Characterization of ice nucleating particles during continuous springtime measurements in Prudhoe Bay: an Arctic oilfield location

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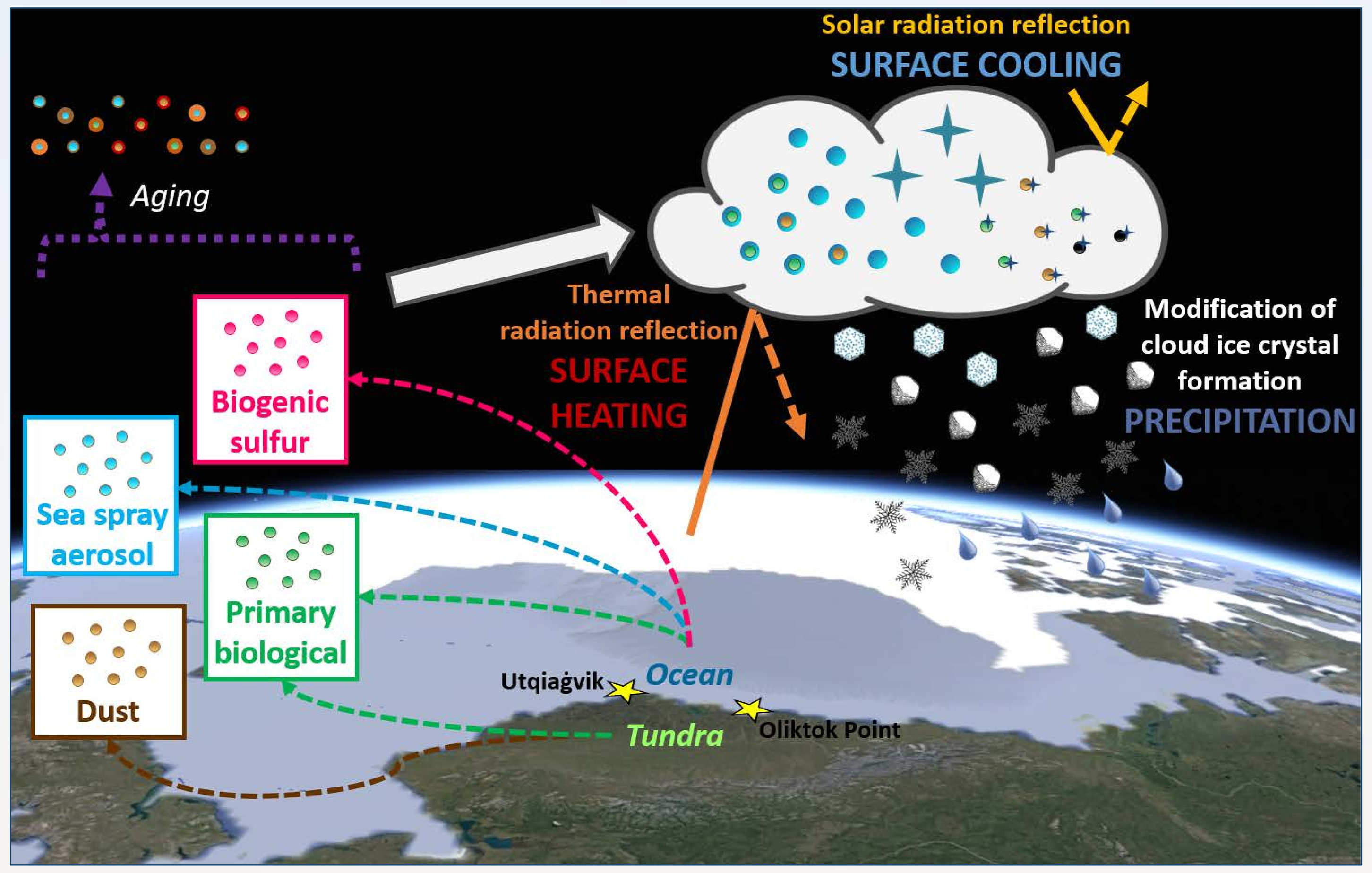
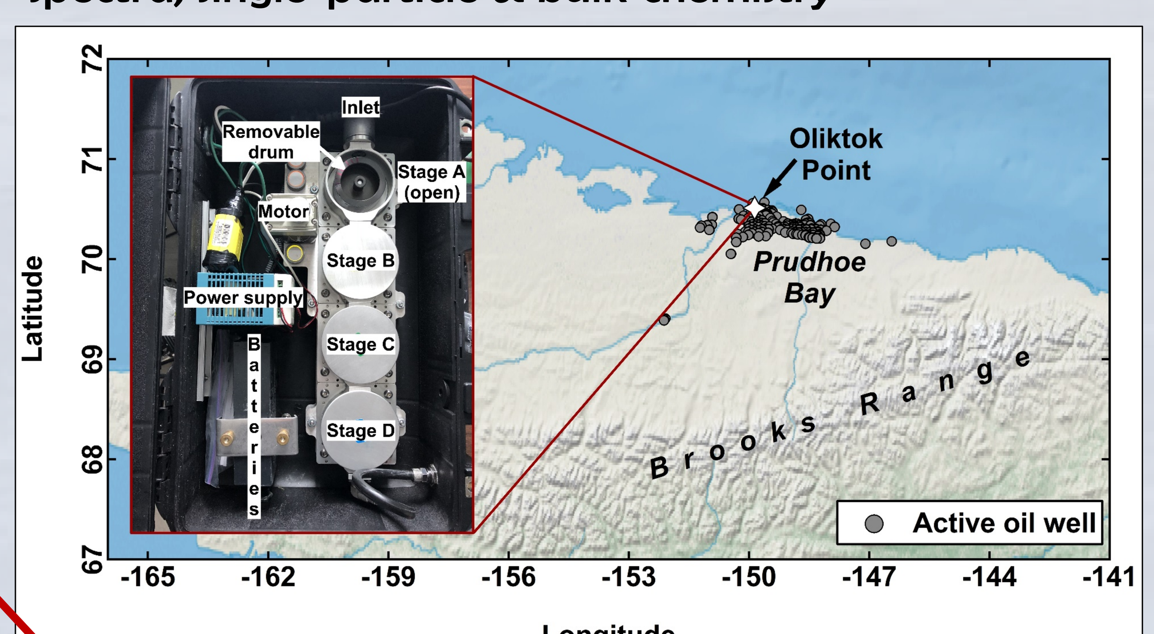
Background & motivation



- Aerosol-cloud interactions are severely understudied in the Arctic—specifically ice nucleating articles (INPs)—yet have implications for radiation reaching frozen surfaces.
- Uncertainties in model representations of heterogeneous ice nucleation are a significant hindrance to simulating Arctic mixed-phase cloud processes.
- A combination of aerosol chemical, physical, and ice nucleating properties is pertinent to evaluating of the role of aerosols in altering Arctic cloud microphysics.

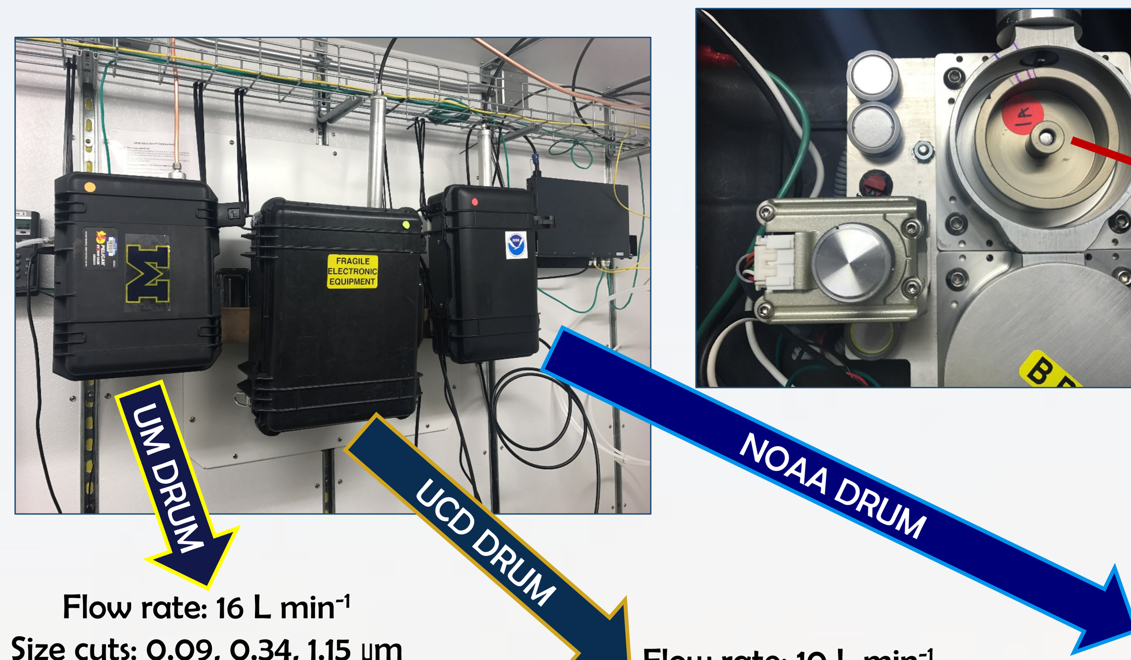
INPOP: Ice Nucleating Particles at Oliktok Point

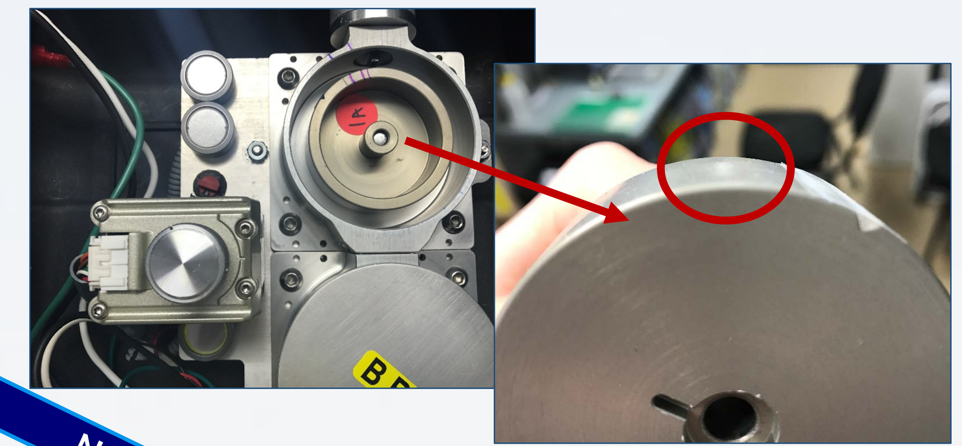
- Objective: evaluate INPs in an Arctic oilfield location (first measurements in an oilfield[1]
- Dates: 1 Mar – 31 May 2017
- Sample collection: 3 DRUMs (3 to 8 size bins from 0.09 – >12 μm)
- Time resolution: 12 – 24 hours
- Data produced: INP spectra, single-particle & bulk chemistry



From sample collection to analysis

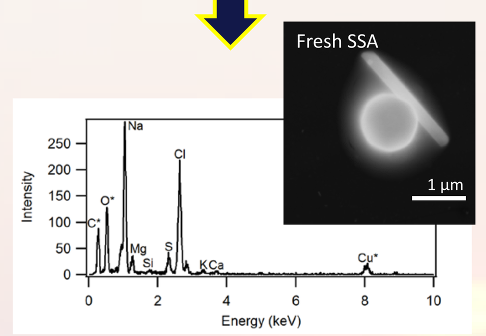
Figure 3. (left & bottom) DRUMs from each institution, their flow rates, size bins, and the analysis and results from the samples from each DRUM. (top right) photos of discs inside DRUM and aerosol loading (circled in red) on one of the discs during INPOP.





UM DRUM: Flow rate: 16 L min^{-1}; Size cuts: 0.09, 0.34, 1.15 μm

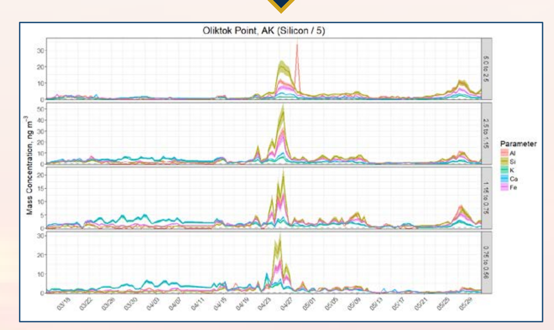
Computer controlled scanning electron microscopy & dispersive x-ray spectroscopy (CCSEM-EDX)[2]



Single-particle morphology and chemistry

UCD DRUM: Flow rate: 10 L min^{-1}; Size cuts: 0.09, 0.26, 0.34, 0.56, 0.75, 1.15, 2.96, 5.0 μm

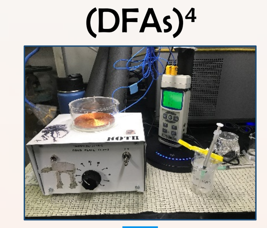
Optics & synchrotron-induced x-ray fluorescence (S-XRF)[3]

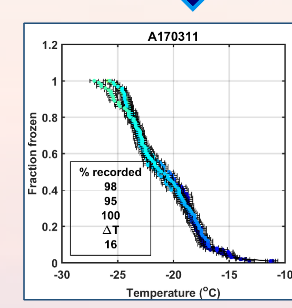


Extinction, bulk metal concentrations, bulk mass

NOAA DRUM: Flow rate: 27 L min^{-1}; Size cuts: 0.15, 0.34, 1.21, 2.96 μm

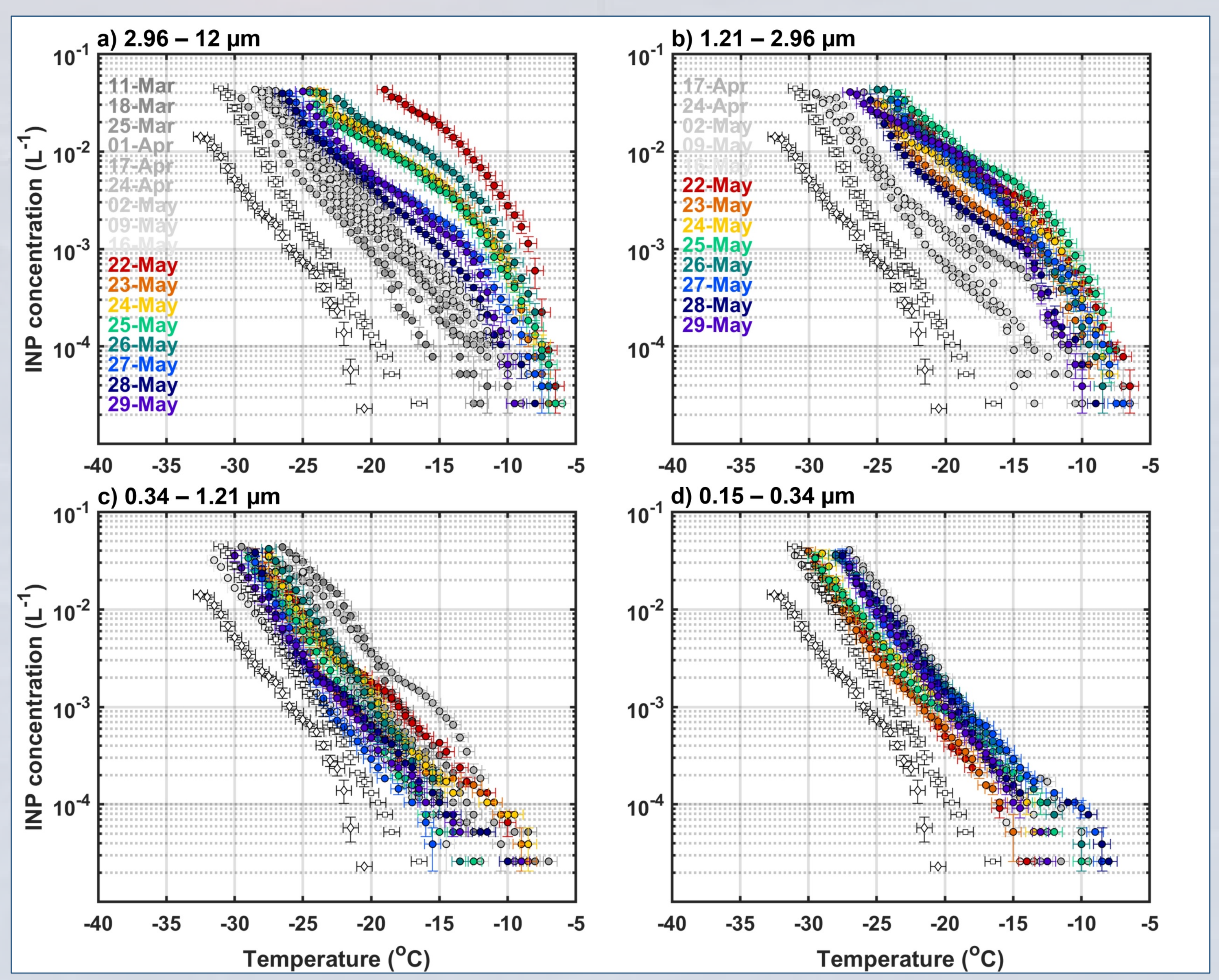
Cold plate drop freezing assays (DFAs)[4]





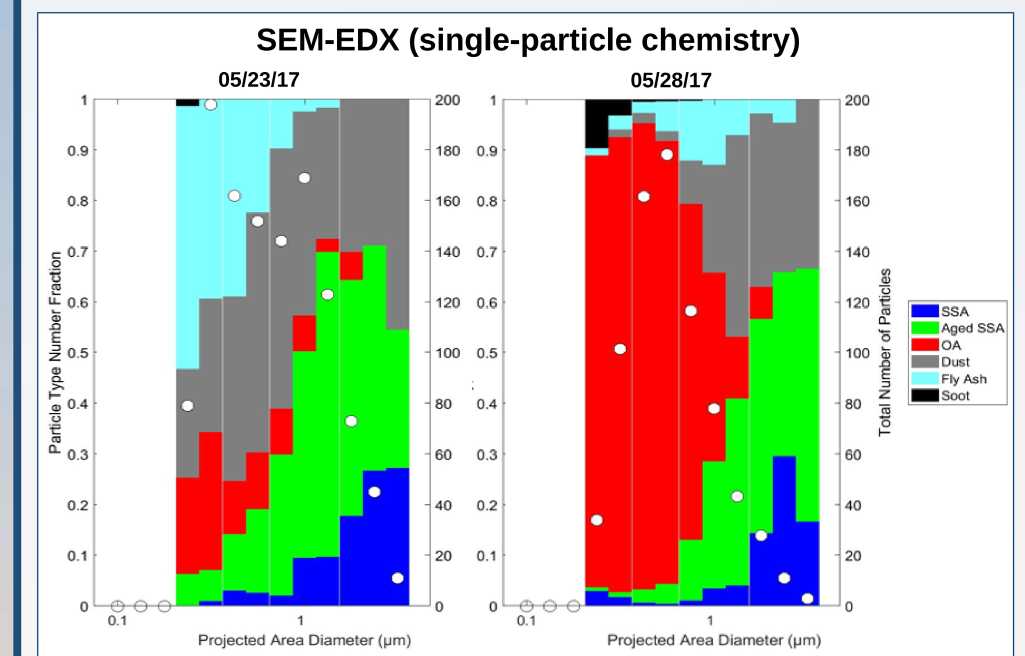
INP freezing temperatures and concentrations[4]

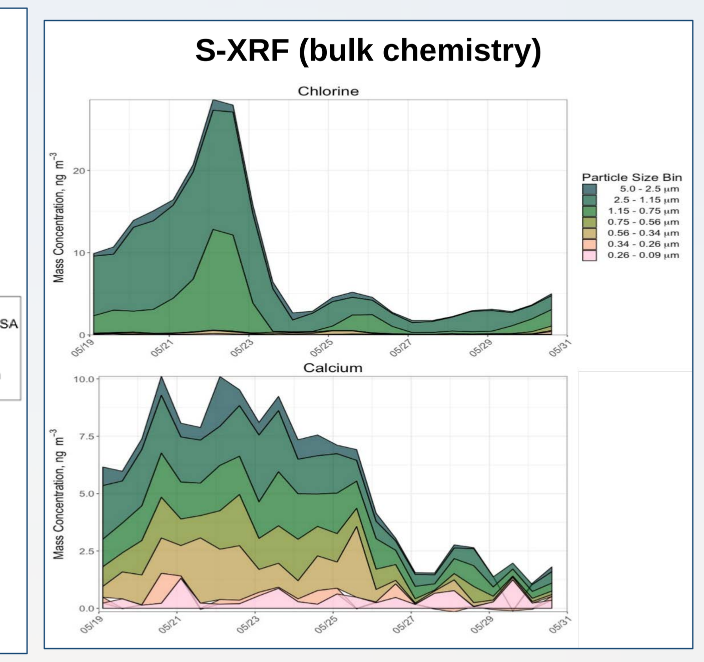
Overall INP results from INPOP

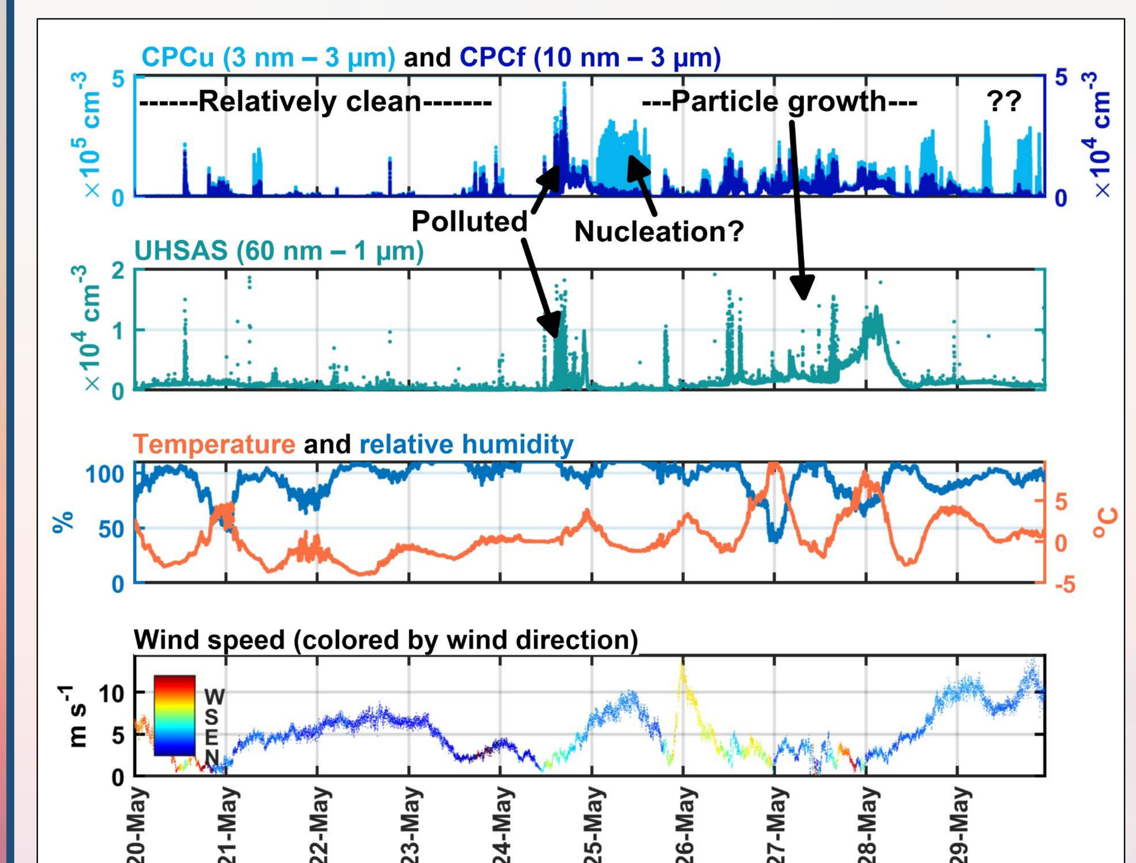


- "Typical" spectra (grey) spanned a wide range of temperatures, but INPs were mostly low in concentration.
- Larger particles were more efficient INPs, especially during 22 – 29 May.

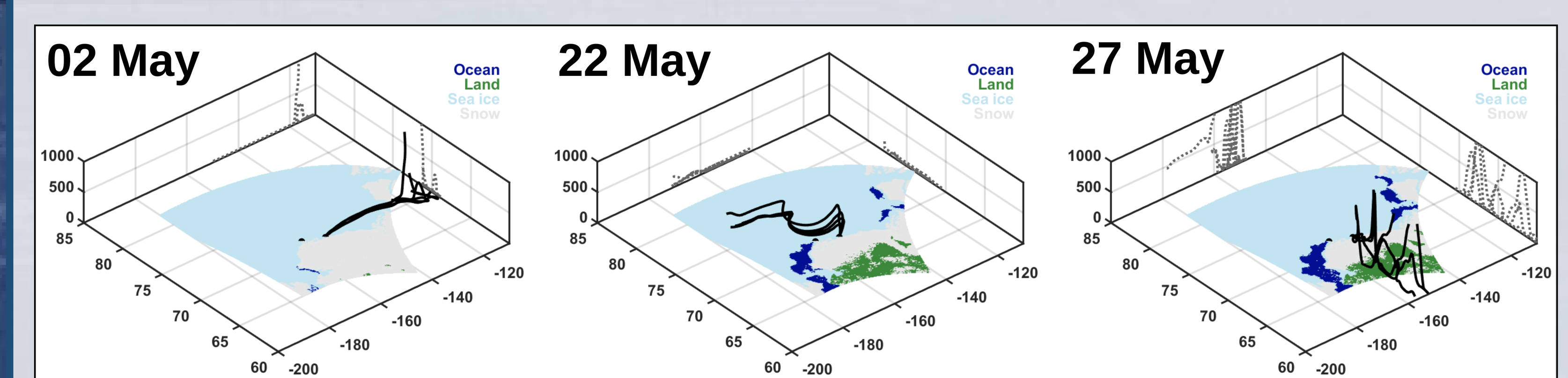
Case study: Enhanced INPs during late May 2017







- Influenced polluted, clean, and what appeared to be new particle formation.
- Clean conditions = more sea salt, fly ash, dust, while polluted = more organic aerosol.
- N/E winds and elevated chlorine and calcium, then S/W winds.



- Possible sources from exposed Arctic Ocean and tundra, shown by 5-day air mass backward trajectories and satellite-derived snow and ice cover data.

Summary

- We present preliminary INP and single-particle and bulk aerosol composition results from INPOP.
- Mar and Apr 2017 were characterized as polluted, containing less efficient INPs. During late May, cleaner conditions, efficient INPs, and possible influence from the open Arctic Ocean and tundra were observed.

References

1. Creamean et al. (2017) *Atmos. Chem. Phys.*, accepted.; 2. Ault et al. (2012) *Environ. Sci. Technol.*, 46 (8), 4331–4339.; 3. Cahill et al. (2016) *Atmos. Environ.*, 145, 158-175.; 4. Creamean et al. (2018) *Atmos. Meas. Tech. Disc.*, in review.

Acknowledgements

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