An Early Overview of the Soot Aerosol Aging Study (SAAS) Laboratory Campaign

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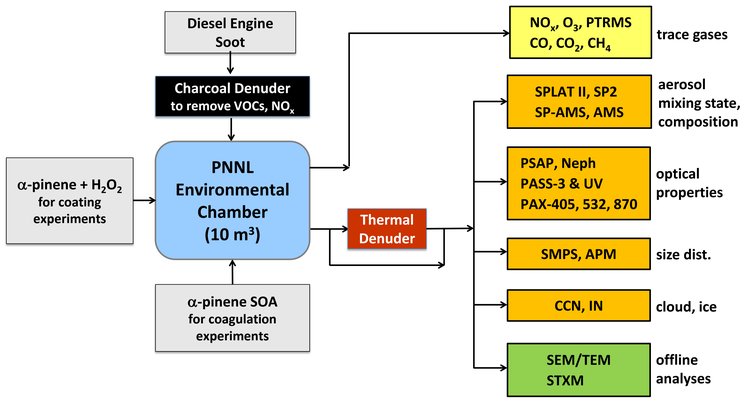
1. Introduction

Soot aerosol from fossil fuel combustion plays an important role in the warming of the atmosphere. However, there still exists a large uncertainty in the warming potential of the aged soot both from observational and climate modeling studies. This poster presents **preliminary results** from the Soot Aerosol Aging Study (SAAS) laboratory campaign that was designed to simultaneously characterize the evolution of soot mixing state due to condensation and coagulation processes and the associated optical, CCN, and ice nucleation properties. The experiments were conducted in the environmental chamber facility at Pacific Northwest National Laboratory over four weeks (2 weeks each in November 2013 and January 2014).

2. Experimental Setup



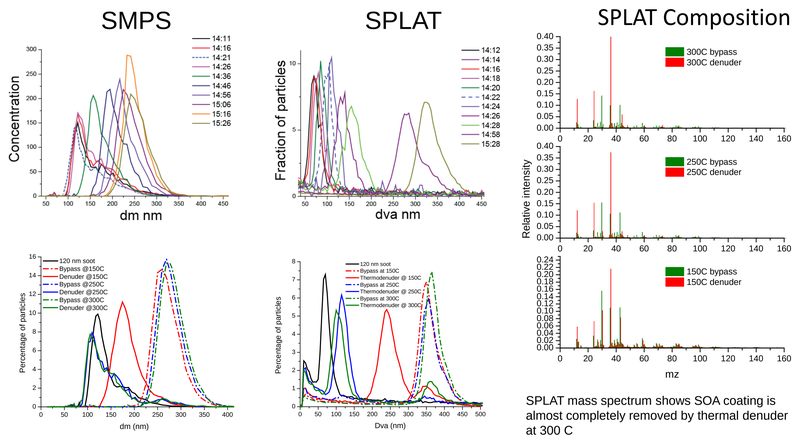
3. Types of Experiments

Type	Experiment Description	Relative Humidity	Number of Experiments
Coating	Size-selected soot aerosol was coated with SOA formed from photooxidation of α-pinene in the presence of VOCs and NO_x that were not completely removed by charcoal denuder.	<2%	7
Coating	Same as above	80%	3
Coagulation	Size-selected soot aerosol was coagulated with pre-existing α-pinene SOA for ~18-20 h.	<2%	4
Coagulation + Coating	Highly coagulated Soot + SOA mixture was further coated with SOA formed from photooxidation of α-pinene	<2%	2

In several experiments, aerosol mixing state, composition, and properties were measured with and without passing the aerosol through a thermal denuder at multiple temperatures.

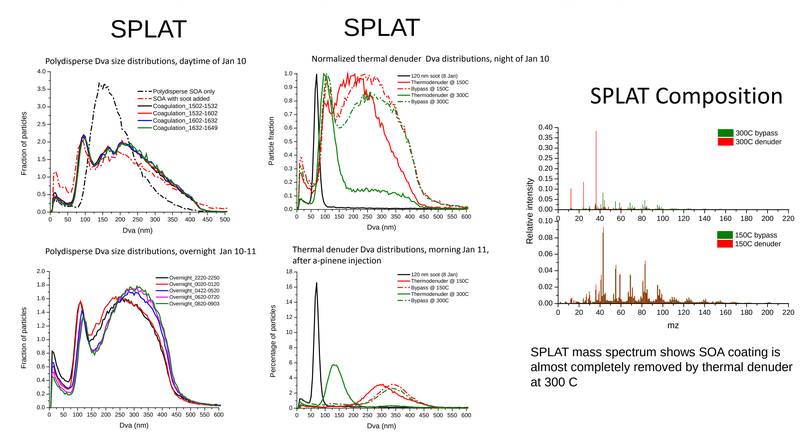
4. Size Distribution Evolution

Example of Coating Experiment



SPLAT mass spectrum shows SOA coating is almost completely removed by thermal denuder at 300 C

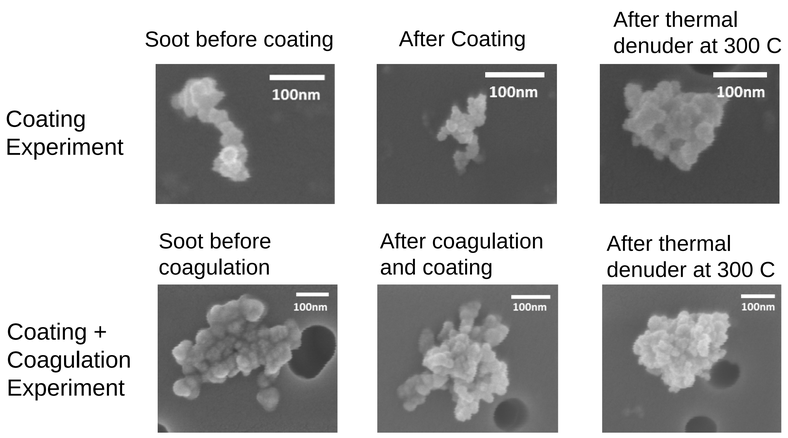
Example of Coagulation + Coating Experiment



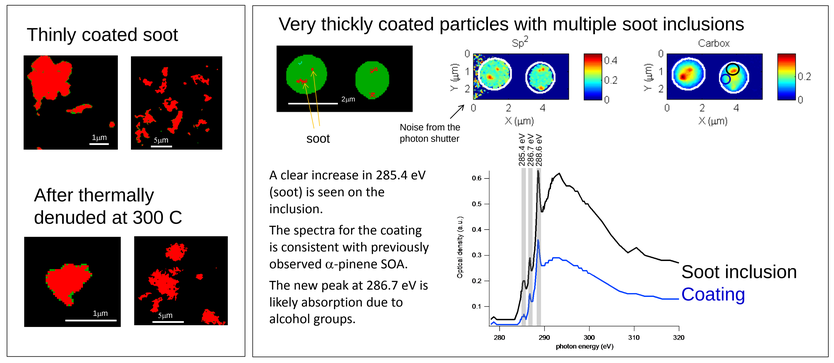
SPLAT mass spectrum shows SOA coating is almost completely removed by thermal denuder at 300 C

5. Morphology & Composition

Examples of SEM Images

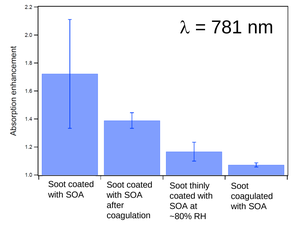


Examples of STXM Images of Soot Overlaid on Organic Carbon



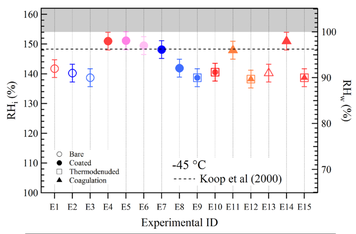
5. Absorption Enhancement

Absorption enhancement was estimated as the ratio between particle absorption and the absorption after particle heating in a thermal denuder, assuming 20% particle loss in the denuder.

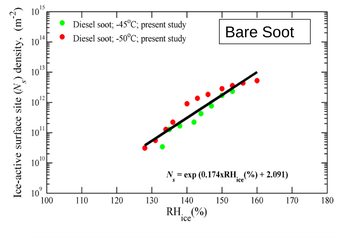


6. Ice Nucleation Activity

- Bare soot particles efficiently nucleate ice in deposition mode.
- Coagulated soot (for 11 hours, E13) has similar IN efficiency as bare soot.
- Coated and coagulated + coated soot particles are less efficient or require homogeneous freezing saturation ratios to nucleate ice.
- Thermally denuded soot particles have similar IN efficiency as bare soot.
- Ice active surface site densities for bare soot found to be less sensitive to temperature. The derived parameterization for heterogeneous ice nucleation of bare soot at cirrus conditions can be implemented in models.



Relative humidity with respect to ice (RH_i) required for detection of 1% of diesel soot particles as IN for different soot treatments.



Ice active surface site densities for bare diesel soot particles calculated below water saturation.

7. Ongoing and Future Work

- Fully analyze data to relate soot mixing state, morphology to absorption enhancement, CCN activity, and ice nucleation activity.
- Perform optical and CCN closure studies
- Evaluate and improve models of soot mixing state evolution suitable for use in regional and global models

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