Spectro-microscopic Characterization of Physical Properties in Individual Atmospheric Particles

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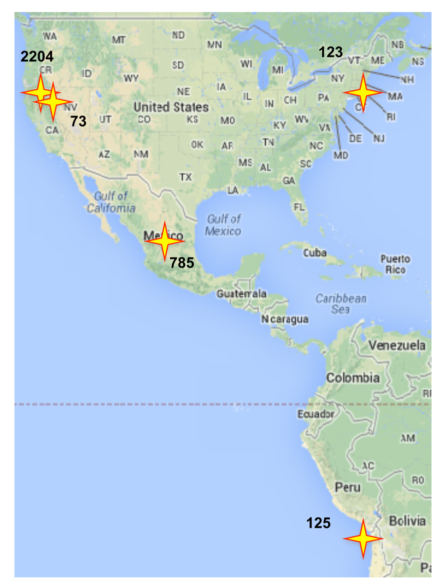
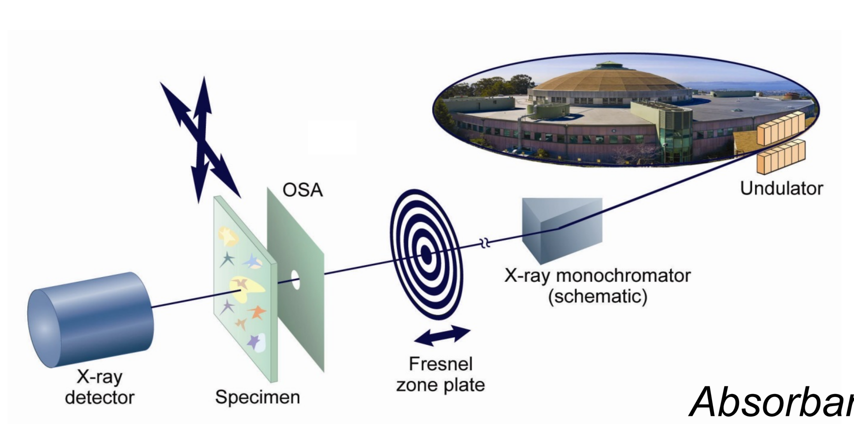
Introduction

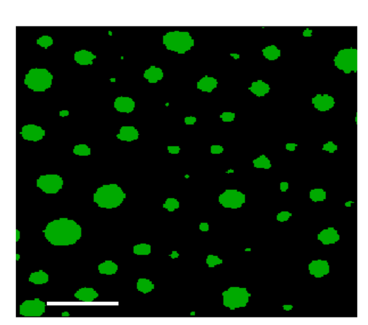
- Physical properties of atmospheric aerosols affect their hygroscopicity, ice nucleation ability, the rate of and types of chemical reactions, etc.
- Recent work has shown that organic aerosols can exist as glassy particles under certain atmospheric conditions.[1-5]
- Here, we investigate the viscosity/surface tension of ambient particles from five field campaigns and compare their physical properties to aerosol particles generated in the laboratory under different conditions.



Methods

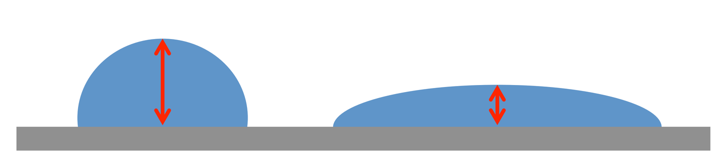
STXM/NEXAFS





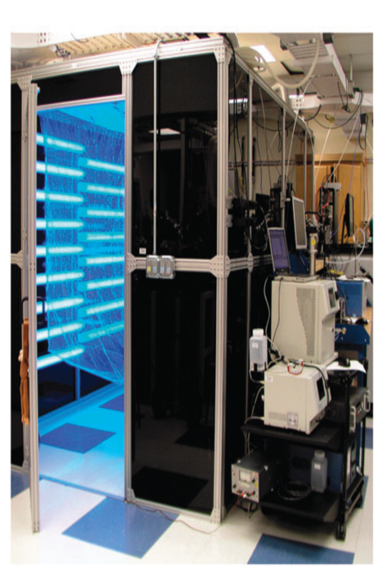
$$Absorbance(OD) = \ln\left(\frac{I_0}{I}\right) \approx \mu(E)\cdot\rho\cdot d$$

Upon impaction:



Particles with higher viscosity deform less

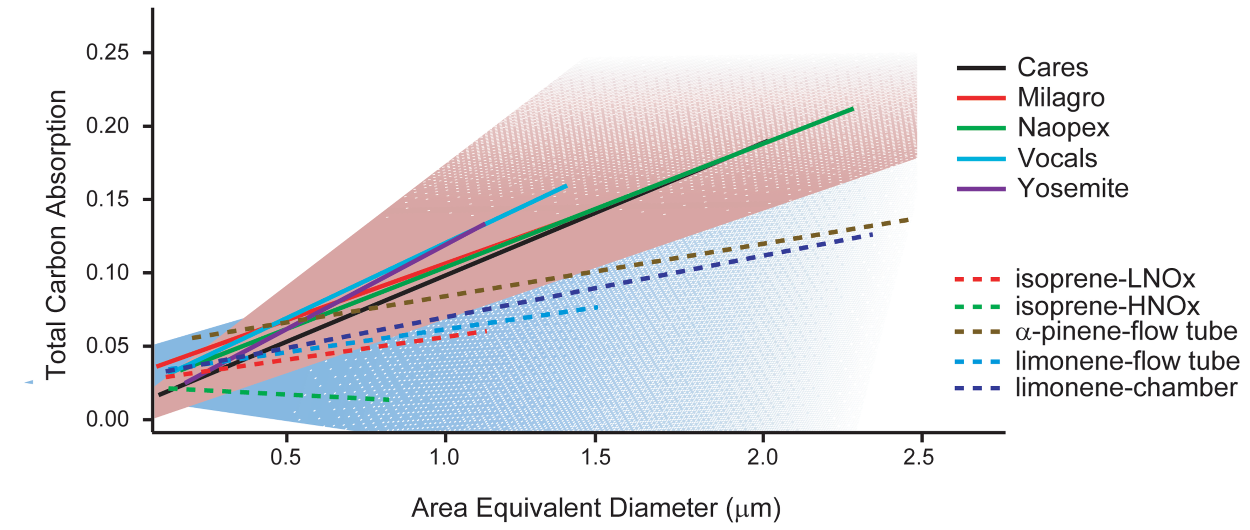
Laboratory generated particles



- Isoprene, α-pinene, d-limonene
- Flow tube and 5 m^3 Teflon chamber
- Conditions: high/low NOx, high/low RH, SO_2, NH_3

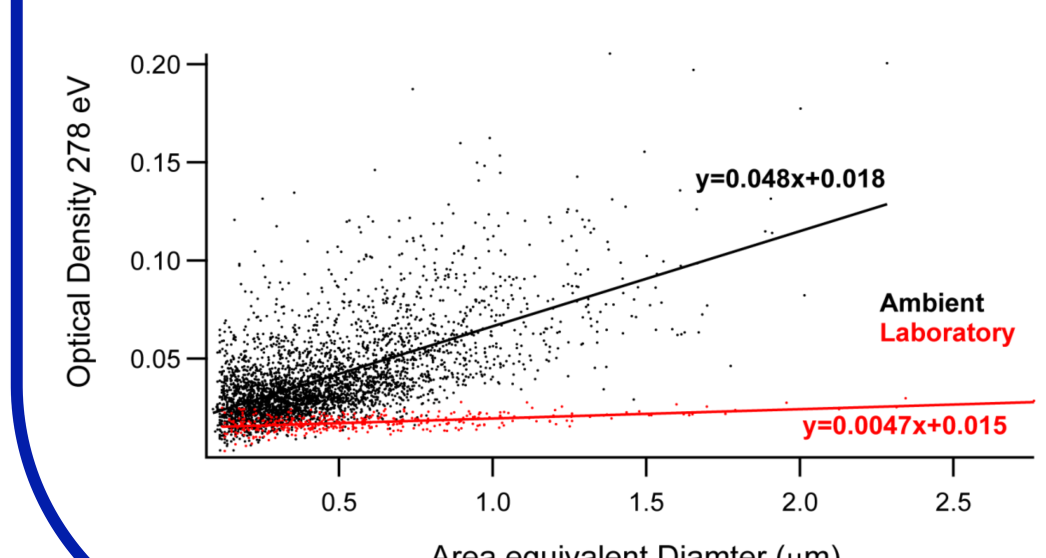
Data/Analysis

Ambient vs. Laboratory



- Optical thickness of carbon (total carbon absorption) as a function of the size of the impacted organic particles.
- Red and blue triangles highlight the ± 95% confidence intervals for ambient and laboratory generated samples.
- Laboratory generated particles → smaller slopes = less viscous/lower surface tension
- High NOx conditions produced the lowest slope.

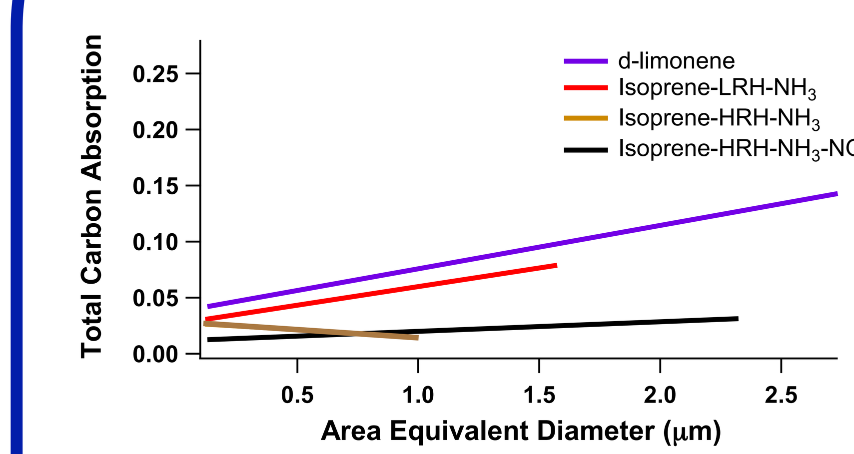
Pre-edge analysis



- Ambient particles have higher pre-edge → higher inorganic content.
- 11-30% inorganic components in ambient

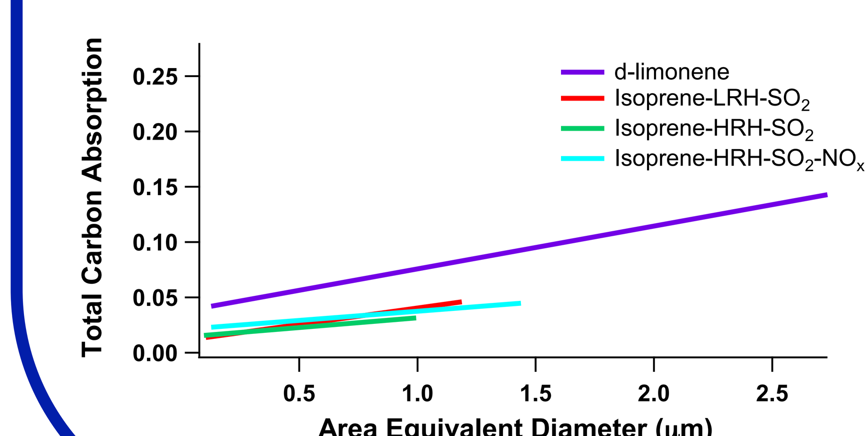
Data/Analysis

Laboratory inter-comparison



- Particles generated with NH_3 in the chamber.
- High NOx conditions again show decreased slope

- High RH sample → negative slope. HRH + NO_3 = lower viscosity



- Particles generated iwith SO_2 in the chamber.
- Slopes are relatively unchanged → SO_2 had minimal impact on viscosity

Conclusions

- STXM/NEXAFS analysis of the size and optical density provides information on the viscosity/surface tension of aerosol particles.
- Organic dominated particles from field campaigns were identified and compared to laboratory generated particles.
- Laboratory generated particles showed lower viscosity than ambient particles.
- Ambient particles have 11-30% inorganic components.
- Neither the addition of NH_3 nor SO_2 to the lab chamber resulted in higher viscosities.

Acknowledgements

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