2002 (de Gouw et al., 2003).
Urban Air Mass: \( \Delta \text{OM}/\Delta \text{CO} \) Increases with Age

Aged urban air approaches \( \Delta \text{OM}/\Delta \text{CO} = 0.10 \).
Lower bound \( \sim 0.04 \) – see Bahreini’s poster (R5P52).
Organic Mass in Ship Channel Plumes

Slightly higher from ship channel.
Also approaches $\Delta OM/\Delta CO = 0.10$. 
Lower CO and less VOC precursors, likely due to meteorology but can’t preclude lower emissions.
$1,000,000 Question:
Is there acidic SOA production?

Look at “last” transect, downwind of Parish.
Small Acidic Sulfate Particles: Not Much SOA (Processed?)

Also not significant in other plumes and flights.
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C-ToF AMS:
Bahreini, Jimenez, DeCarlo, Kimmel, Dunlea, Aiken, Sueper, Furher, Onasch, Jayne, and Worsnop

Other Aerosol Measurements:
Brock, Wollny, Gallar, Baynard, Hecobian, Peltier, Weber, Schwartz, Spackman, Gao, and Fahey

Gas Phase Measurements:
deGouw, Warneke, Holloway, Neuman, Nowak, Huey, and Ryerson

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