SP-AMS: Main Issues for Quantification

1. rBC mIE calibration (laser only)
   • Determination of laser beam and particle beam widths and overlaps
   • mIE_rBC calibration independent of CE issues

2. $R_{BC}$ and NR-PM quantification (laser only; both vaporizers)
   • Is this dependent on particle beam – laser beam overlap?
   • Do RIE’s work across vaporizers?
Collection efficiency of the soot-particle aerosol mass spectrometer (SP-AMS) for internally mixed particulate black carbon

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DOS coated Regal black

- Coated Regal black particles with DOS to make spherical
- With thicker coatings, RIE_rBC increased as the particle beam narrowed down closer to laser beam width
- NOTE: Low RIE_rBC << 1 was initial observation of deviation of RIE’s possibly due to molecular velocity in ion formation chamber!
Particle Beam Vertical Walk
Bare RB and DOS Coated

- DOS coated Regal black particle beam walk is narrower than bare RB
- $R_{BC}$ definitely depends upon overlap of laser and particle beam
Beam Width Probe (Huffmann et al./Salcedo et al.)

Particle beam

laser

wire motion

wire

y

x

Transmission

wire position (mm)

rBC signal
narrow_beam
wide_beam
BWP Results

- Two independent measures of narrowing of particle beam with coating
- Decreasing particle beam width increases particle-laser beam overlap
Laser and Particle Beam Widths

- Particle beam widths: DOS coated Regal black ~ pure DOS particles
- Laser beam width ($\sigma$) is $\leq 0.1$ mm
- Use BWP for CE determination in future
Summary 1

• rBC quantification is dependent upon laser alignment and power and overlap with particle beam.
  • BWP will provide internal measurement of particle beam width and, therefore, CE
  • We have new version of BWP hardware!
  • Qualification is that the CE is a strong function of particle beam width, making accurate measurements difficult
NR-PM$_{BC}$ observations

- ORG and rBC signal transmissions decrease together with increasing DOS coating and narrowing of particle beam.
- Suggesting that the effective particle beam widths for rBC and DOS are similar.
• Coated Regal black particles with DOS to make spherical

• With thicker coatings, RIE_rBC increased as the particle beam narrowed down closer to laser beam width

• Dual laser/tungsten vaporizer setup

• Both rBC and Org ion signals increased
• Question, why did the RIE_org start at ~4??
DOS

Laser ON

Laser OFF
300 nm AN

300 nm DOS

• RIE_DOS = 13569 / 2460.6 = 5.51
Results

- $\text{RIE\_DOS} = 5.46 \pm 0.18$

- Varying:
  - Two different instruments
  - Several different Pulser Frequencies
  - 200 and 300 nm DOS mobility diameters
  - 4 separate measurements

- High precision ($\sim 4\%$), but $>> 1.4$ for standard Org RIE
- RIE_org for DOS on laser vaporizer is ~10!?!?
- RIE_org laser vaporizer >> W vaporizer??
DOS coated RB Laser OFF/ON
Heater Bias Walk

- Similar observations as Toronto!
- More DOS ions generated from laser-RB than tungsten vaporizer
Summary 2

- NR-PM$_{BC}$ sensitivity shows some evidence (lab) for ~2x increase compared with tungsten vaporizer, though it this is NOT yet definitive.
  - DOS has less fragmentation in laser vaporizer than W-vaporizer
  - DOS vaporizing at lower temperatures from soot surfaces than W-vaporizer, thus moving slower in ion chamber
  - DOS is not representative of ambient observations

- Need more measurements of other materials coated on rBC particles!