A Method for Measurement of Fine Aerosol H_2O Content:

The Dry-Ambient Aerosol Size Spectrometer (DAASS)

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Abstract (1)

- Hygroscopic growth of atmospheric particles affects a number of environmentally important aerosol properties.
  - But aerosol water content is typically estimated, not measured, using models and assumptions that may be in error – therefore, we want to <u>measure the water content.</u>
- The system
  - Consists of two Scanning Mobility Particle Sizers (SMPS) and an Aerodynamic Particle Sizer (APS) covering 3 nm to 10 micron
  - Inlets either ambient RH or dried through Nafion driers (switched every 7.5 minutes)
  - Sheath air RH for SMPS also dried or ambient
- Aerosol water is measured and growth factors are calculated from the difference or ratio between aerosol volumes

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Abstract (2)

- Benefits of combined system
  - When sampling in dry only mode
    - After data processing, provides a single dry number size distribution for the entire range
    - Aerosol volume through 2.5 microns was highly correlated with dried TEOM using this technique
  - When sampling in dry-wet mode, can calculate aerosol water
    - The measured value of aerosol water was found to be more accurate than f(RH) or modeled values in the following applications:
      - estimating light scattering
      - nitrate partitioning
      - physical state of the aerosol
    - Amount of absorbed water also used to calculate water uptake by organics

Organization of This Poster

Panels 6-8	Background
Panels 8-12	Experimental Setup
Panels 13-15	Example Results (Dry Only)
Panels 16-18	Example Results on H_2O Content

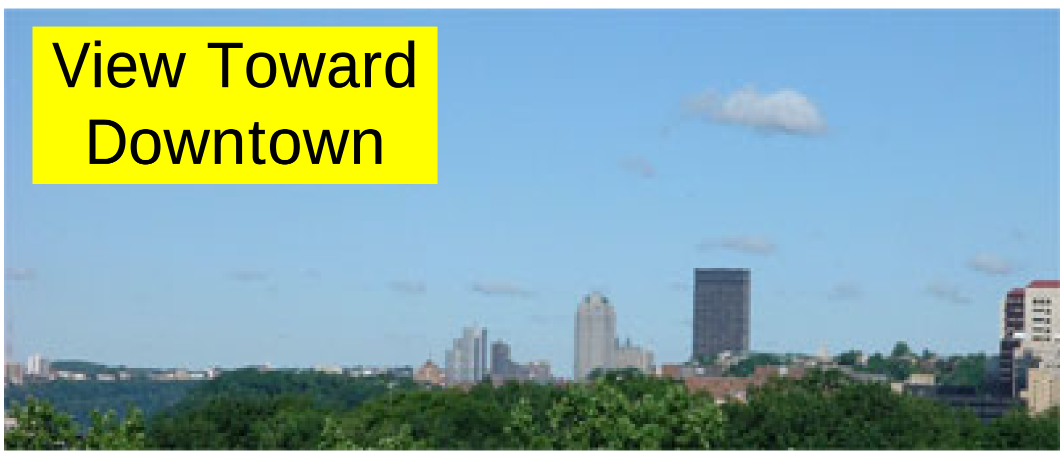
Pittsburgh Air Quality Study (PAQS)

- 2 Year Collaborative Study
  - 17 Participating Groups
  - Funded by
    - Environmental Protection Agency
    - Department of Energy
- Main goals
  - Characterize Pittsburgh aerosols
    - Sources
    - Atmospheric Processes
    - Instruments
- Measurements
  - Meteorology
  - Atmospheric gases
  - Aerosol parameters
  - Particle size distribution, ambient relative humidity
  - Particle size distribution, dried

This Method Presented in this work

Pittsburgh Air Quality Study – Schenley Park Station

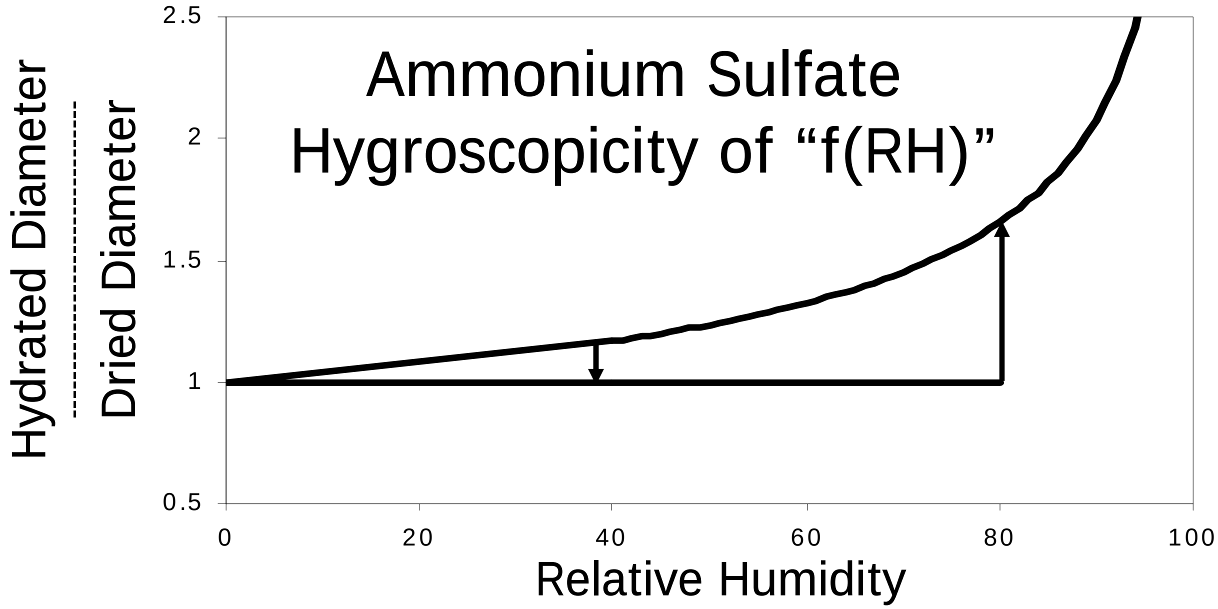
Schenley Park Sampling Site



View Toward Downtown

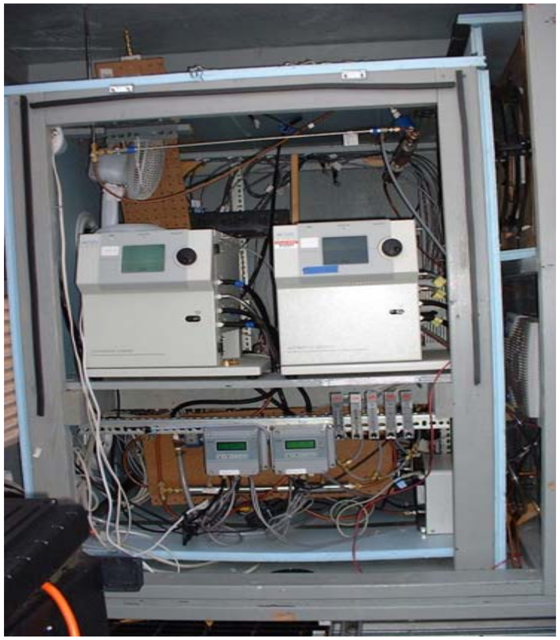
Particle Size Sampling Instruments

Aerosol Water Content – Review



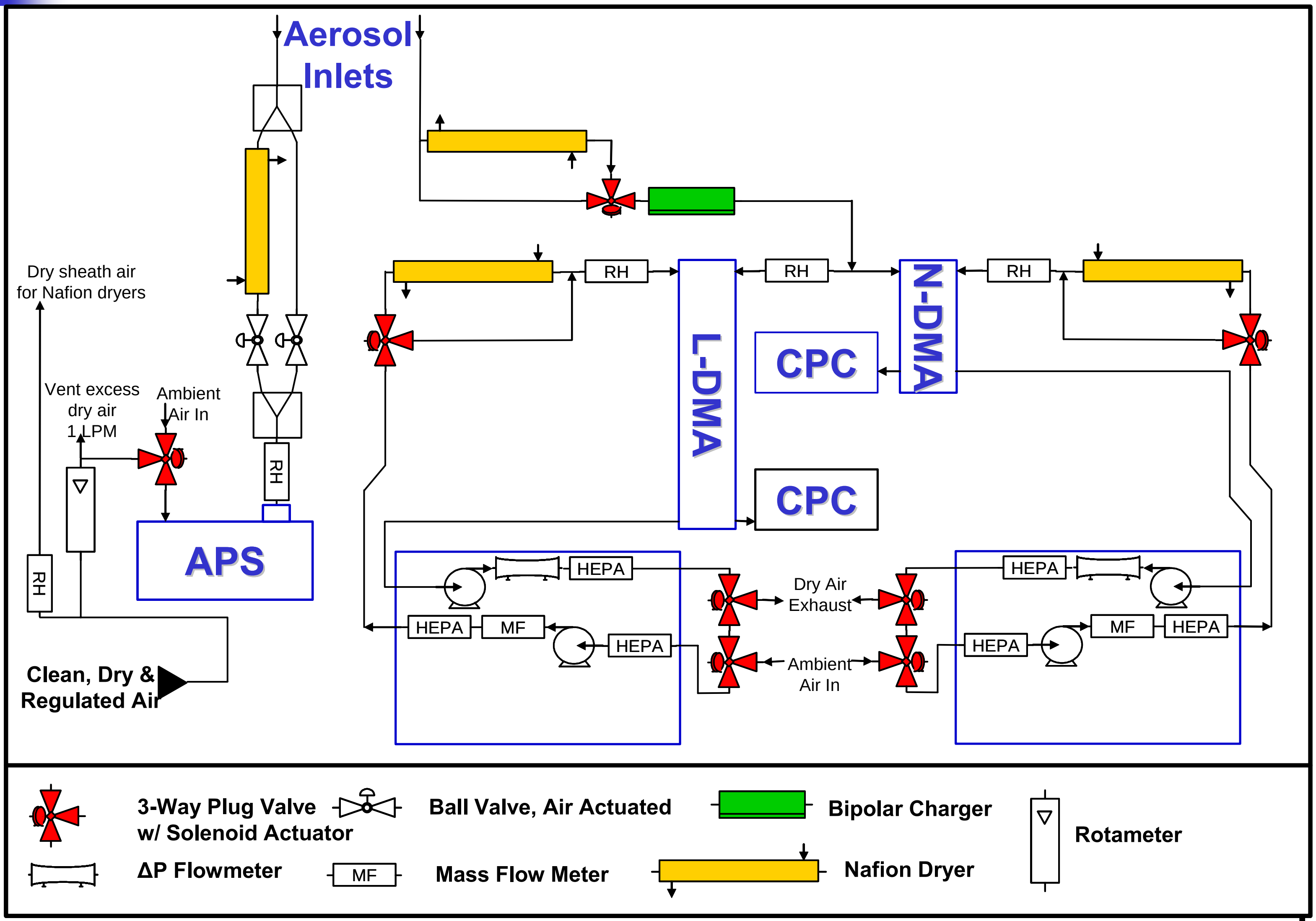
- Which “branch” or state are particles generally in
  - hydrated or dried?
- What is the crystallization relative humidity?
- How well can we model water uptake?
- What is the role of organic compounds in water uptake?

Dry-Ambient Aerosol Size Spectrometer



- Reconfigured commercial instruments
- RH control system
- Inlet particle losses characterization
- Custom control, data acquisition, and data reduction software

Dry-Ambient Aerosol Size Spectrometer



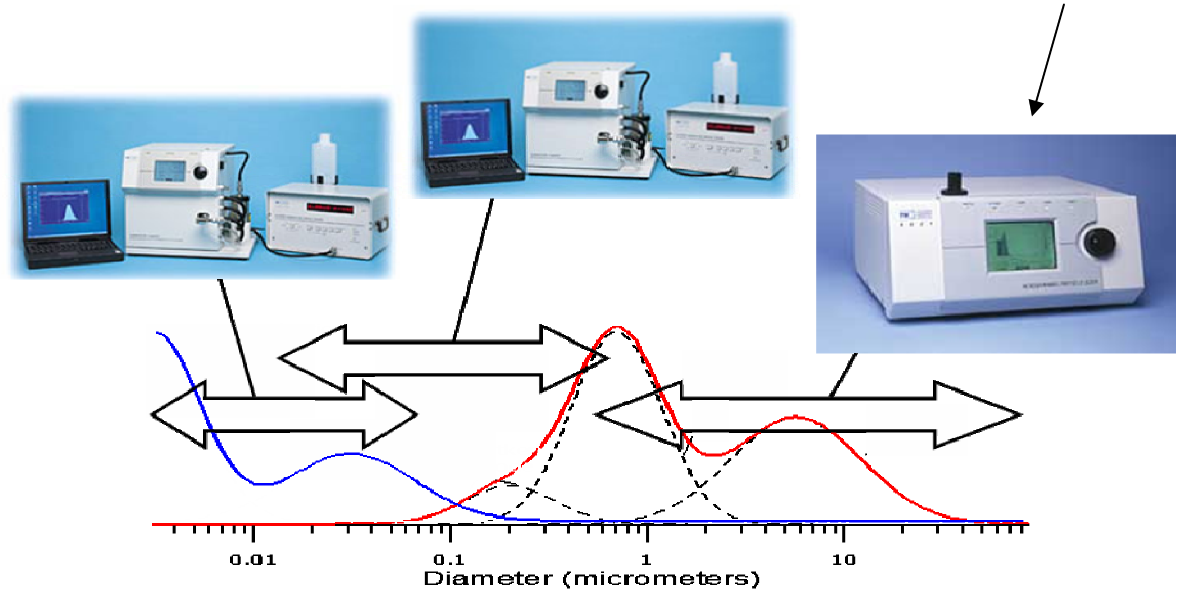
SMPS and APS Overlap

$$\frac{D_{st}}{C(D_{st})} = \frac{2ne\bar{V}L}{3\mu q_{sh}\ln\left(\frac{r_2}{r_1}\right)}$$

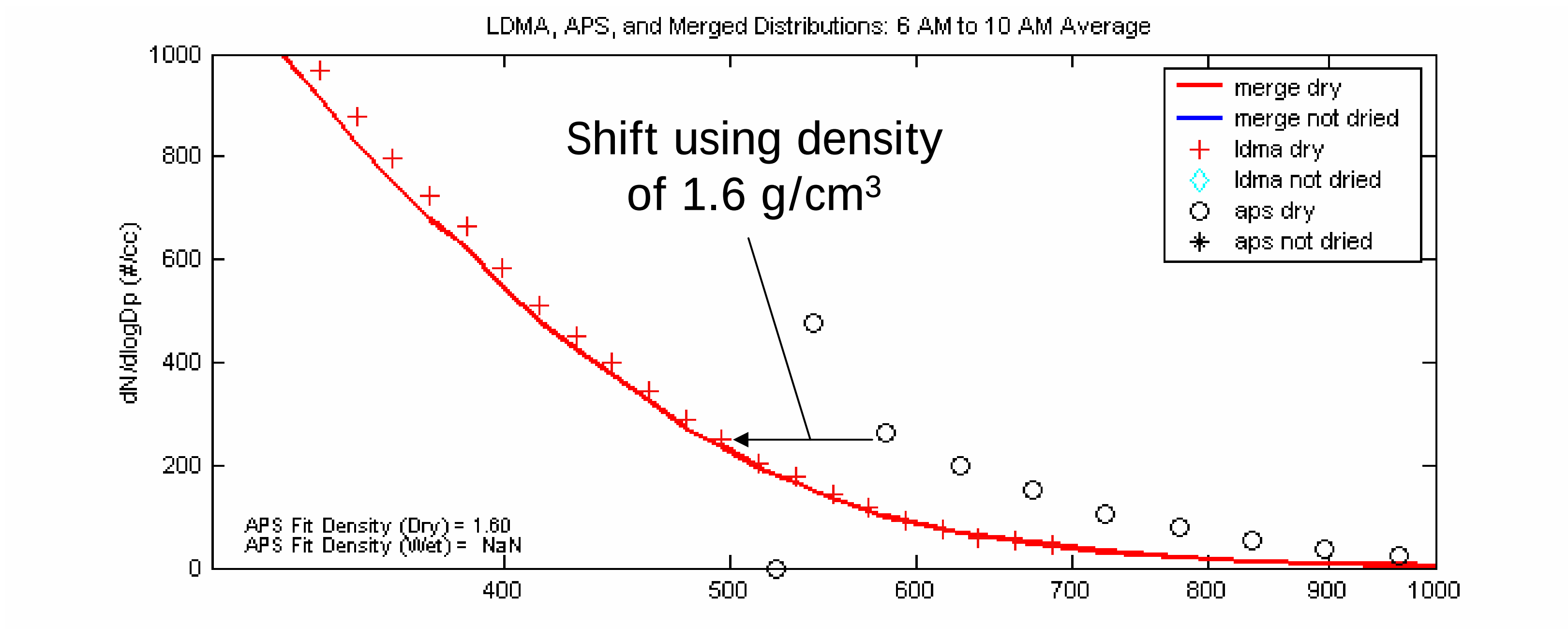
- Size Particles under very low Reynolds Number conditions
- $F_{viscous} >> F_{inertial}$
- Mass & density do not effect measured size
- Only physical size and shape

$$D_{aero} \approx D_{st}\rho_p^{1/2}$$

- Sizing under high Re
- Physical size, shape, ***and density*** matter



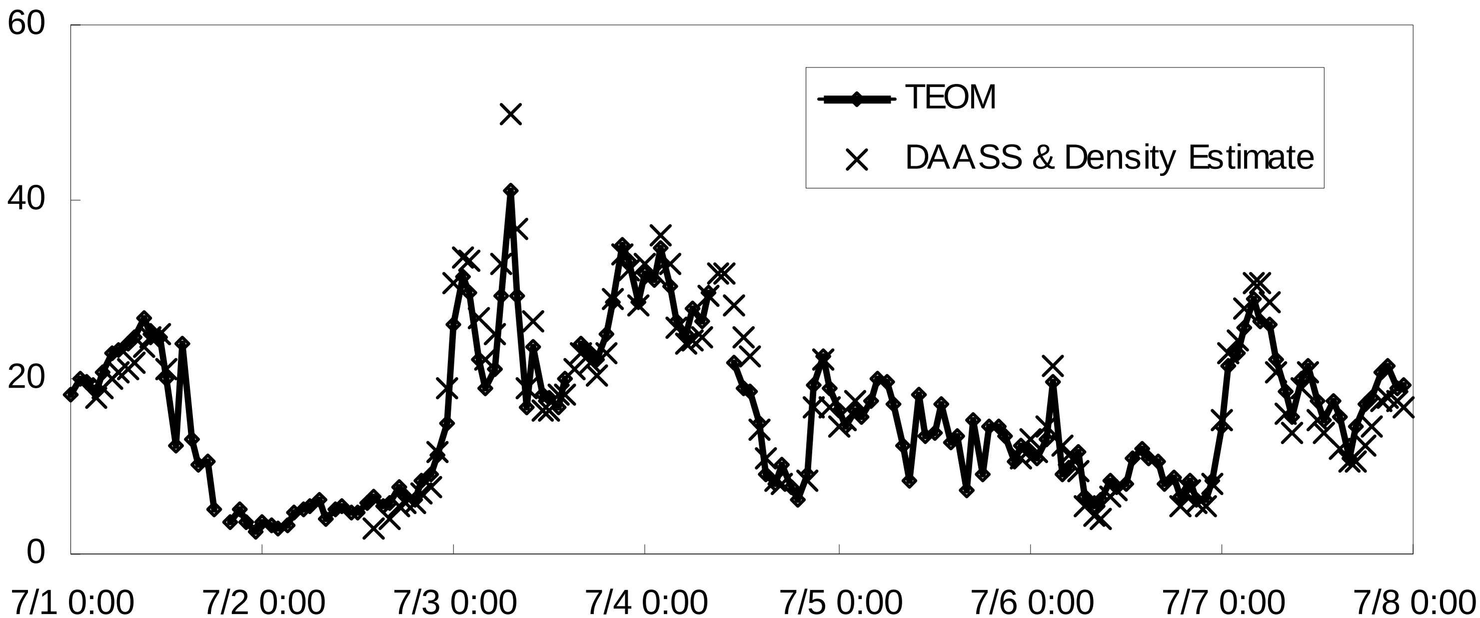
SMPS and APS Overlap



June 14, 2002 – 6 AM – 10 AM

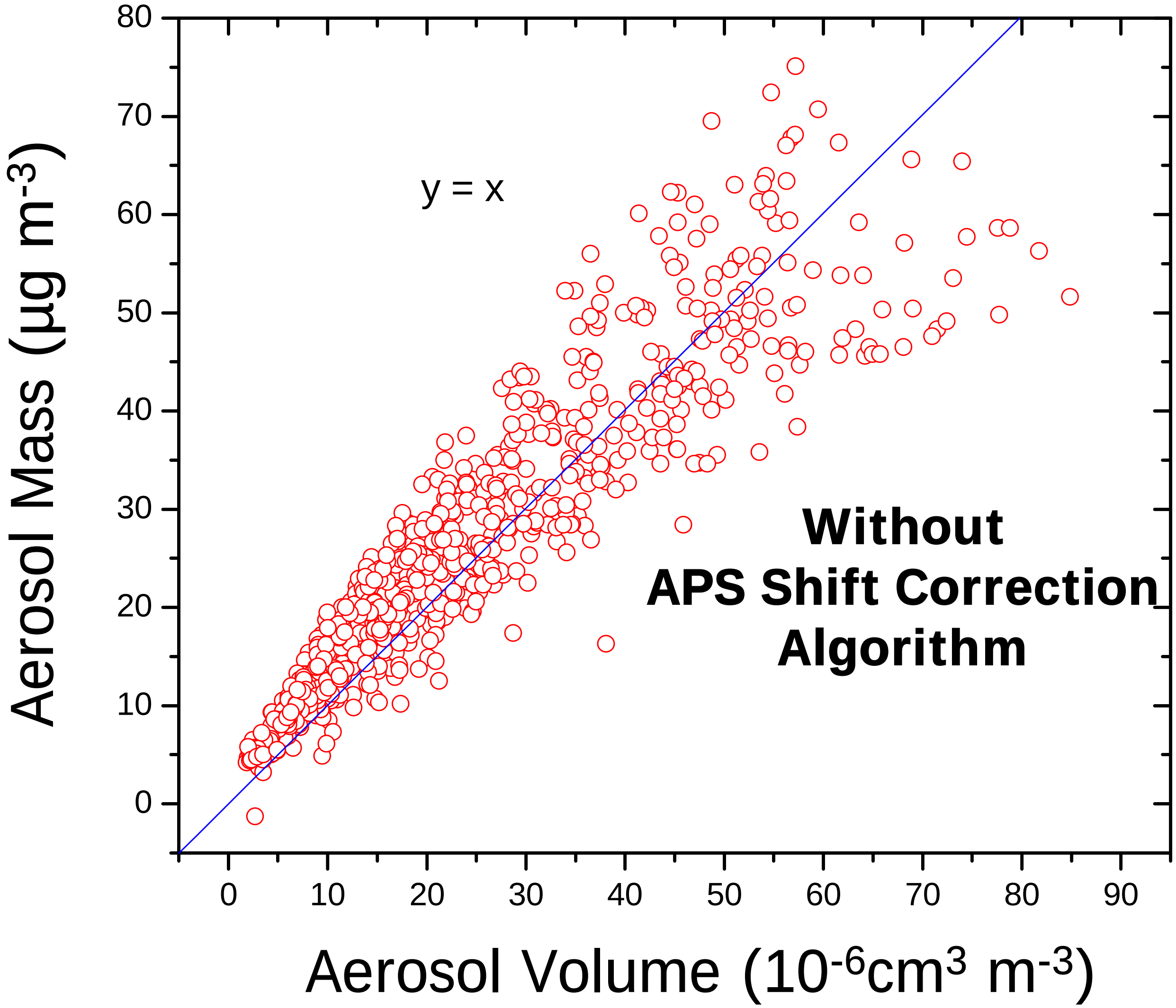
Effective density for shift determined independently for each hour

Calculating Aerosol Mass with DAASS

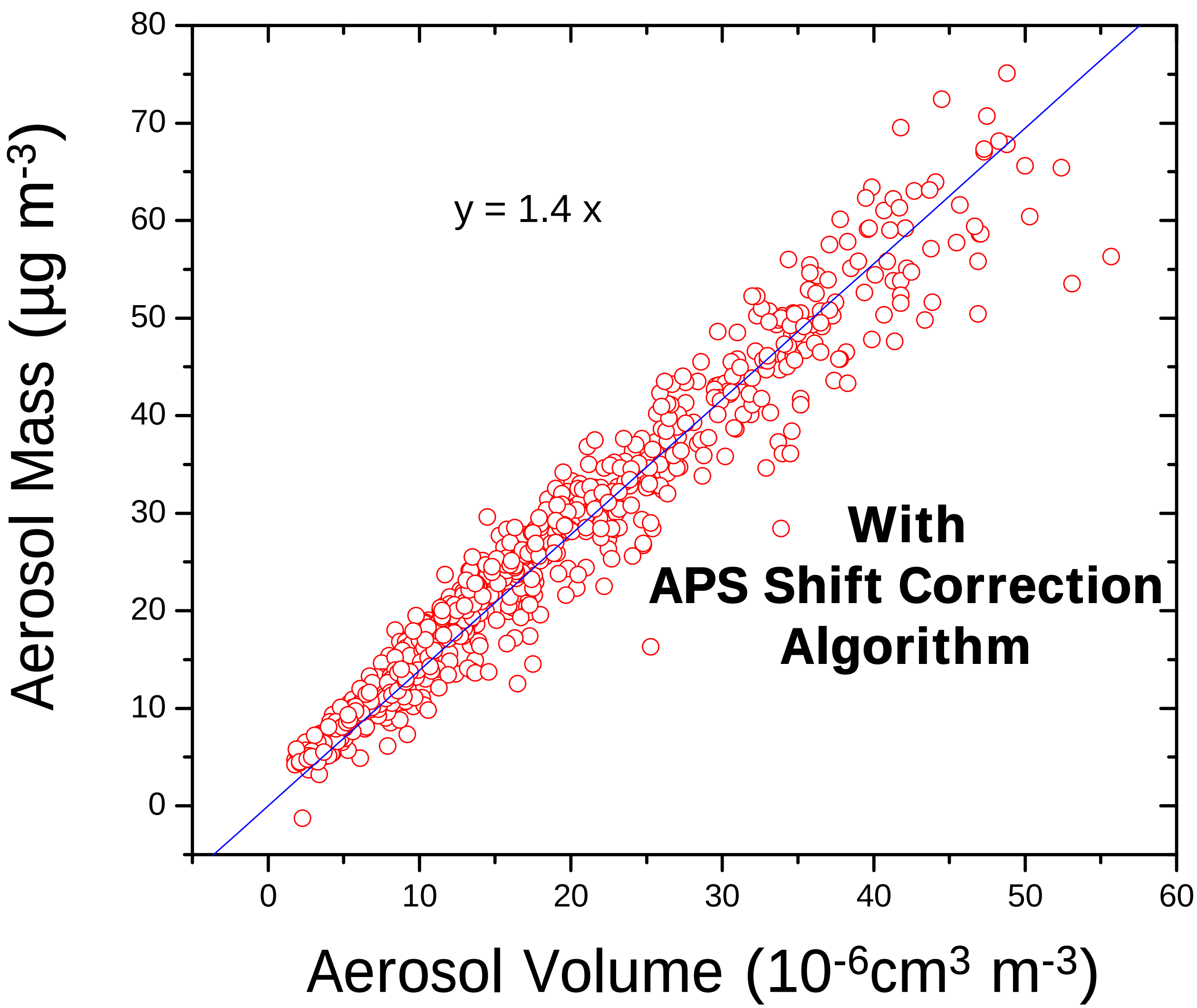


Density estimate (for volume to mass conversion) made from speciation measurements (mainly OC and ammonium sulfate)

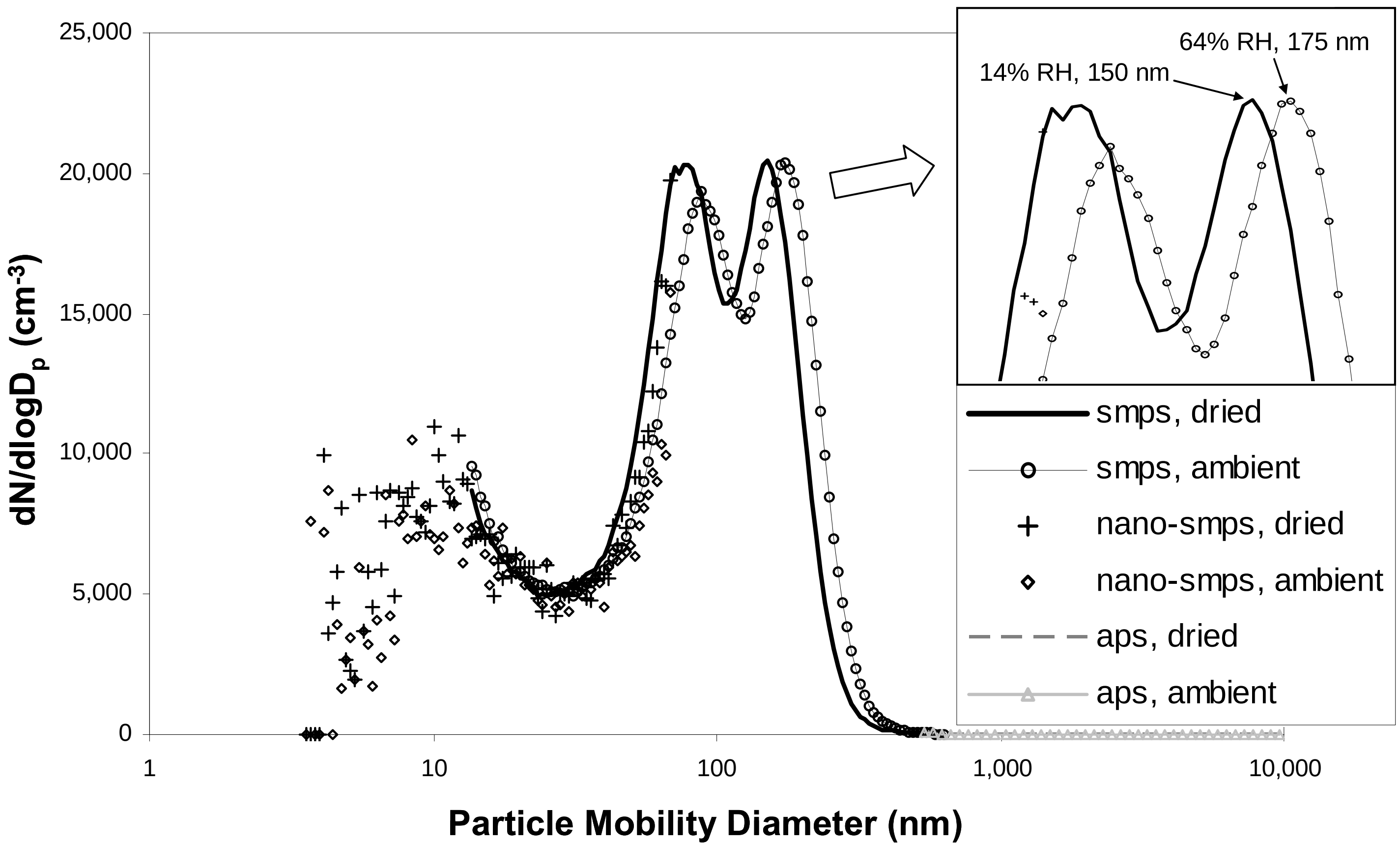
Comparison to Independent Measurement



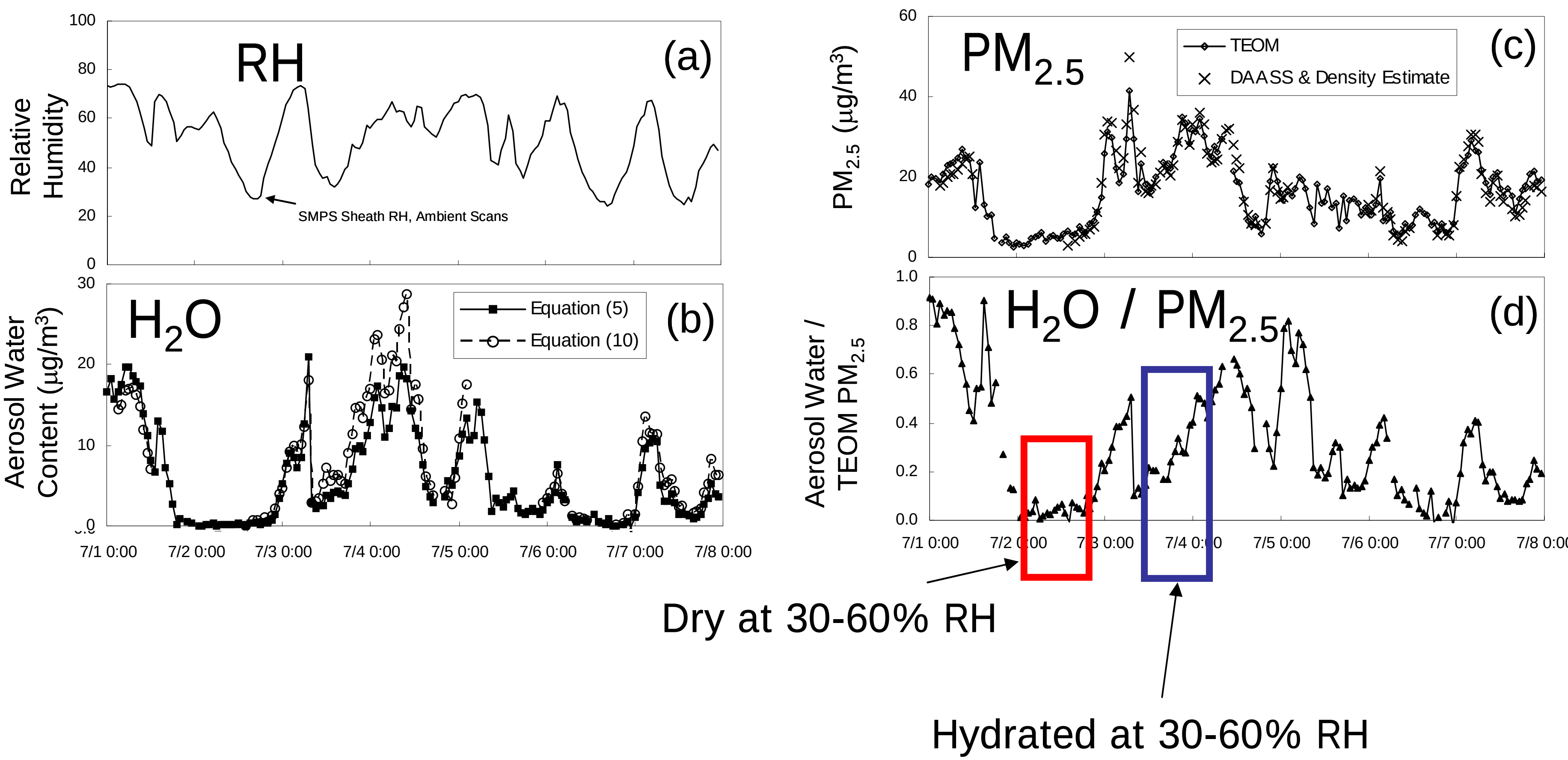
Comparison to Independent Measurement



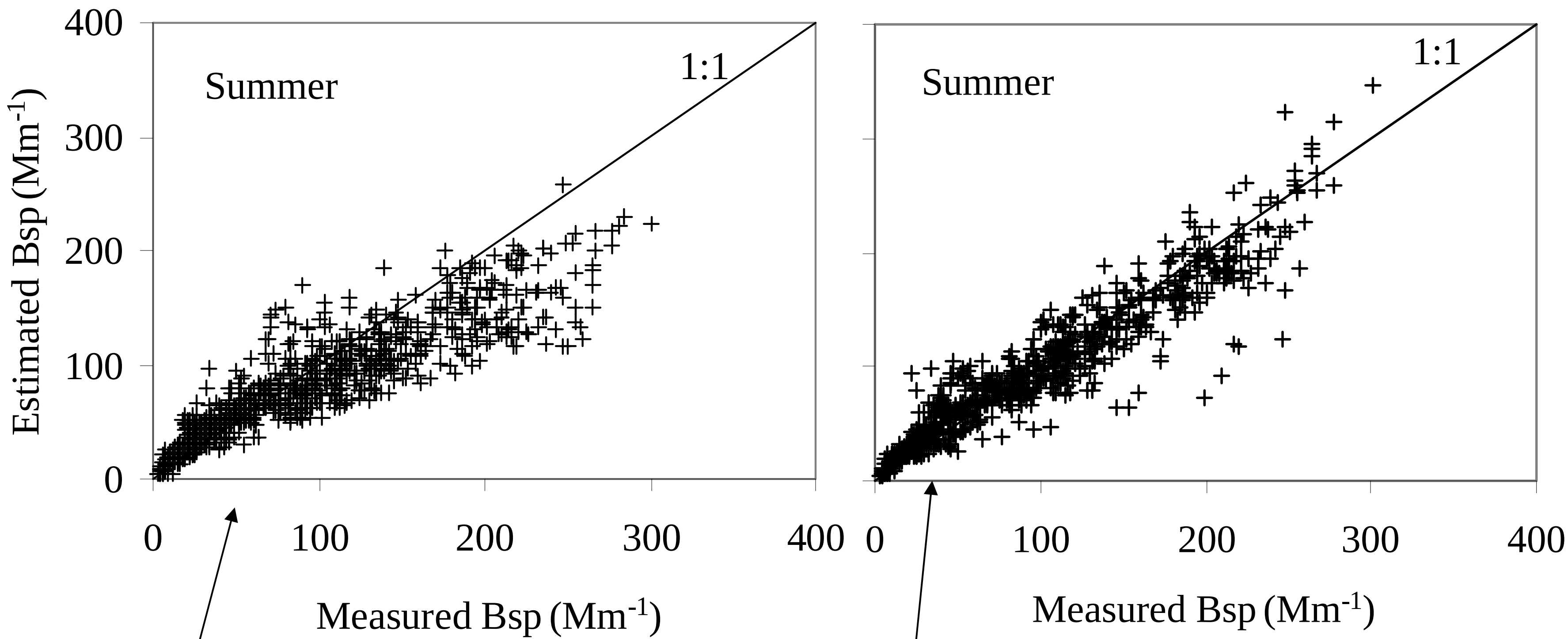
Example Result, Dry-Wet Operation



Example Results for Aerosol Water



Aerosol Water & Nephelometer B_{scat}



H_2O estimated as f(RH, Chemical Composition)

H_2O from DAASS measurement

Acknowledgements

- US Environmental Protection Agency Contract R82806101
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- Related Presentations
  - Poster 12-PD16 Particle Density And Shape Factors Estimated From Merging Aerodynamic And Mobility Size Distributions
  - Poster 12-PA9 Light Scattering by Fine Particles During PAQS: Measurements and Modeling
  - Poster 12-PD13 Ambient Aerosol Size Distributions Measured During PAQS
  - Talk 19-C2 (Friday 10:20) Aerosol Water Content During Pittsburgh Air Quality Study: Observations And Model Comparison