

Aerosol Water Content During PAQS Observations and model comparison

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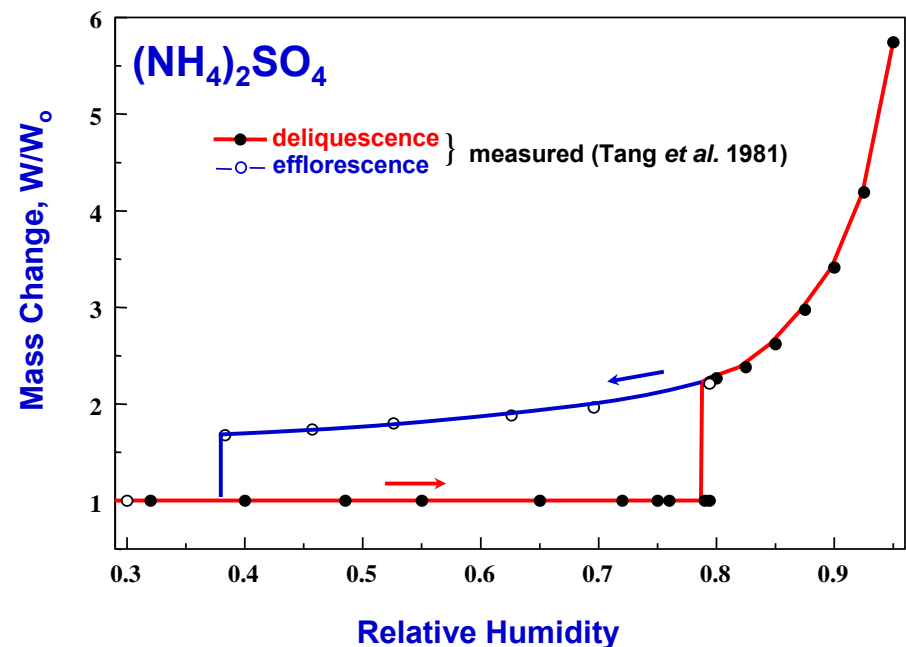
Charlie Stanier

Satoshi Takahama

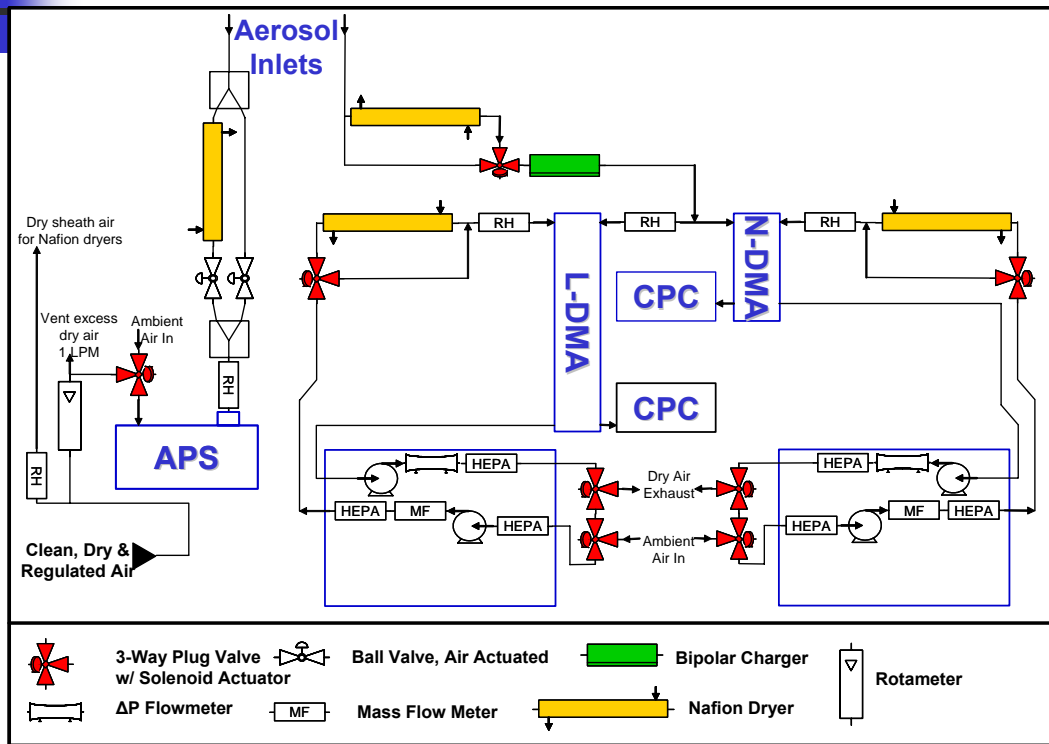
Spyros Pandis

Importance of Aerosol Water

- Dominant aerosol component at RH above 80%
- Influences
 - Visibility
 - Climate effects
 - Partitioning of semi-volatiles
 - Aerosol lifetime
- Questions:
 - Is particle wet or dry?
 - How much water does it contain?
 - What is the role of organics?

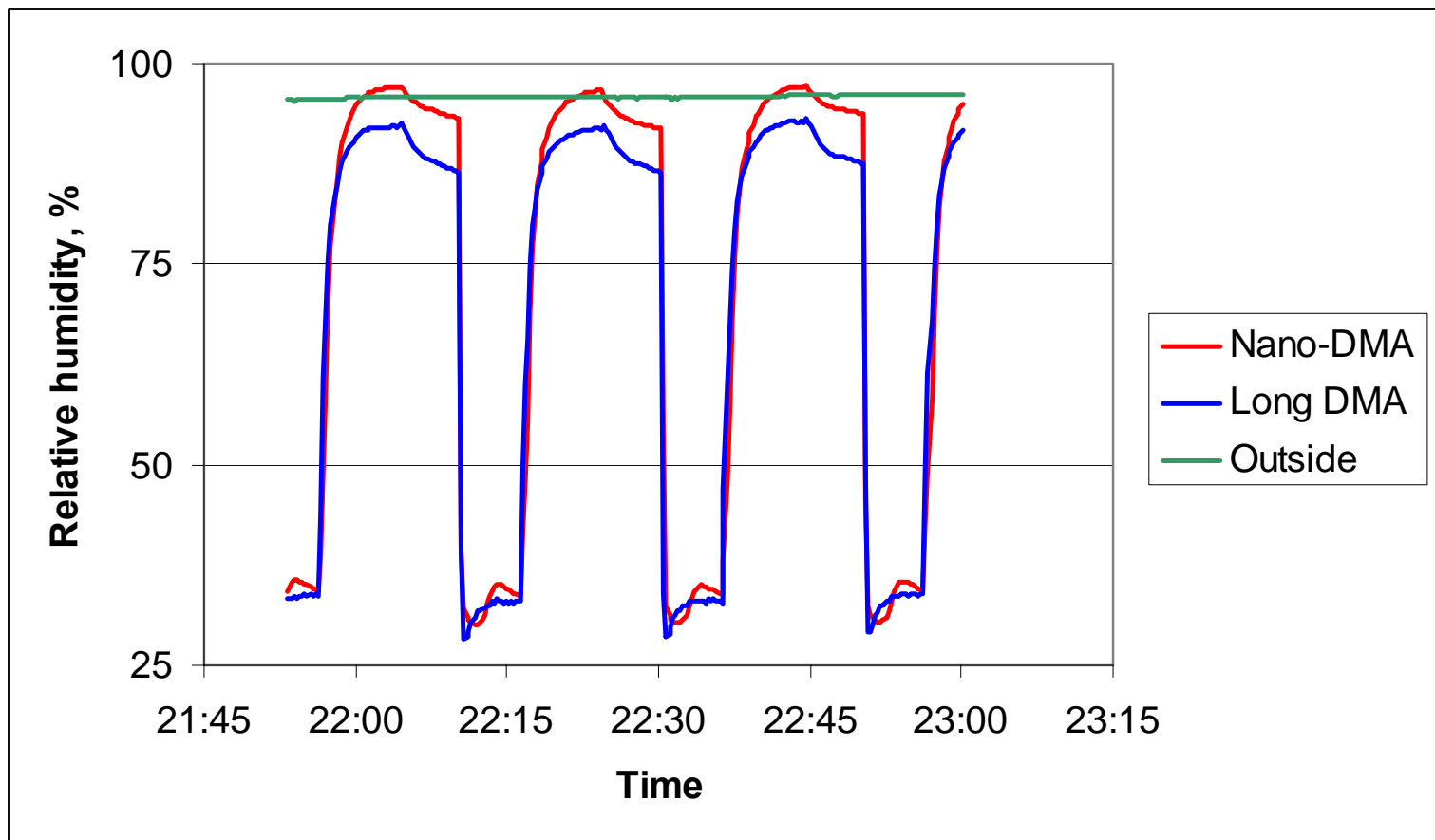


Dry-Ambient Aerosol Size Spectrometer (DAASS)

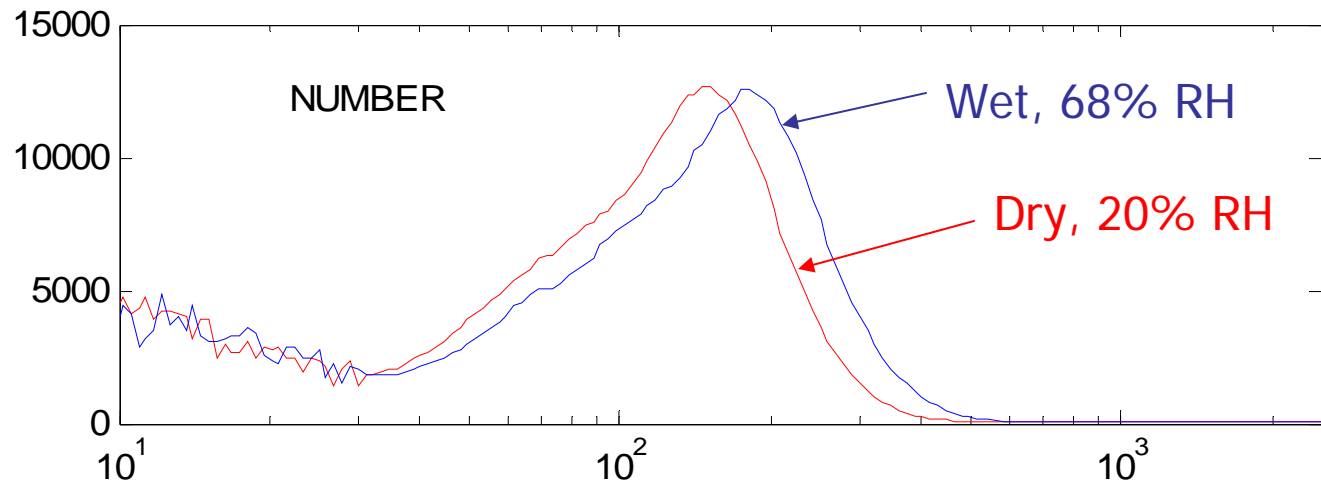


- Measures “wet” and “dry” aerosol size distributions (5 nm – 10 μm) 4 times per hour at ambient temperature
- Comparison of wet and dry distributions provides a measure of aerosol water content

Relative humidity cycle in DAAS

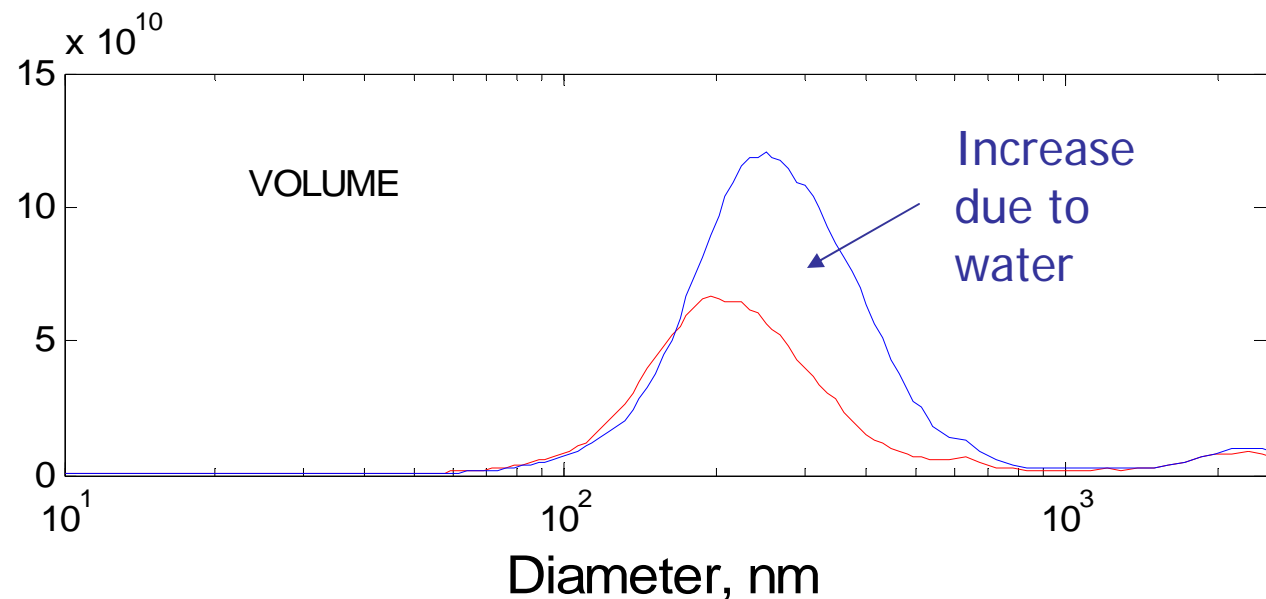


Amount of water is determined from wet and dry size distributions

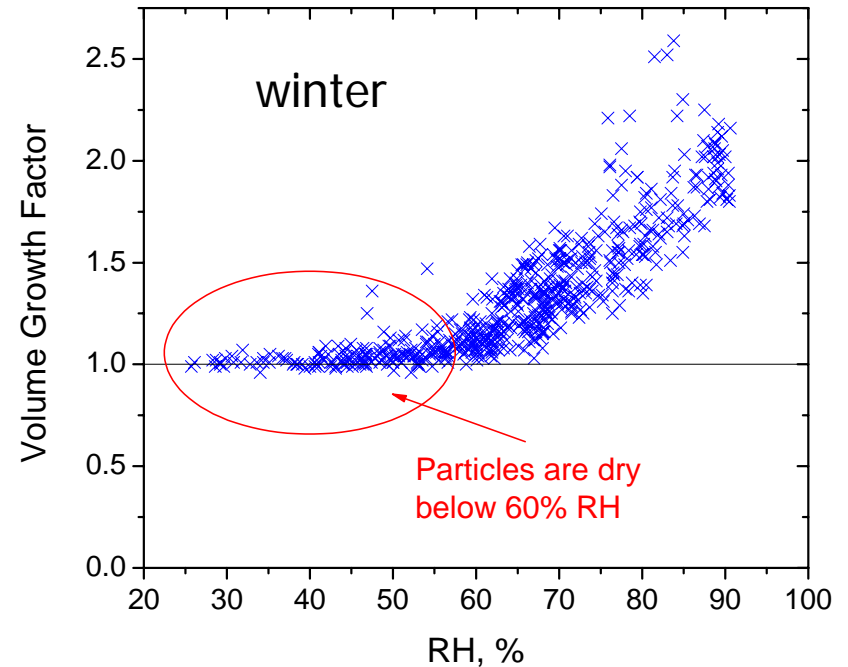
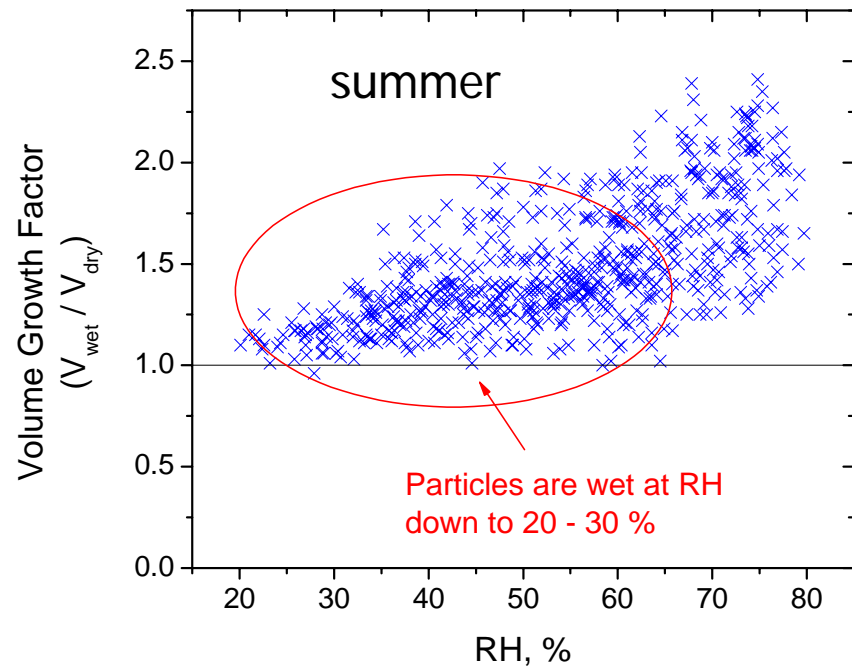


Aerosol water =

$$\rho_w (V_{\text{wet}} - V_{\text{dry}})$$



Seasonal behavior of aerosol water content



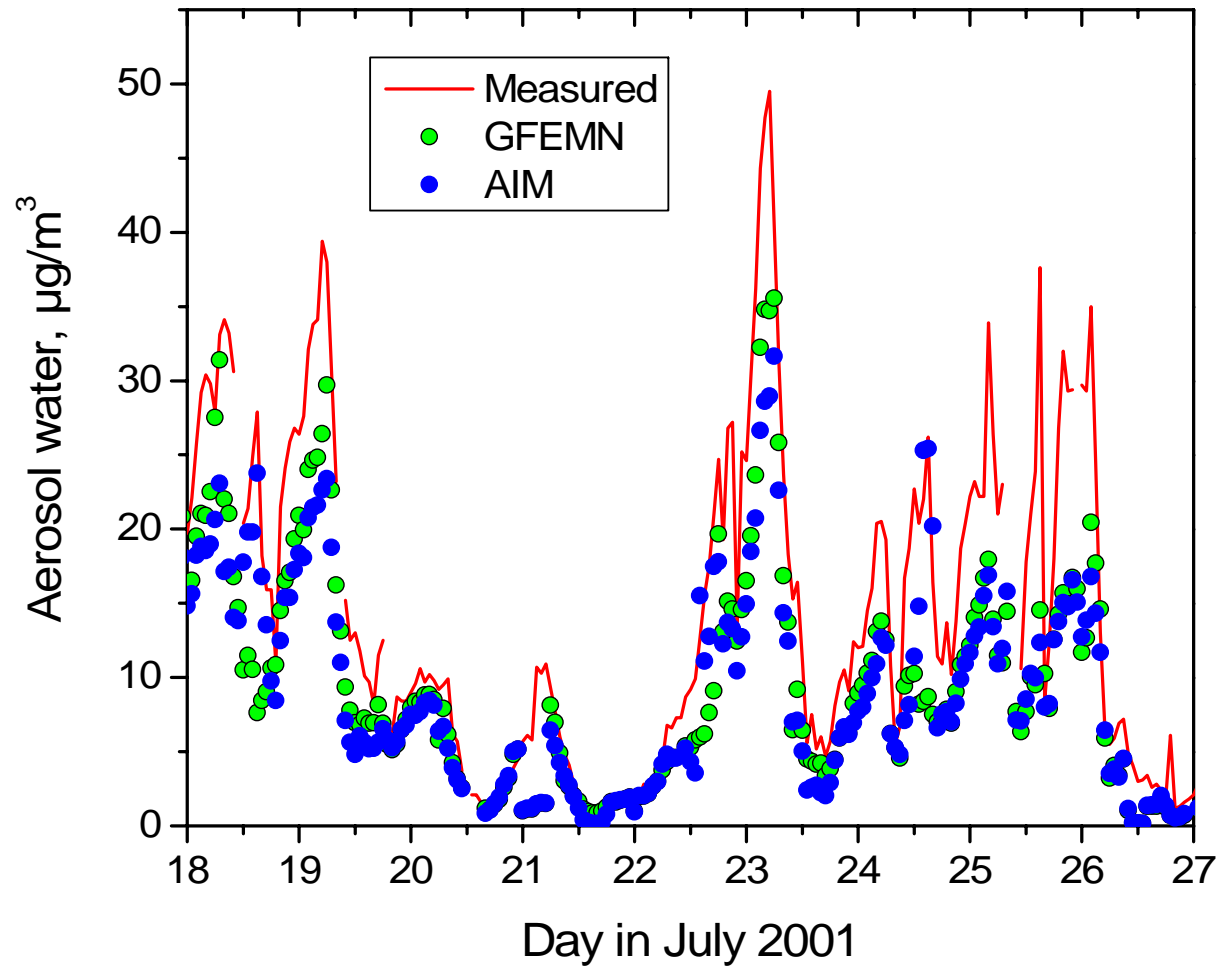
- Summer: aerosol is always wet because it is acidic
- Winter: aerosol is dry below 60% RH because it is neutral



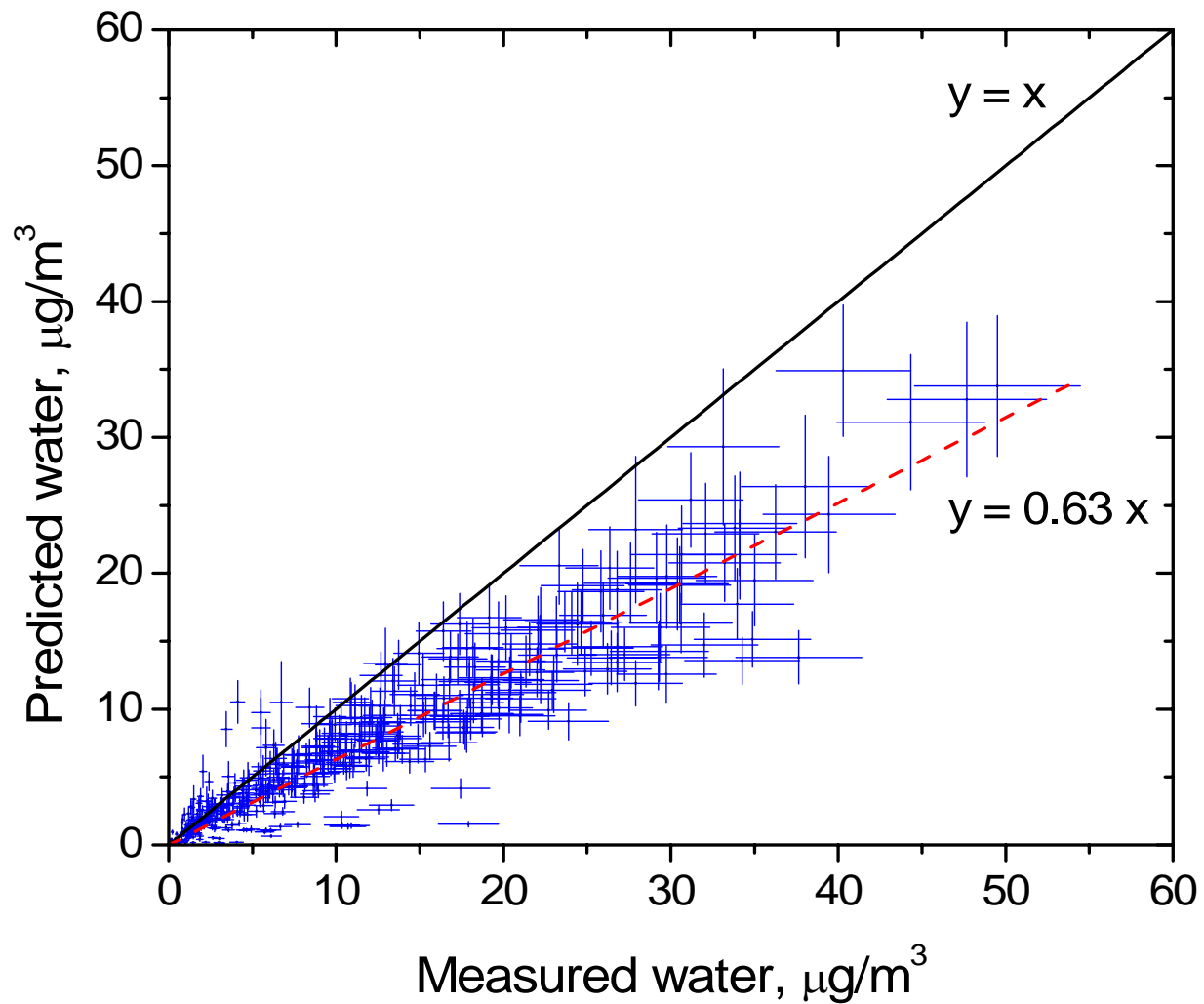
Comparison with theory

- Thermodynamic models
 - GFEMN (Ansari and Pandis, 1999)
 - AIM (Clegg et al., 1998)
 - AIOM (Clegg and Edney, 2004)
- Input :
 - Inorganic species (PM_{2.5} sulfate; nitrate, ammonium)
 - OC and EC; **OC contribution to aerosol water is neglected in GFEMN and AIM**
- Models calculate equilibrium PM volume at the RH of dry and ambient measurements

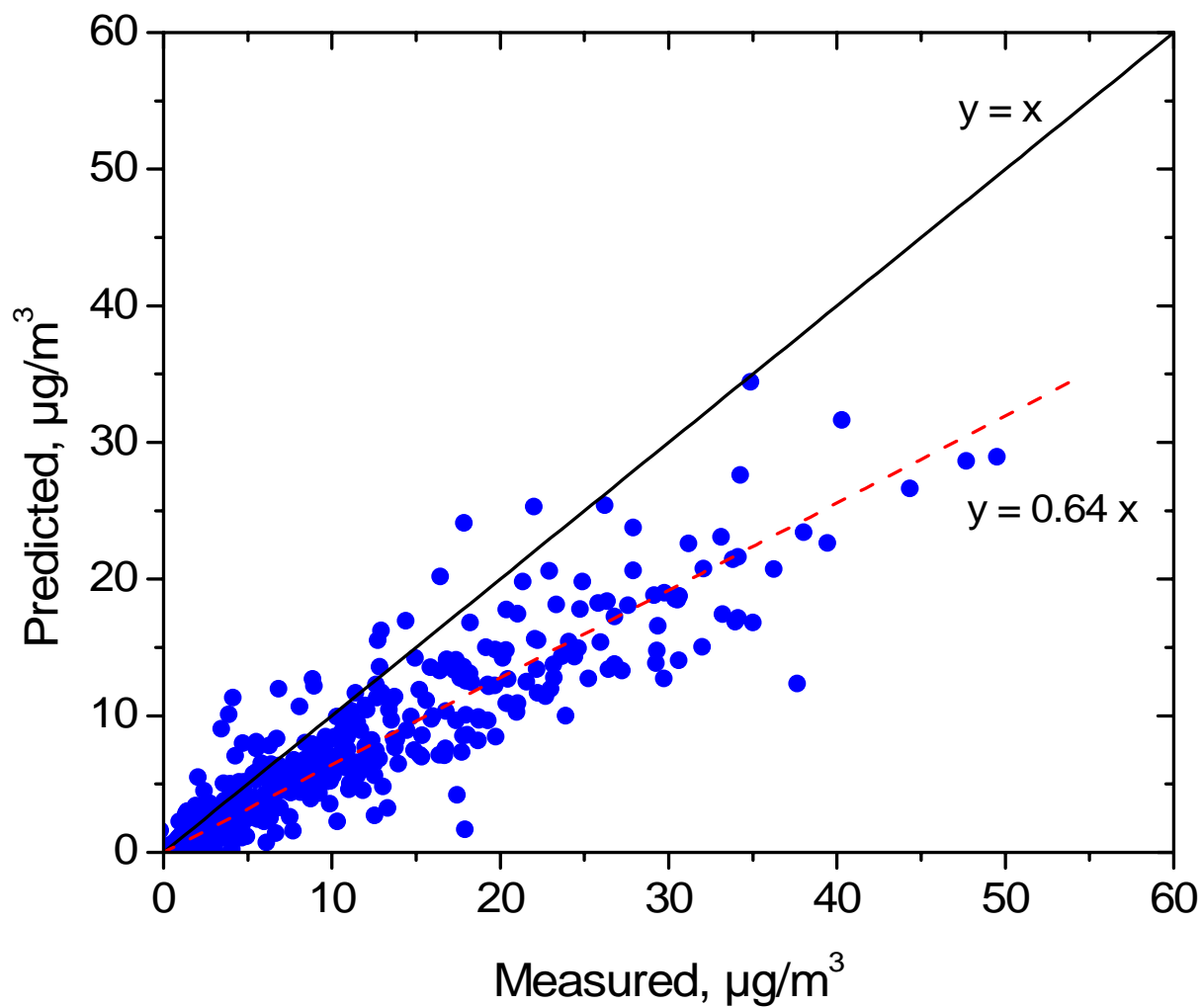
Time series of observed and modeled water content



Measurements vs. GFEMN

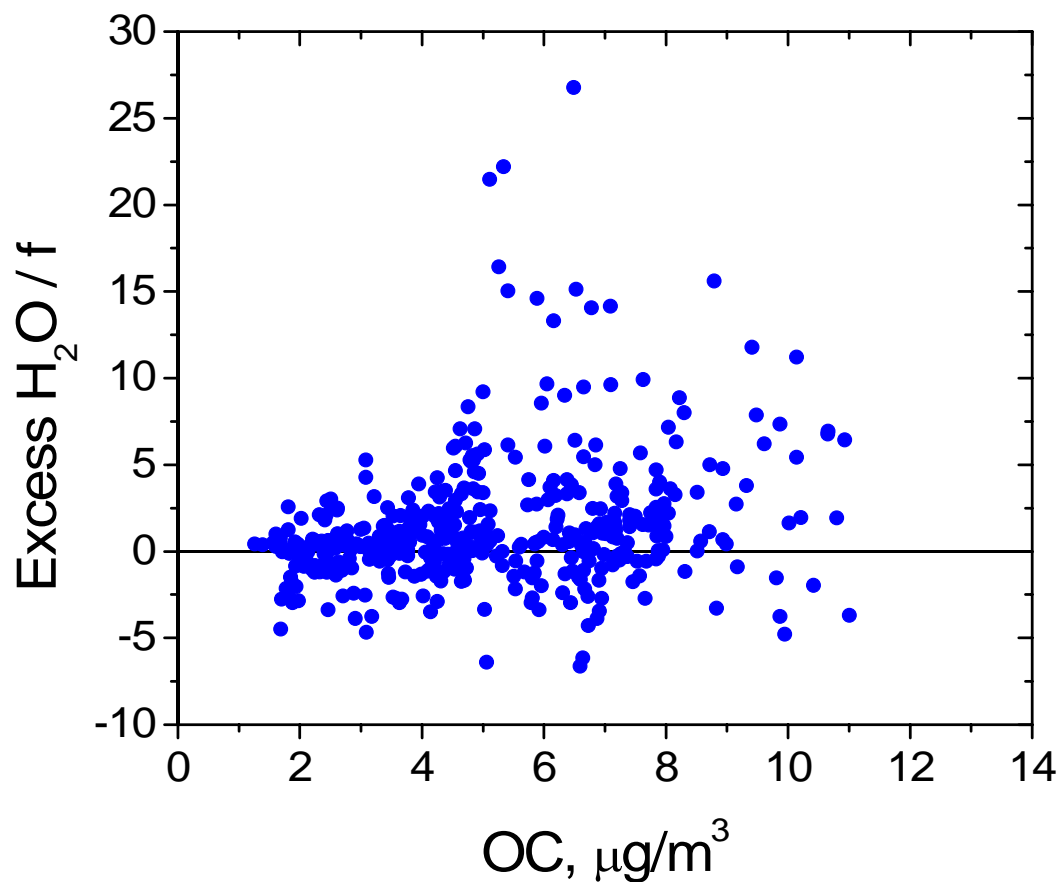


Measurements vs. AIM

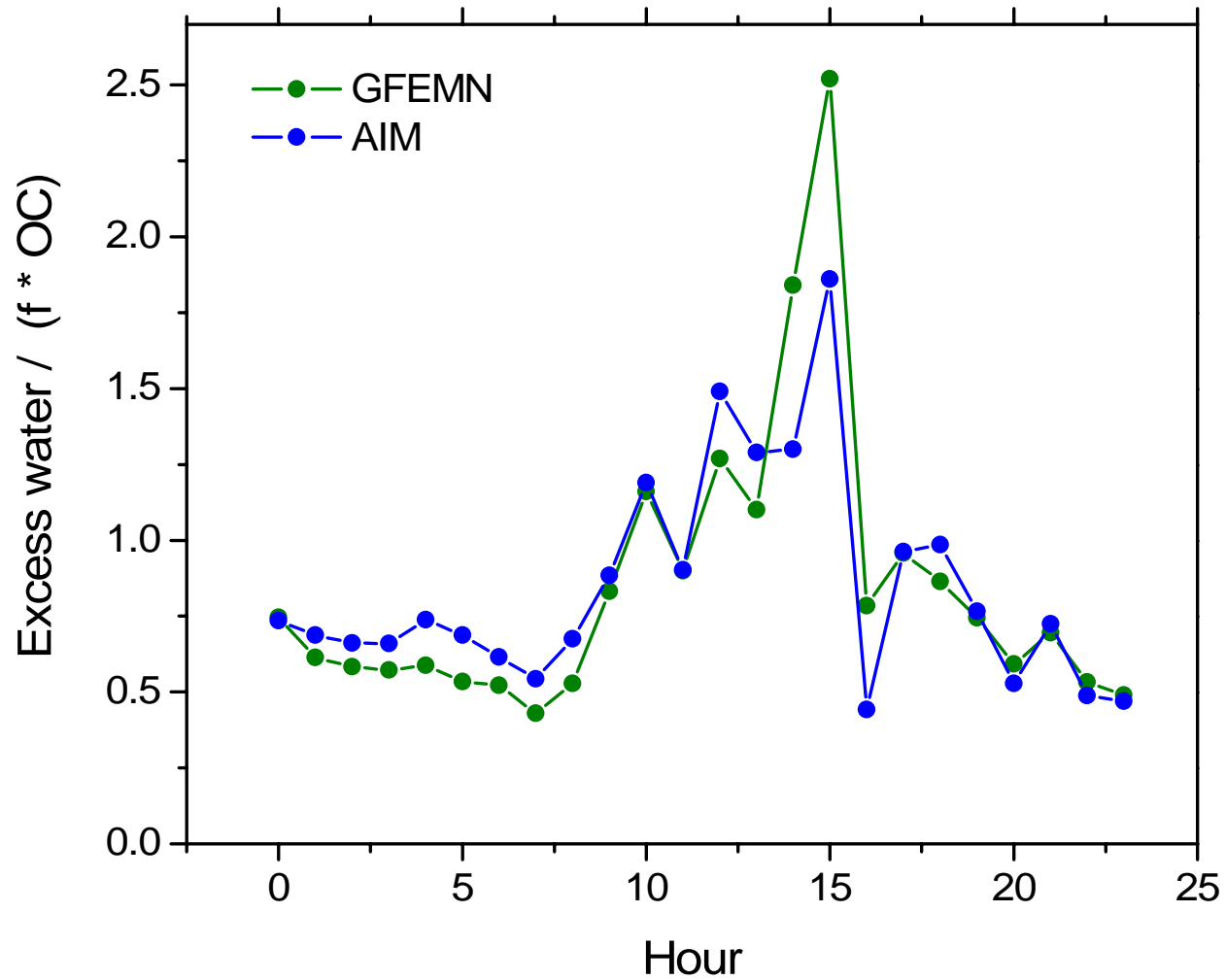


Organics and the discrepancy between observations and model

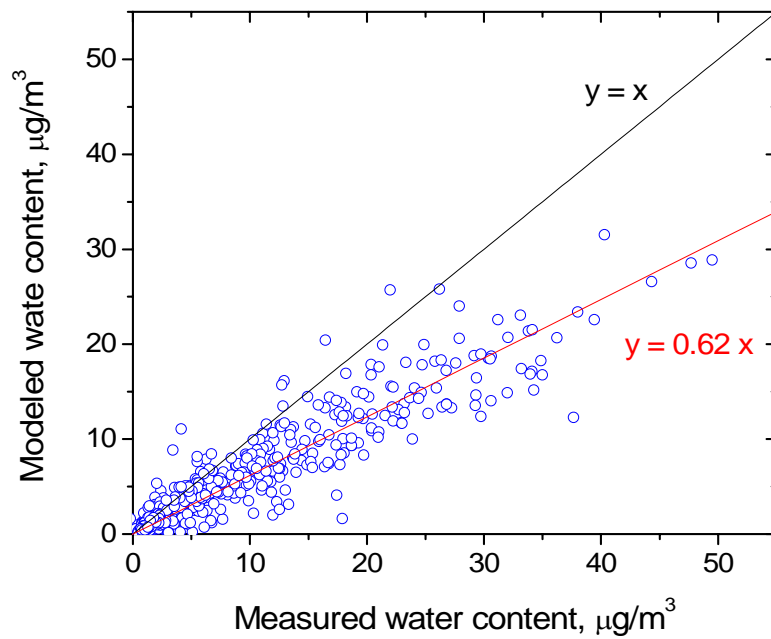
- RH has an overwhelming effect on the amount of water
- To observe relationship between water and OC the amount of water is scaled with $f = \text{RH}/(1-\text{RH})$



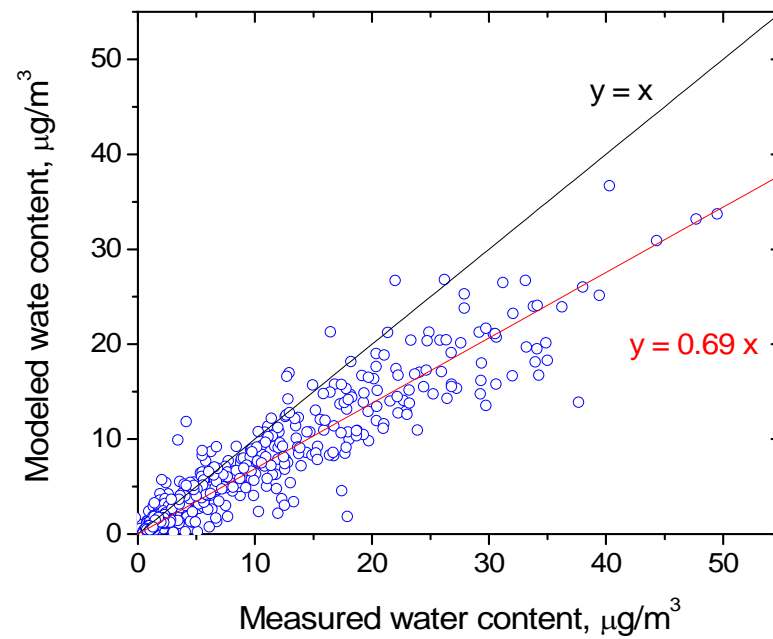
Organic Carbon and Excess Water



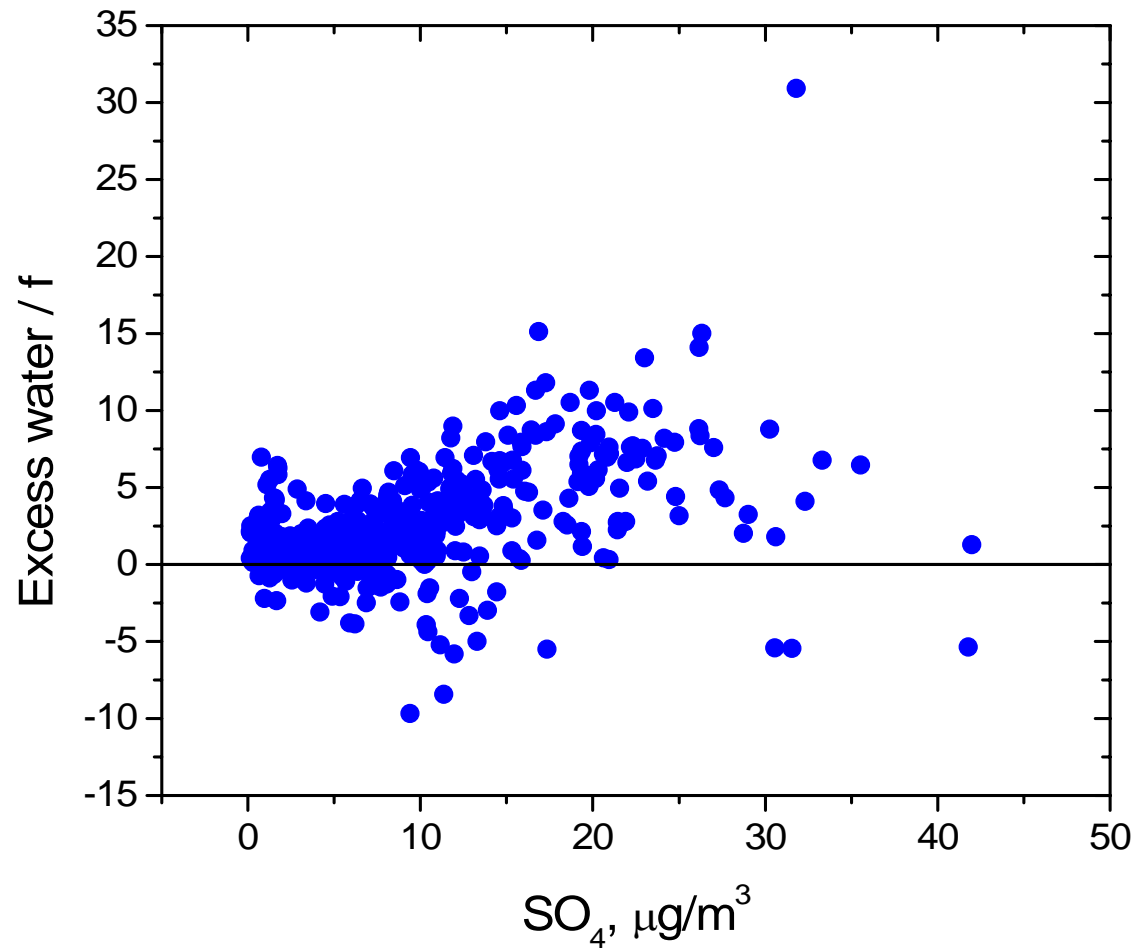
Inorganic only



Inorganic + all OC as oxalate



PM_{2.5} sulfate and excess water





Conclusions

- Hygroscopic properties of aerosol in Pittsburgh vary with seasons:
 - summer aerosol was practically always wet
 - winter aerosol was dry below 60%RH
 - spring exhibited transitional behavior
 - seasonal behavior is consistent with aerosol acidity
- GFEMN and AIM under-predict water content by 35% if contribution from OC to water absorption is neglected
- Contribution of organics to water absorption is variable and has a diurnal pattern with more contribution during the day.
- However, it is possible that water absorption by sulfate is influenced by the organics, rather than the organic fraction itself absorbing water



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