

9: Humidity effects on black carbon and brown carbon light absorption: Laboratory and TRACER studies

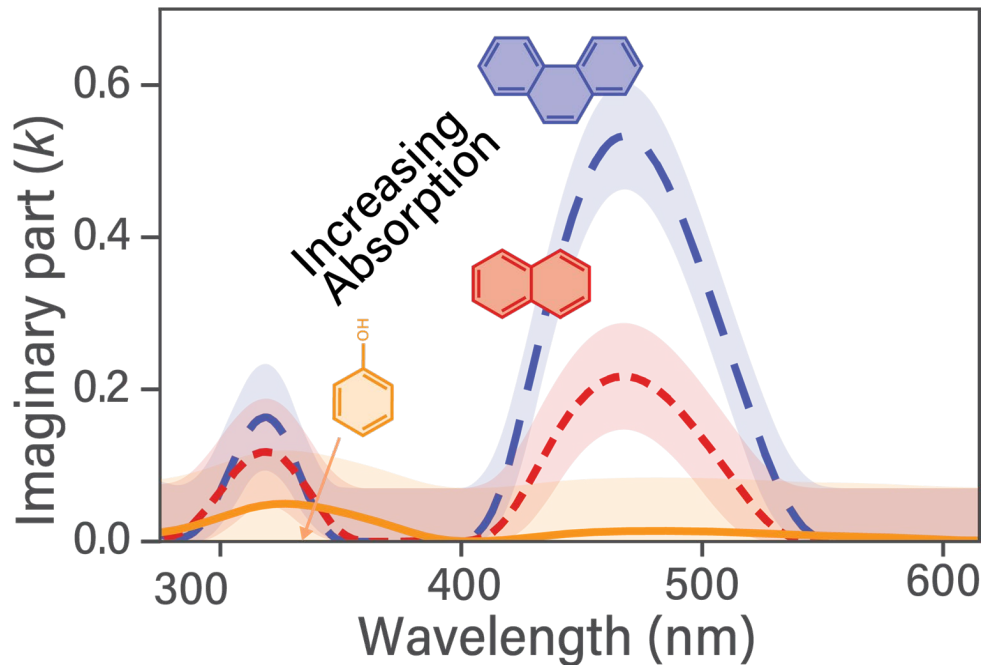
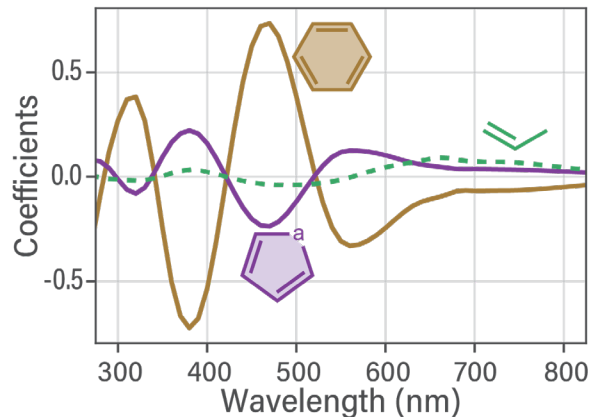
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2022 Joint Atmospheric Radiation Measurement (ARM) User
Facility/Atmospheric System Research (ASR) Principal
Investigators (PI) Meeting



Predictive optical modeling

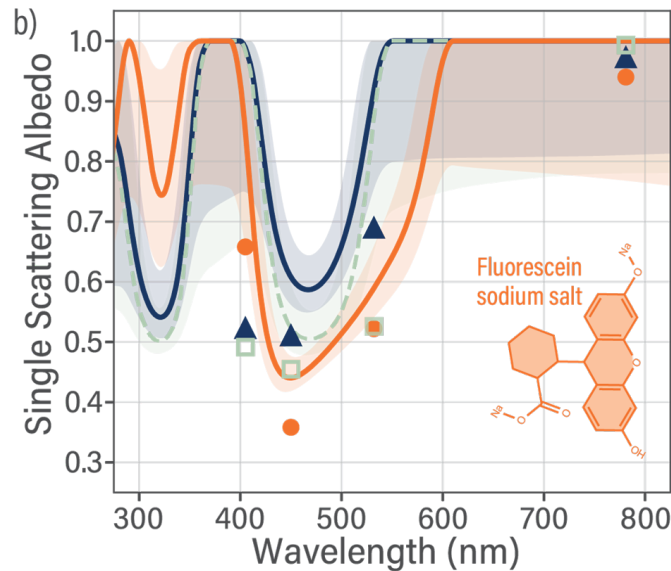
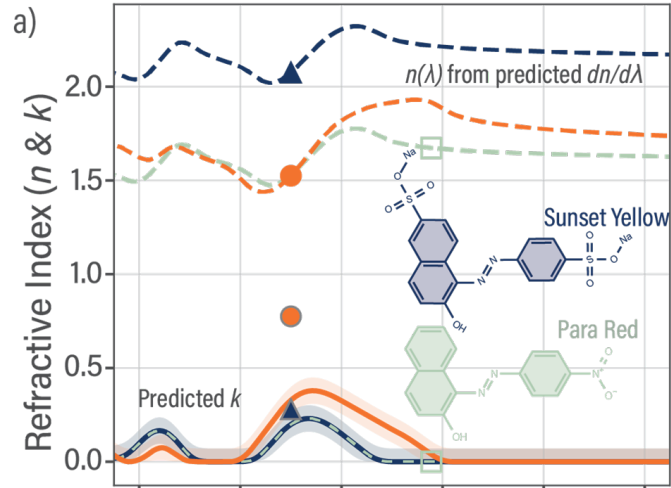
- Predicting the complex part of the refractive index, $n(\lambda) + k(\lambda)j$.
- Group contribution model based on molecular structures.
- Multivariate linear regression of $k(\lambda)$.



Gorkowski, K., Benedict, K. B., Carrico, C. M., & Dubey, M. K. (2022). Complexities in Modeling Organic Aerosol Light Absorption. *The Journal of Physical Chemistry A*, 126(29), 4827–4833. <https://doi.org/10.1021/acs.jpca.2c02236>

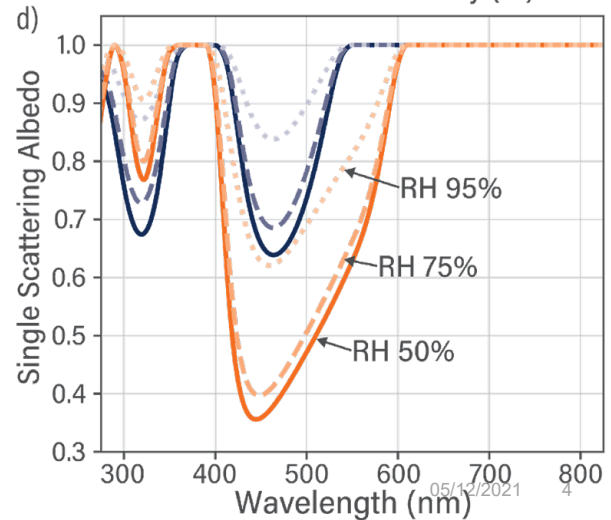
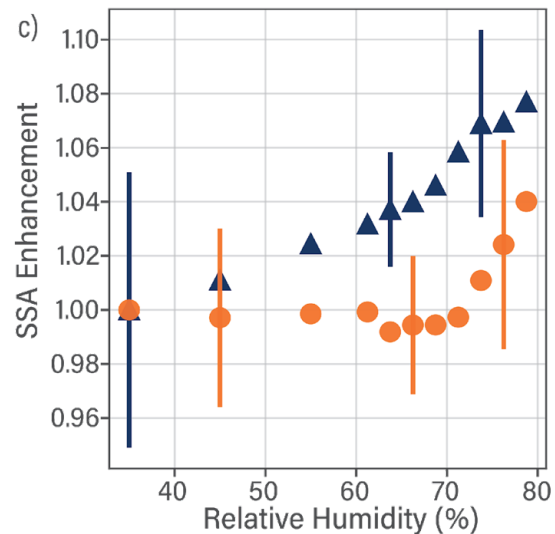
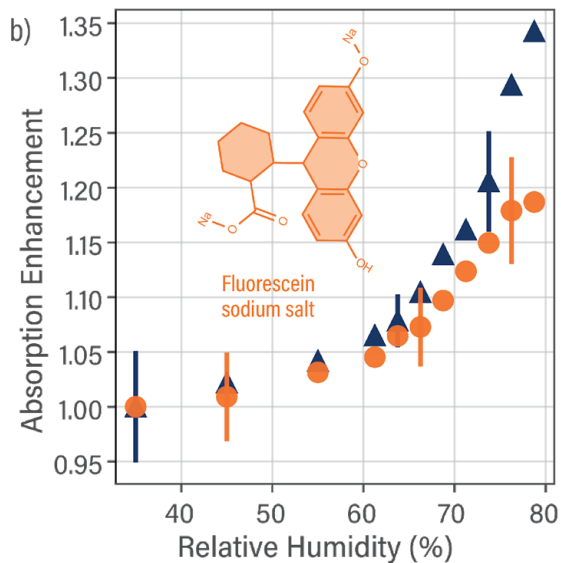
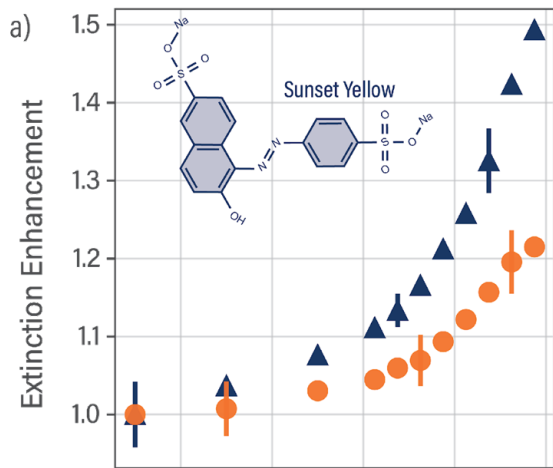
Model Validated with Novel Organic Dyes Measurements

- Validation using three dyes not used in the fitting of the coefficients.
- a) Predicted spectra for each dye with $n(\lambda_{\text{ref}=450 \text{ nm}})$ from optical closure.
- b) Single Scattering Albedo (scattering/extension light) measured and modeled spectrum.
- We predicted the spectrum dependence well, but with room to improve the magnitude.



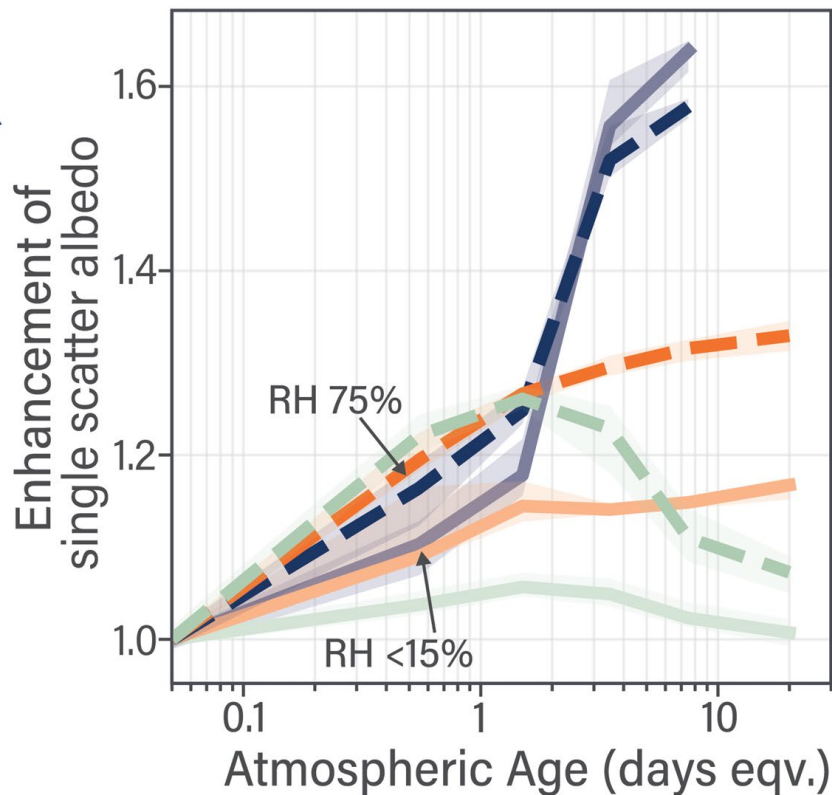
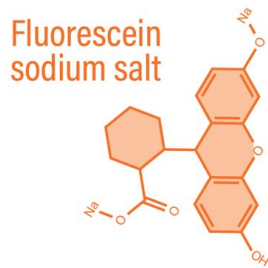
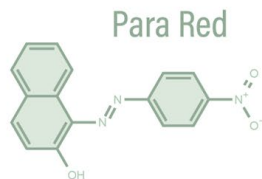
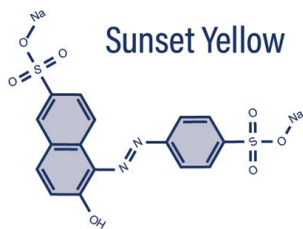
Enhancements with Humidity

- The albedo enhancement increases with humidity, but not always.
 - Due to the interplay of particle size, mixing of refractive index (water + dye).
- This is important for radiative forcing.
 - **Fluorescein Salt**, shows a flat humidity dependence until RH of 75%.



Aging (OH & O3) can increase hygroscopicity

- The increased oxidation state of the dye should increase hygroscopicity.
- This effect is strongest for the more hydrophobic Para Red.
- Fluorescein sodium salt is in the middle with a
 - $\kappa_{HGF} = 0.12 \pm 0.02$.
- Sunset Yellow has a
 - $\kappa_{HGF} = 0.17 \pm 0.02$.



Application to ambient data collected at TRACER-CAT

- We are working on the TRACER-CAT analysis, to match the hygroscopicity and optical measurements.
 - Humidified CAPS (450 nm) & CCNc
- Then using our refractive index model to predict the optical properties at other measured wavelengths (405, 650, 870 nm)

