

# Semi-volatile aerosol and its effect on on aerosol optical properties during SOAS

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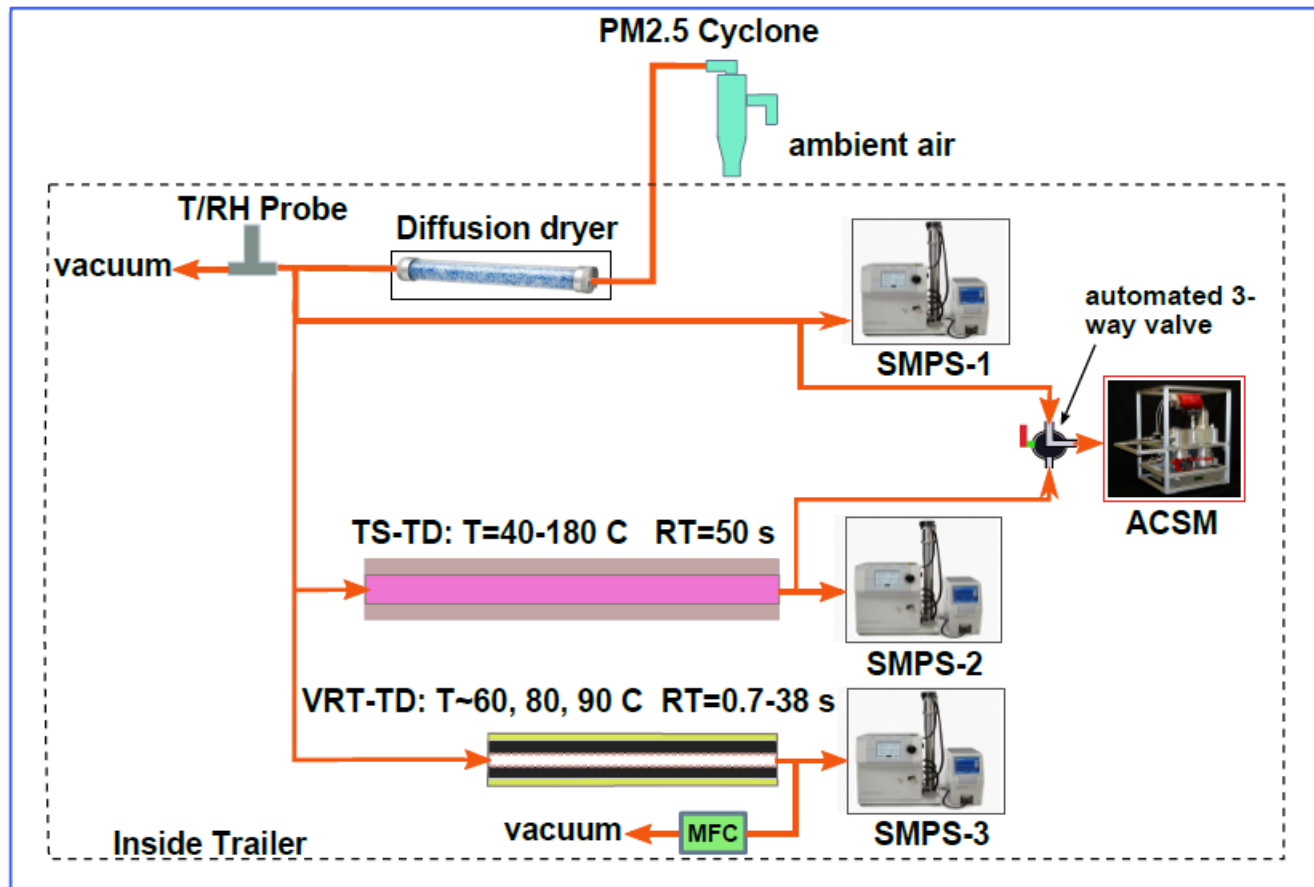
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# Science questions

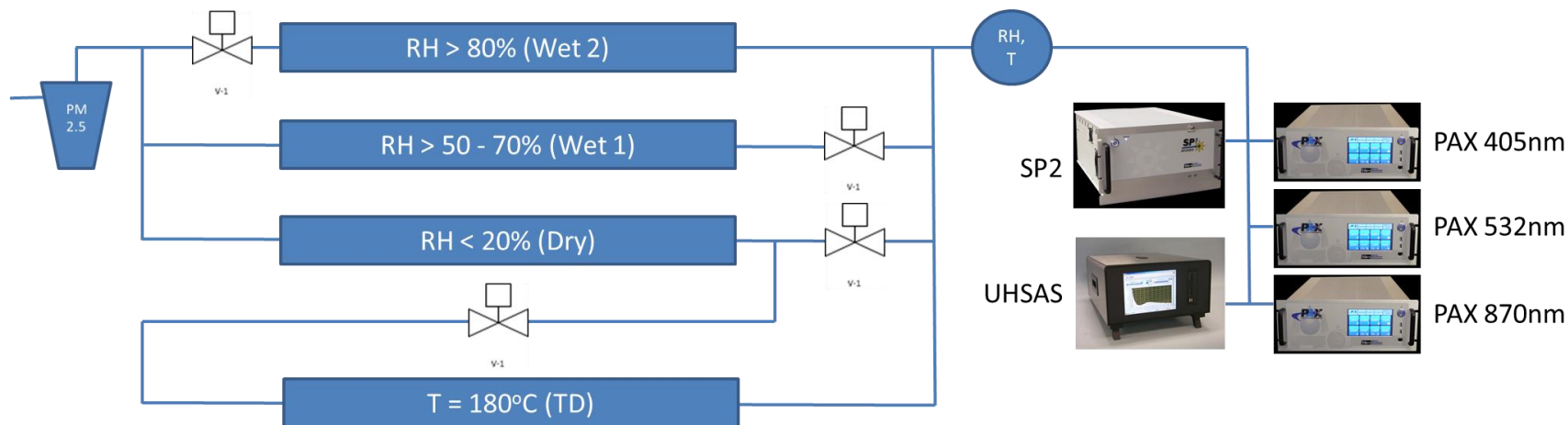
- Gas / particle partitioning
  - Volatility basis sets (VBS)
  - Enthalpy of vaporization ( $\Delta H_{\text{vap}}$ )
  - Kinetics of equilibration
- SOA and optical properties
  - Secondary brown carbon and organo-N compounds
  - Lensing effect (enhanced absorption by black carbon due to coating)
  - Contribution of SOA to hygroscopic growth and light scattering

# Aerosol volatility measurements



- Temperature Stepping TD with a long residence time (50 s)
- Variable residence time TD (0.7-38 s) with moderately heated activated carbon surface at constant temperature

# Optical property measurements

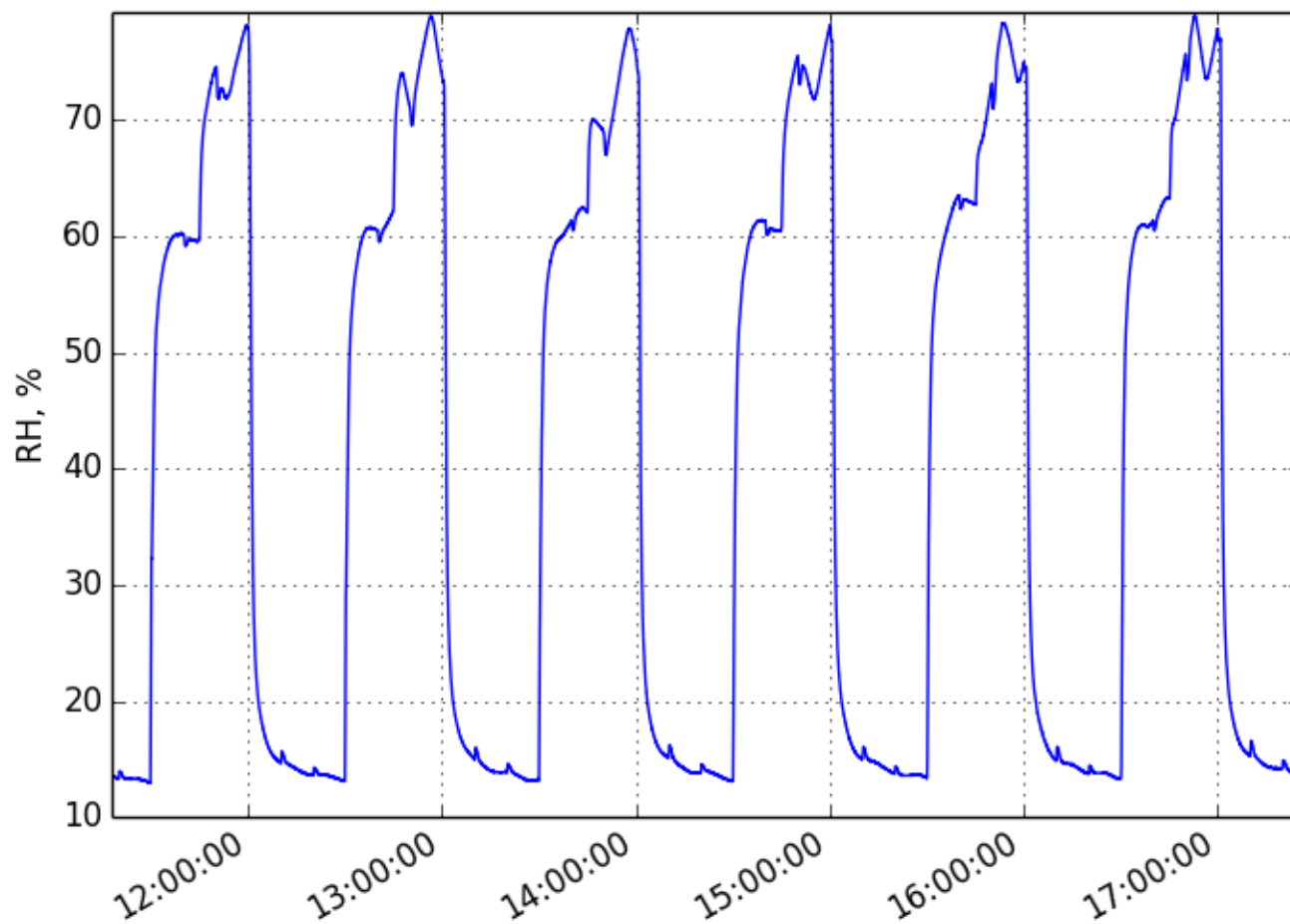


## RH and temperature conditioning:

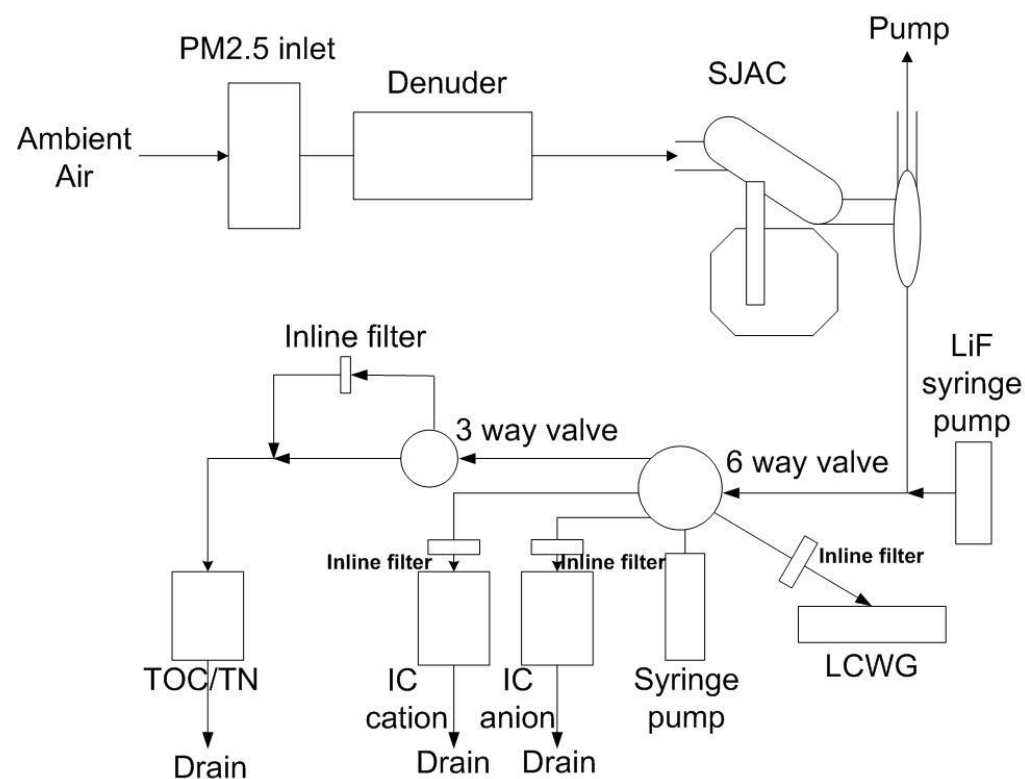
- “Dry” line: < 10% RH
- “Intermediate” line: ~60-70% RH
- “High RH” line: > 85% RH
- Thermodenuder (TD): 180 C or scanning
- Lines are switched every 15 min

## Measured parameters:

- Aerosol scattering and absorption at 405nm, 532nm, 870nm
- Single particle black carbon and coating thickness
- Particle size distribution above 70nm (only in July)

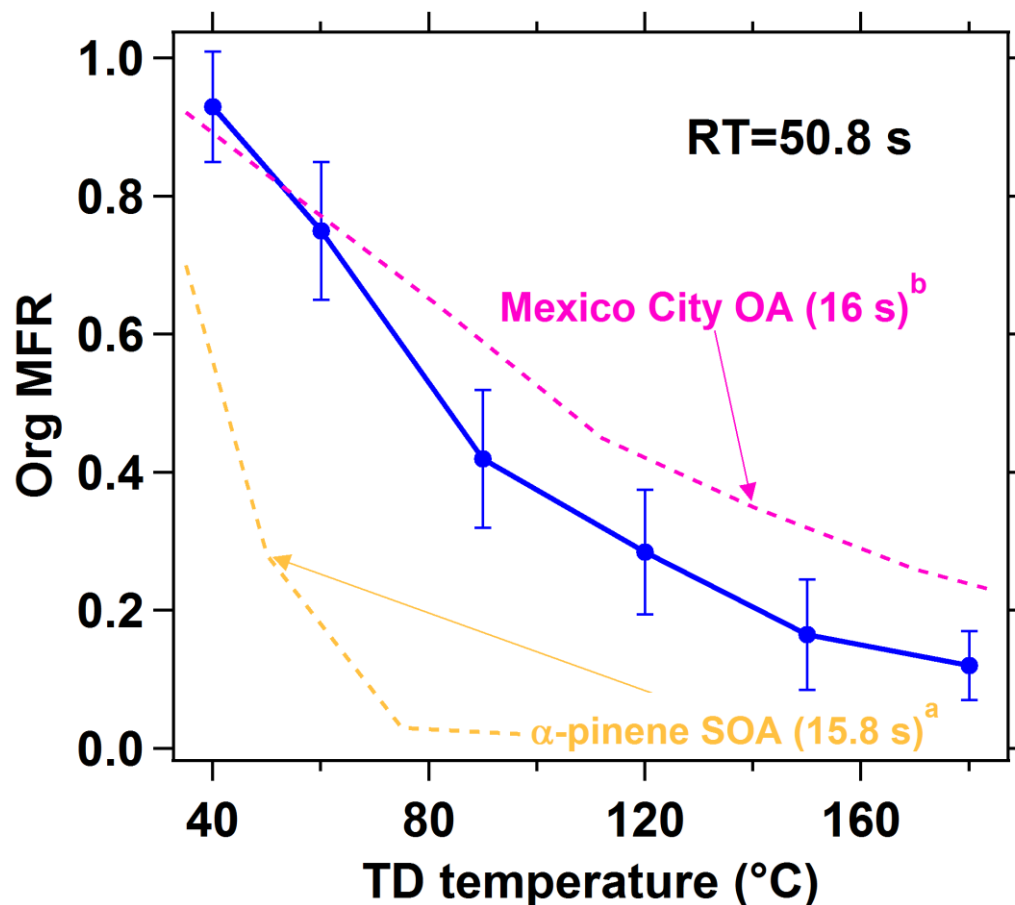


# Chemical composition measurements



- SJAC
  - Major ions, TC, TN
  - ON (TN-IN)
  - 30 min resolution

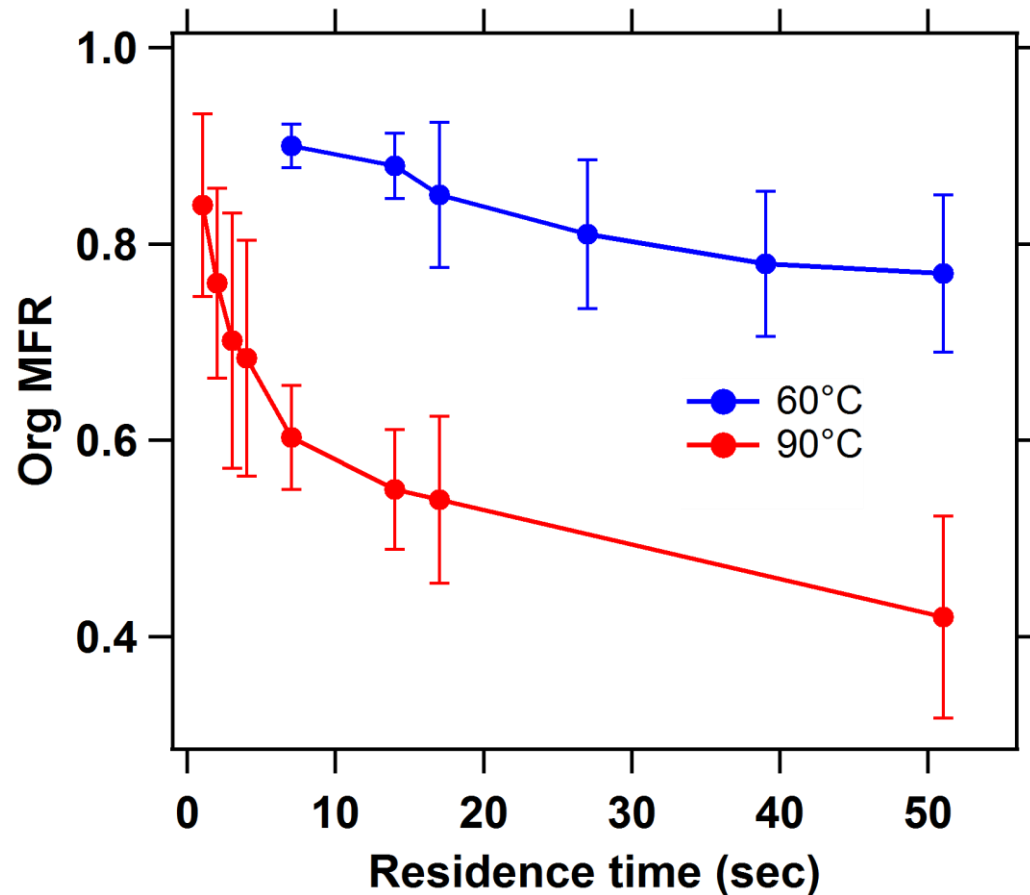
# Mass fraction remaining (MFR)



<sup>a</sup>An W.J., Pathak R.K., Lee B., and Pandis S.N. "Aerosol volatility measurement using an improved thermodenuder: Application to secondary organic aerosol". J Aer Sci. 2007 Mar;38(3):305–14.

<sup>b</sup>Cappa C.D., Jimenez J.L. "Quantitative estimates of the volatility of ambient organic aerosol". Atmos. Chem. Phys. 2010 Jun 21;10(12):5409–24.

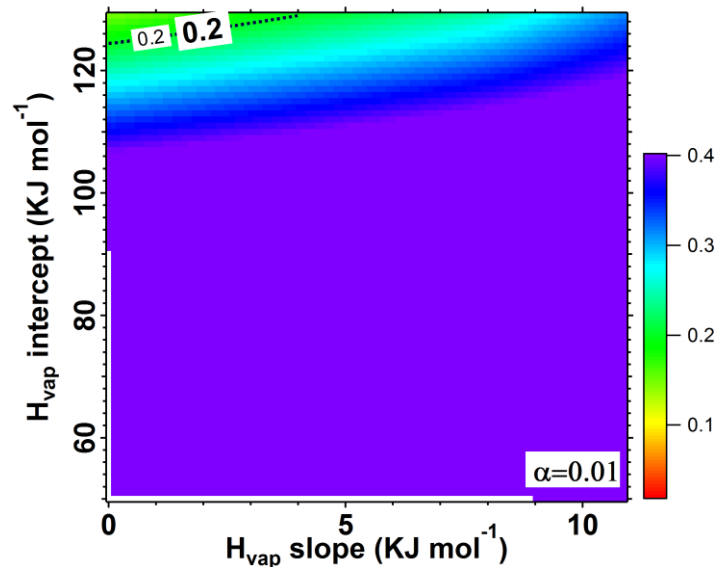
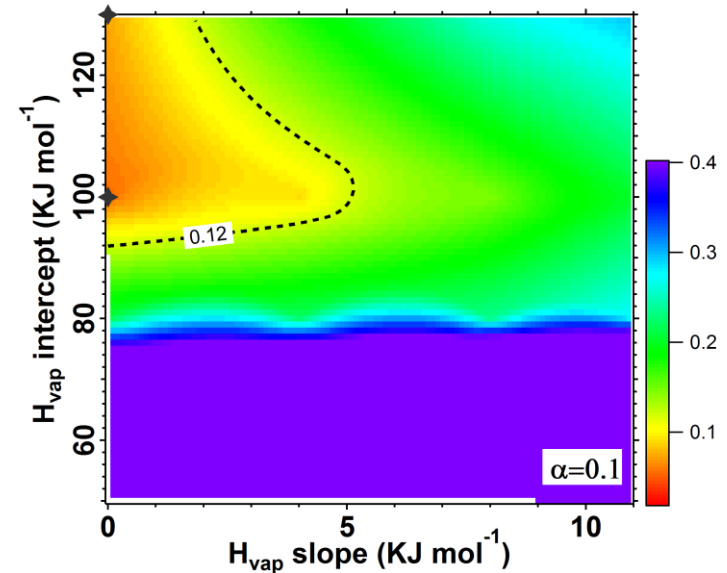
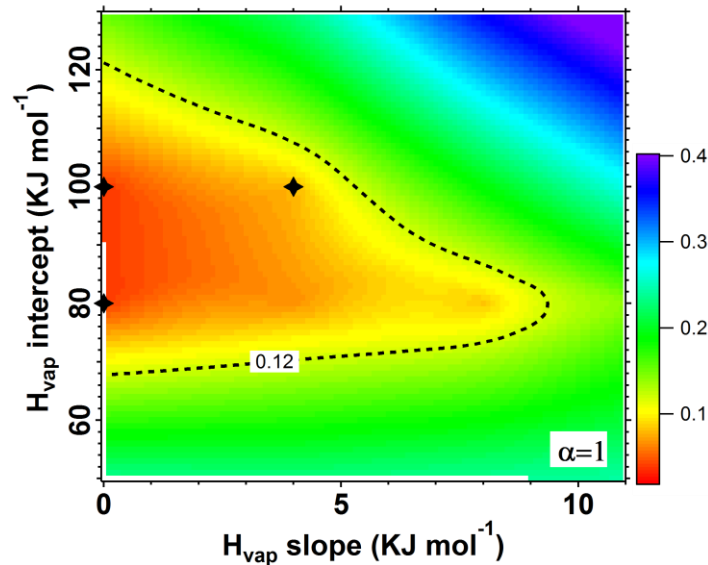
# MFR as a function of residence time



MFR depends on the residence time in TD

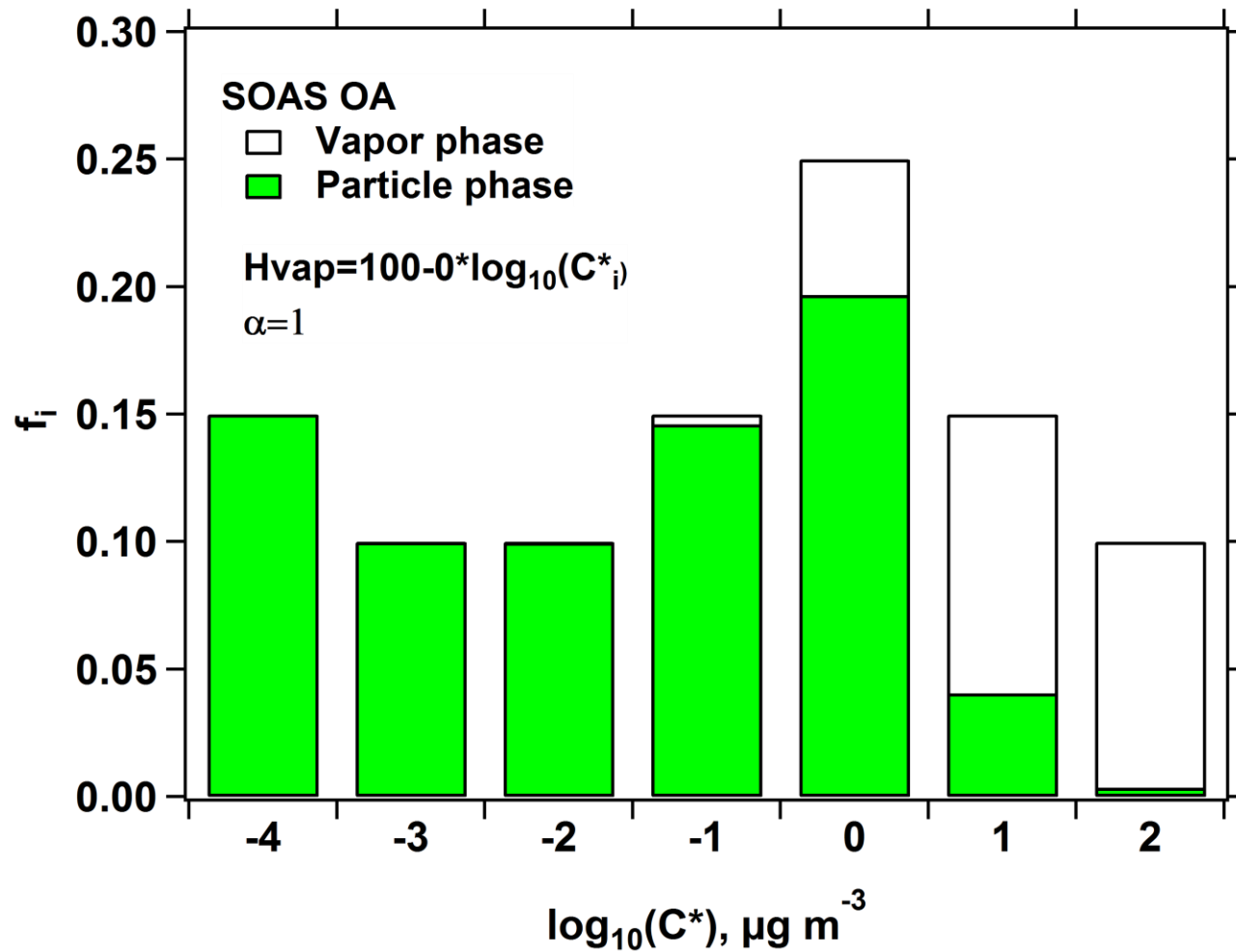


# Modeling of thermodenuder results

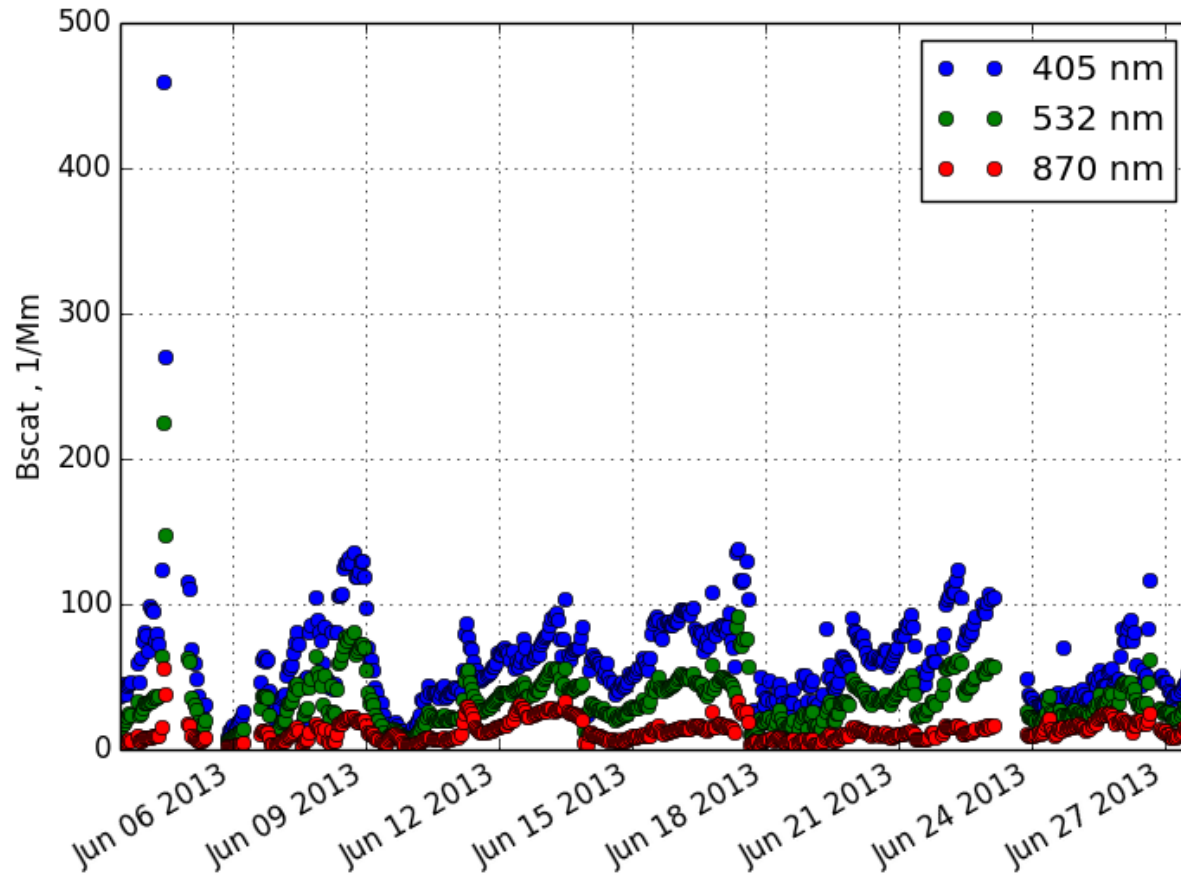


- Evaporation coefficient likely  $> 0.1$
- $dH_{\text{vap}} = 80\text{-}130 \text{ KJ mol}^{-1}$
- Epstein correlation ( $dH_{\text{vap}} = 130 - 11 \log C^*$ ) does not agree with observations
- Variable residence time data provide much more constrained fit

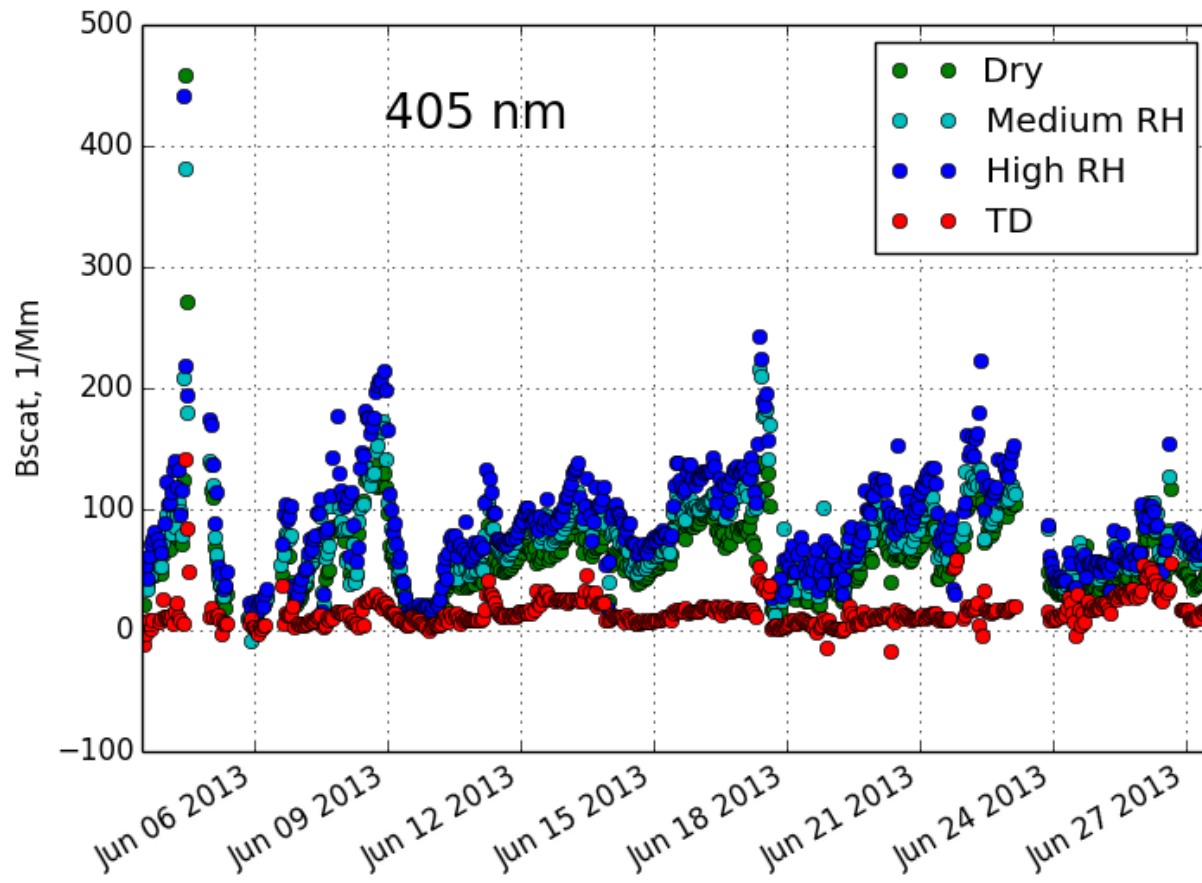
# Average VBS during SOAS



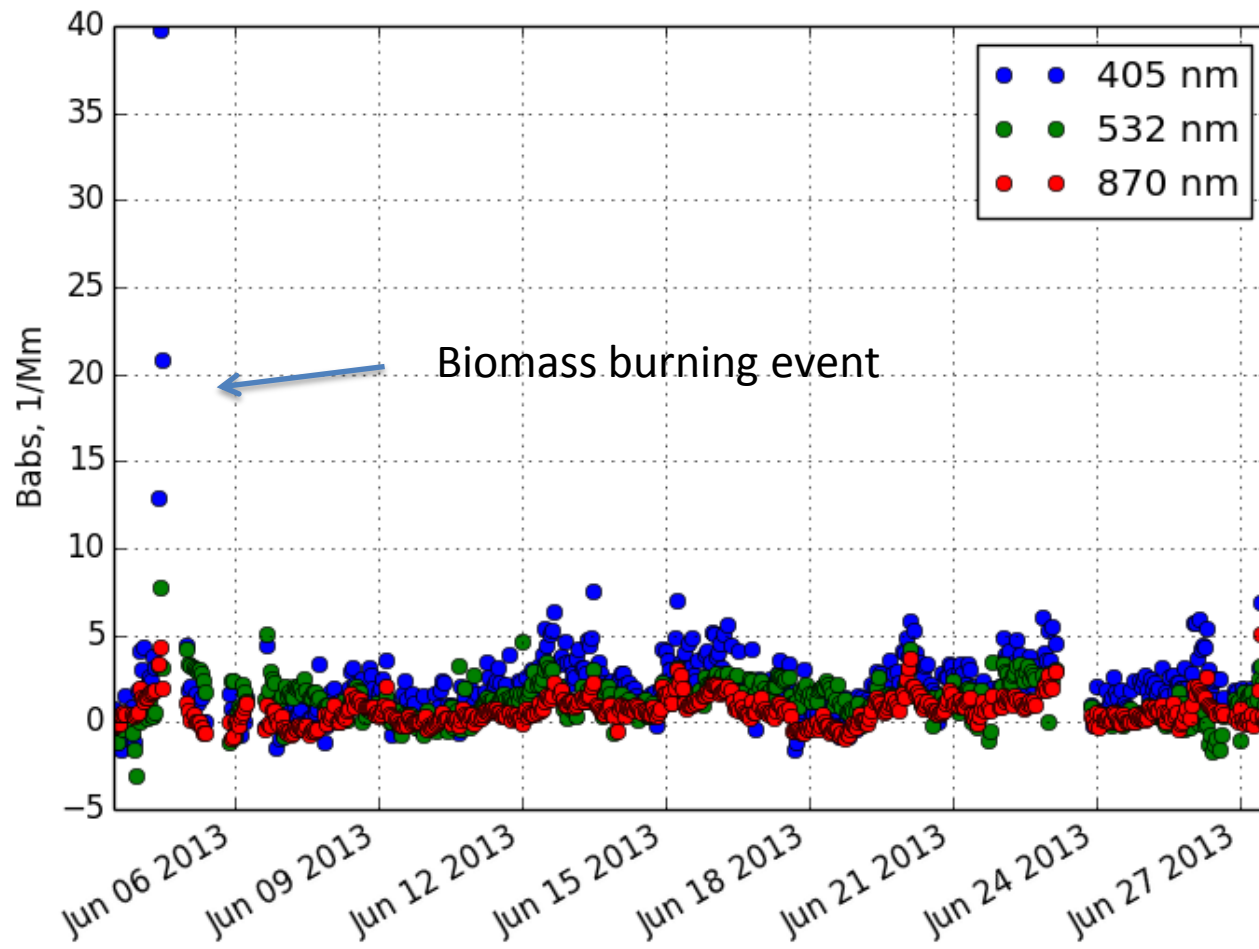
# Dry scattering



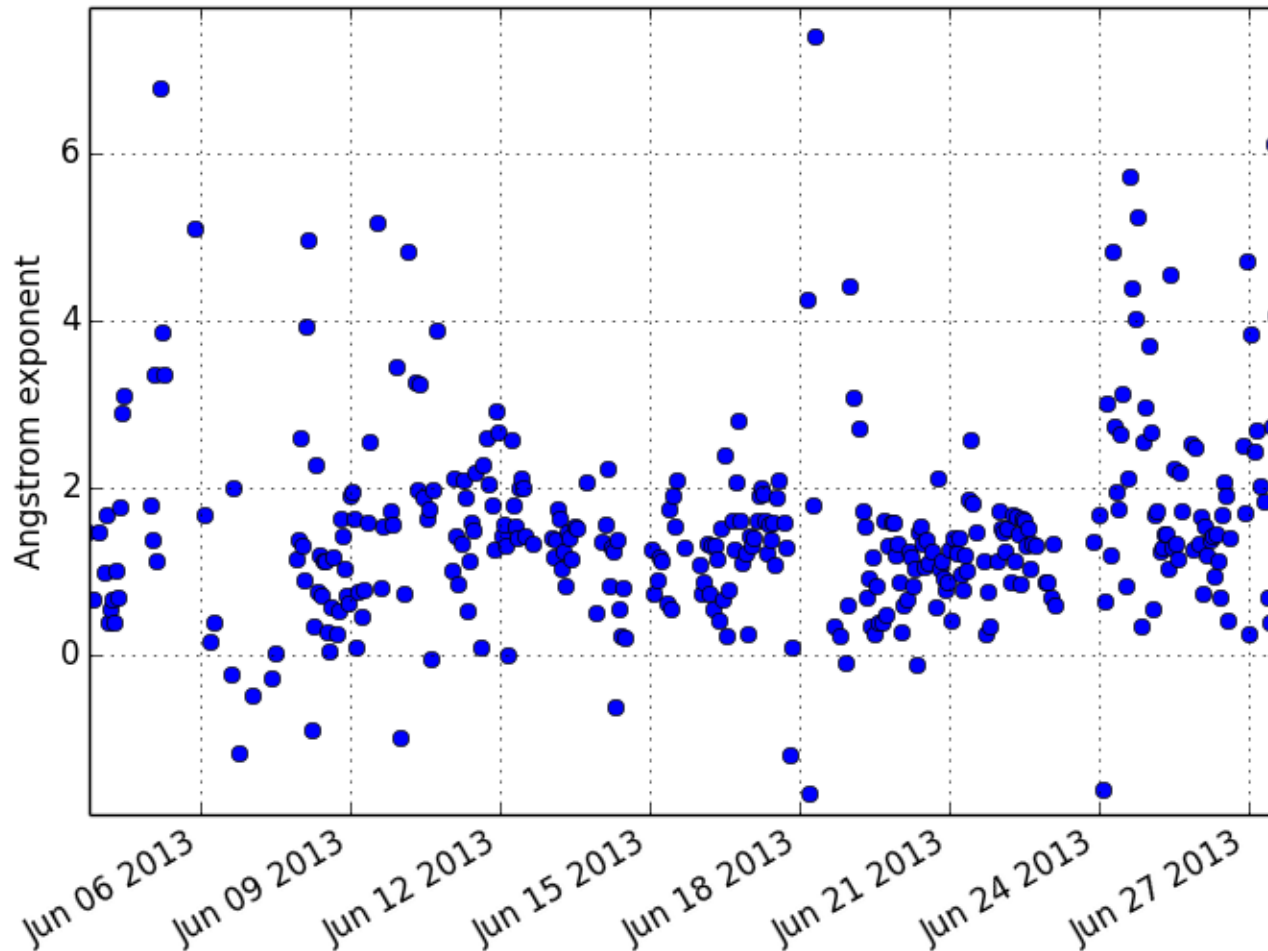
# Scattering during different measurement cycles



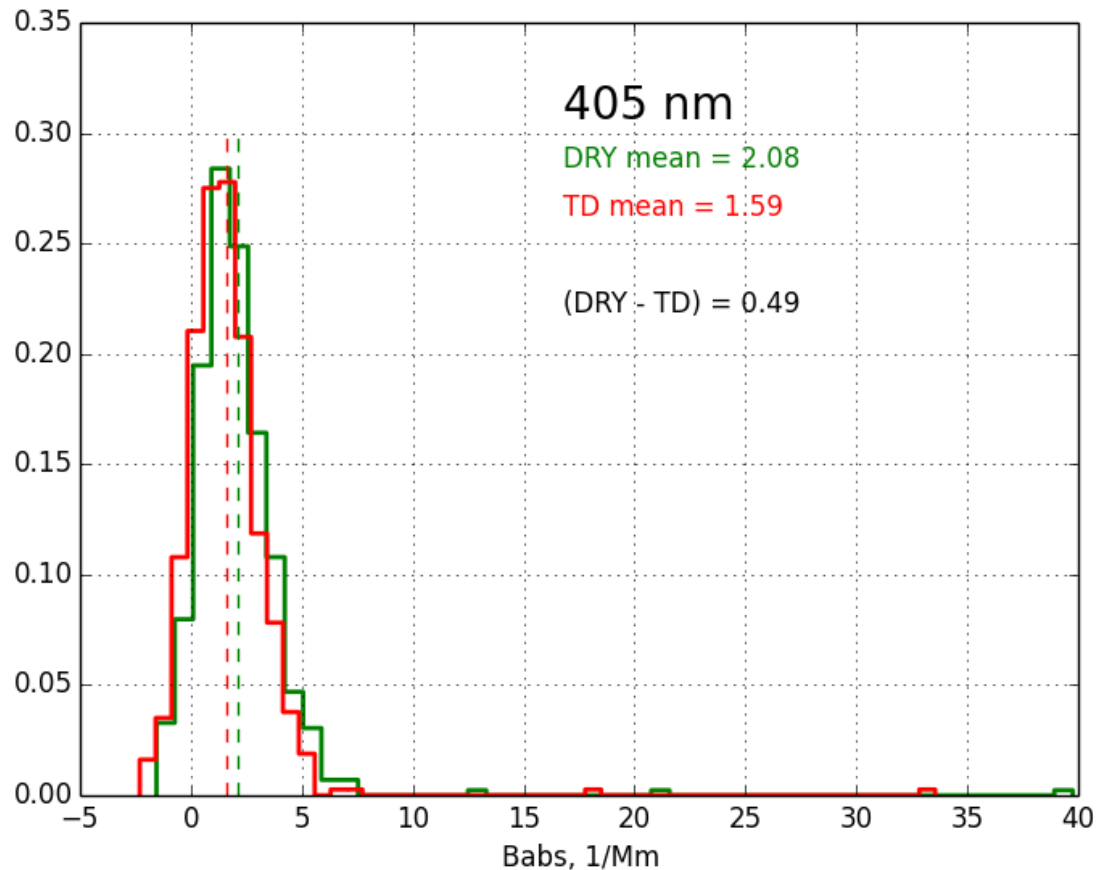
# “Dry” absorption from PAX



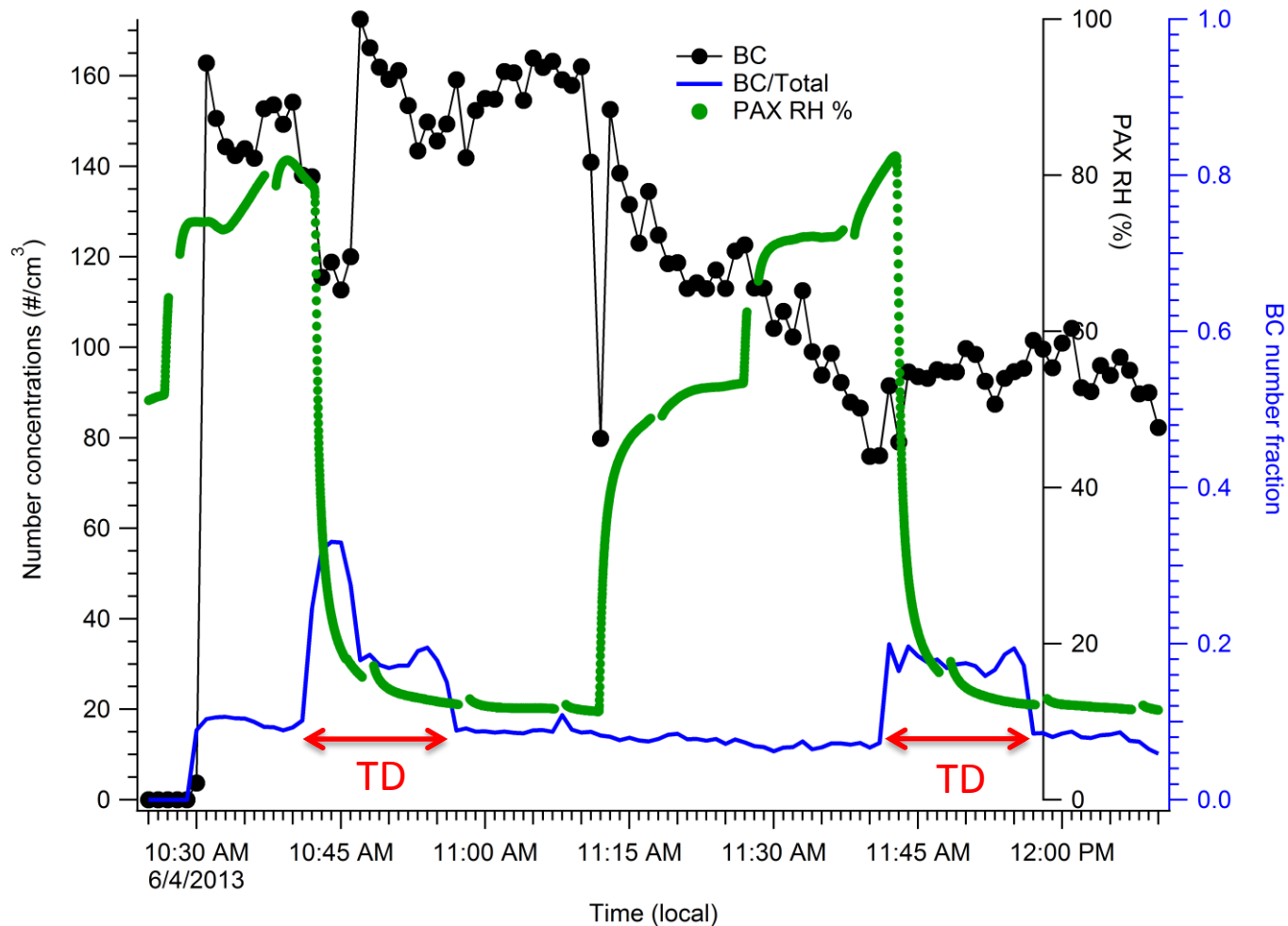
# Angstrom exponent



# There are indications of brown carbon and/or lensing effect

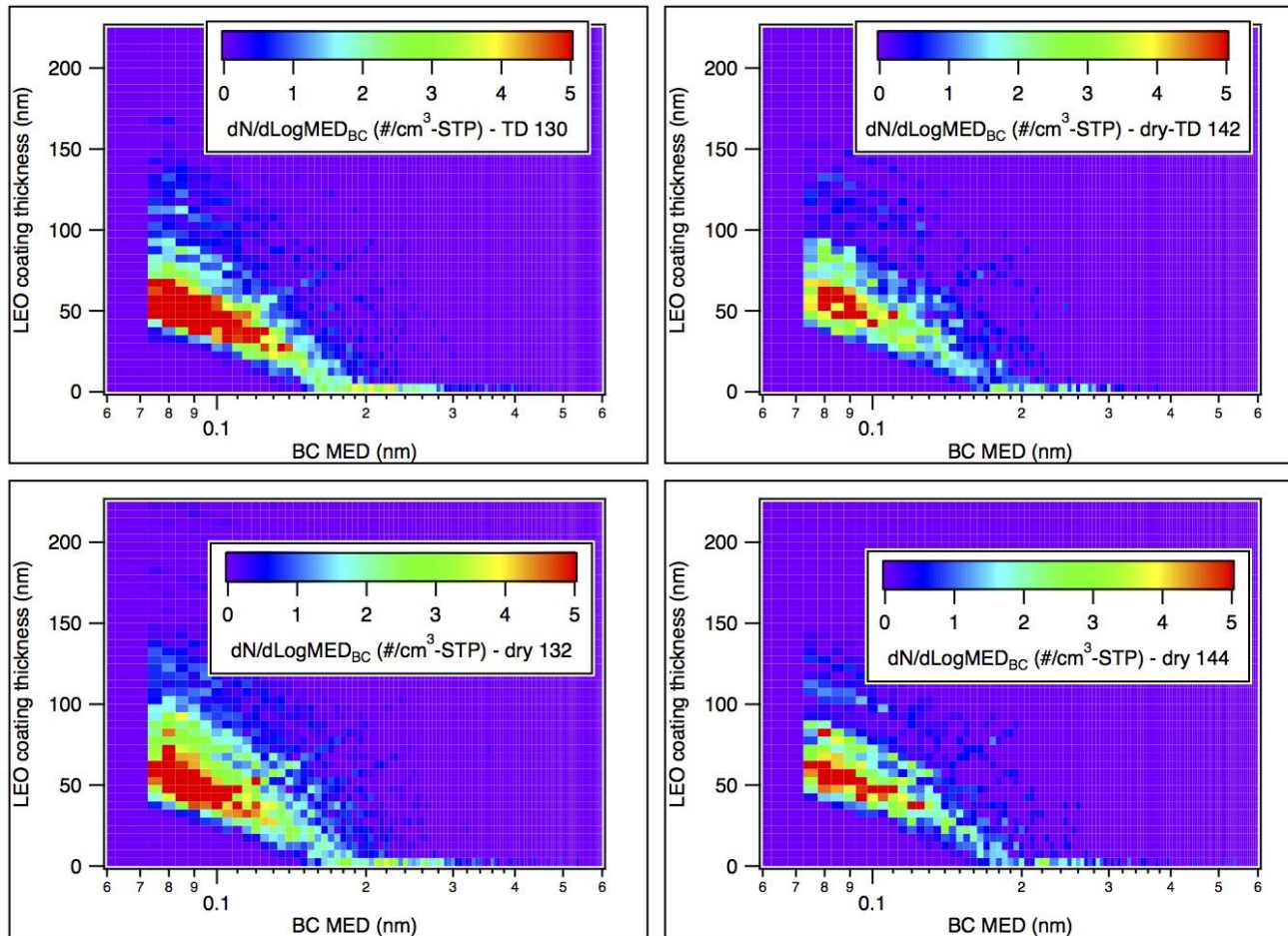


# SP-2 measurements of biomass burning event on 6/4/2013





# Coating thickness from SP-2



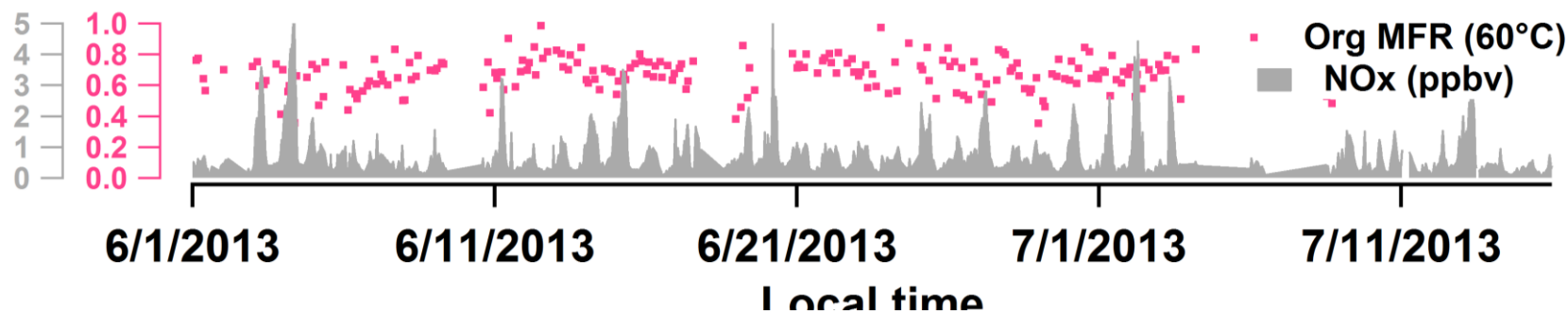
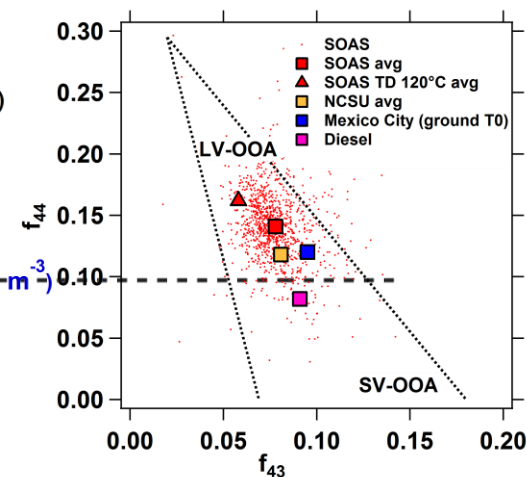
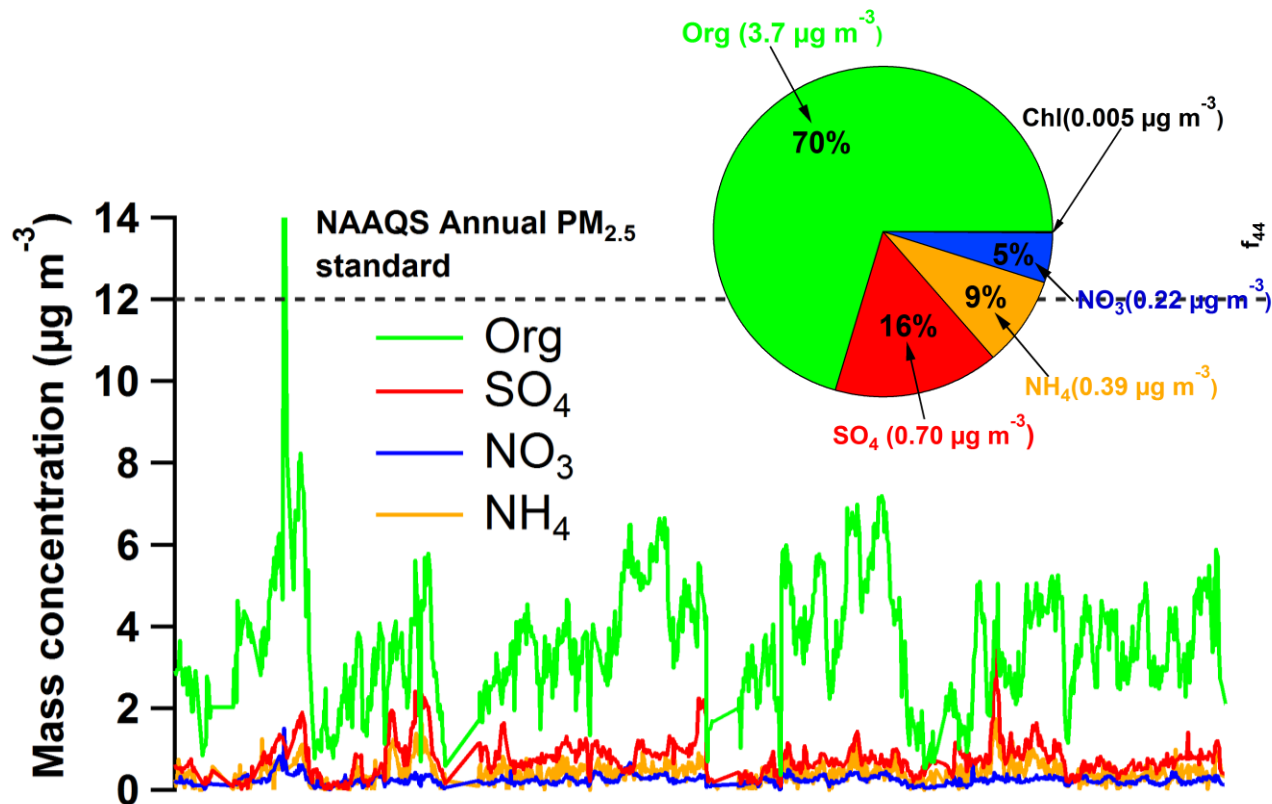
Coating does not seem to evaporate at 180C

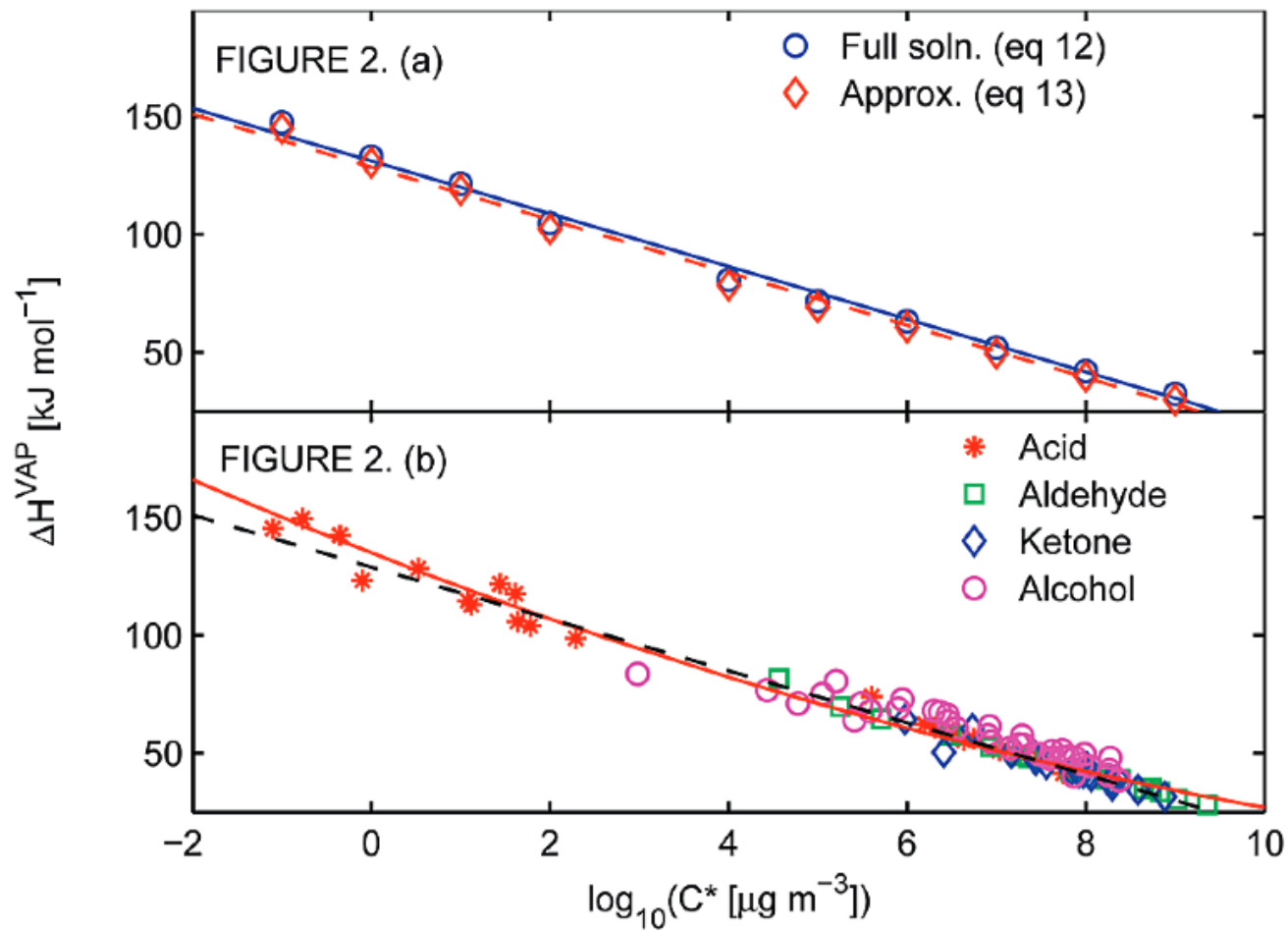
# Conclusions

- Very little kinetic constraints for gas/particle equilibration
- $dH_{\text{vap}} = 80\text{-}130 \text{ KJ mol}^{-1}$ , no or little variation with  $C^*$
- Both temperature and RH have a strong effect on  $B_{\text{scat}}$
- Some evidence of lensing enhancement and/or brown carbon
- Based on Angstrom exponent, very little evidence of brown carbon except for biomass burning episodes
- Preliminary analysis indicates black carbon is coated with very low volatility material (or there are issues with LEO)

# Next steps

- Similar measurements this summer in Duke Forest (near RTP, NC)
- Continue data evaluation





Epstein et. al. EA Semiempirical Correlation between Enthalpy of Vaporization and Saturation Concentration for Organic Aerosol. *Environ. Sci. Technol.* 2010, 44, 743–748

