Field measurements of the impact of the reactive uptake of reduced nitrogen on the hygroscopicity and light absorption of ambient secondary organic aerosol

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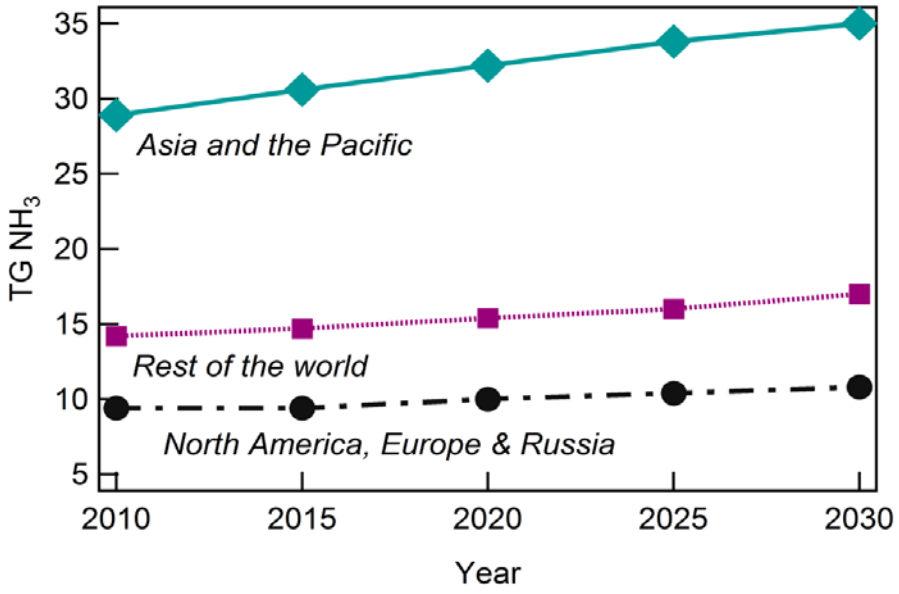
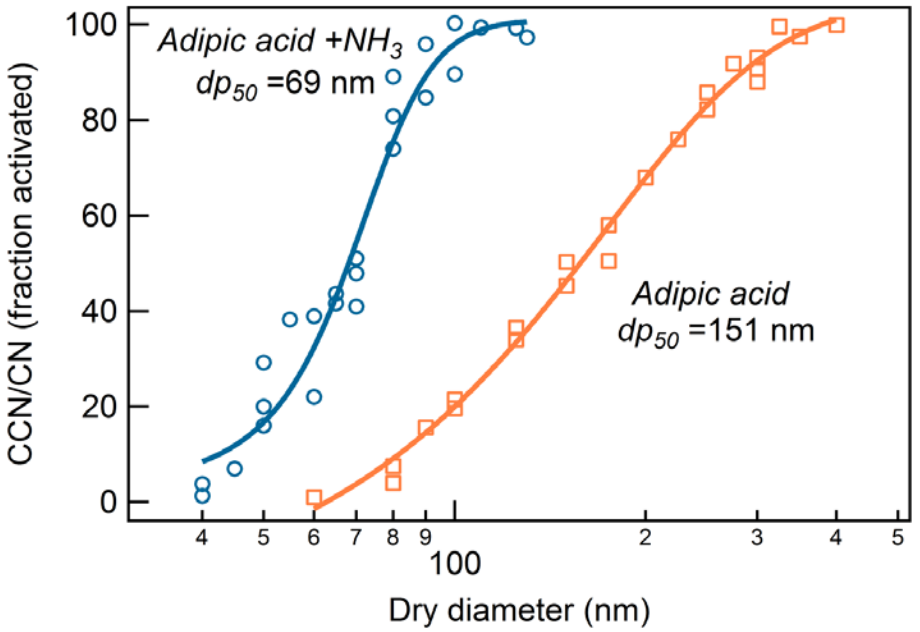
Trends in NH_3 Emissions & Potential Impacts



Ammonia emissions are estimated to increase as use of synthetic fertilizers becomes more popular and per capita meat and dairy consumption increase among developing countries.

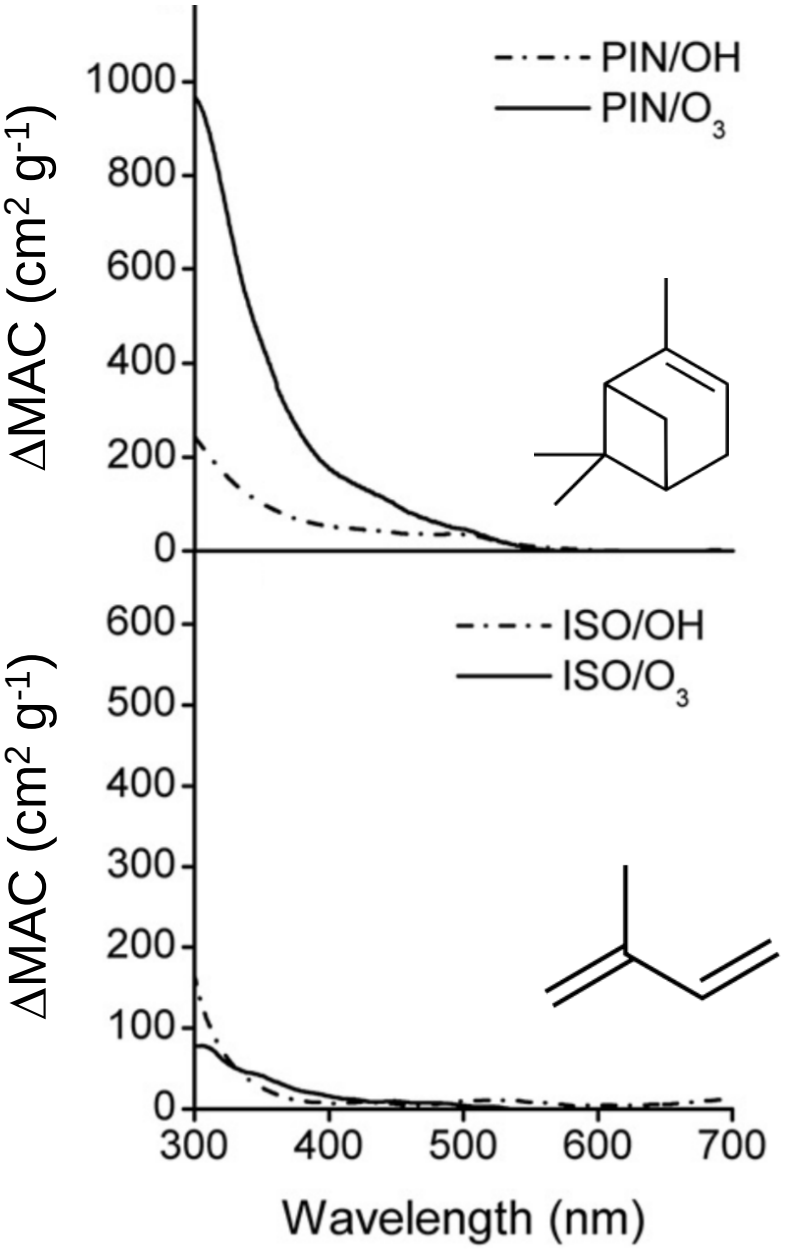
Amann et al., A. Rev. Env. Res. 2013



Multi-phase reactions of NH_3/NH_4^+ have been shown to **enhance** the hygroscopicity of laboratory generated aerosols composed of slightly soluble organic acids *via* the formation of organic acid-derived ammonium salts.

Dinar et al., ES&T 2008

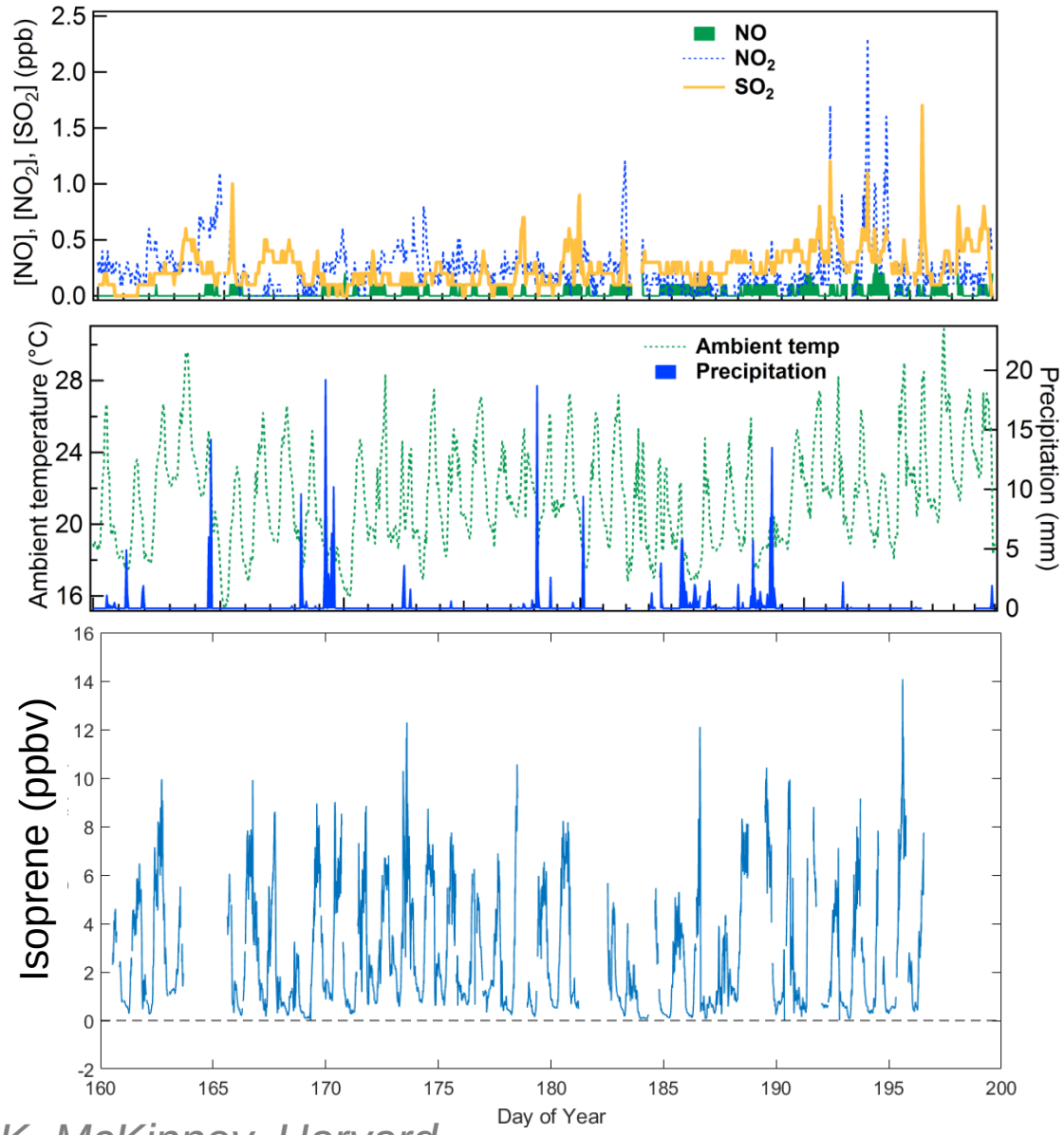
Trends in NH_3 Emissions & Potential Impacts



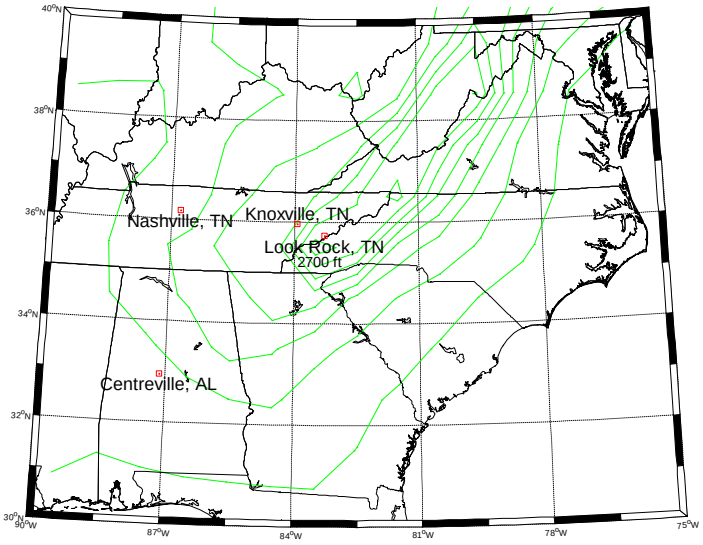
Multi-phase reactions of NH_3/NH_4^+ have been shown to **increase** the mass absorption coefficient (MAC) for secondary organic aerosol *via* the formation of conjugated nitrogen containing species.

Adapted from Updyke et al., Atmos. Env. 2012

June in Look Rock, TN

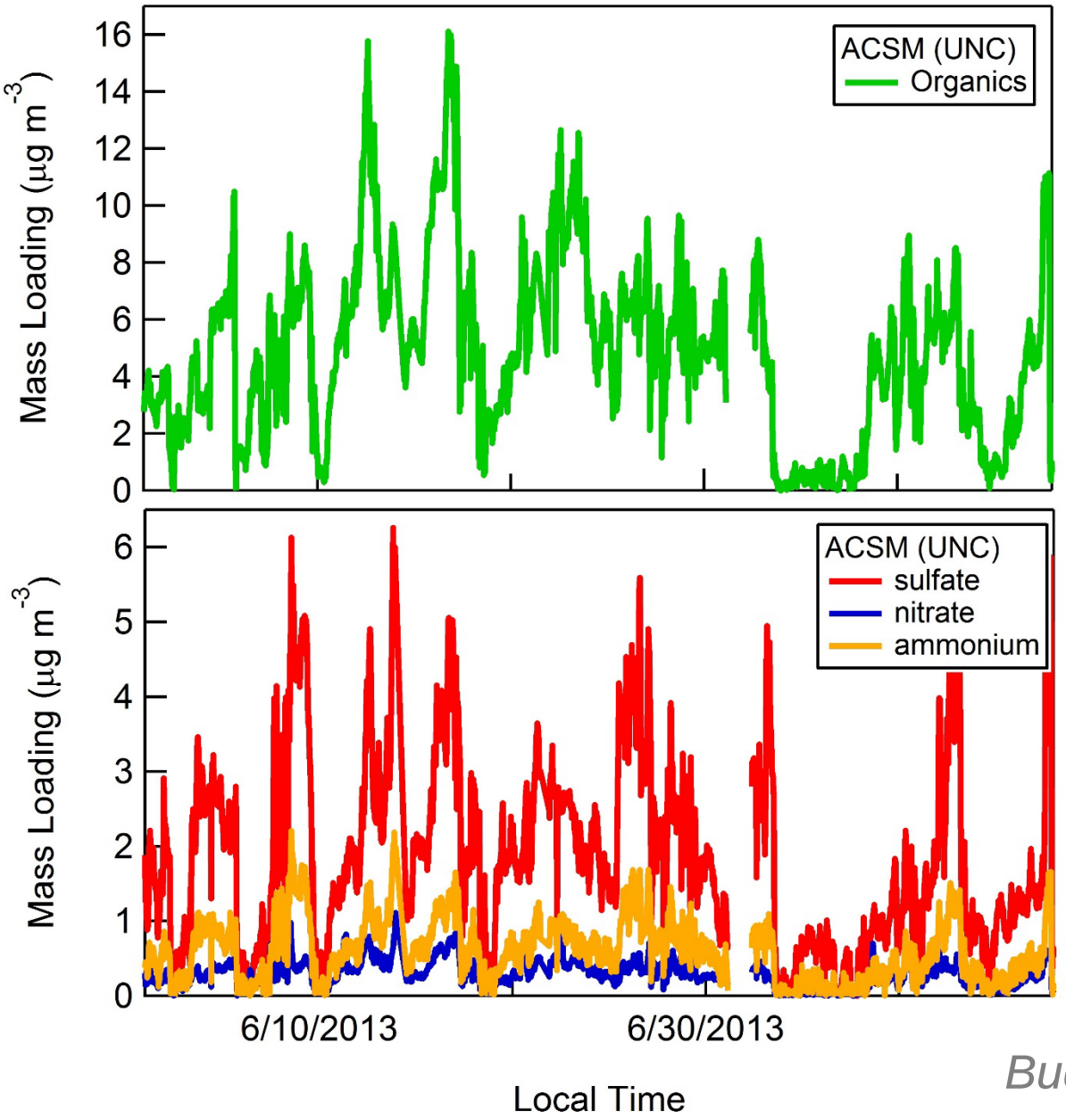


$[NO_x] < 250$ ppt
$[O_3] = 25 – 50$ ppb
$[Isoprene]_{max} = 4\text{-}12$ ppb
$T_{max} = 22\text{-}28$ °C



K. McKinney, Harvard

Particle Chemical Composition



Campaign Averages:

PM_1 = 7.6 ± 4.7 μg m^{-3}

$f_{organic}$ = 0.64

$f_{sulfate}$ = 0.24

$f_{ammonium}$ = 0.08

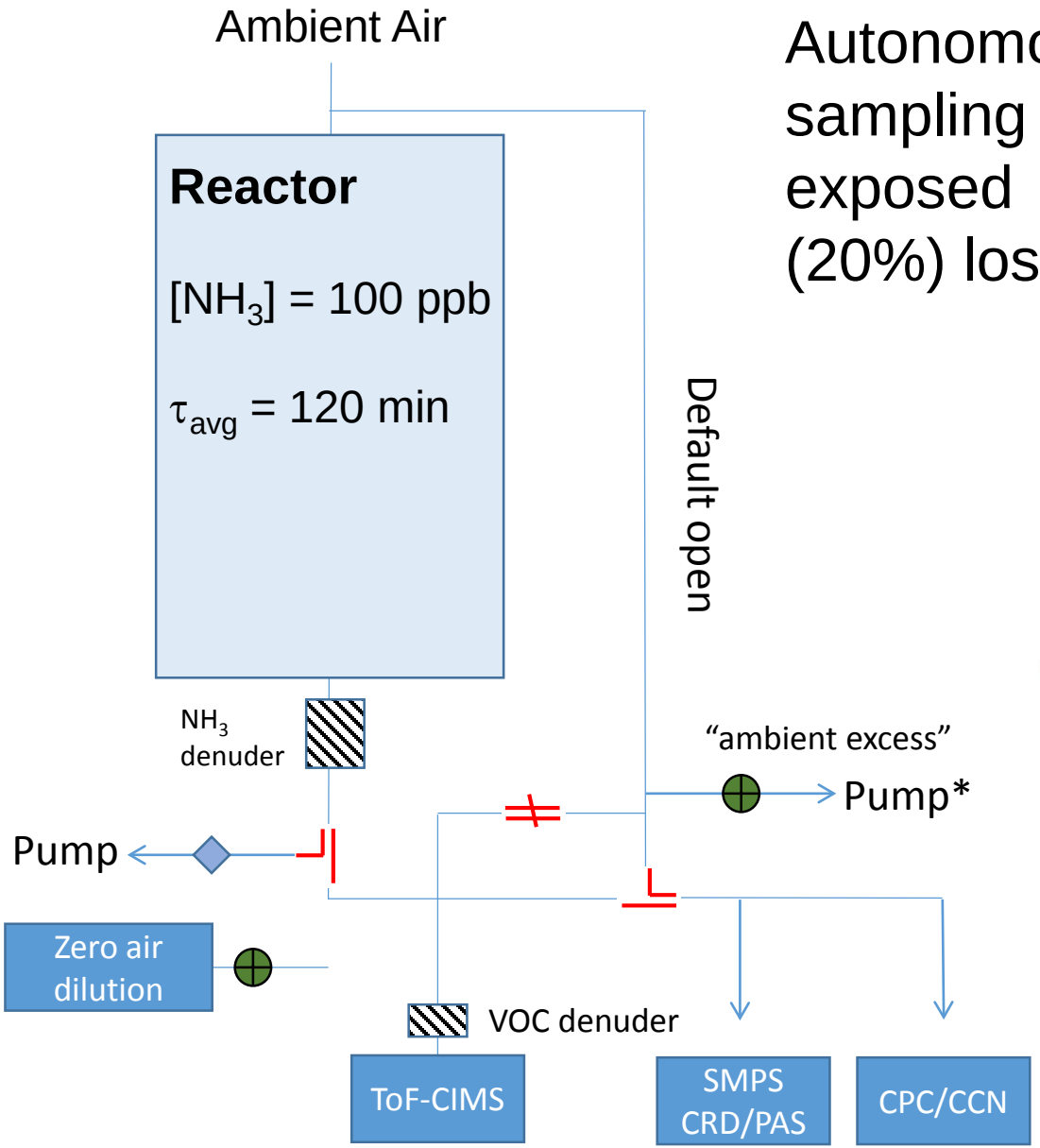
$f_{nitrate}$ = 0.04

O:C = 0.77 ± 0.12

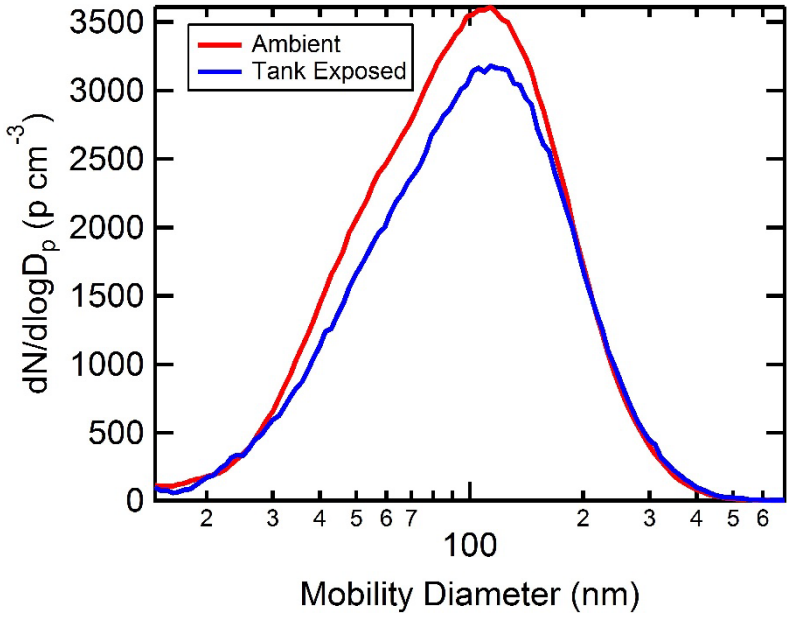
pH = 1.78 ± 0.53

Adapted from Budisulistiorini et al., ACP 2015

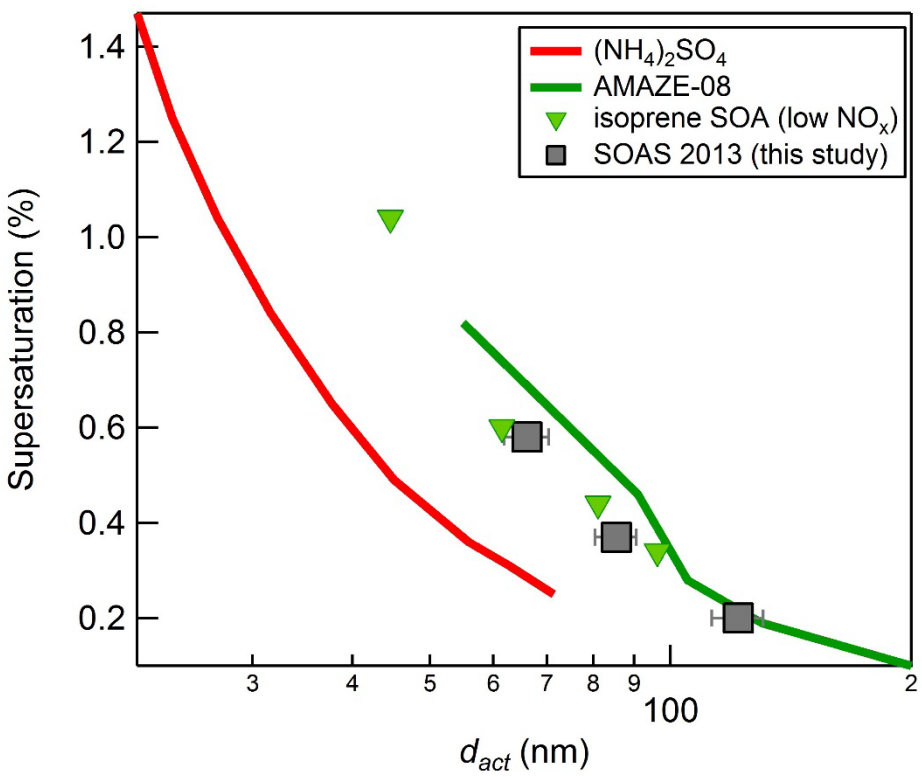
Ammonia Perturbation Experiment

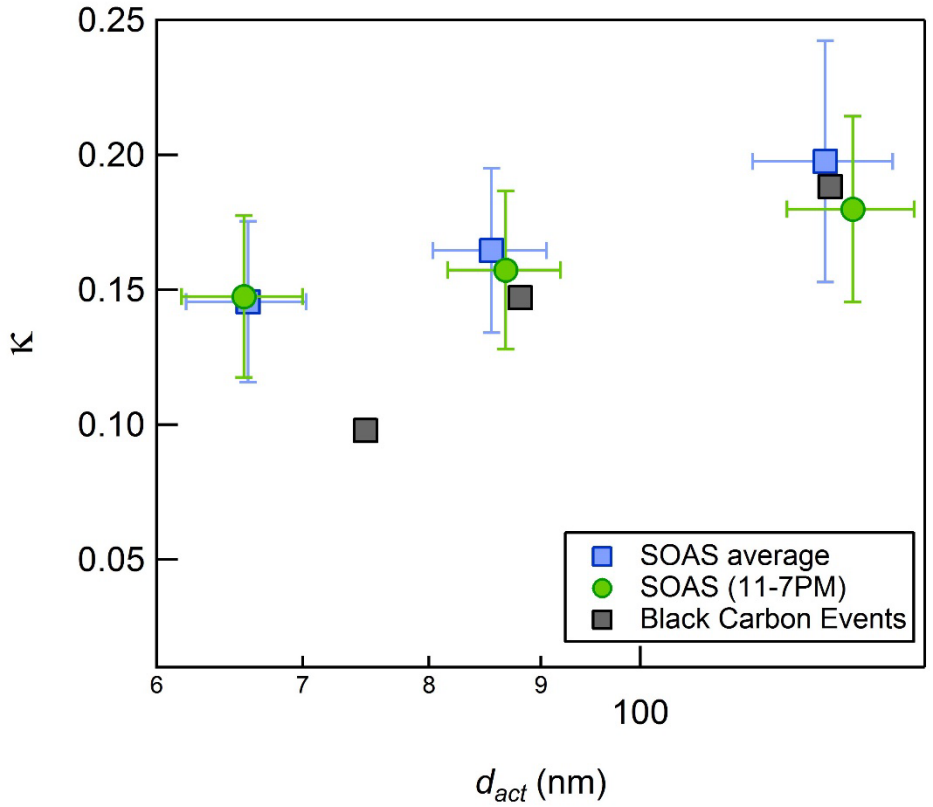


Autonomous duty cycle permits sampling of ambient and NH_3 exposed particles, with measured (20%) loss in particle number.



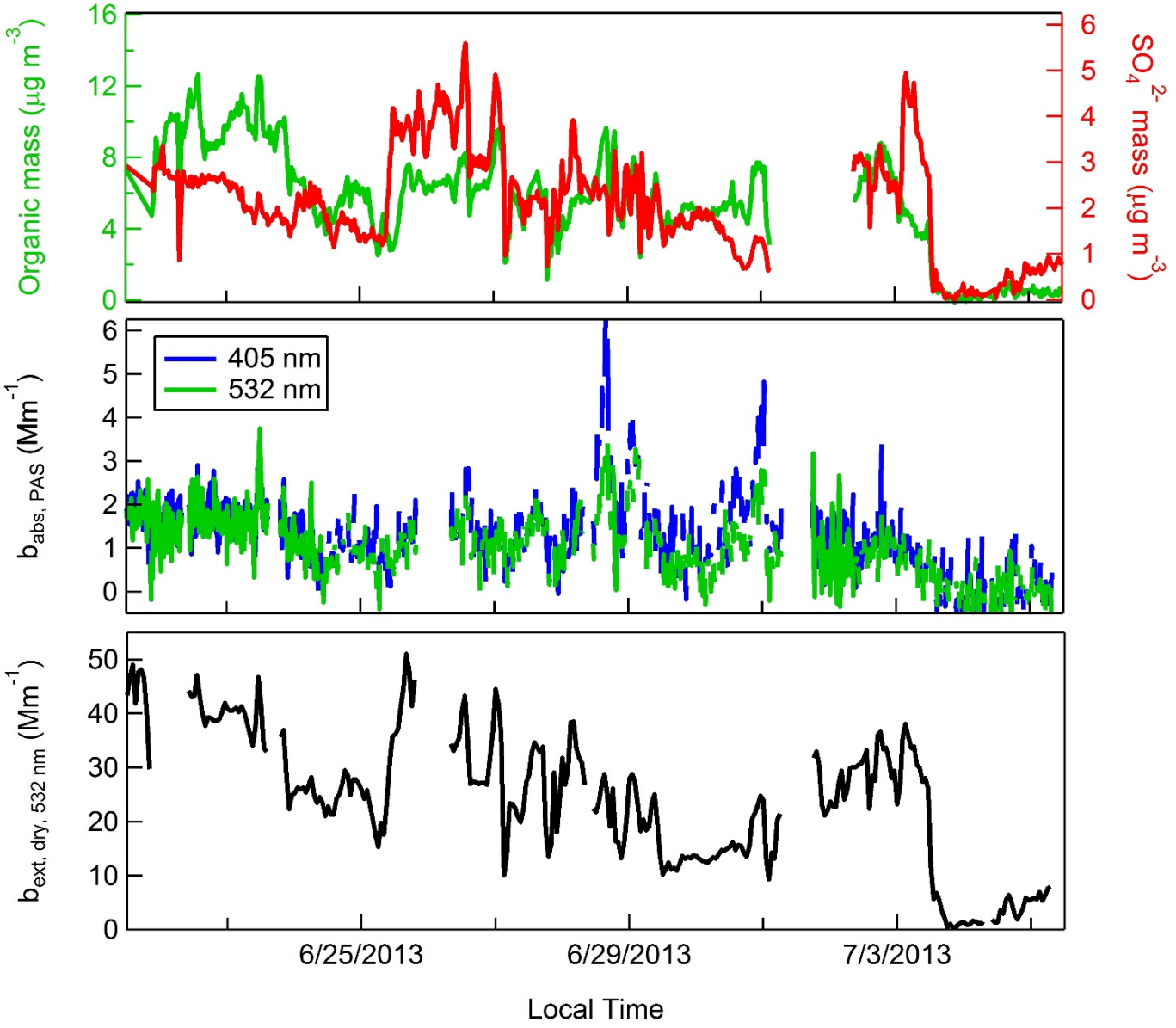
Ambient Particle Hygroscopicity





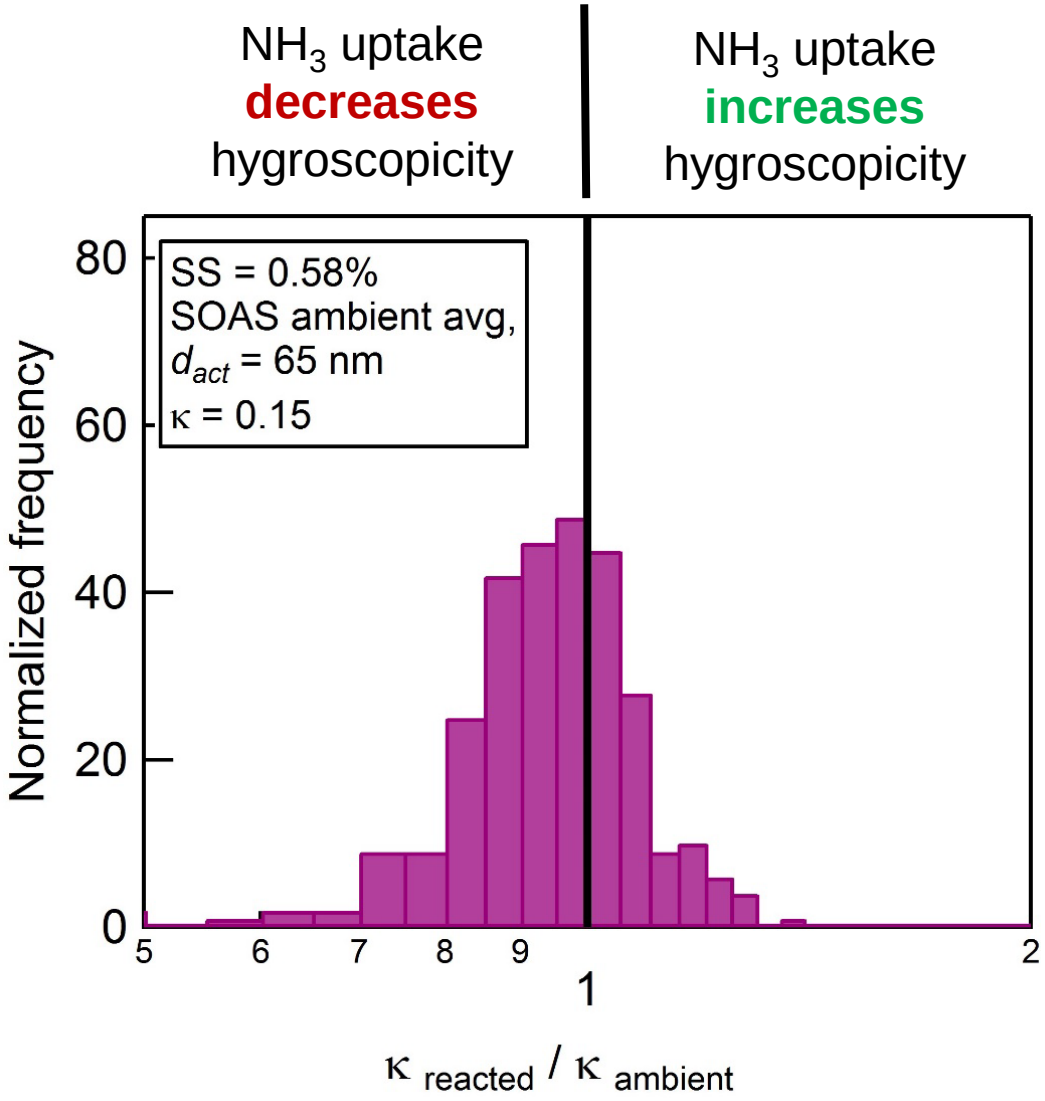
1) Ambient determinations of supersaturated hygroscopicity are in agreement with ambient measurements in regions dominated by isoprene chemistry and chamber determinations.
2) Size-dependent κ values indicate size-dependent organic mass concentrations of aerosols at Look Rock (*more on poster*).

Ambient Light Extinction and Absorption



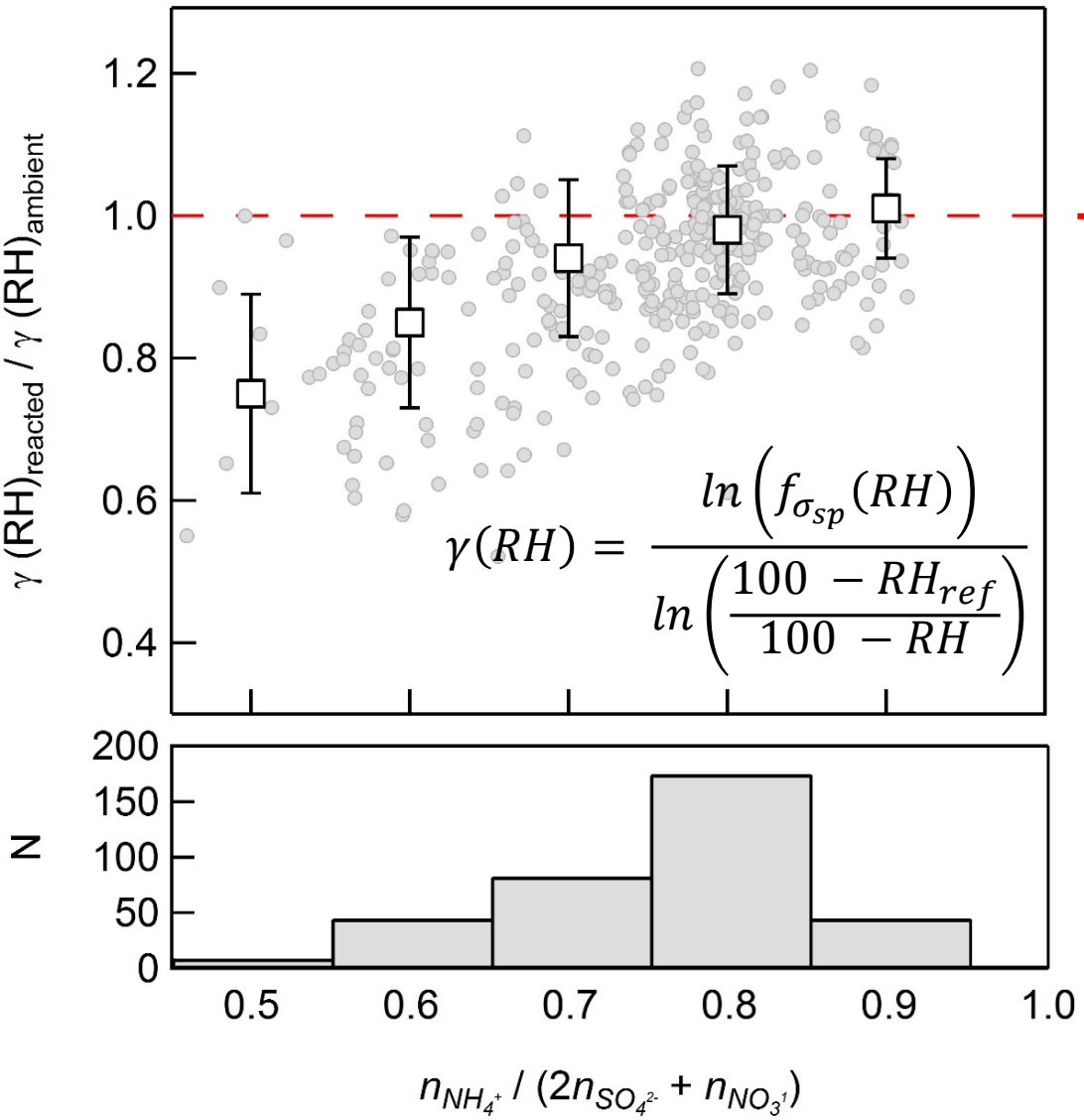
Zhang / Cappa UC Davis

Measured Impact on Hygroscopicity



Particles exposed to NH_3 are **less hygroscopic** than ambient particulates. The net impact on hygroscopicity is small (< 20%).

Measured Impact on Hygroscopicity

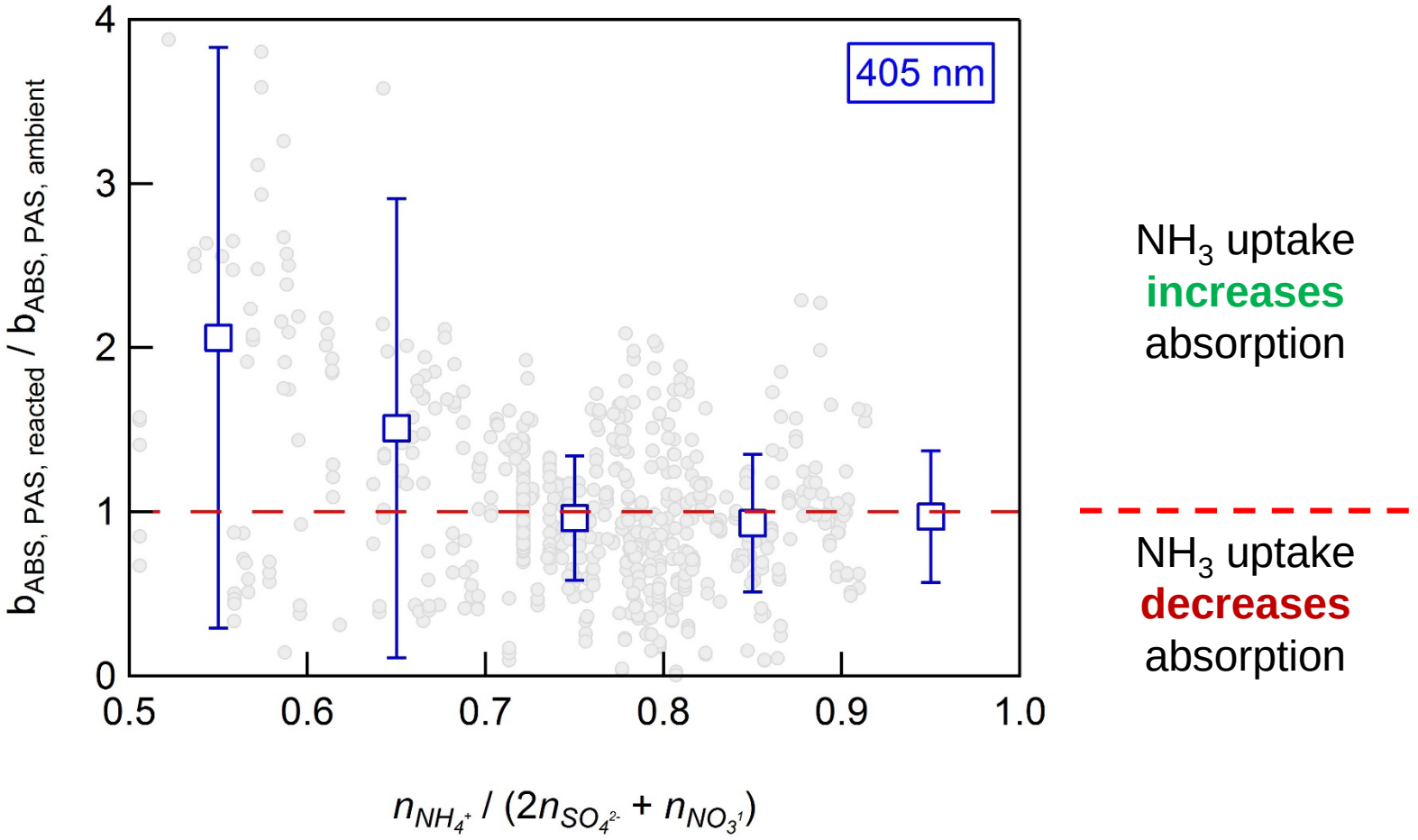


NH_3 uptake **increases** hygroscopicity

NH_3 uptake **decreases** hygroscopicity

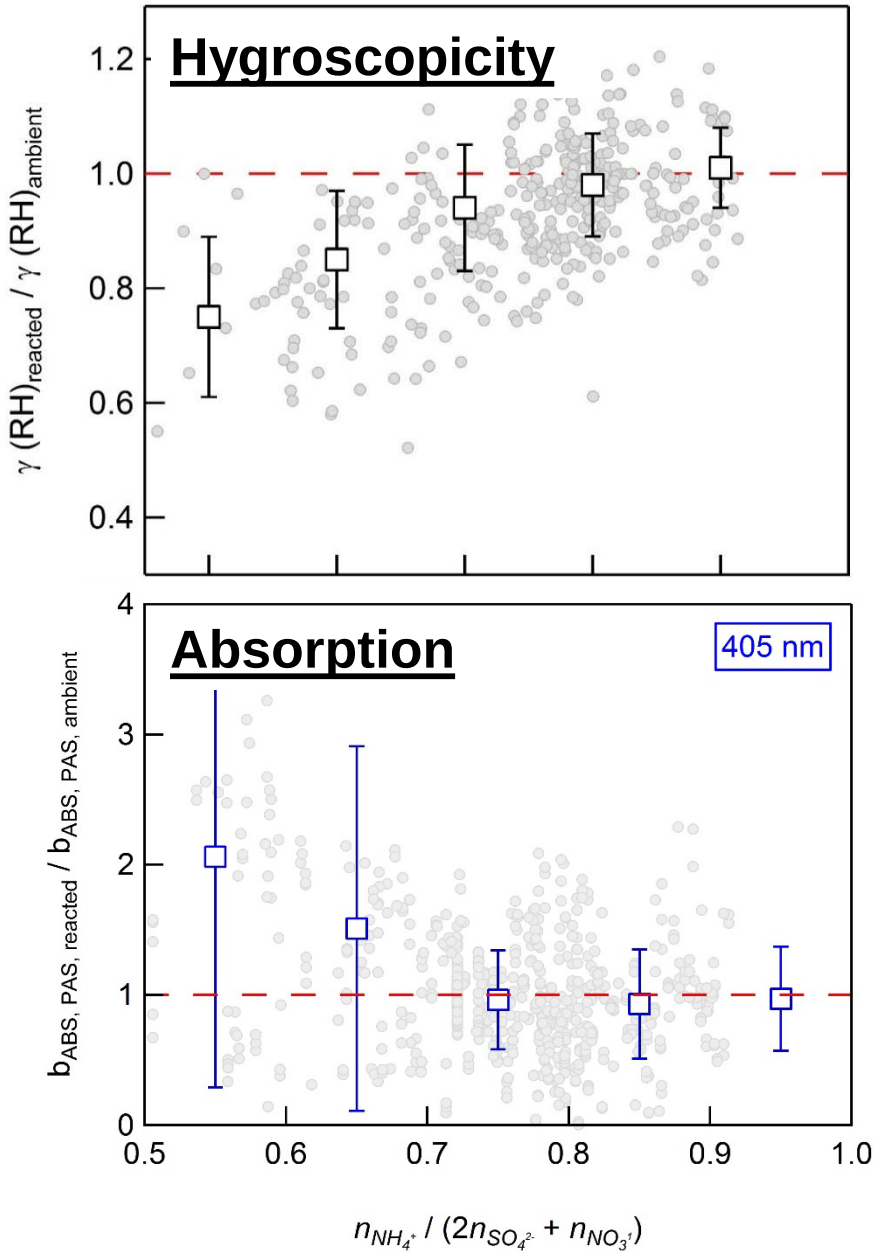
Net NH_3 reactive uptake is observed at low ratios of NH_4^+ / (SO_4^{2-} + NO_3^-) leading to a decrease in particle hygroscopicity.

Measured Impact on Light Absorption



Net NH_3 reactive uptake is observed at low ratios of NH_4^+ / (SO_4^{2-} + NO_3^-) leading to a increase in absorption at 405nm and has no effect on absorption at 532nm.

Conclusions and Acknowledgements



Conclusions:

Net NH_3 uptake is observed at low ratios NH_4^+ / (SO_4^{2-} + NO_3^-) leading to a measureable:

Decrease in hygroscopicity

Increase in absorption at 405 nm

Acknowledgements:

Katy Zimmermann, Xiaolu Zhang, Lynn Russell, Jason Surratt, Karena McKinney, Chris Cappa.

ASR Atmospheric System Research

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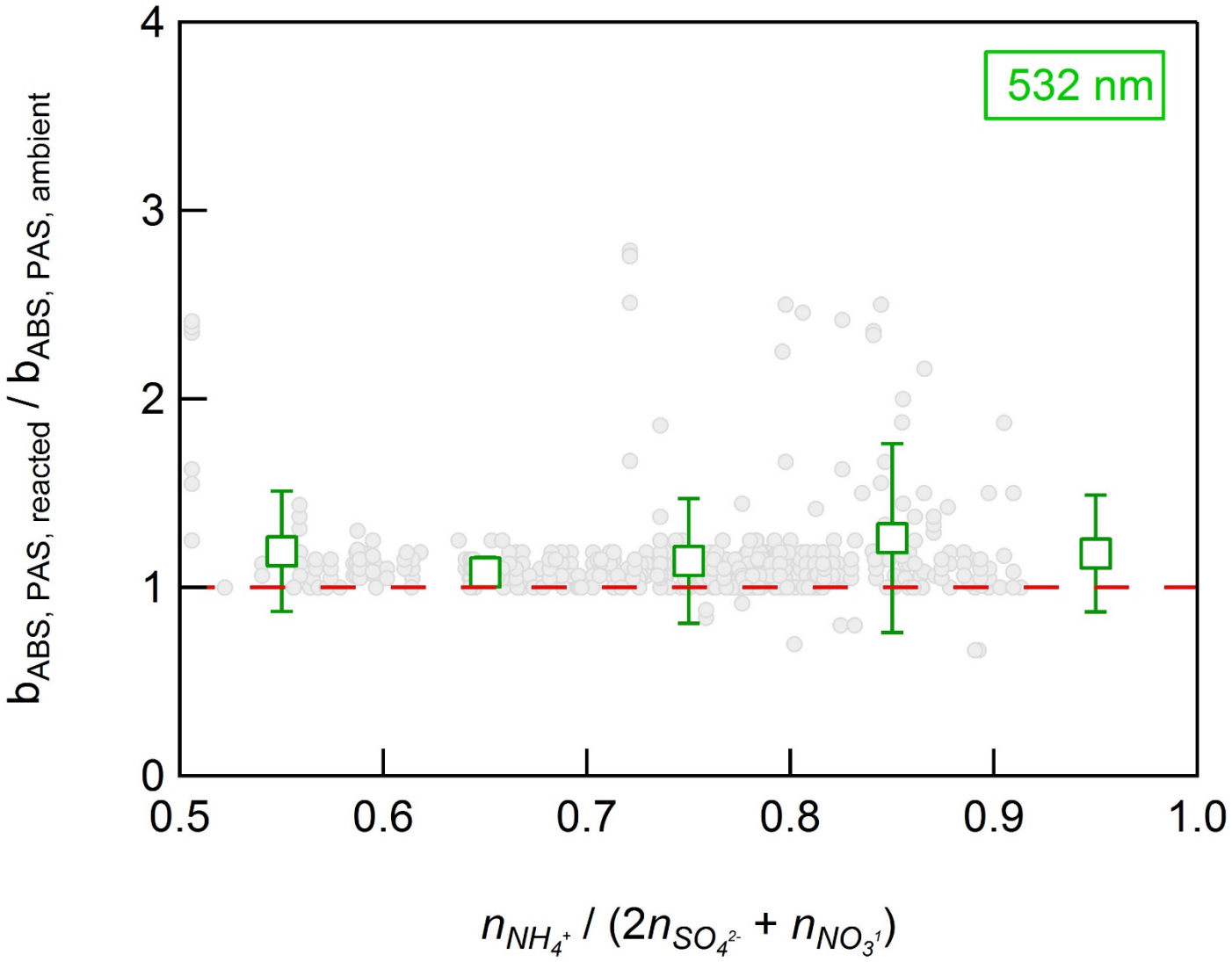
Extra Slides



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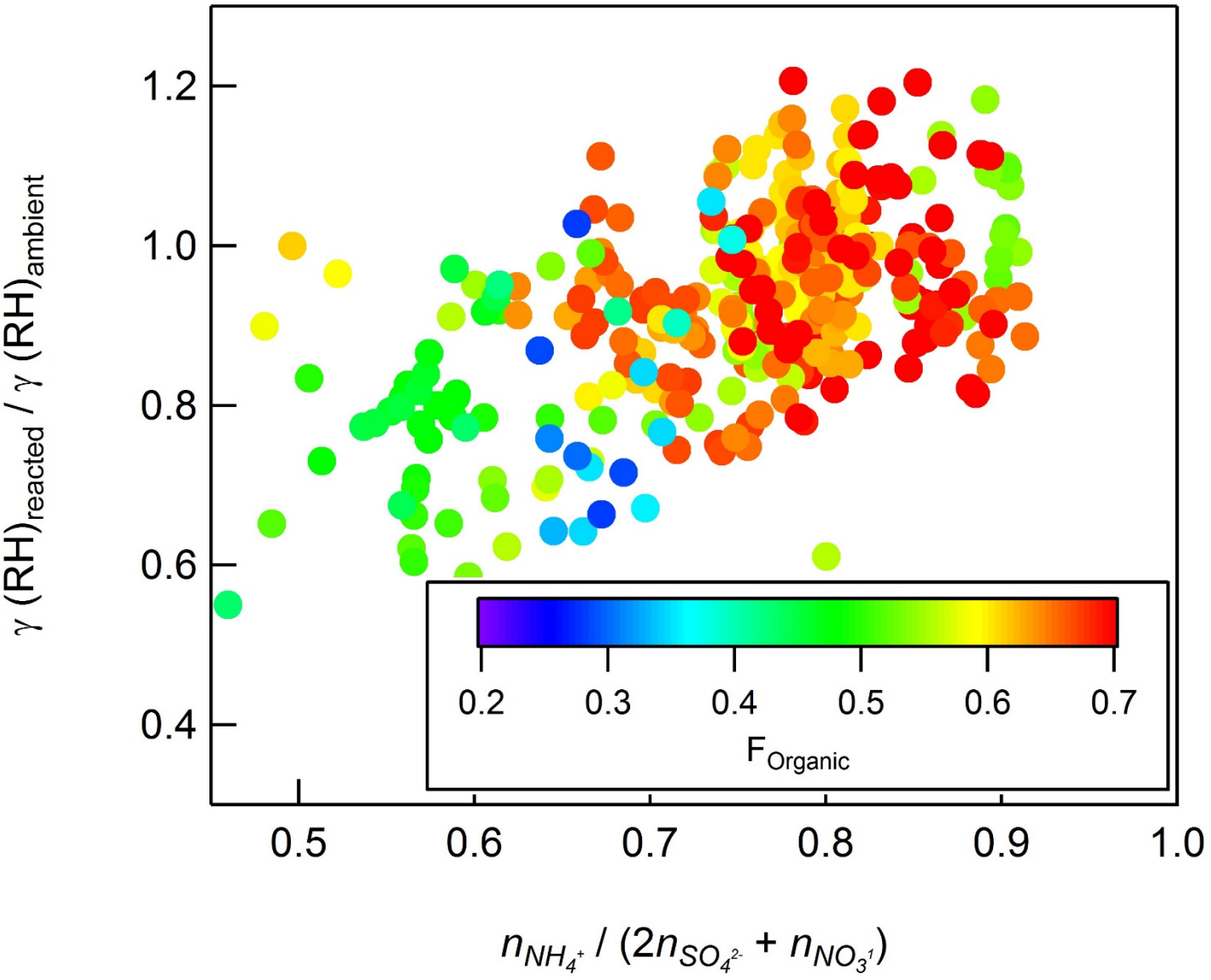

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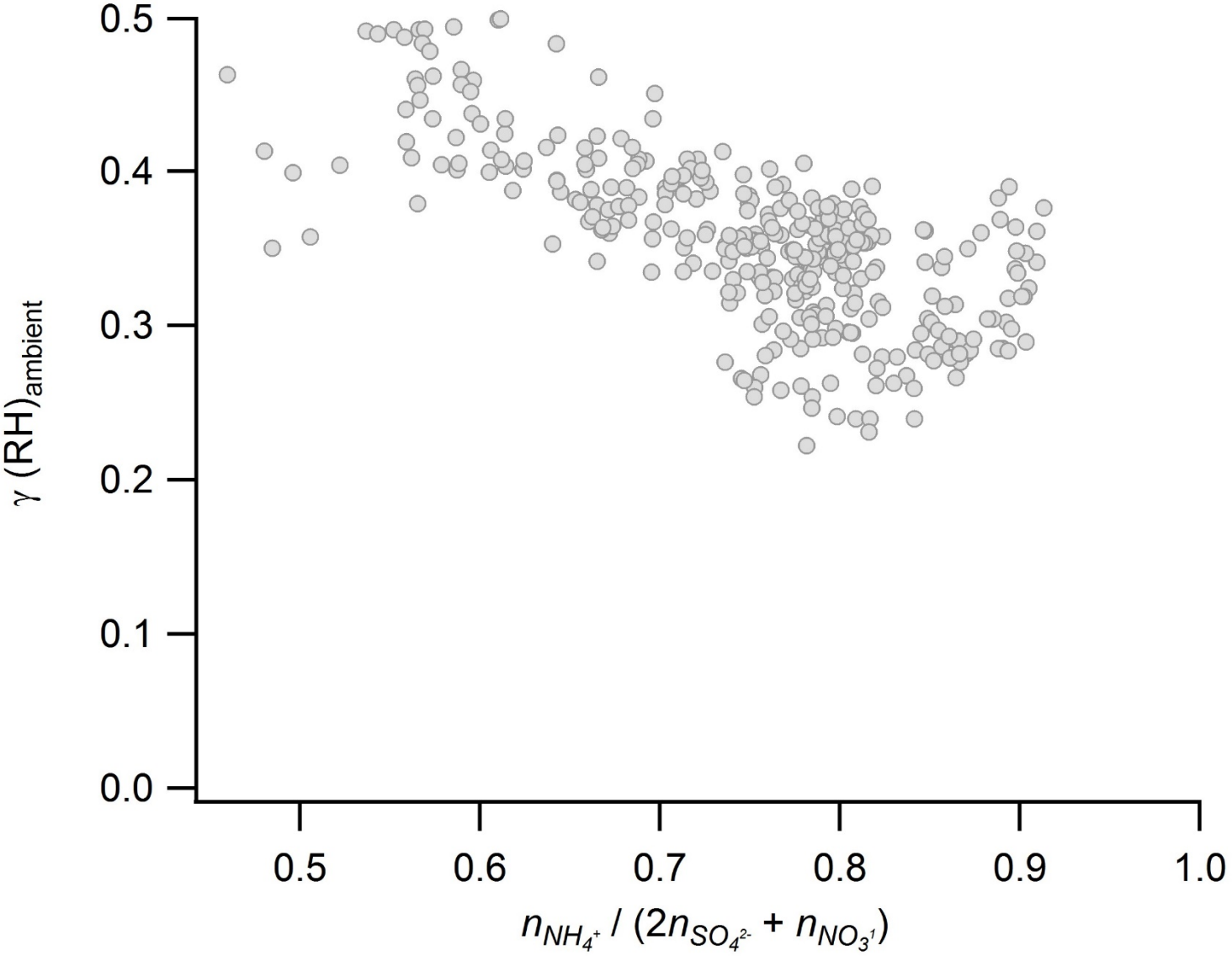

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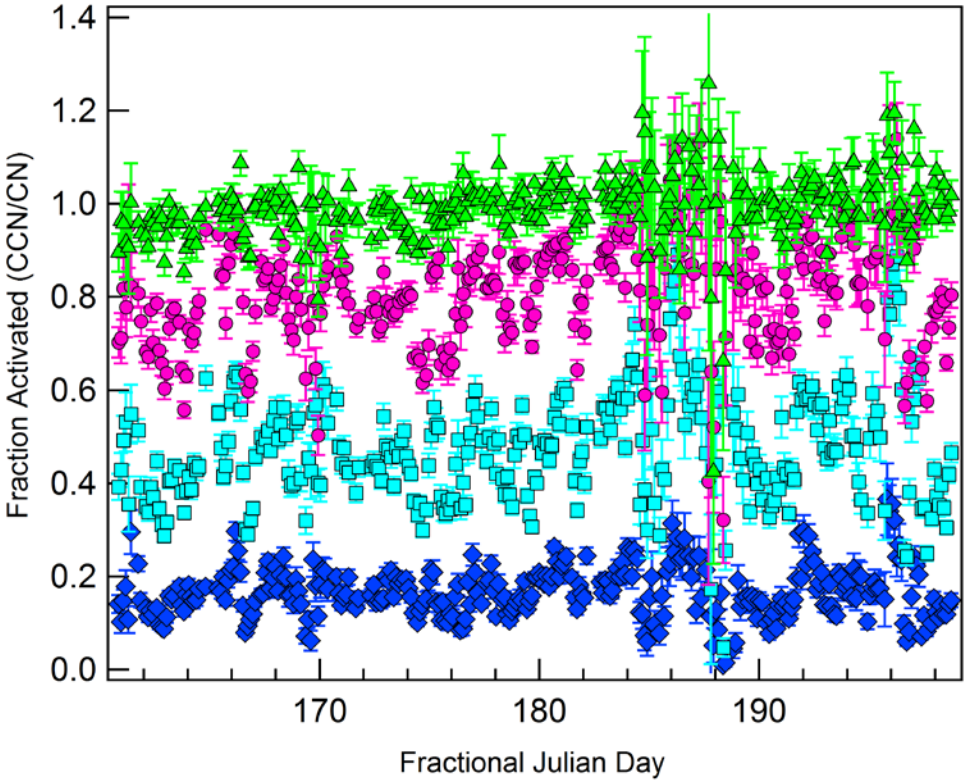

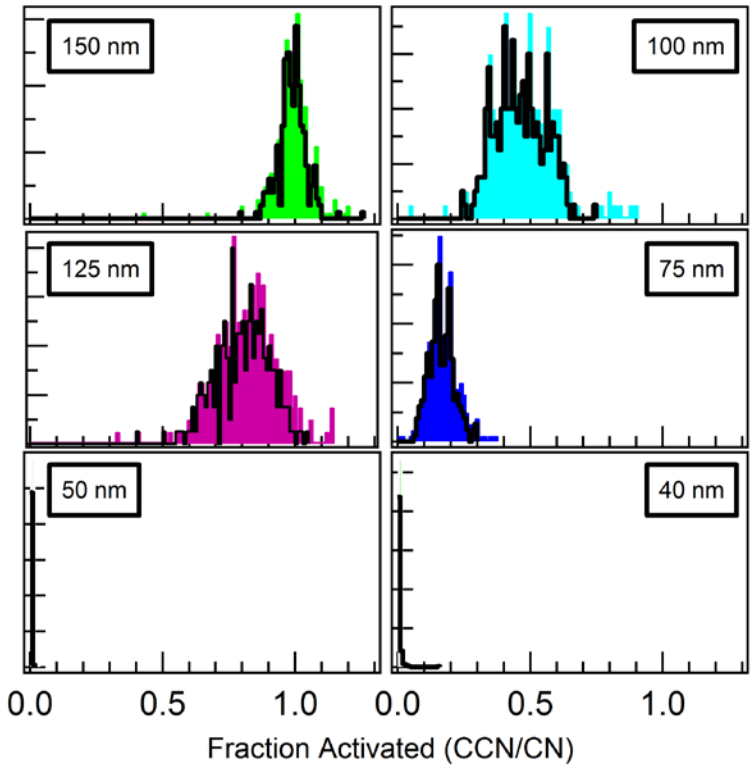

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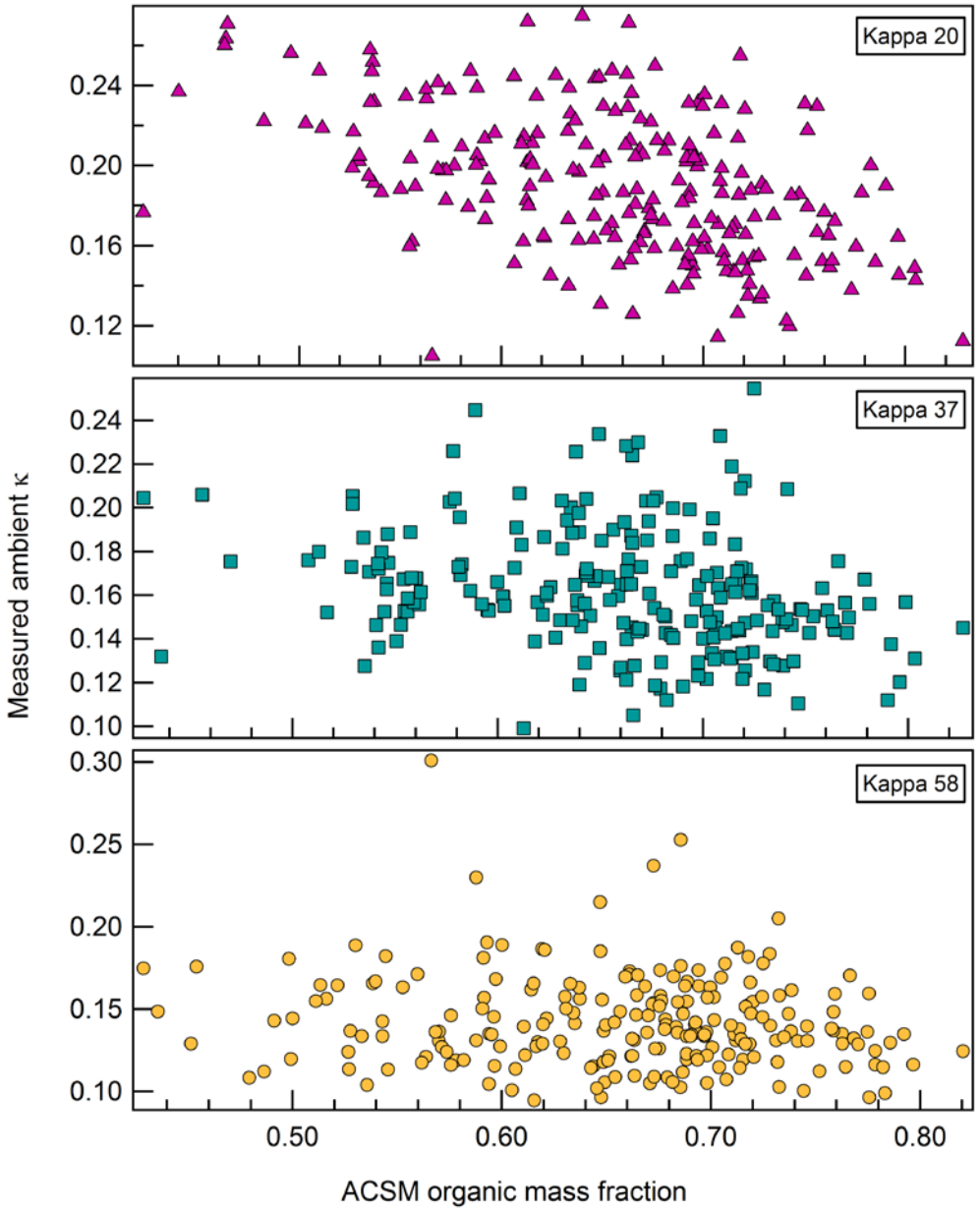

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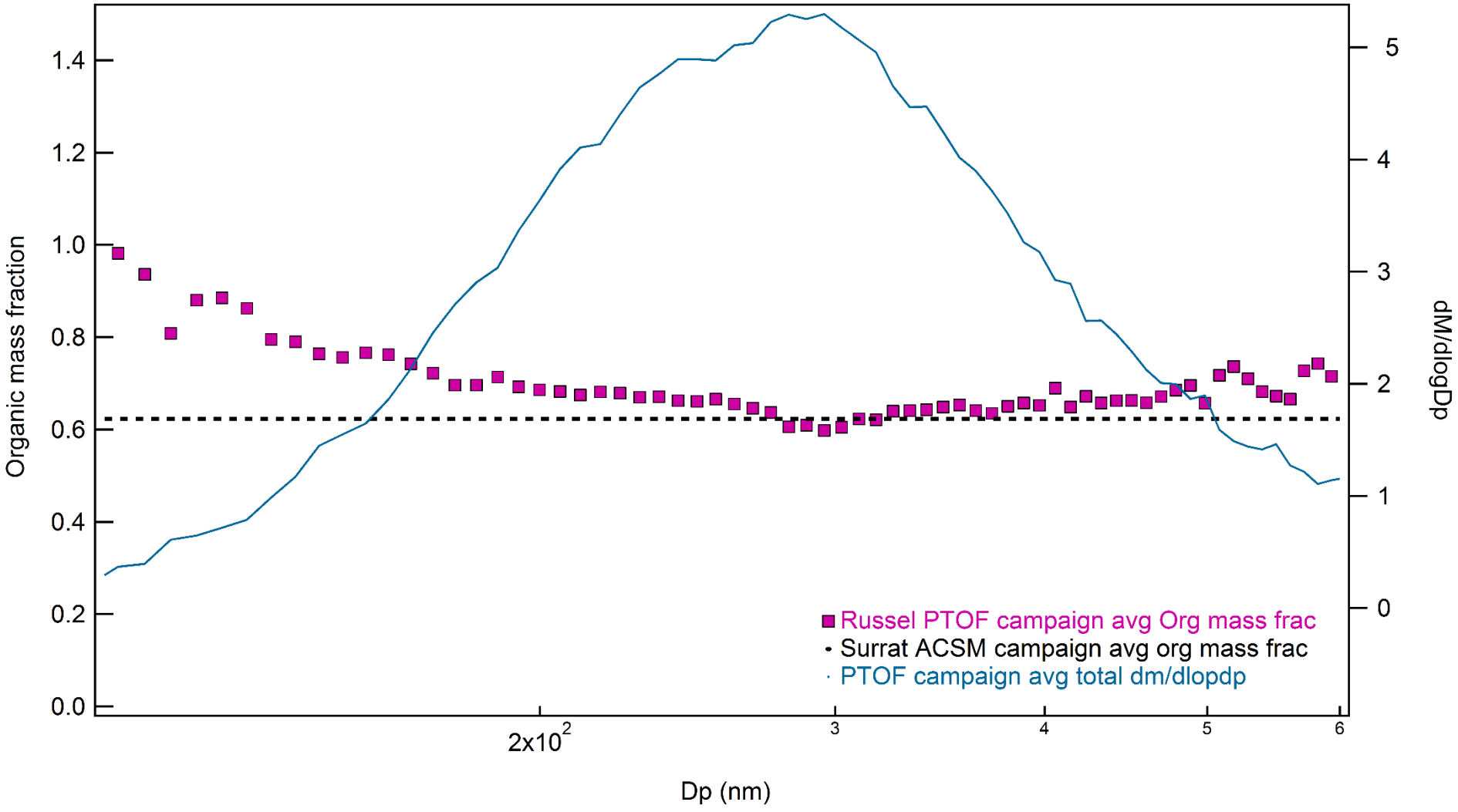

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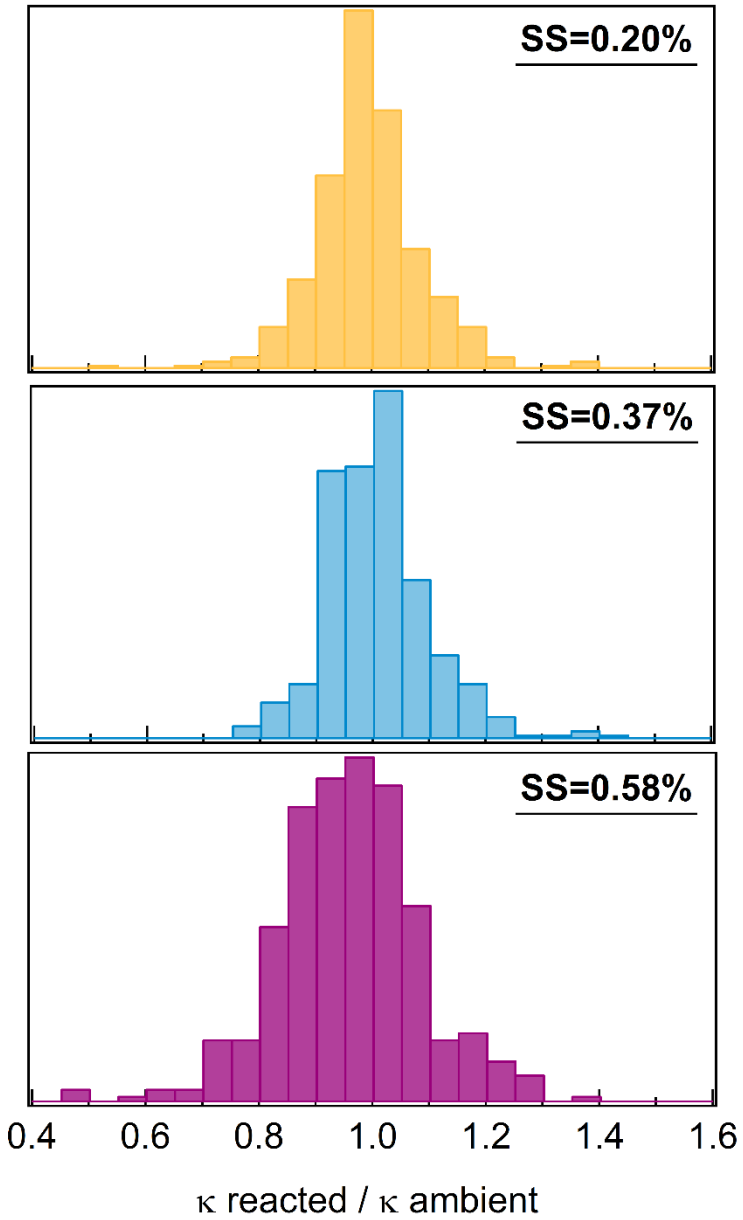

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