Stony Brook University
School *of* Marine and Atmospheric Sciences

Micro-Spectroscopic Examination of Free Troposphere and Marine Boundary Layer Ice Nucleating Particles During ACE-ENA

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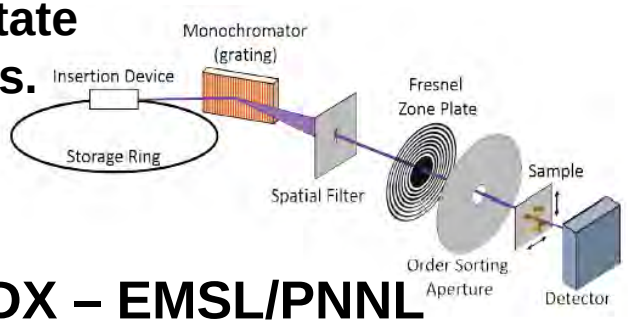
Particles Collected at Ground Site and on DOE G-1 Research Aircraft Using Impactor

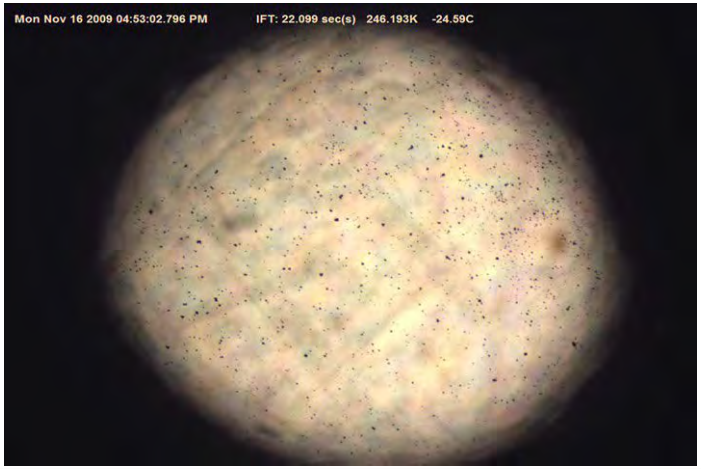
STXM/NEXAFS – ALS/LBNL

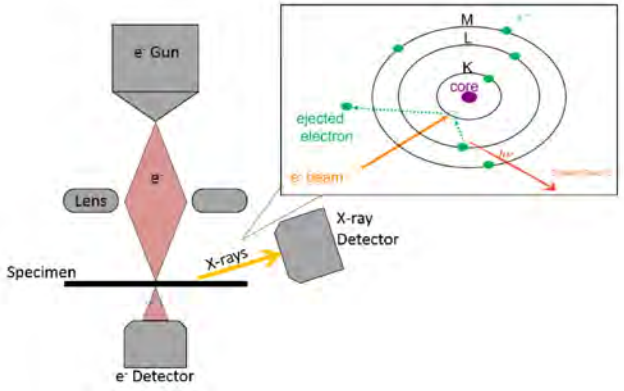
- Organic speciation
- Mixing state
- 30 nm res.



CCSEM/EDX – EMSL/PNNL

- Elemental composition
- Aerosol population characteristics
- INP identification





Fraund, Ph.D. Thesis, 2019

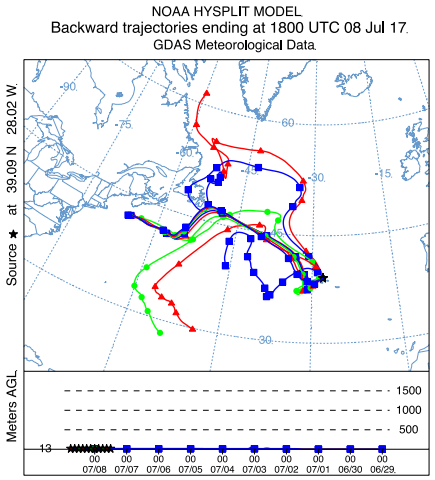
T, RH controlled ice nucleation

Backward Trajectory Analysis - HYSPLIT

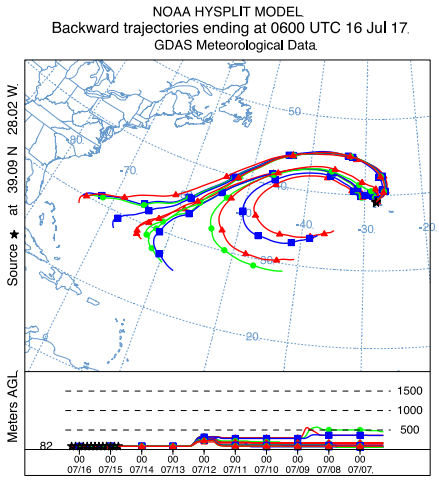
Ground Site Sampling

At 30 m height, all trajectories remain close to surface.
Using 100 m height, night sample may include air masses from higher altitude.

At 30 m height:

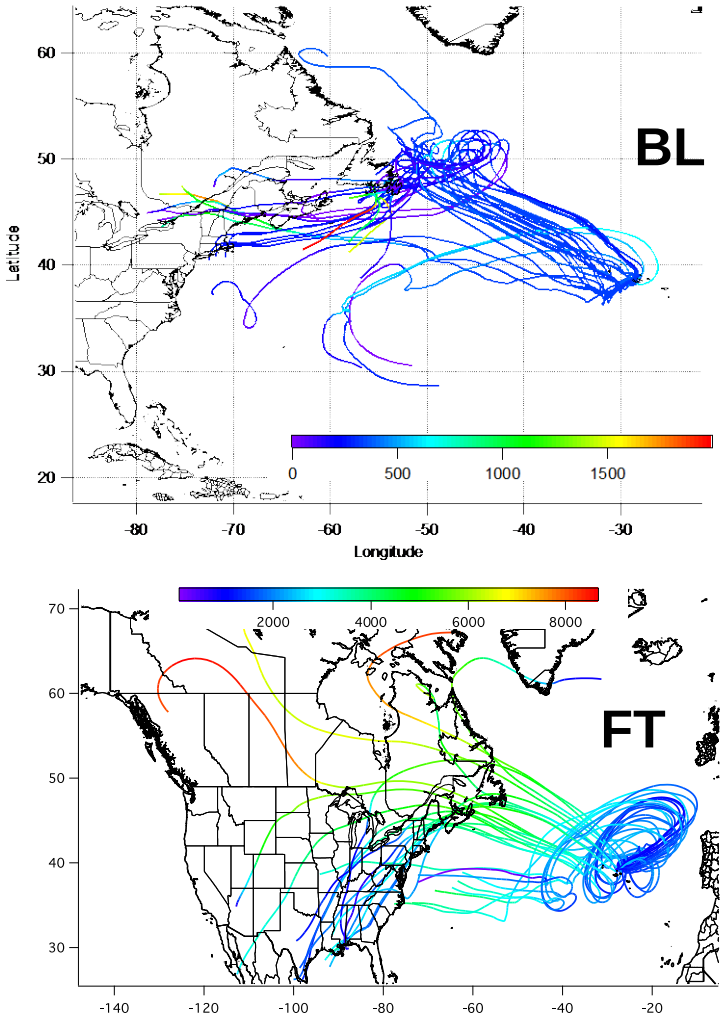


At 100 m height:



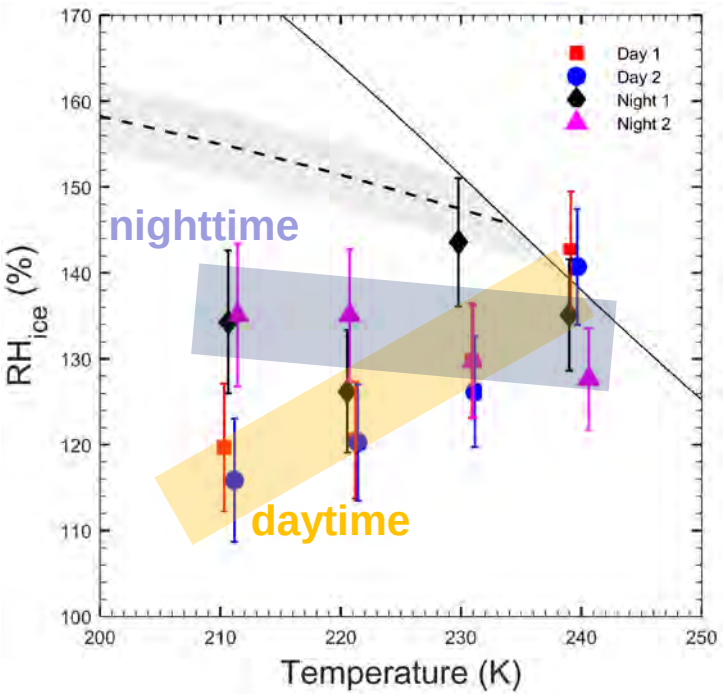
Ground site:
Collaborators on backward trajectory simulations welcomed!

Airborne Sampling



Ice Nucleating Particles From the ACE-ENA Ground Site

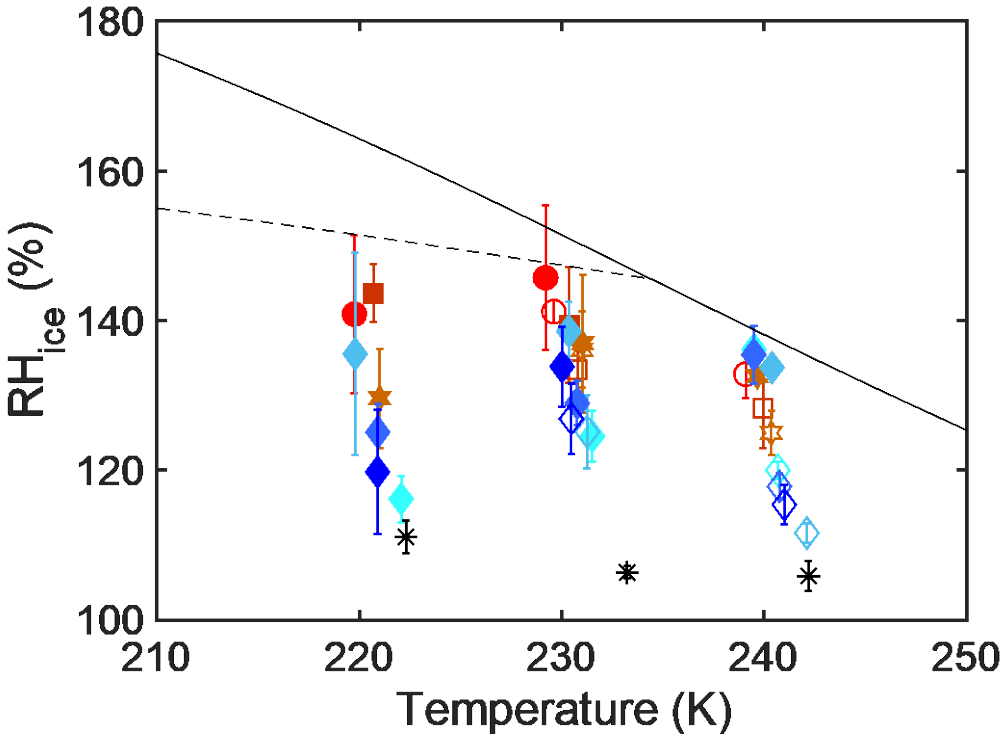
Ground Site INP Samples



Day 1: 7/11 – 7/17
Day 2: 6/27, 6/28
Night 1: 7/14-7/19
Night 2: 7/2-7/9

Stage 6: cut-off: 560 nm

Airborne INP Samples

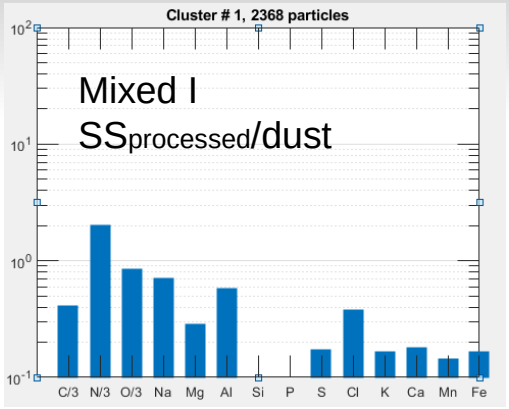


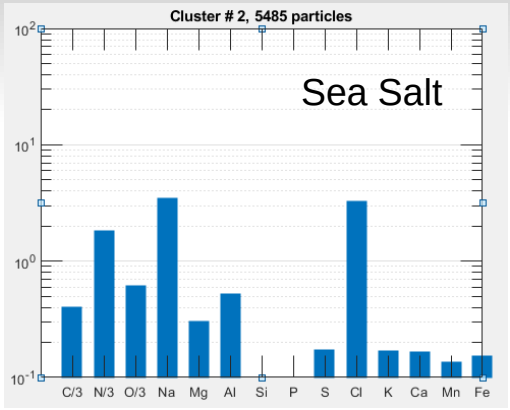
IOP2 01/25/18 BL
IOP2 02/10/18 BL
IOP1 07/07/17 BL
Kaolinite

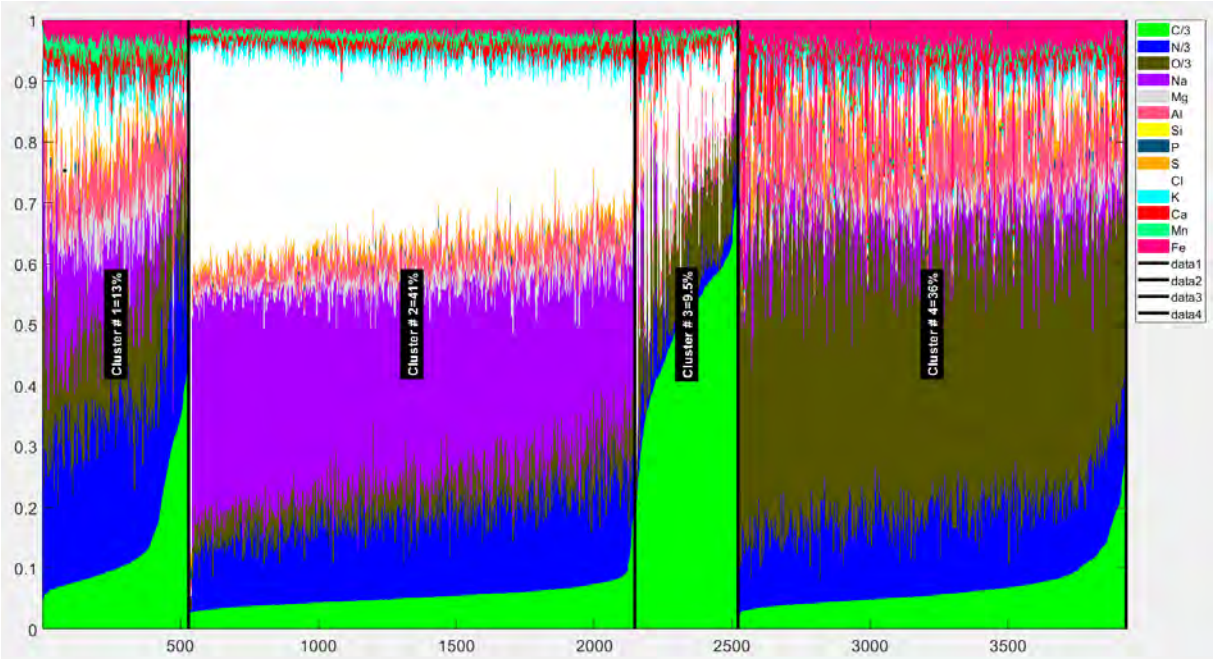
IOP2 02/19/18 FT
IOP2 01/30/18 FT
IOP2 01/25/18 FT
IOP1 07/15/17 FT

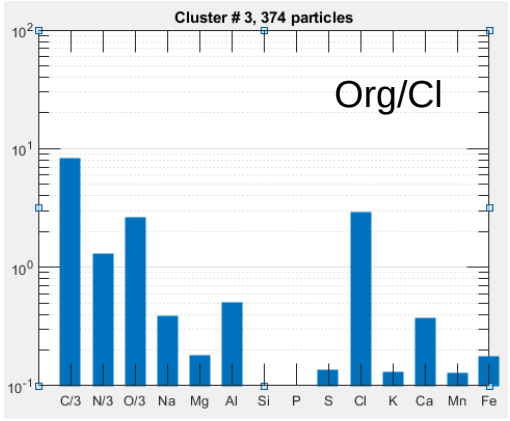
CCSEM/EDX Cluster Analysis

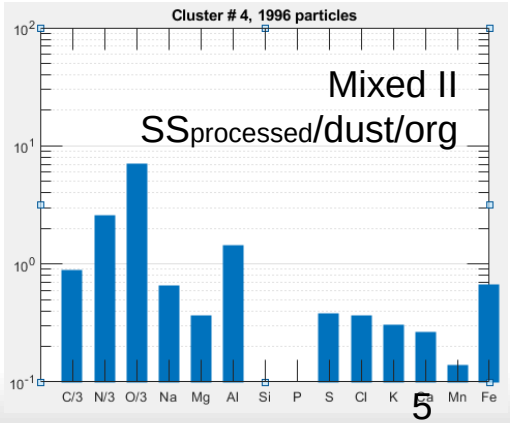
4 unique particle-type cluster recognized.











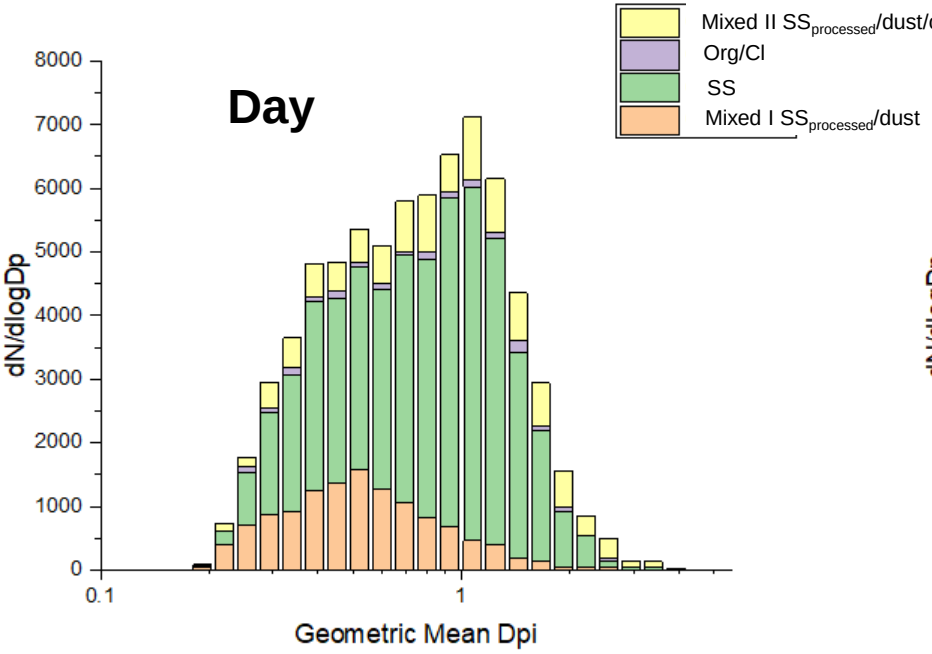
Mixed I
SSprocessed/dust

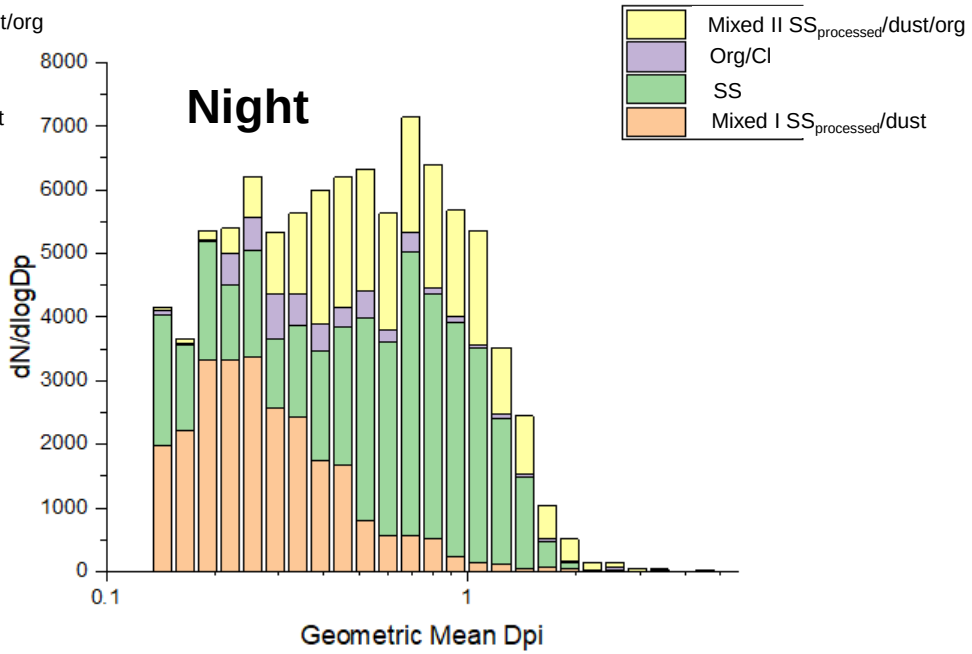
Sea Salt
(only partially processed, mostly fresh)

Org/Cl

Mixed II
SSprocessed/dust/org

CCSEM/EDX - Analysis of All Day and All Night Samples

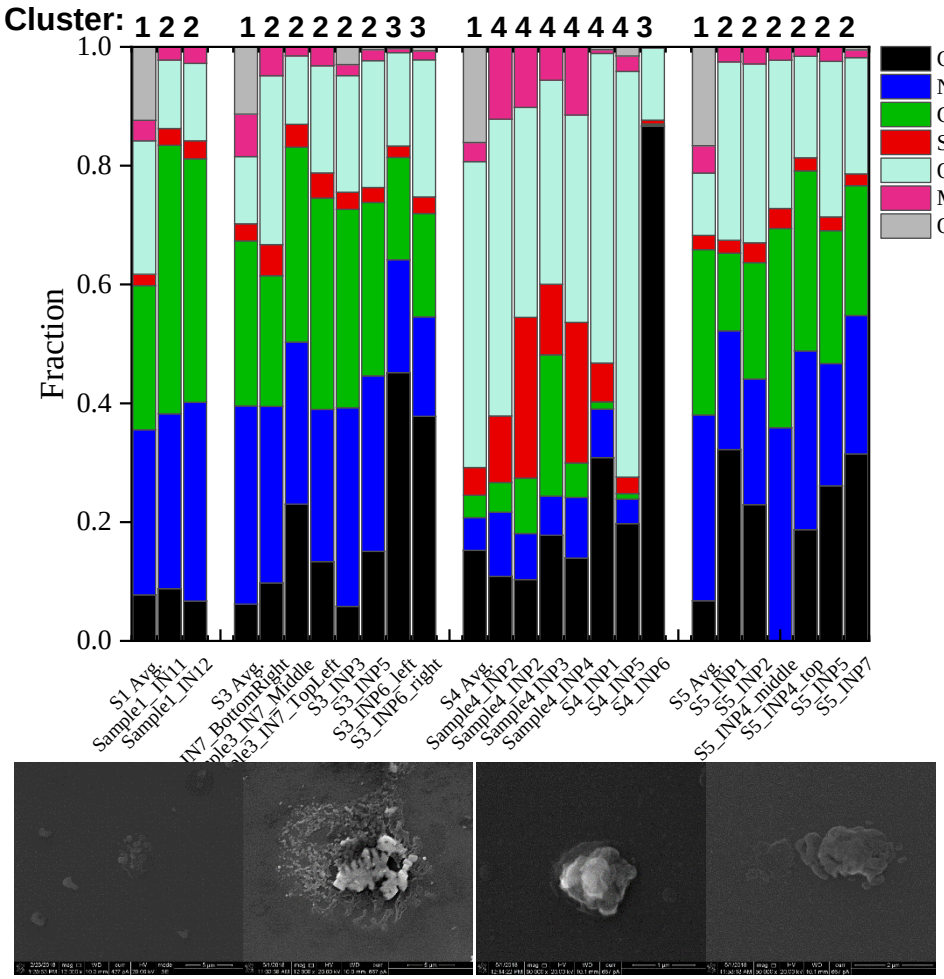




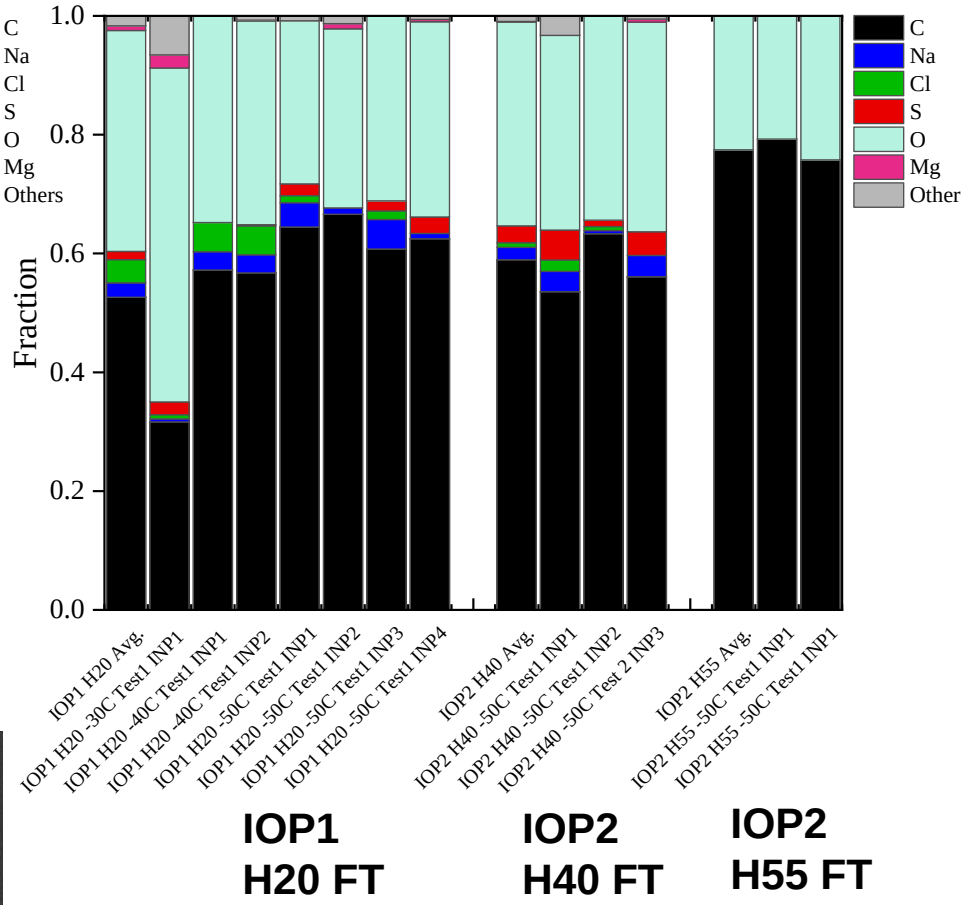
Nighttime samples display greater abundance of aged sea spray particles and mineral dust components.

SEM/EDX Analysis of Individual INPs

Ground Site INP Samples



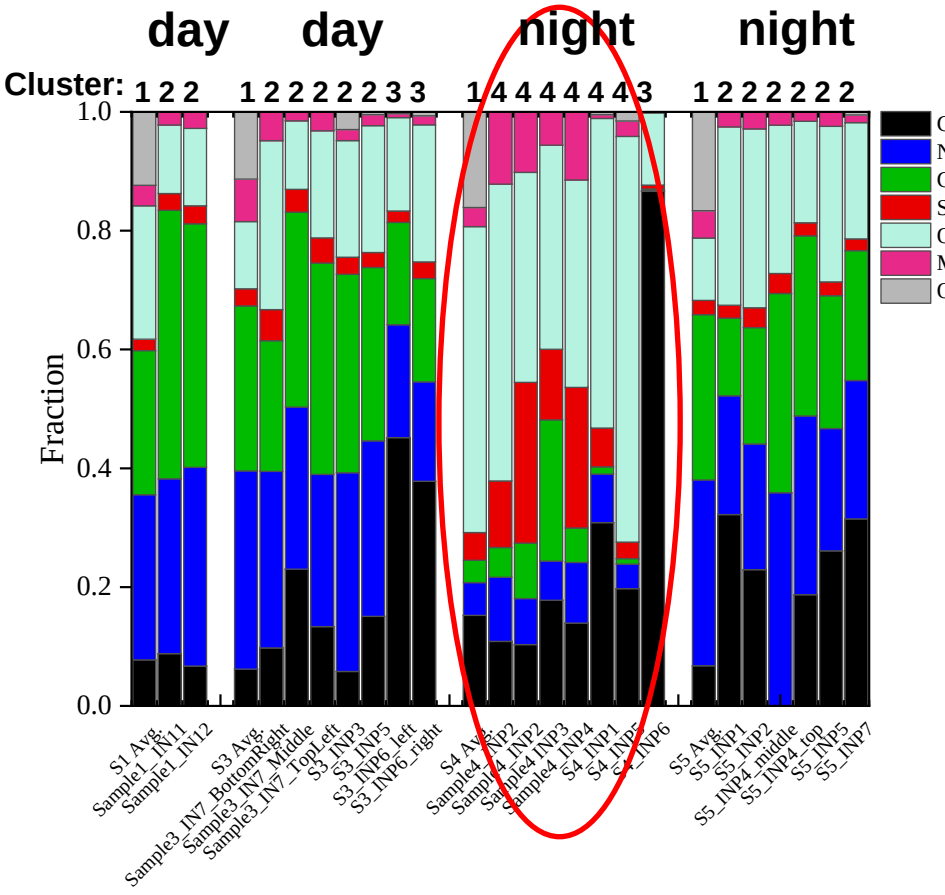
Airborne INP Samples



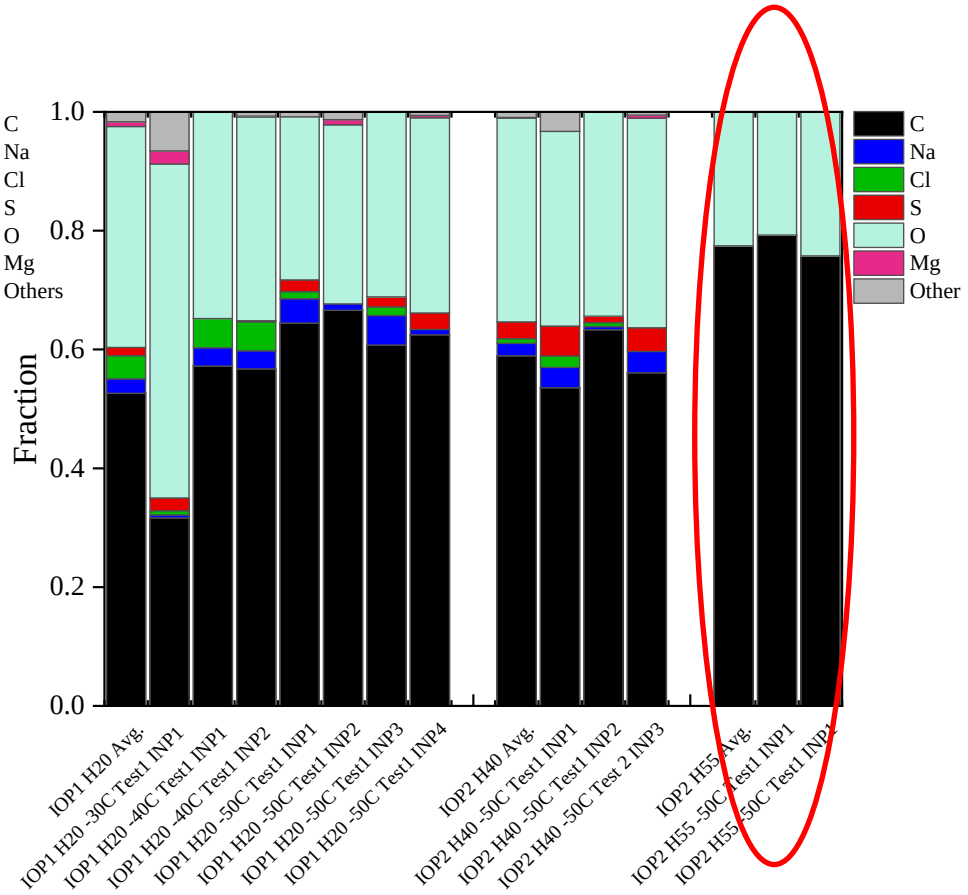
IOP1 H20 FT **IOP2 H40 FT** **IOP2 H55 FT**

SEM/EDX Analysis of Individual INPs

Ground Site INP Samples



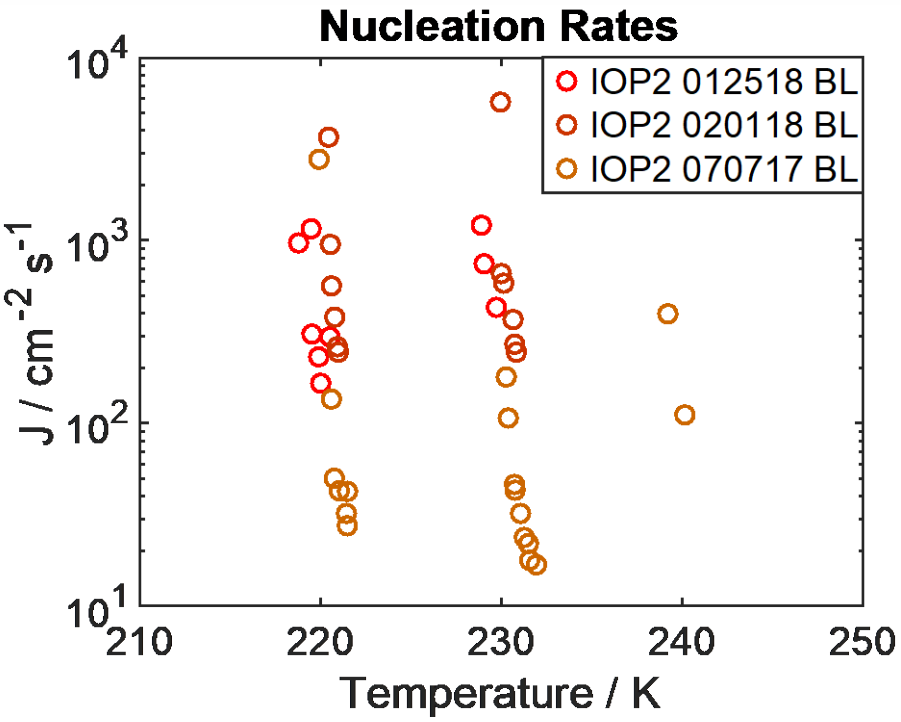
Airborne INP Samples

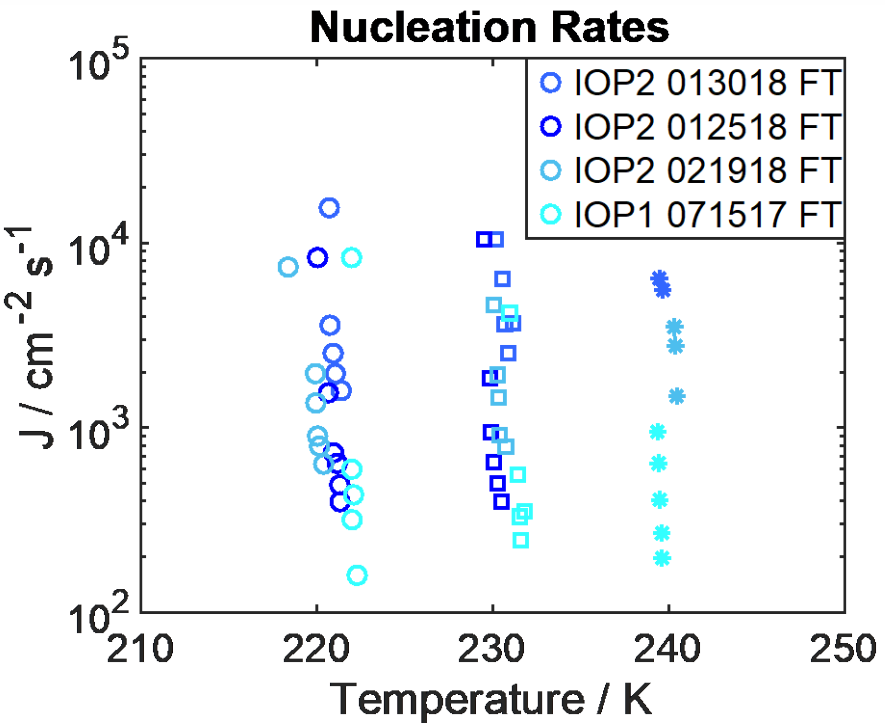


INPs belong to major identified particle type class. Highlighted night sample is unique in its particle type class.

Purely organic aerosols might act as INPs. However, also aged sea salt and potentially mineral dust, all associated with organic material.

Ice Nucleation Kinetics



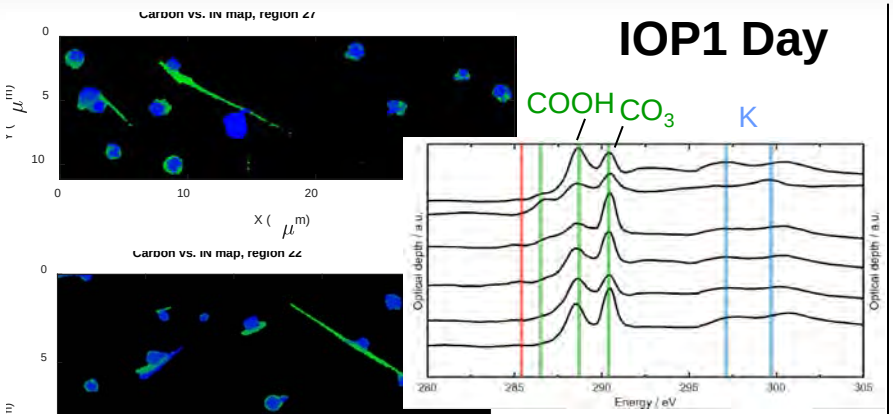


Free troposphere aerosol exerts about one order of magnitude greater ice nucleation rate coefficients!

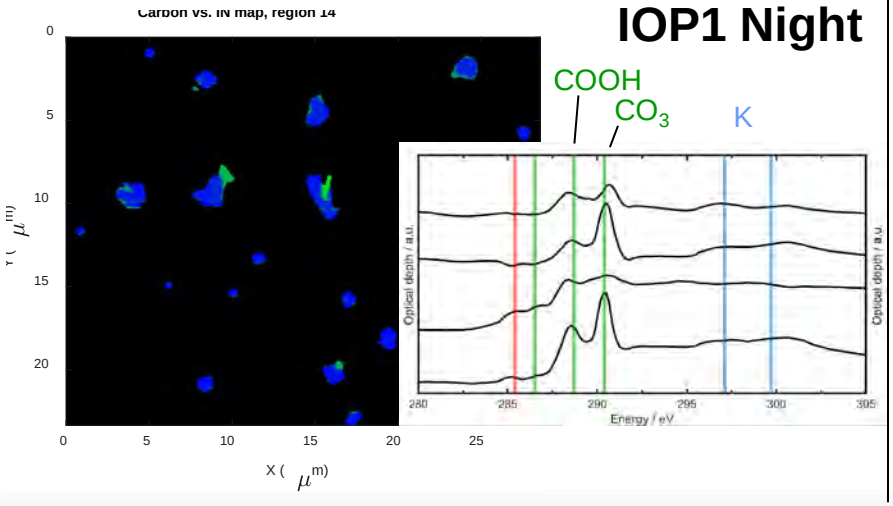
Aerosol Population – STXM/NEXAFS

Ground Site Aerosol Samples

IOP1 Day

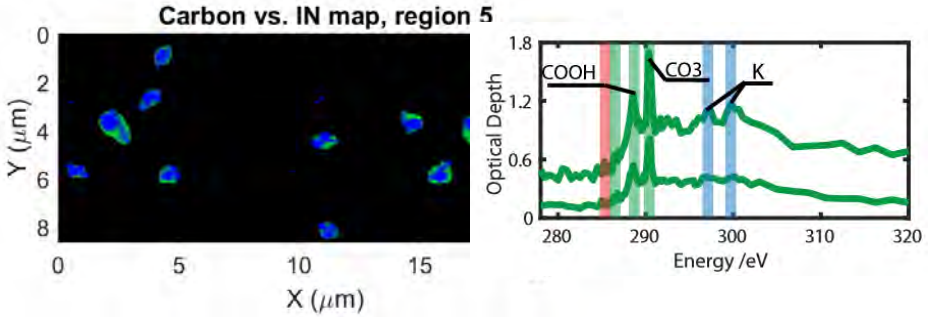


IOP1 Night

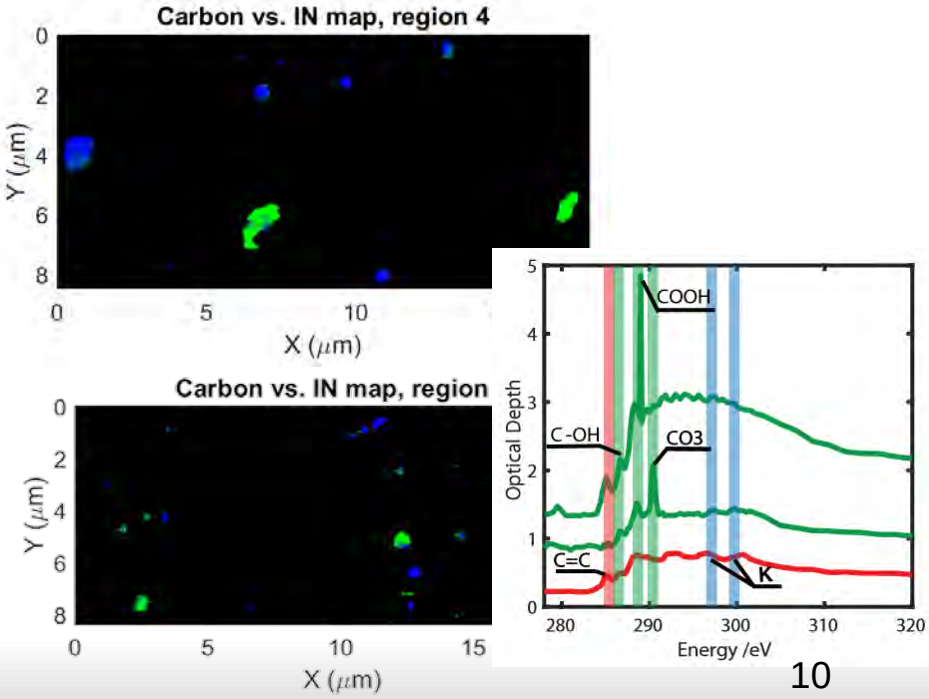


Airborne Aerosol Samples

IOP2 BL



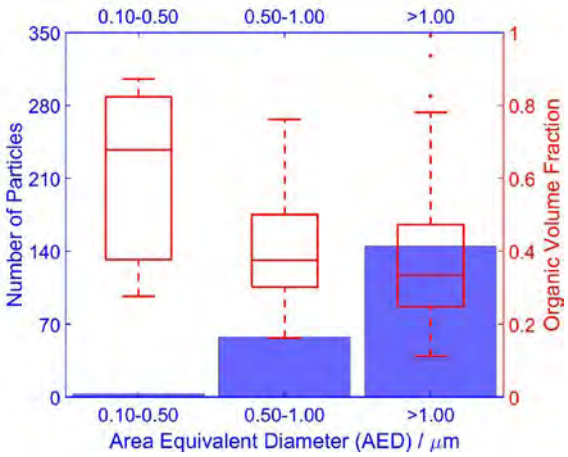
IOP2 FT



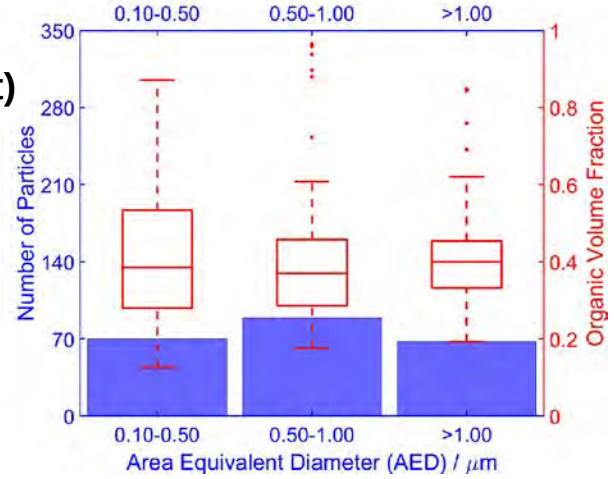
Organic Volume Fraction – STXM/NEXAFS

Ground Site Aerosol Samples

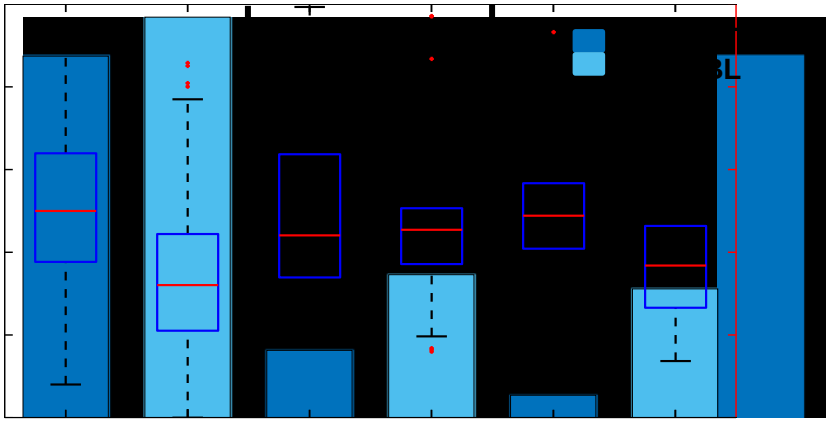
Sample 1 (7/7-11 Day)



Sample 4 (7/14-19 Night)



Airborne Aerosol Samples



Summary

- During IOP1, particles were collected at ground site during night- and day-time. During IOP1+2, particles were collected onboard G-1 aircraft.
- Particles and INPs have been physicochemically characterized and identified.
- INPs reflect typical aerosol population composition.
- Differences in ice forming propensity are partly explained by composition, however, open questions remain.

Outlook

- Preparing two manuscripts on INP sources at ACE-ENA compiled from ground site and airborne collected samples.

Funding & Acknowledgements

U.S. Department of Energy
Atmospheric System Research: DE-SC0016370
Climate and Environmental Science Division

DOE National User Facilities