More Field Evaluation of Collection Efficiency as $f(\text{Composition})$

Middlebrook et al.
AMS Clinic, June 2015
Previously …

• Used NOAA CSD field data to estimate how CE due to “bounce” changes with composition
  – Default CE = 0.5
  – High acidic sulfate, higher CE
  – High ammonium nitrate, higher CE
  – No dependence on organic mass fraction

• Now have composition-dependent CE calculation included in Squirrel

• How well does it work?
AMS Data Processing

• For the SENEX study,
  – Applied one set of flow rate and particle size calibrations
  – From all cals, IE(NO3) = 1.29e-7+1.24e-12*AB
  – RIE(NH4) = 4.8 before 6/6, 3.9 after 6/28, otherwise 4.26
  – Used default values of RIE for other species

• For each flight,
  – Adjusted frag table values for water and filtered air
  – Determined detection limits from filter data
  – Removed data points with silicone contamination
  – For each data point, used Squirrel to calculate CE as
    $f$(composition) – RH < 80%, no smoothing
  – Applied this CE to each data point
  – Adjusted timestamp to match peaks and valleys with other data
PM1 Volume Comparisons

• Calculate volume from mass loadings,
  – Organic density = 1.25 g cm\(^{-3}\)
  – Inorganic (SO4+NH4+NO3+Chl) density = 1.75 g cm\(^{-3}\)
  – BC density = 1.8 g cm\(^{-3}\)
  – Add together -> volume from composition

• From Size,
  – Obtain number distribution from N-MASS plus UHSAS
  – Apply AMS lens transmission function to distributions
  – Calculate volume from size, transmitted by lens

• Compare them, averaged over AMS sampling time (10 s)
  – Combined measurement uncertainties +/- 45%
PM1 Volume Comparison:
11 JUN 2013, Birmingham

Rainbow Colored (red high) by Organic Mass Fraction

Flight Num = 2
\[ r^2 = 0.97 \]

Coefficient values ± one standard deviation

\[ a = 0.193 \pm 0.033 \]
\[ b = 0.71259 \pm 0.00378 \]
PM1 Volume Comparison: 12 JUN 2013, Atlanta

Rainbow Colored (red high) by Organic Mass Fraction

Flight Num = 3
$r^2 = 0.99$

Coefficient values ± one standard deviation

$a = -0.078035 ± 0.0344$
$b = 0.98314 ± 0.00277$

PM1 Volume Comparison:

Rainbow Colored (red high) by Organic Mass Fraction

PM1 Volume from Composition

PM1 Volume from Size

Coefficient values ± one standard deviation

$a = -0.078035 ± 0.0344$
$b = 0.98314 ± 0.00277$
PM1 Volume Comparison:
29 JUN 2013, Birmingham

Rainbow Colored (red high) by Organic Mass Fraction

Flight Num = 11
r^2 = 0.97

Coefficient values ± one standard deviation
a = -0.24761 ± 0.0405
b = 1.7969 ± 0.00753
Calculated Dry Extinction (Mm$^{-1}$)

Measured Dry Extinction (Mm$^{-1}$)

20130629
Slope=0.727477
**Flight with “Fresh” Biomass Burning Particles**

Flight Num = 13

$r^2 = 0.93$

Coefficient values ± one standard deviation

- $a = 4.8562 ± 0.0849$
- $b = 0.71951 ± 0.00442$

**PM1 Volume from Composition**

**PM1 Volume from Size**

**Organic Mass Fraction**

0.0 0.4 0.8

0 50 100 150 200 250 300

Flight Num = 13

$r^2 = 0.93$

Coefficient values ± one standard deviation

- $a = 4.8562 ± 0.0849$
- $b = 0.71951 ± 0.00442$

**PM1 Volume from Composition**

**PM1 Volume from Size**

**Organic Mass Fraction**

0.0 0.4 0.8

0 50 100 150 200 250 300

Flight Num = 13

$r^2 = 0.93$

Coefficient values ± one standard deviation

- $a = 4.8562 ± 0.0849$
- $b = 0.71951 ± 0.00442$
PM1 Volume Comparisons Summary

• Overall, comparisons using the composition-dependent CE from Squirrel look reasonable
• Flight to flight variability is biggest effect on comparisons
• RIE for organics doesn’t seem to affect comparisons
• Some comparisons poor because UHSAS low, relative to extinction
• “Fresh” biomass burning particles compare well
• May need to use size-dependent composition CE