P3 vs. Cessna 402B Comparisons

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And a cast of thousands!
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DISCOVER-AQ Data Workshop
February 14, 2012
Newport News, VA
Maryland and NASA Intercomparison on 7/27/2011
The graph shows the relationship between pressure (mb) and altitude (km) for Maryland and P-3B data. The plots indicate a linear correlation between the two variables. The data points for Maryland are represented by red dots, and those for P-3B are shown in blue. The graphs also include annotations for the beginning and end times: Begin 18:38:25 and End 19:22:20 GMT. The slope of the correlation for Pressure Correlation 07/27/11 is 0.999 ± 0.001 with an intercept of 0.495 ± 1.11 and an R² of 0.99.
NO\textsubscript{2}
NO$_2$ detection
Limit $\sim 100$ ppt
CO

Detection Limit
TECo 48 ~20 ppb
Zero problem this day
Others better
Scattering Correction

- Nephelometer interior warmer than ambient
- RH much lower in instrument chamber
- $B_{scat} = B_{scat} \times f(RH)$
- $f(RH) = \left[\frac{(100-RH_{neph})}{(100-RH_{ambient})}\right]^\gamma$
- We used a fixed gamma and get a correction of ~ +50 ± 16%
- Corrected scattering is higher
July 21, 2011

**Total Scattering 450 nm (Mm⁻¹)**

**Total Scattering 550 nm (Mm⁻¹)**

**Total Scattering 700 nm (Mm⁻¹)**

**CN (cm⁻³)**
CPC # are not CN!!

TSI 3007 has a 50% detection threshold at 10 nm
O$_3$

TECo 49
NIST calibrated
Pre & Post Campaign
NCAR Chemiluminescence
Conclusions

- T, RH, P All in good agreement
  - T, RH corrections added since summer worked well
- NO₂ UMD, NCAR and UC Berkeley instruments in good agreement. NCAR and UCB especially close
- UMD ozone UV absorption instrument v. chemi
  - 49C NIST-calibrated pre and post-campaign, within 2%
  - NCAR ozone chemiluminescence instrument does not agree
- UMD CO suffers from background drift and has a higher detection limit—use with caution
  - ~20 ppb in the lab
Conclusions (2)

• Scattering Comparison OK
  – Use of fixed gamma for f(RH) brings UMD instruments into better agreement
  – Shape of profiles the same, absolute values not identical
  – Most days very comparable
    • 1 sigma error is 16% (fixed gamma on P3 data)
• UMD CPC is not the same as the CN counters!
  – Similar results, but CN ≠ CPC
  – CPC 50% detection threshold ~10 nm particles
Time lags

• Correlation analysis reveals some time lags (and two leads) between UMD data and P3 data.

• Still investigating these, though they make physical sense.
Acknowledgements

• Everyone in this room!
• NOAA, NASA, MDE, M-DNR
• URF: Jim Cramer and John McKinley
Correction for ram heating

- Temperature correction:
  \[ AT = \left( T_m + 273.15 \right) / \left( 1.0 + 0.2 \times rf \times M^2 \right) - 273.15 \]
  - \( T_m \) = measured temperature in °C
  - \( M \) = mach number of aircraft speed
  - \( RF \) = empirically determined factor
  - \( AT \) = actual temperature in °C

  Ambient temperature is lower than ram-heated air
RH Correction

- \( RH = \frac{P(H_2O)}{P_{\text{sat}(H2O)}} \)
- Need to correct RH to the proper temperature
- \( RH_{\text{proper}} = RH_{\text{indicated}} \times \frac{P_s(T_{\text{measured}})}{P_s(T_{\text{corrected}})} \)
- So ambient RH is higher than that measured with ram heating