UNH Soluble Acidic Gases and Aerosol (SAGA) during INTEX Phase A

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With Thanks to the INTEX Science Team
HNO$_3$ and fine SO$_4^{2-}$ in MC every ~106 seconds.

Paired filter samples (ions and radionuclide tracers) on level legs.

On this example flight 323 MC samples, 41 filter samples.

Mission totals: ~ 5000 MC samples, ~700 filters.

Data “final” except for $^{210}$Pb (analysis will start soon).
Two different measurements of HNO$_3$ on the DC-8.

Agreement between the SAGA MC and CIT CIMS is reasonable at first glance.

For the 3156 overlapping samples in the MC merge the mean value of the ratio CIMS/MC was 1.30±0.98, with median of 1.07.

However, there is substantial scatter, and an apparent trend in the ratio with altitude.

There is a poster with more details, see John Crounse if you are interested but missed it last night.
In the field we all noted that O₃ was pretty low in the troposphere. High O₃ in stratospheric parcels was encountered, but did not seem that frequent or important as a source of tropospheric O₃.

Altitude distributions of O₃ and ⁷Be suggest strat influence may have been significant above 6-7 km.
Relationship between HNO₃ and O₃ clearly indicates distinct “strat” and “trop” populations in the INTEX data set.

The INTEX “strat” relationship is very similar to what we found on PAVE in Jan-Feb, 2005.

Also, measurements by Fahey from the WB-57 during AVE Houston (Oct, 2004) show the same trend.
Can the stratospheric influence be filtered out?

Choosing thresholds of $O_3$ or $^7$Be problematic near the vertex of the two “arms” of the distribution.

The correlation between HNO$_3$ and $^7$Be in the clearly “strat” influenced airmasses can be used to estimate “strat” HNO$_3$, hence “trop” HNO$_3$ as the residual.

Encouraging, but, we only have $^7$Be on level legs!
Estimated “trop” HNO₃ nearly an order of magnitude lower than total in UT/LS, and 2.5 times lower in mid troposphere.

Above 8 km mean = 232 ppt  
(1464 samples)

5-8 km mean = 267 ppt  
(975 samples)

Above 8 km mean = 25 ppt  
(825 samples)

5-8 km mean = 101 ppt  
(393 samples)
Suggested (during mission and at AGU) that enhanced HNO₃ in UT could reflect convection.

May still be true, remember the ⁷Be filter excludes many samples taken on ascents/descents.
Three different measurements of SO₄²⁻ in aerosol on the DC-8.

The SAGA MC data on fine (< 2.5 micron) SO₄²⁻ agrees closely with the SAGA filter-based data.

Differences between the two techniques should generally fall below the 1:1 line if there is any coarse SO₄²⁻, so the agreement is a little “too good”.

\[ y = 6.8 + 1.03x \quad R^2 = 0.90 \]
SAGA bulk $\text{SO}_4^{2-}$ was generally $>$ PILS sub-micron $\text{SO}_4^{2-}$.

(This is very much as expected, but still good news!)
SAGA measurements of \( \text{NH}_4^+ \) were usually much less than those by PILS.

Different size cuts of the two techniques should not impact these data (most of the \( \text{NH}_4^+ \) is submicron).

Analytical, or blank, issues seem to be responsible for these differences.
Given that SAGA $SO_4^{\equiv}$ exceeded PILS $SO_4^{\equiv}$, while the reverse was true for $NH_4^+$, large differences in $NH_4^+/SO_4^{\equiv}$ should not be surprising.

SAGA observations suggest the inorganic aerosol was dominated by $NH_4HSO_4$, while PILS data suggest that $NH_3$ was generally abundant enough to more than fully neutralize $SO_4^{\equiv}$. 
Neither technique found aerosol NO$_3^-$ to be all that high, except in a few plumes.

Higher NO$_3^-$ in the SAGA bulk samples than PILS is consistent with much of it being on larger particles (e.g., not NH$_4$NO$_3$).
Coarse aerosol NO$_3^-$ can result from HNO$_3$ reacting with dust and/or seasalt.

Highest NO$_3^-$ mixing ratios in the filter samples often associated with elevated Ca$^{2+}$.
Flight 10, 20 July
2nd Pease Local

Filter sample locations along flight track, color coded by $\text{C}_2\text{O}_4$ mixing ratio.

Filter sample locations along flight track, color coded by $\text{K}^+$ mixing ratio.

Smaller symbols represent low altitude. Numbers are hours UTC.

(Thanks Nicola!)
Biomass Burning

Strong enhancements in NH$_4^+$, K$^+$ and C$_2$O$_4^{2-}$ (and to a lesser extent NO$_3^-$) just above 4 km are consistent with a smoke plume.

Smaller enhancements in the BL could support the suggestion that the smoke was down there too.
It appears that there are too many other sources of NH$_4^+$, K$^+$, and C$_2$O$_4^-$ for any one of them to be unambiguous tracer of biomass burning.

The correlation between NH$_4^+$ and C$_2$O$_4^-$ hints that elevated levels of both tracers may be more specific.

However, C$_2$O$_4^-$ may be a general tracer of combustion.

Multiple tracers likely needed to identify biomass burning plumes in the INTEX data set.