Regional Aerosol Intensive Network (RAIN) RESULTS

Work by Al Leston & George Allen
Presented by John Graham
RAIN: PM/Haze Rural “Transport Supersites” in MANE-VU Haze RPO Domain

- Multiple sites with detailed PM and visibility-related measurements
  → high-elevation (500 - 2500 ft), rural, transport characterization
  ==> contrast “Fresh” vs. Aged secondary aerosols
  → highly time-resolved (1-2 h) aerosol composition measurements

- Hourly aerosol composition data provide enhanced insight into:
  → source characterization
  → factors that drive short-term visibility
  → aerosol model performance and evaluation

- Tech Transfer of new measurement methods into routine SLT use
  → Sunset EC/OC
  → Thermo sulfate
RAIN Parameters

• Core components
  ➔ Continuous [hourly] PM2.5, trace SO2, O3
  ➔ Surface Met [wind, temp, RH or dew point,]
  ➔ IMPROVE measurements for carbon, ions and PM2.5
  ➔ Continuous sulfate (Thermo 5020 method)
  ➔ 2-hour EC/OC (Sunset Lab Model 3 method)
  ➔ NGN-2 (wet) nephelometer
  ➔ Hazecam automated digital scene photos

• Additional Measurements at some sites:
  ➔ NO/NOy, “true” trace level CO, Profiler

• Wish-list
  ➔ ASOS, NH3, continuous NO3, HNO3, strong aerosol acidity
Profiler Map

Empty Symbols 2004 sites no longer in place
Mohawk Mt. CT PM reconstruction components:
2-hour sulfate and organic carbon-related PM, and measured PM2.5

=> note the relatively small dynamic range of OC compared to SO4
Five-site Thermo 5020 Hourly Sulfate, July 30 - August 13, 2004

Pinnacle data courtesy SUNY-A/Schwab

- Acadia NP, ME
- Mohawk Mt, CT
- Pinnacle SP, NY
- Frostburg, MD
- Miller SP, NH

Sulfate, µg/m³ (STP)

July - August 2004 (EST)
Frostburg MD SO2 and sulfate detail, August 13-25, 2004

Piney Run (Frostburg) MD SO2 and SO4, August 2004

SO4, µg/m³

SO2, PPB

Preliminary data.

SO2 and SO4 (STP) nm/m³

Black = SO2
Red = SO4

% S converted

% S converted plot is limited to hours where total S is > 20 nmole/m³

Aug 2004
Acadia NP Data comparisons

McFarland Hill RAIN SO$_4$ vs IMP SO$_4$

\[ y = 1.25x - 0.04 \]
\[ R^2 = 0.95 \]

McFarland Hill TEOM vs Reconstructed RAIN Mass
7/7/04 - 3/31/05 (OM & ammSO$_4$ only)

\[ y = 0.80x - 0.35 \]
\[ R^2 = 0.86 \]
\[ n = 193 \]

Daily averaged hourly SO$_4$ represents 80% of IMPROVE SO$_4$

Daily averaged SO$_4$ and OC represent 80% of “FRM-like” PM$_{2.5}$ mass

note: IMPROVE PM$_{2.5}$ ~ FRM-like PM$_{2.5}$
Mohawk Mnt. Data comparisons

Daily averaged hourly SO$_4$ represents 85% of IMPROVE SO$_4$

Mohawk RAIN SO$_4$ vs IMPROVE SO$_4$

\[ y = 1.17x - 0.09 \]
\[ R^2 = 0.93 \]

Mohawk BAM Fine Mass vs IMPROVE Mass

\[ y = 0.80x - 0.46 \]
\[ R^2 = 0.90 \]

Daily averaged SO$_4$ and OC represent 80% of BAM PM$_{2.5}$ mass

Note: IMPROVE PM$_{2.5}$ ~ 80% BAM PM$_{2.5}$
Visibility Reconstruction
2-hour average
Sulfate \* 1.37^3 \* f(RH)
OC \* 1.8 \* 4
Mass Reconstruction:
EC/OC/\text{SO}_4\text{2-hour data}
1.8 OC factor/ 0.5 OC Blank
1.3 NH_4\text{ adj}/1.2 water adj
"default" 10\% \text{NO}_3/crustal
Preliminary Comparison of TC data from IMPROVE/ Sunset & IMPROVE/STN

RAIN Sunset: No Blank Correction

STN: Blank Corrected Data
Preliminary Comparison of Mohawk Mountain C data from IMPROVE and Sunset Methods

**Organic Carbon Mass (as C)**

- \(y = 0.85x - 0.55\)
- \(R^2 = 0.62\)

**Elemental Carbon Mass**

- \(y = 0.62x + 0.13\)
- \(R^2 = 0.46\)

Available data from July – December 2004
Northeast Region IMPROVE Organic and Elemental Carbon


- Acadia, ME and Lye Brook, VT are both rural sites. Brigantine, NJ is near major urban centers. Washington, D.C. is urban.

- All sites show summer maxima and spring minima for both EC and OC, with rural sites displaying greater seasonal variation.

- OC seasonal amplitude > EC amplitude.

- Evidence of winter EC peak, especially in urban areas.

- OC summer peak consistent with increased secondary production, potential increased biogenic contribution.
Time Series of OC and “smoke tracer”

KNON = [K]-0.6*[Fe], from Teflon “A” filter XRF elemental analysis

y = 29.7x + 0.58
R² = 0.16
Comparison of O₃ and OC

Diurnal O₃ vs OCs, Mohawk Mt., CT, 7/7/04-8/18/04
(2-Hour averages, OC data is blank corrected)

\[ Y = 0.029x + 0.70 \]
\[ R^2 = 0.57 \]
Comparison of $O_3$ and OC

McFarland Hill $O_3$ v OCs, $O_3$ "Breakpoint" = 69ppb
(7/7-9/26/04, High $O_3$ days = blue, Low $O_3$ days = red)

\[
y = 0.04x + 0.60 \\
R^2 = 0.51
\]

\[
y = 0.04x + 0.34 \\
R^2 = 0.17
\]
Long-term summer diurnal $O_3$ and Isoprene; 2004 OC

Diurnal $O_3$, Isoprene and OCs
($O_3$ & Isop = Acadia NP, 1997-2004; Ocs = Suset Labs, Summer '04)
Isoprene / OC comparison

Mean OCf (with 95% CL) on High and Low Isoprene Days

- High Ispr Day OC (90th)
- Low Ispr Day OC (90th)
- High Ispr Day OC (75th)
- Low Ispr Day OC (75th)
- High Ispr Day OC (50th)
- Low Ispr Day OC (50th)
Summary

- RAIN Sites are up and running, producing volumes of data
- Real-time data will improve our understanding of state of the atmosphere in northeast
- Carbon data will likely prove particularly important for both model and biogenic aerosol evaluation