AMF-3: Oliktok Point Science

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CIRES

NOAA

IRISS Integrated Remote & In Situ Sensing

ASR Atmospheric System Research

ARM Climate Research Facility

2022 ARM/ASR PI Meeting, 25 October 2022, Rockville, MD

Humble Beginnings

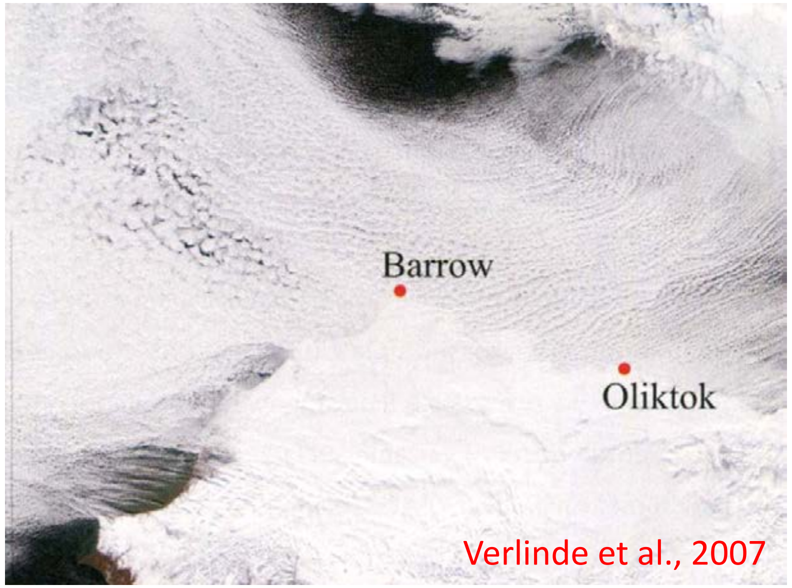
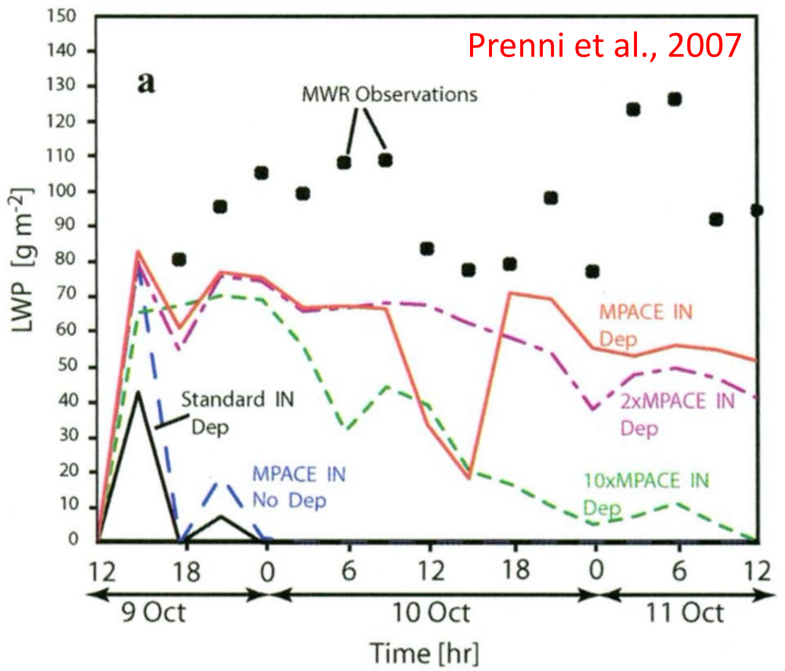


Table 1. Major facilities to be deployed during M-PACE.

	Facility PI	Location
DOE ARM Climate Research facilities at Barrow and Atqasuk		Barrow and Atqasuk
U. of North Dakota Citation (in situ aircraft)	Verlinde (PSU)	Prudhoe Bay
DOE-UAV Program Proteus (remote-sensing aircraft)	McFarquhar (U. of Illinois)	Fairbanks
U. of Alaska, Fairbanks depolarization lidar	Sassen (UAF)	Barrow
PNNL Atmospheric Remote Sensing Laboratory	Mather (PNNL)	Oliktok Point
ARM rapid-scan AERI	Turner (PNNL)	Oliktok Point
Aerosonde	Curry/Pinto	Barrow



AMF-3 at OLI Timeline

Oct 2013
First AMF Infrastructure Installed at OLI

Spring 2015
OLI Site Science Team Formed, OLI Integrated Into IASOA Network

Summer 2016
OLI AOS Fully Commissioned

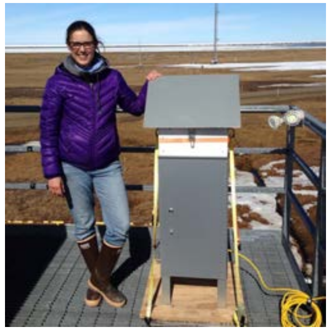
Summer 2016/2017
Routine ARM UAS/TBS Flights under ICARUS, JUBA

Spring/Summer 2018
Enhanced UAS and TBS Obs as Part of the Year of Polar Prediction (POPEYE, AVPOP)

Oct 2014
COALA UAS and TBS Flights

Summer 2015-Fall 2016
ERASMUS UAS flights, ACME-V G-1 mission

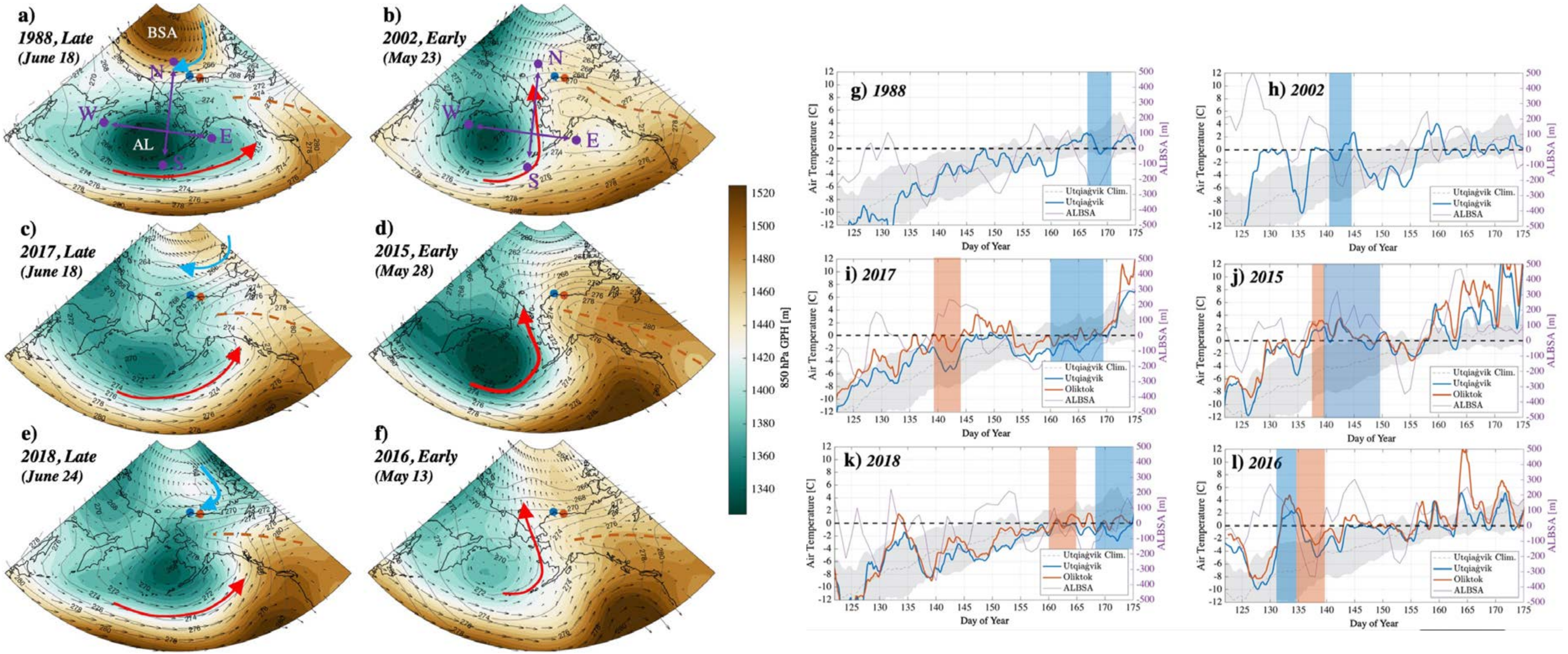
Summer 2015-2021
Campaigns to Enhance Aerosol Sampling



2017-2020
Campaigns Focused on INPs, snow, and Ice Fog (INPOP, IFFExO)

Summer 2021
OLI De-Installation Completed

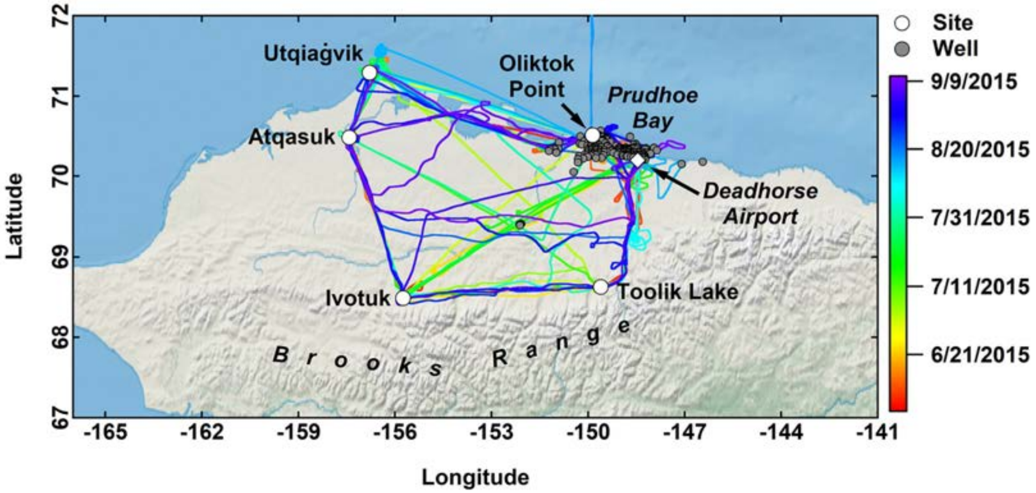
Regional Perspectives

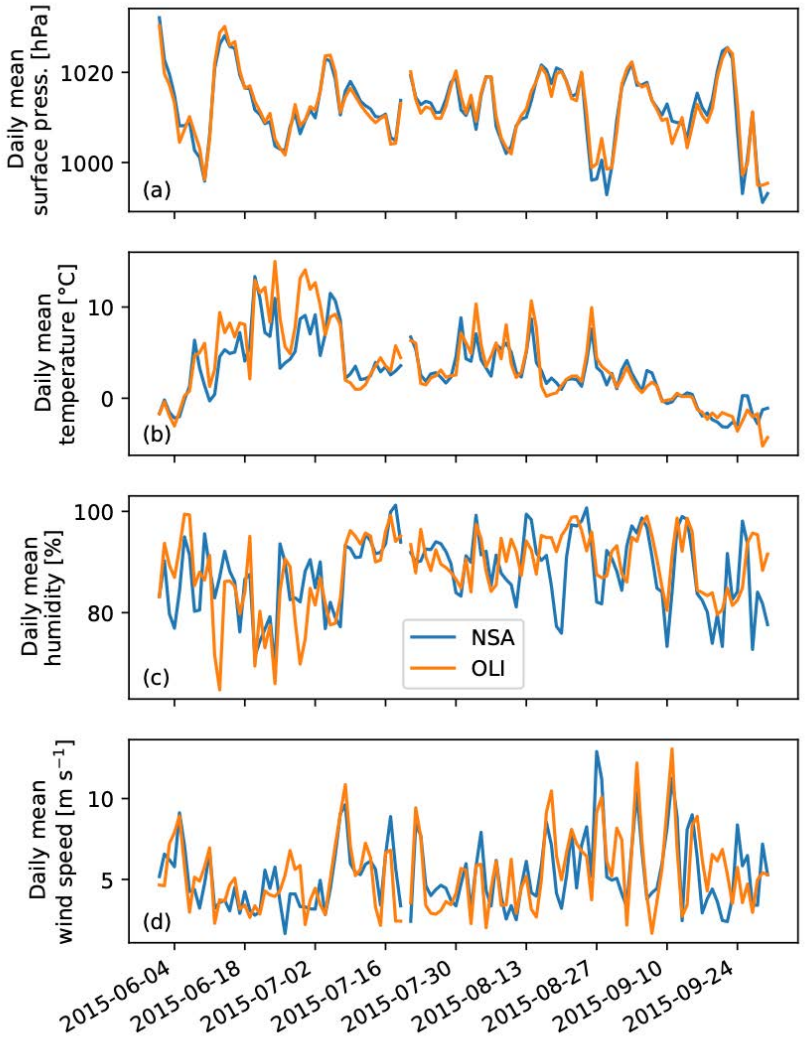


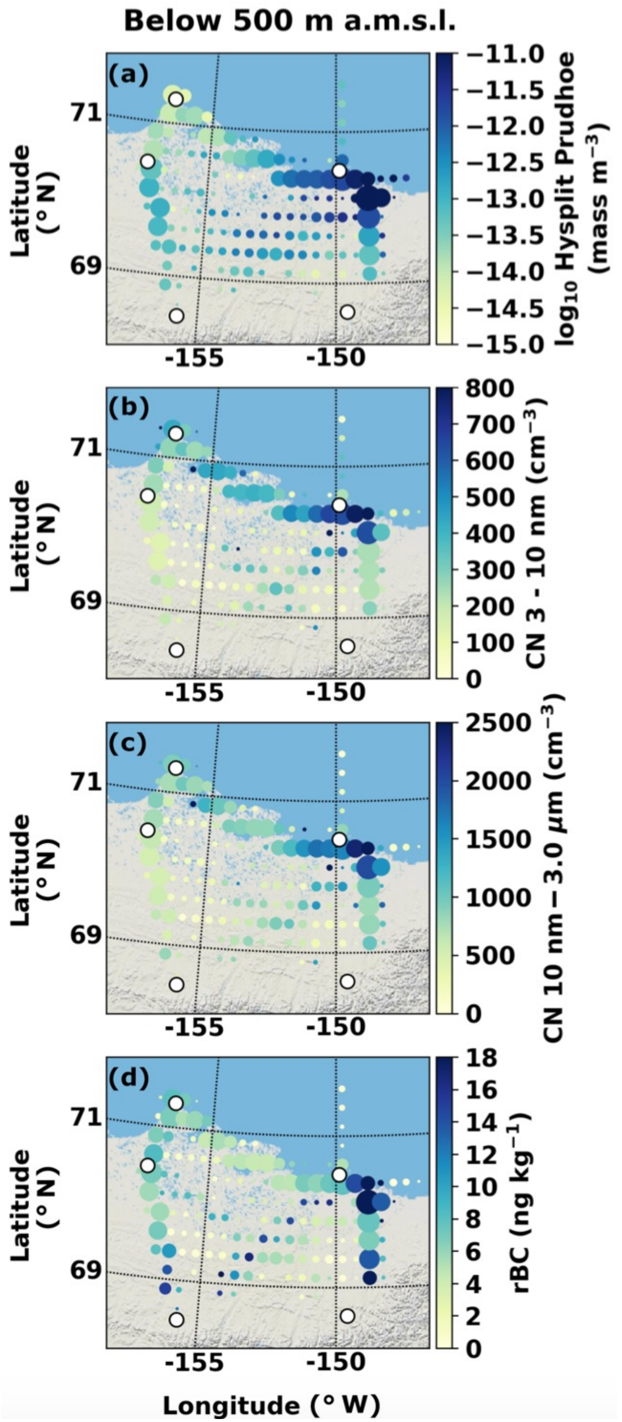
Cox et al., 2019

OLI as a Proxy For a Developed Arctic

Aerosol and Emissions Gradients

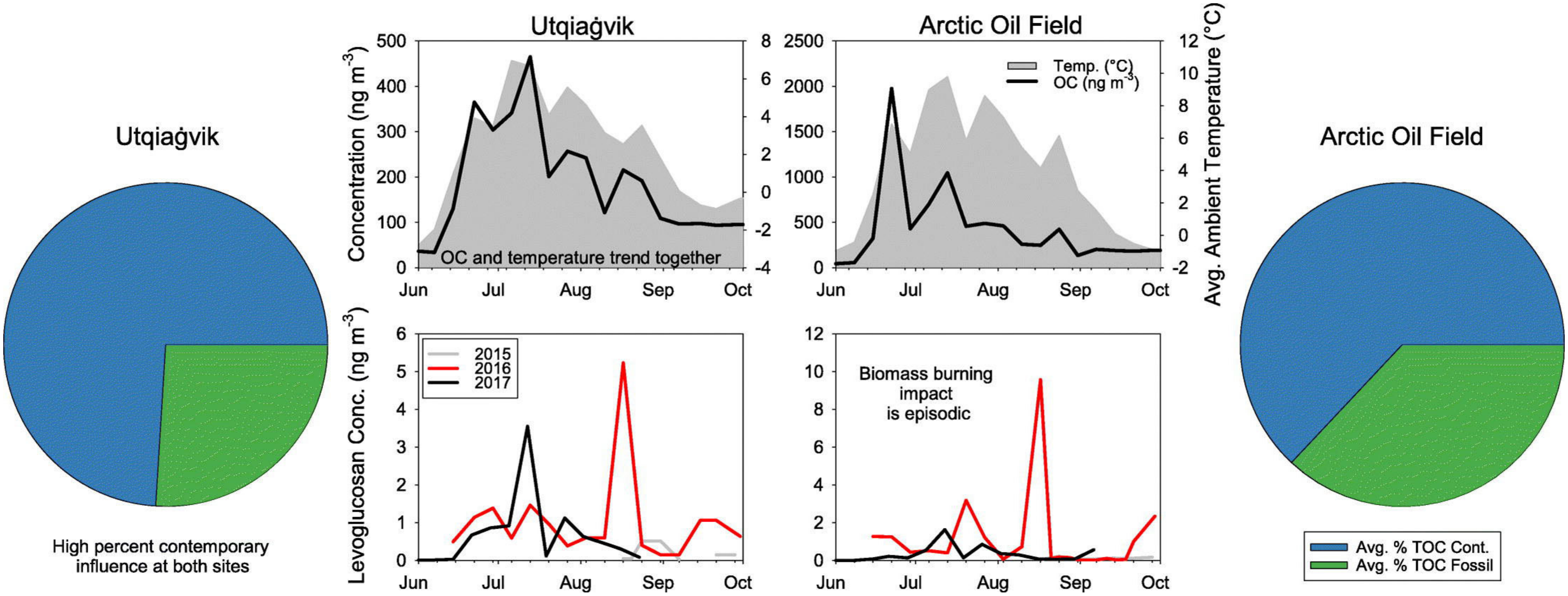






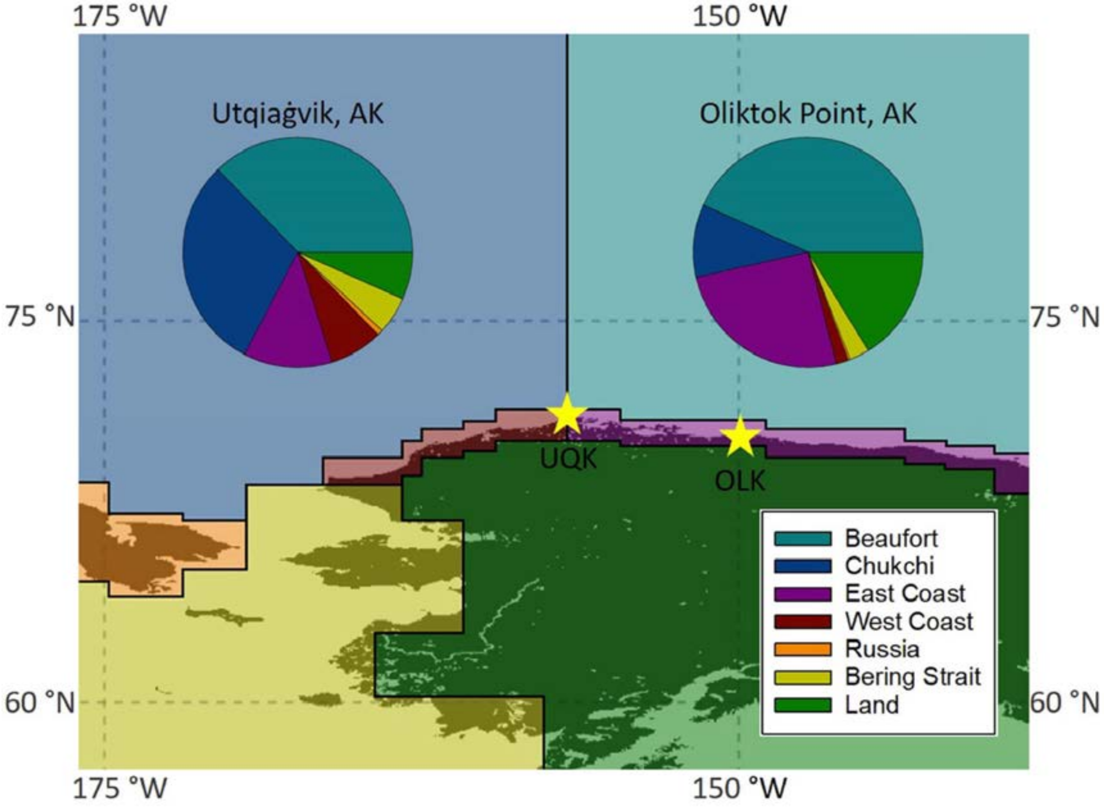
Biraud, 2016; Creamean et al., 2018; Maahn et al., 2017

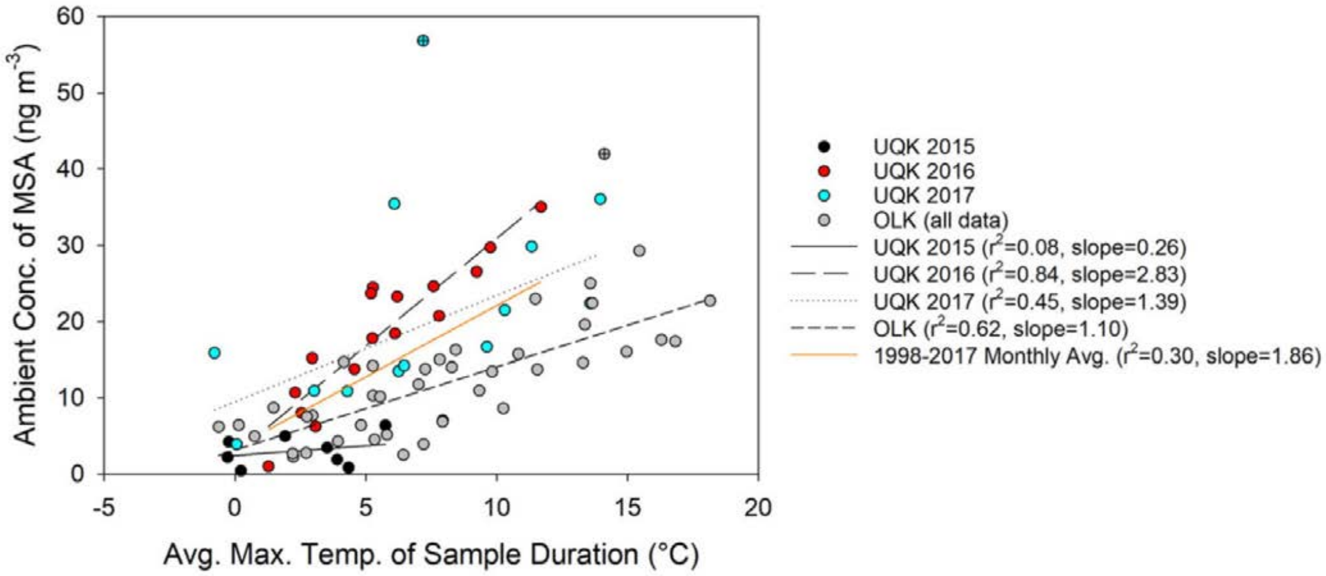
Anthropogenic vs. Natural Sources

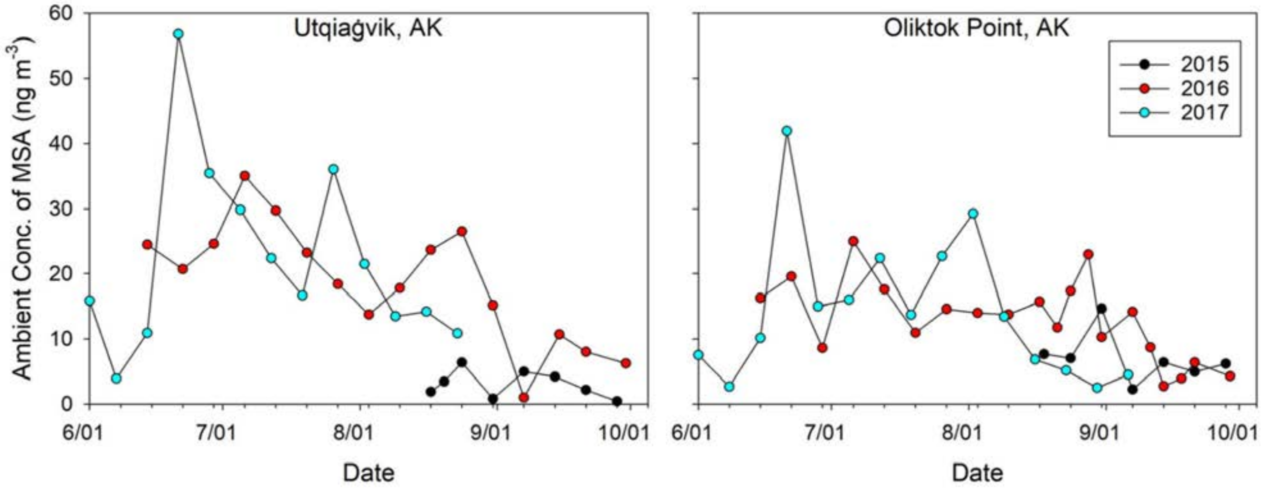


Moffett et al., 2022

Coastal Influence on Marine Sulfur Aerosol

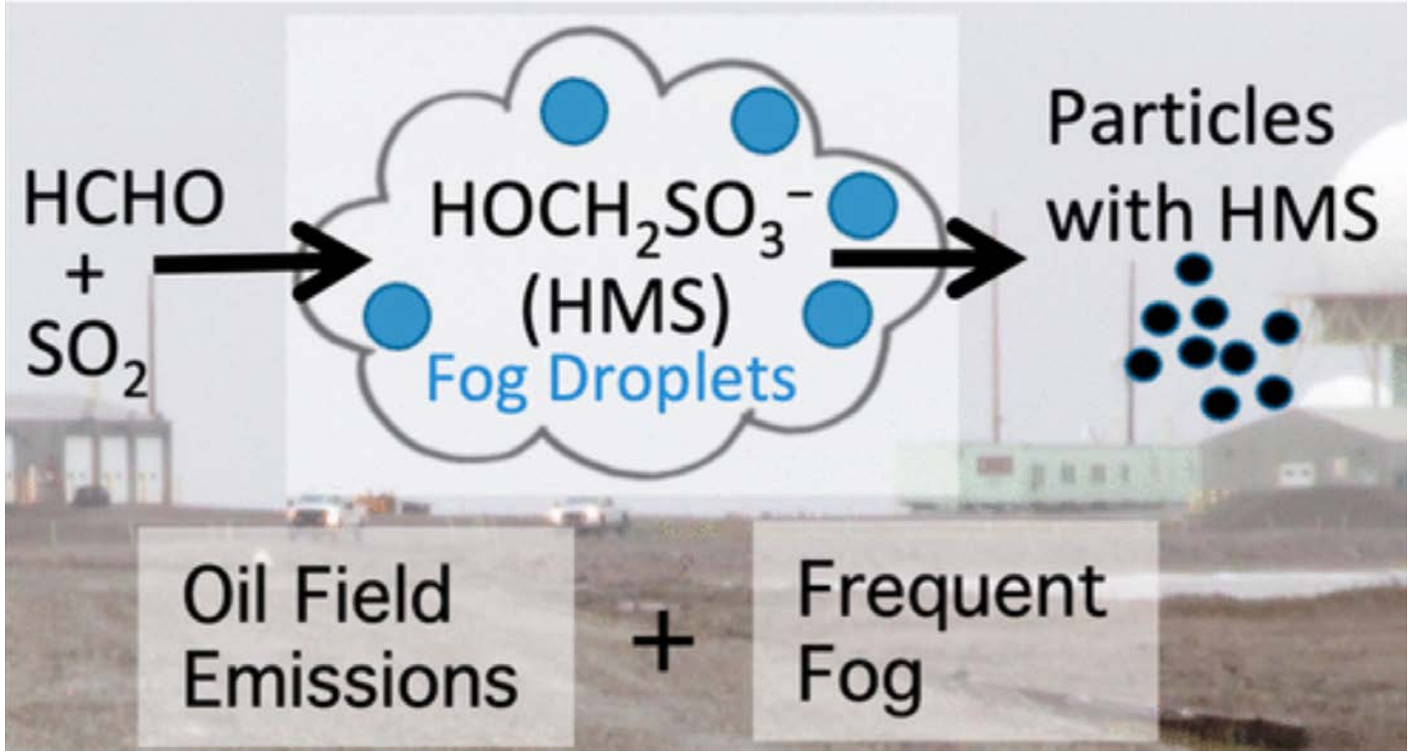


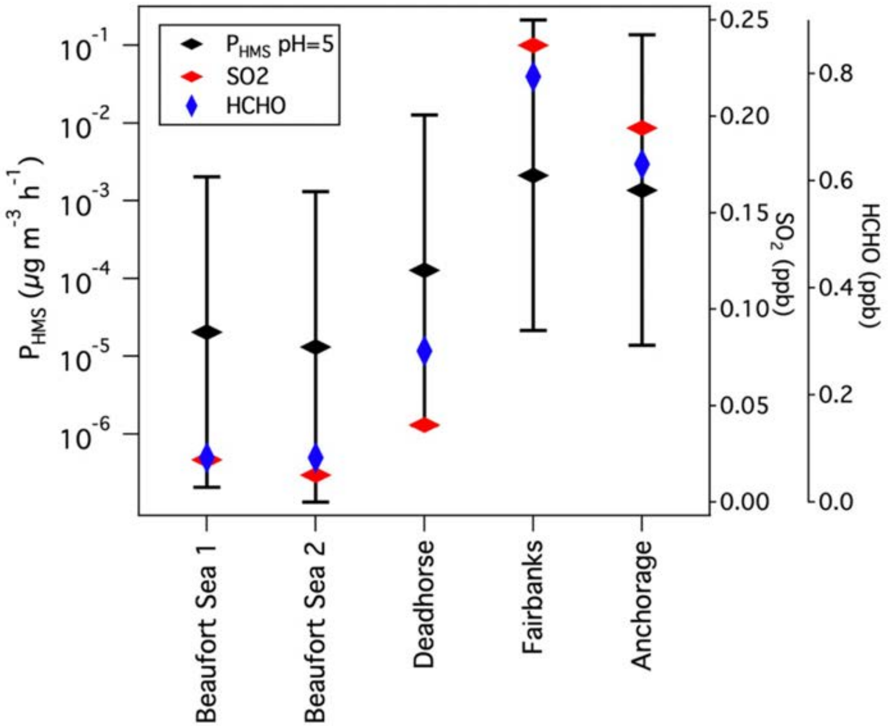




Moffett et al., 2020

Impacts of Industry on Air Quality

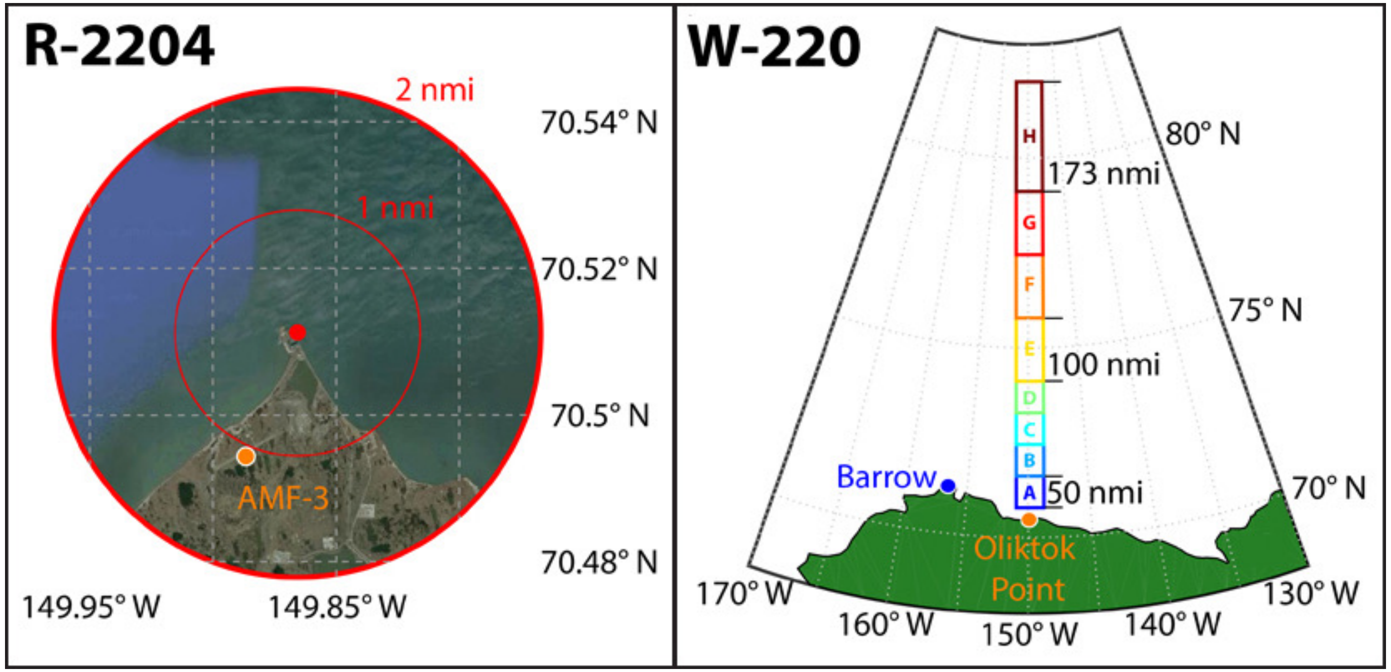




Aqueous-phase reactions between formaldehyde (HCHO) and sulfur-dioxide (SO_2) result in production of Hydroxymethanesulfonate (HMS), a process that is supported by the frequent presence of fog.

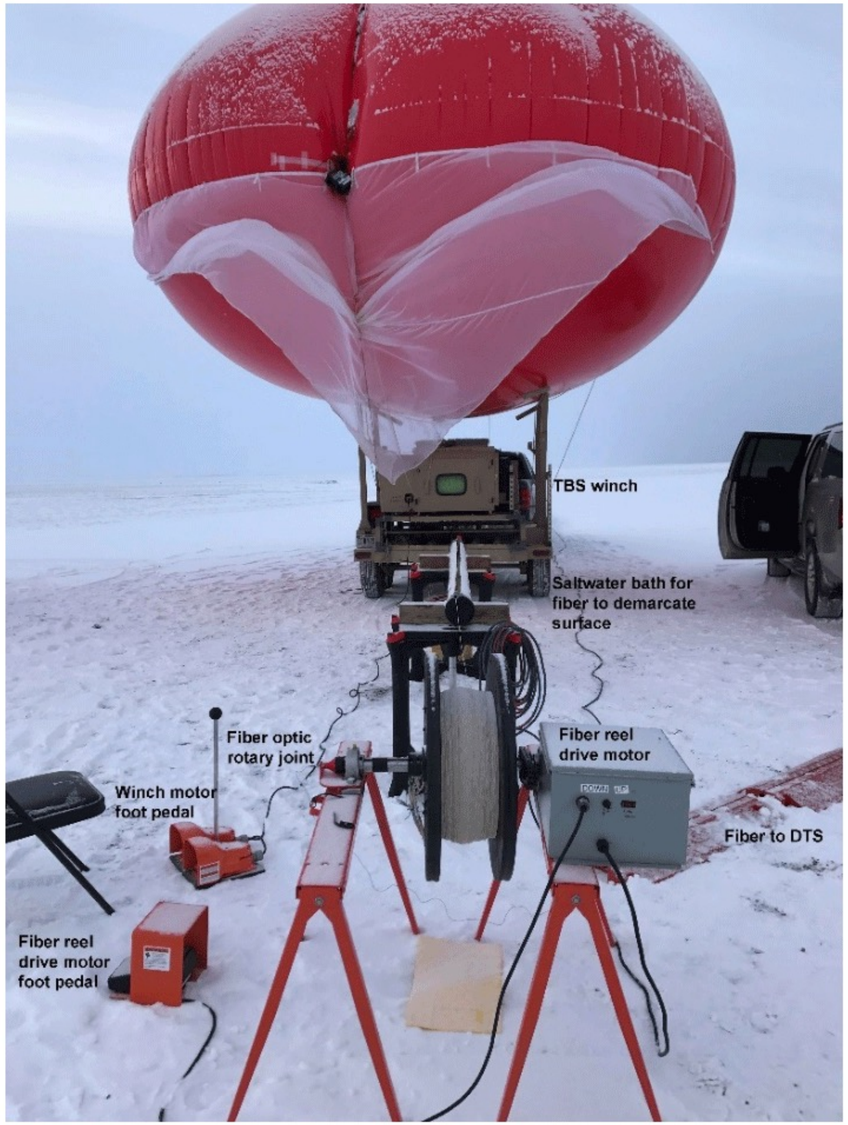
Liu et al., 2021

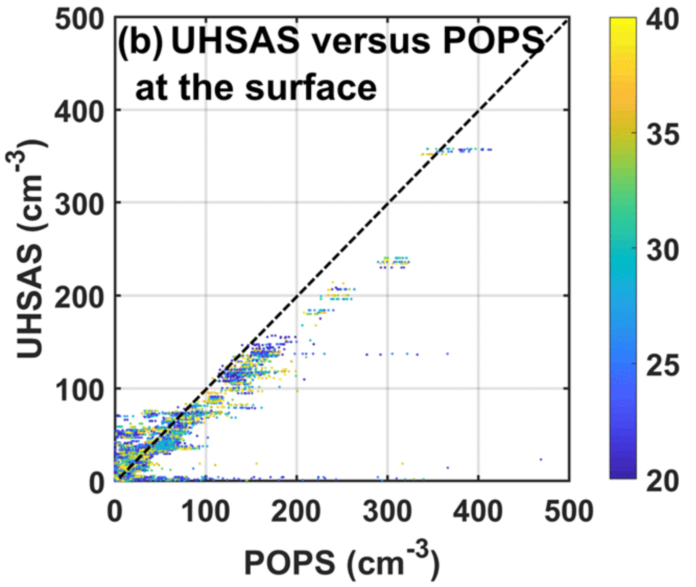
Access to Airspace for New Observational Platforms

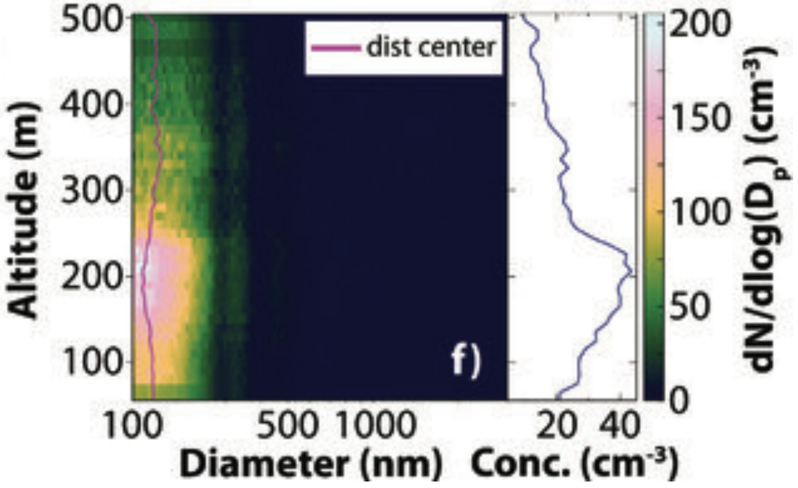


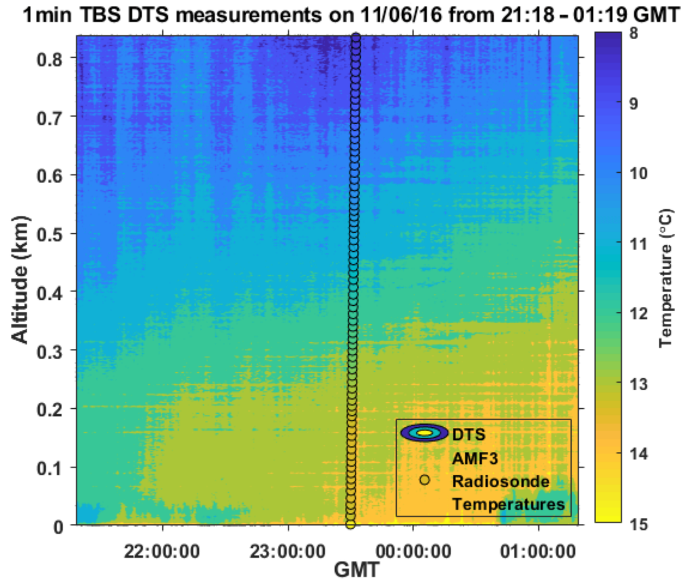
de Boer et al., 2015; 2018

Engineering Science to Advance Airborne Capabilities



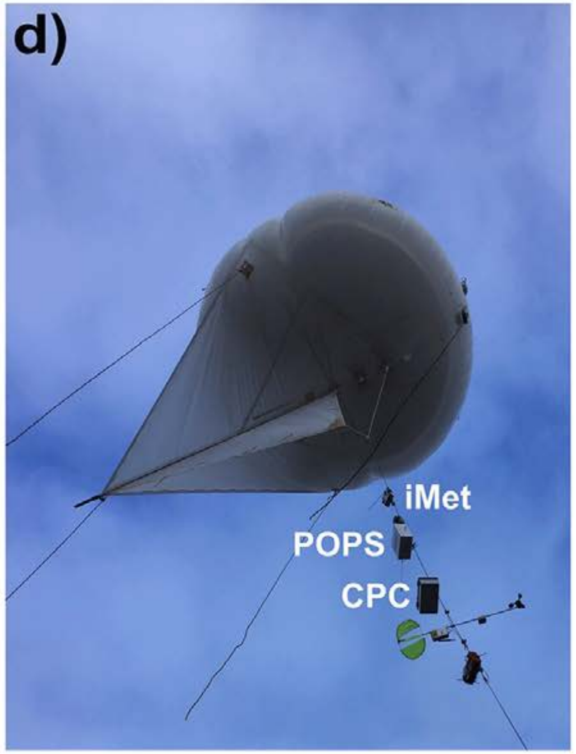


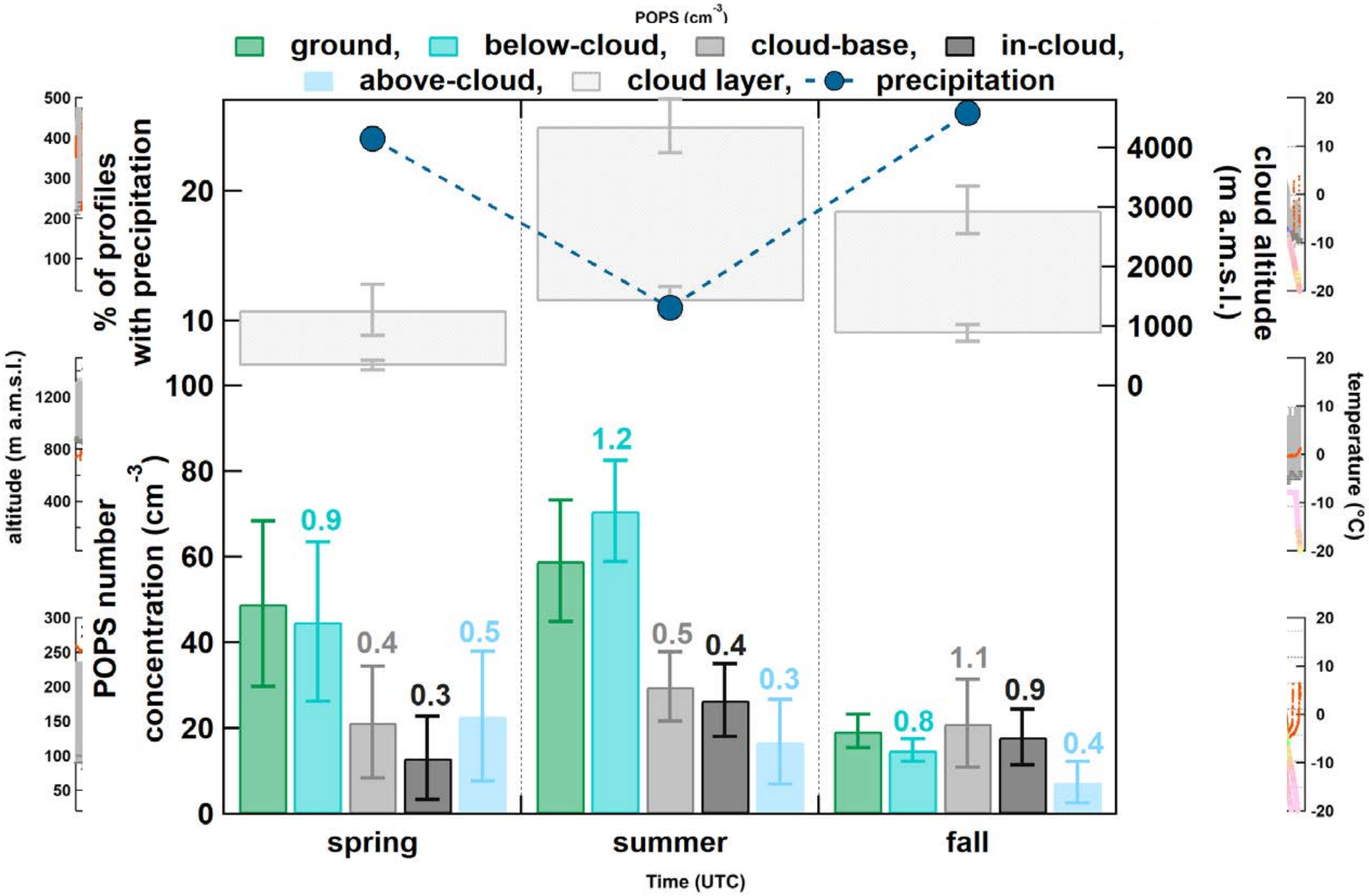




Dexheimer et al., 2019; Creamean et al., 2021; de Boer et al., 2016; de Boer et al., 2018

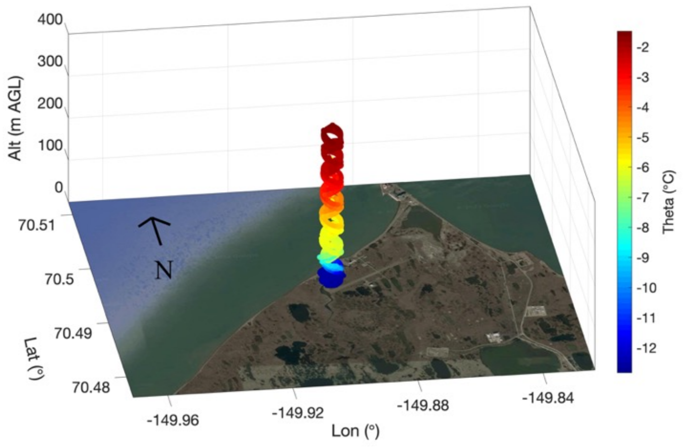
Vertical Structure of Aerosols

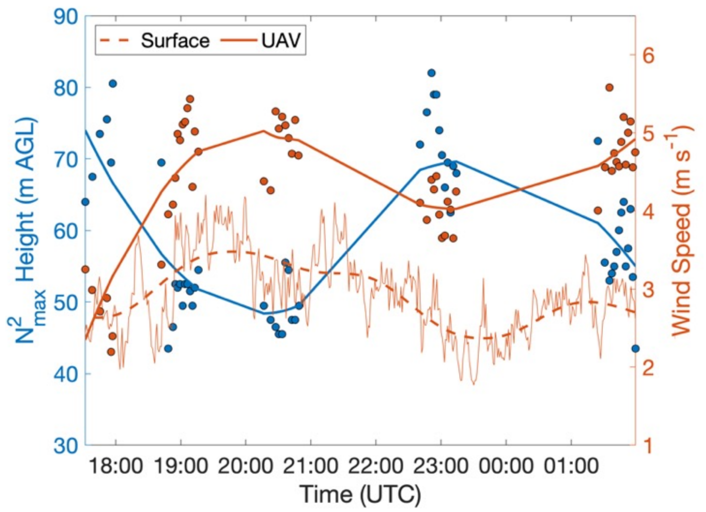


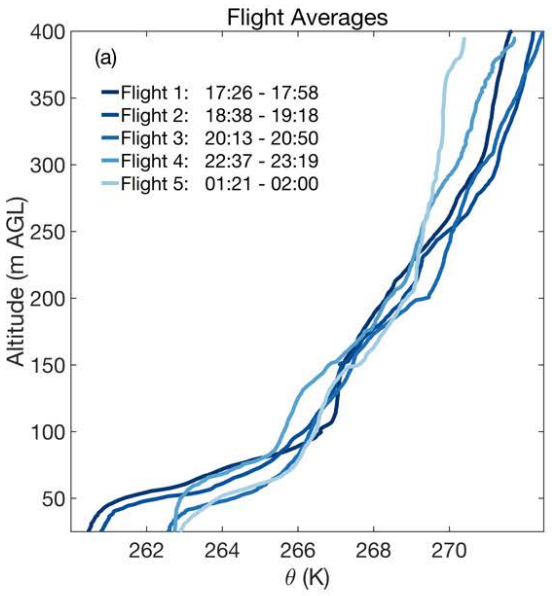


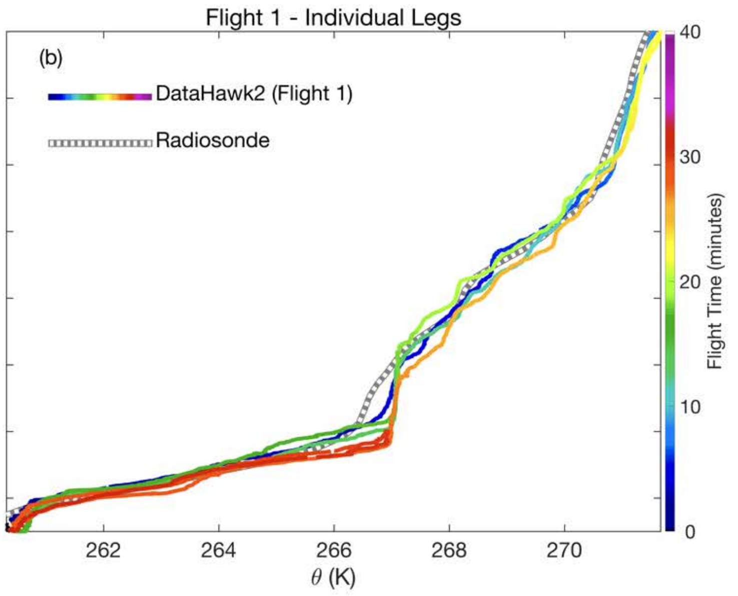
Creamean et al., 2021

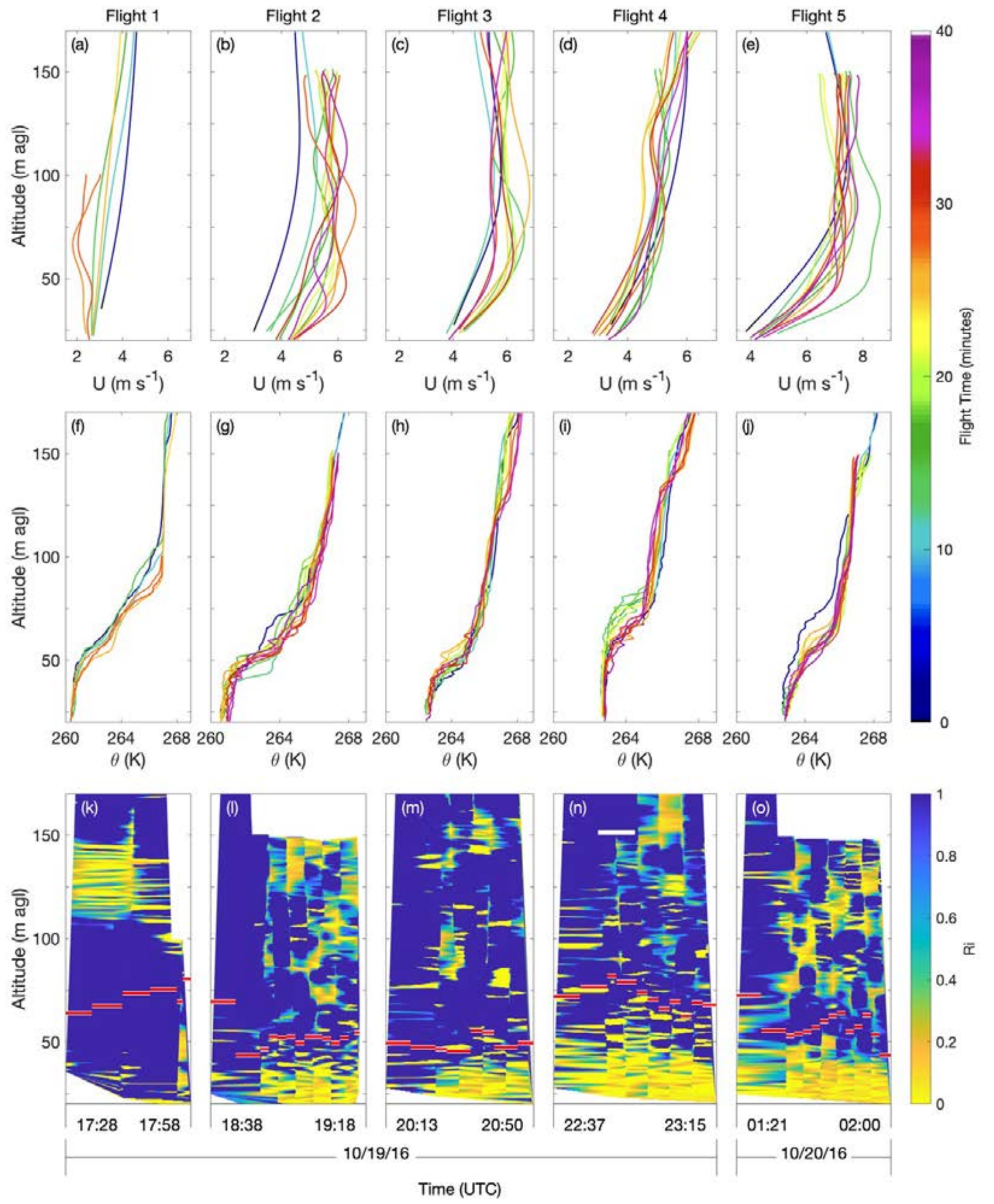
Lower Atmospheric Structure





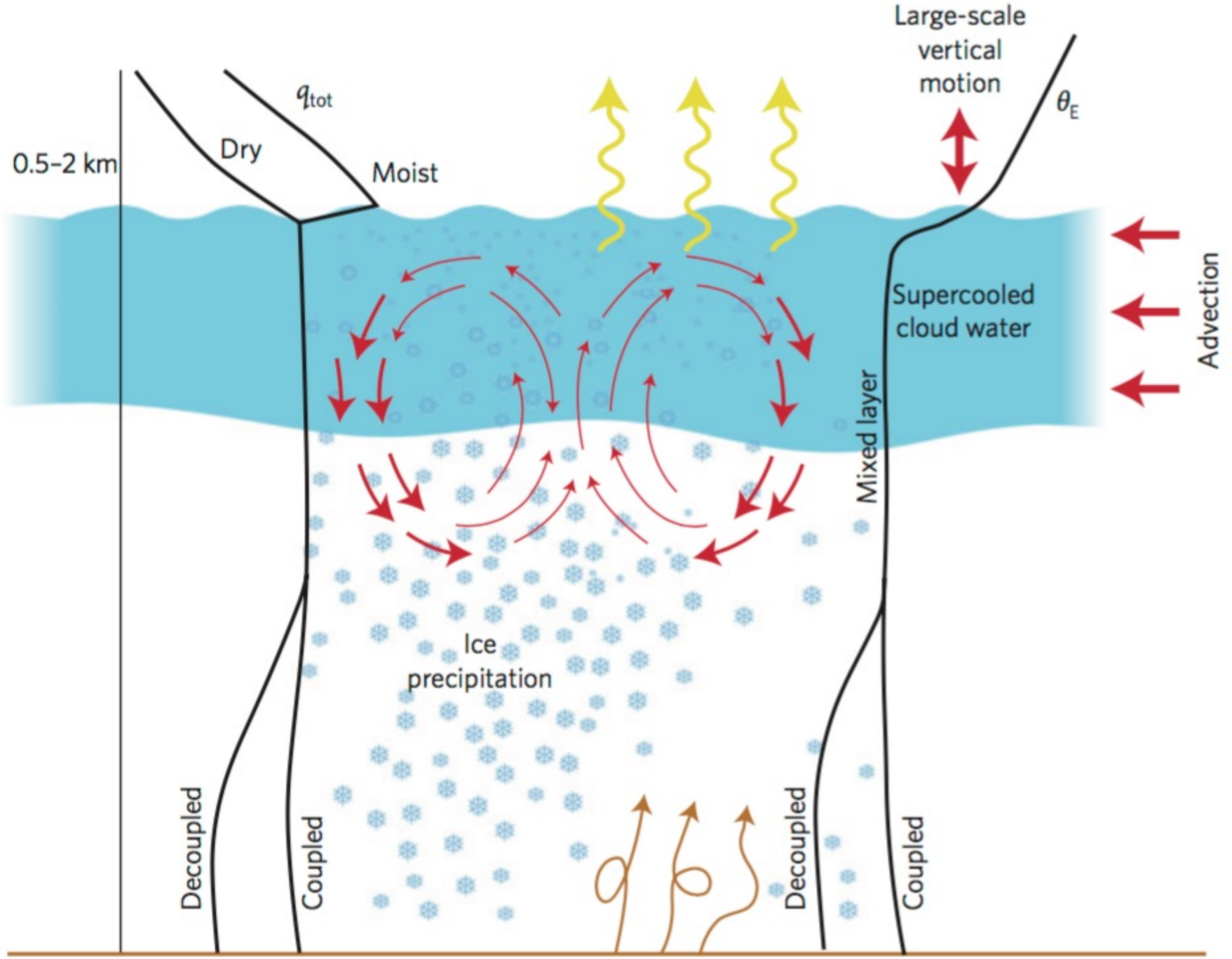






Butterworth et al., in prep.

Improving Understanding of Arctic Clouds



Radiative Cooling
- Drives buoyant production of turbulence
- Forces direct condensation within inversion layer
- Requires minimum amount of cloud liquid water

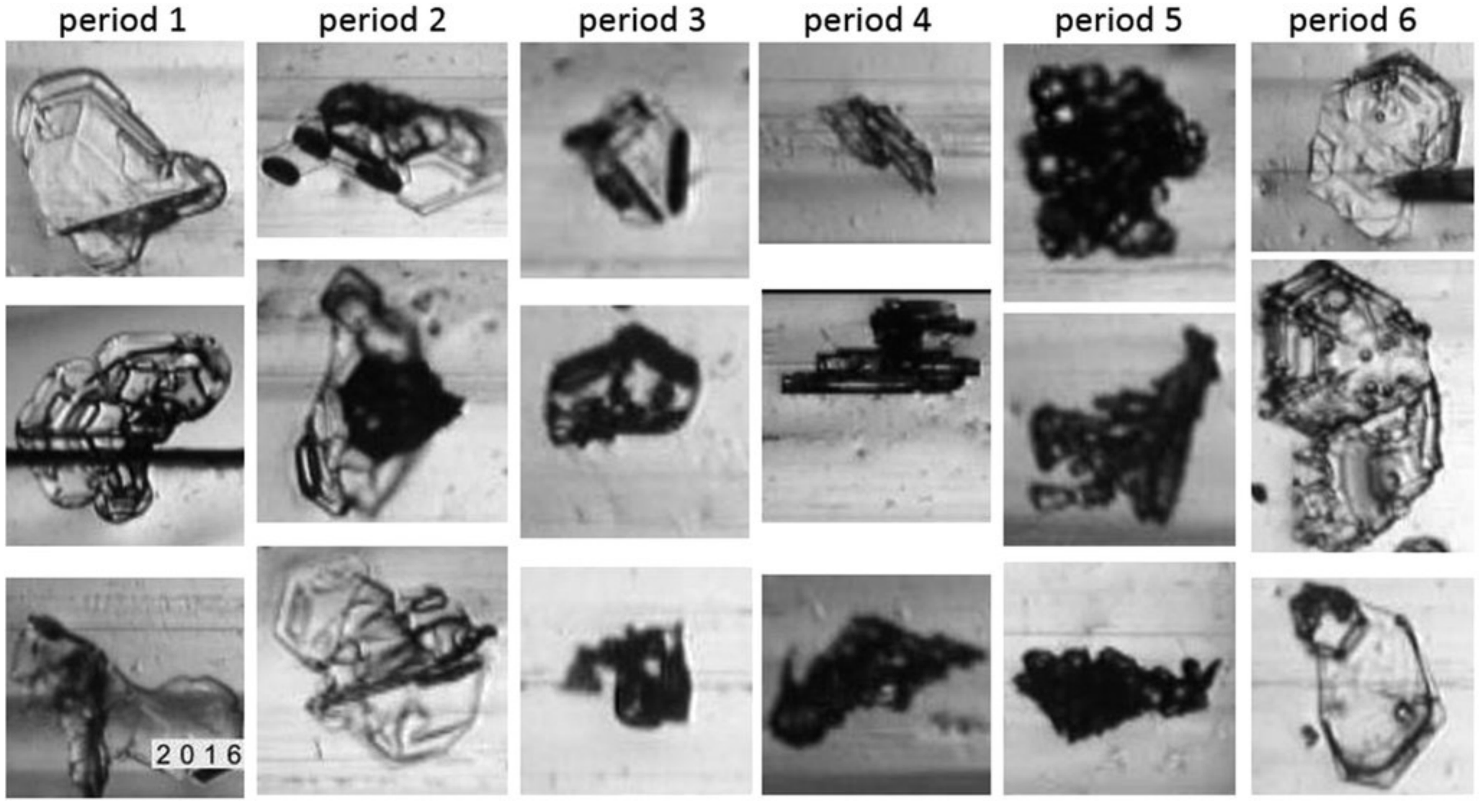
Microphysics
- Liquid forms in updrafts and sometimes within the inversion layer
- Ice nucleates in cloud
- Rapid ice growth promotes sedimentation from cloud

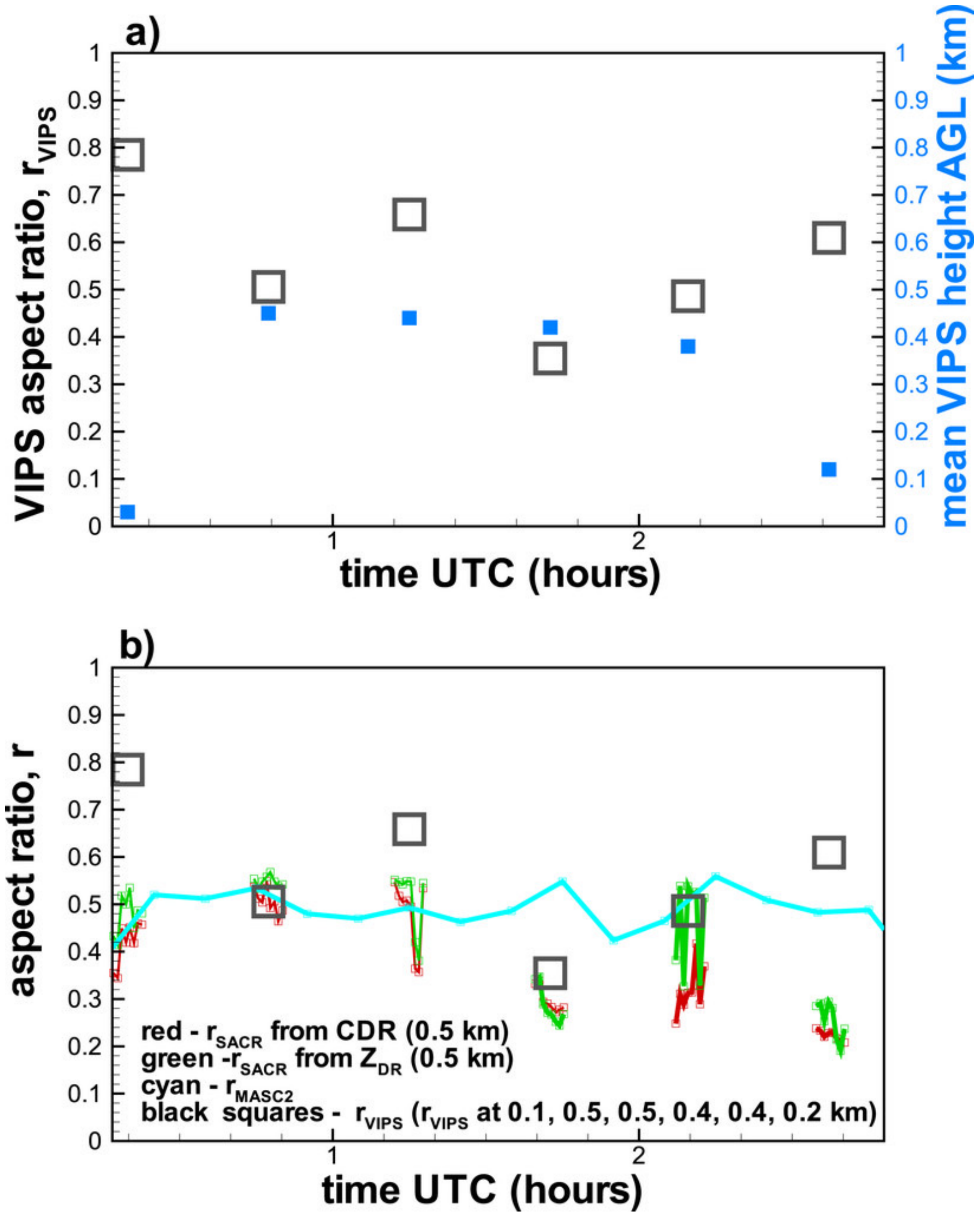
Dynamics
- Cloud-forced turbulent mixed layer with strong narrow downdrafts, weak broad updrafts, and q_{tot} and θ_E nearly constant with height
- Small-scale, weak turbulence in cloudy inversion layer
- Large-scale advection of water vapour important

Surface Layer
- Turbulence and q contributions can be weak or strong
- Sink of atmospheric moisture due to ice precipitation
- Surface type (ocean, ice, land) influences interaction with cloud

Morrison et al., 2012

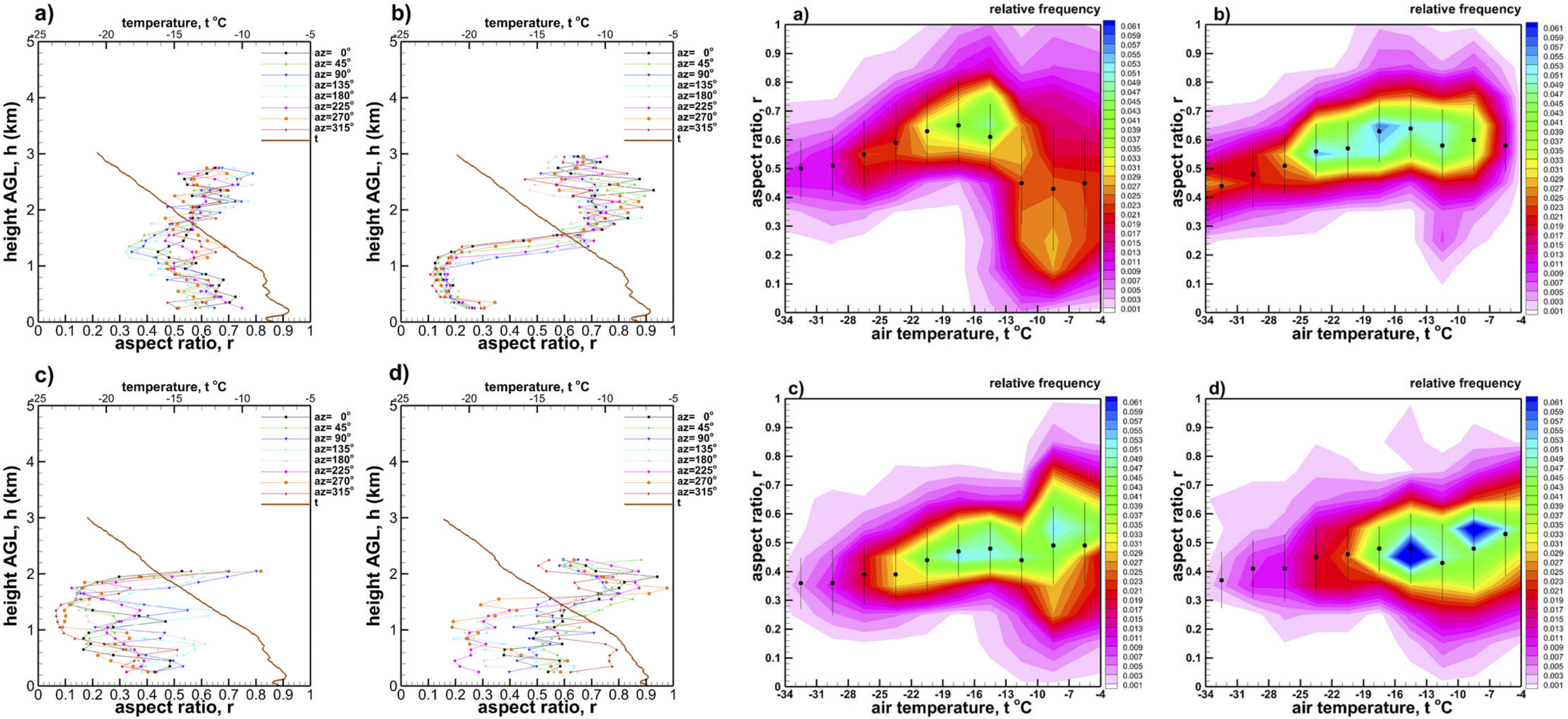
Perspectives on Ice Crystal Properties





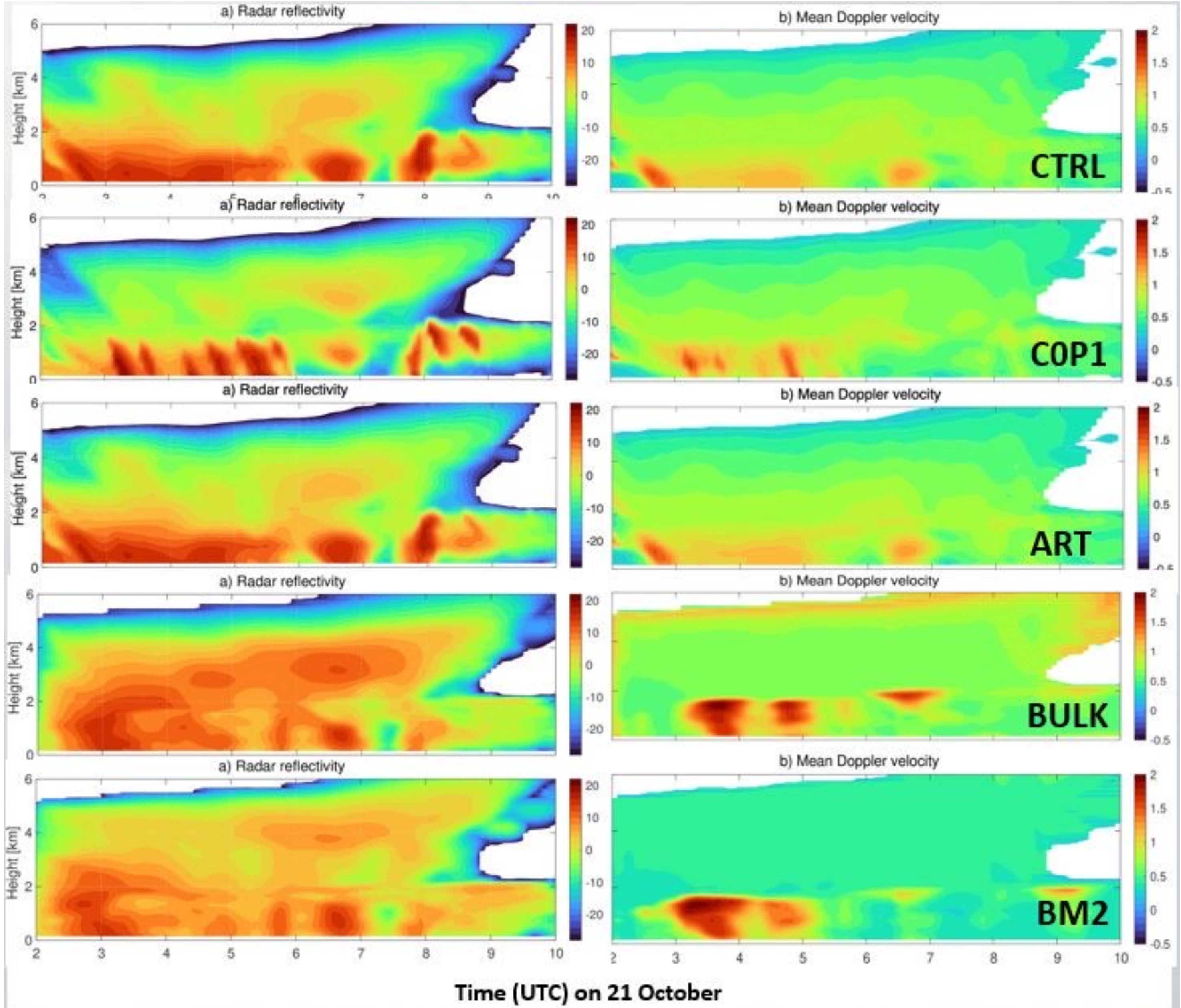
Matrosov et al., 2017

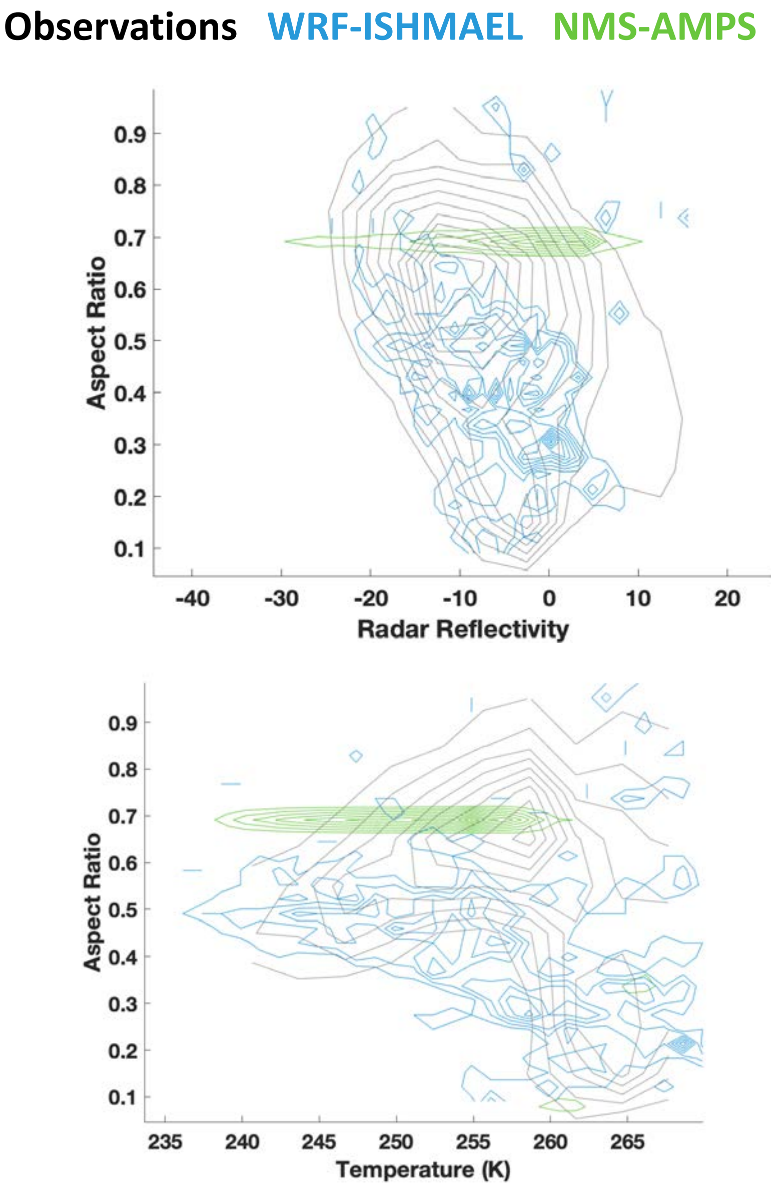
Documenting Ice Shape with Scanning Radar



Matrosov et al., 2020

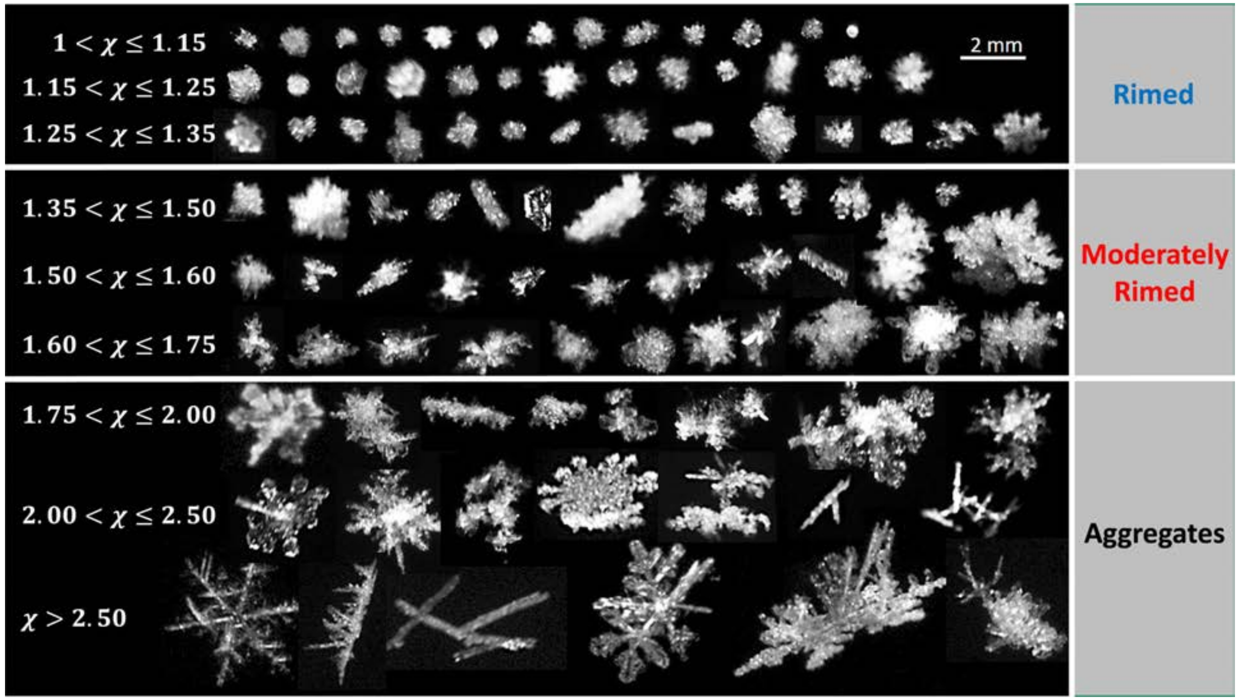
Modeling Ice Crystal Habit

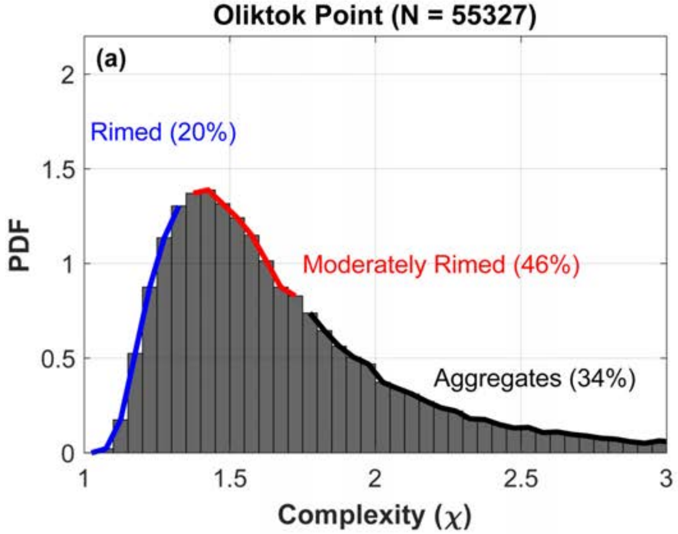


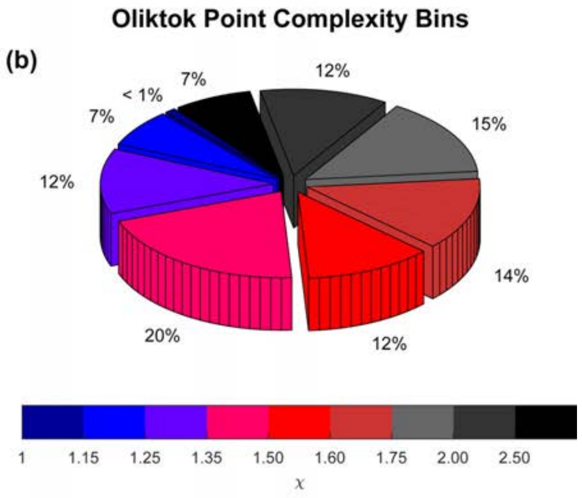


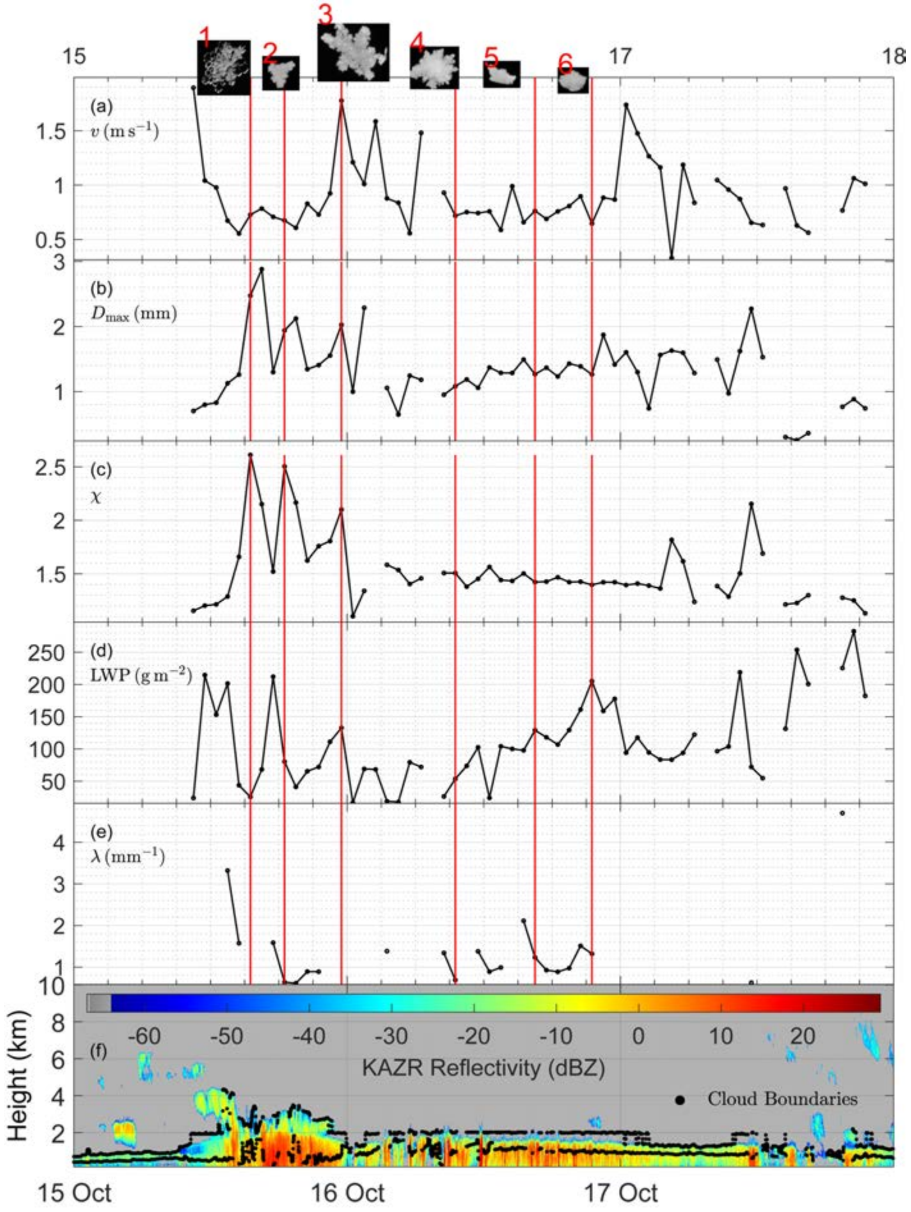
de Boer, Hashino, Jensen, Matrosov and Solomon, in prep.

Documenting Ice Riming Frequency



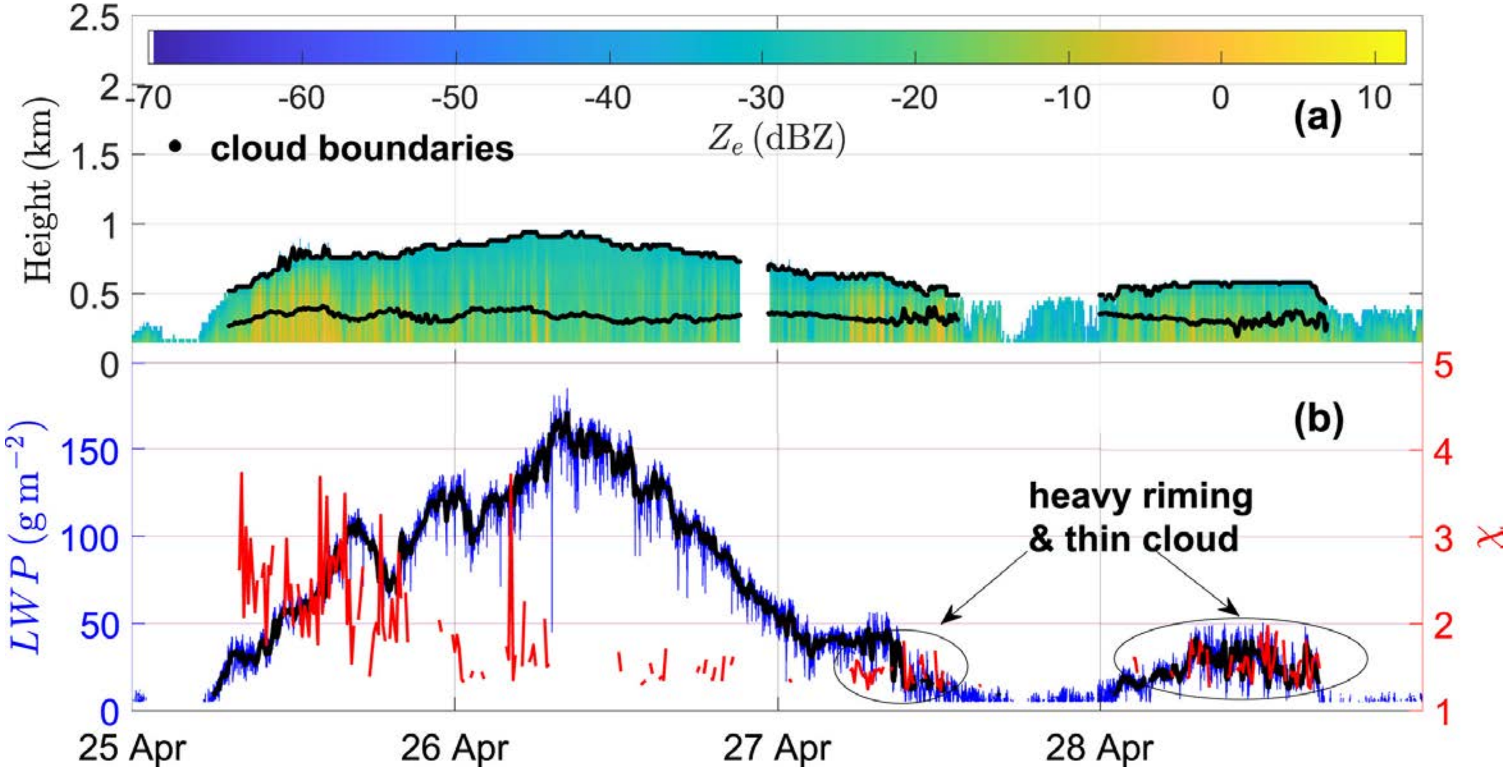


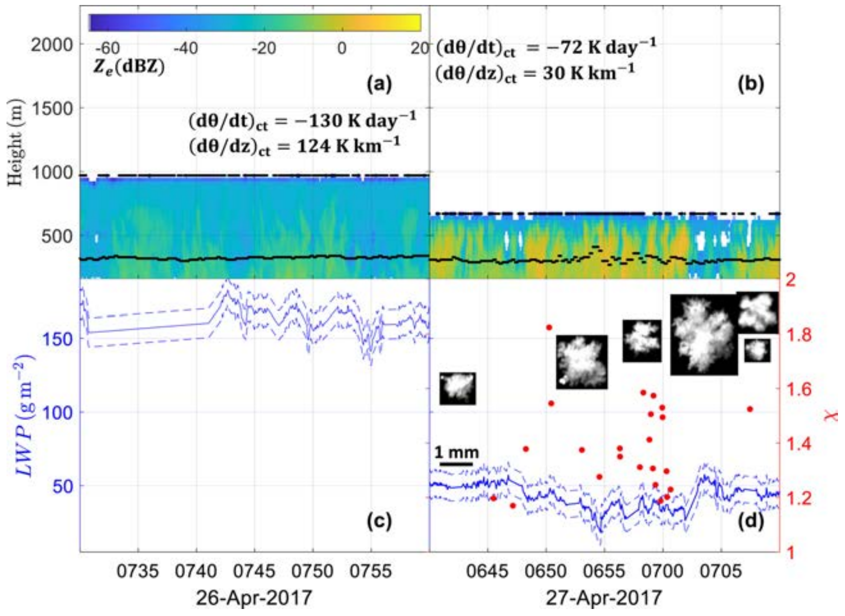


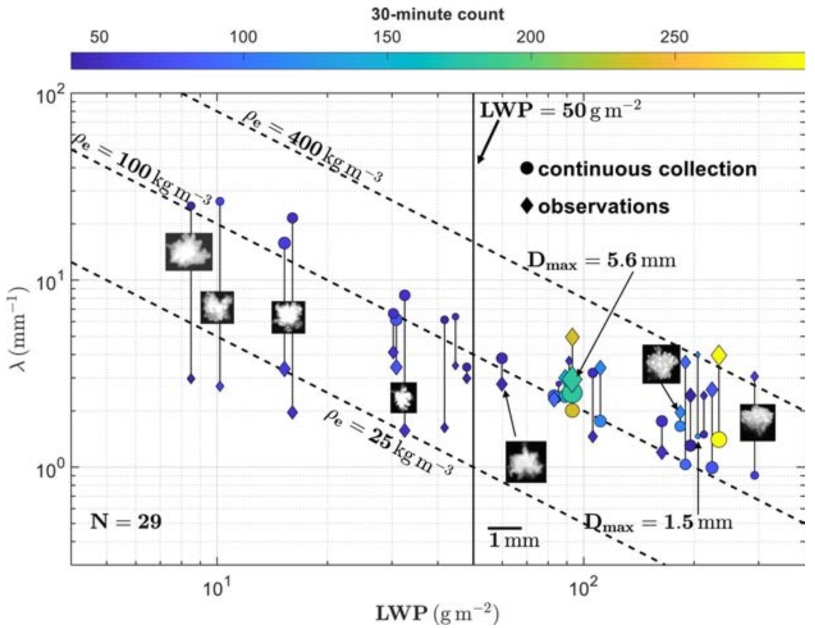


Fitch and Garrett, 2022

Riming in Thin Liquid Clouds

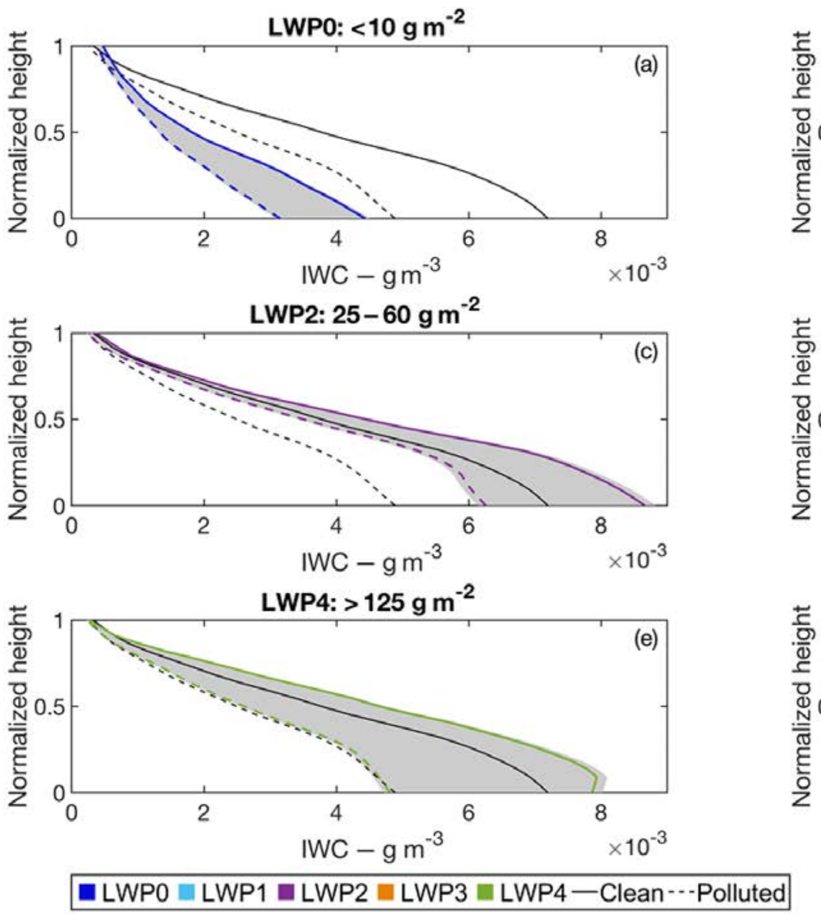


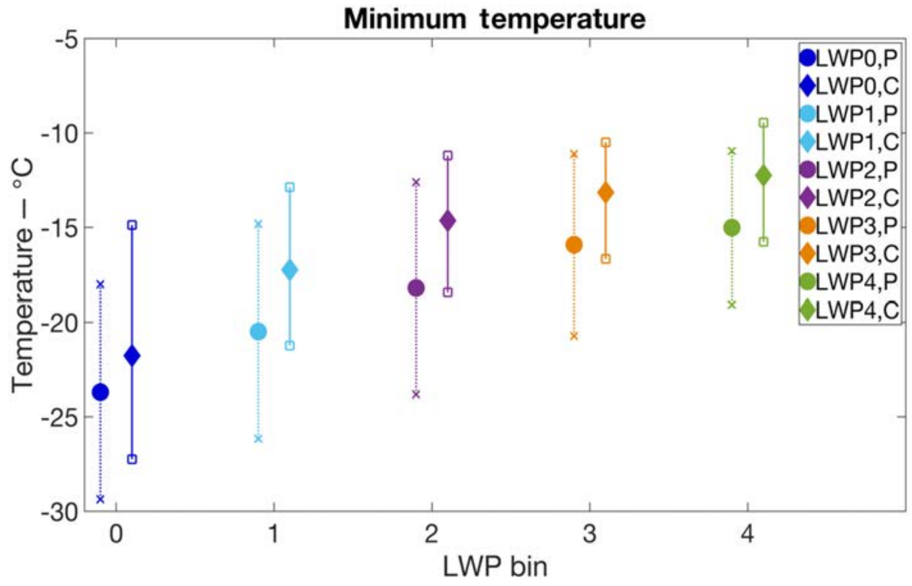


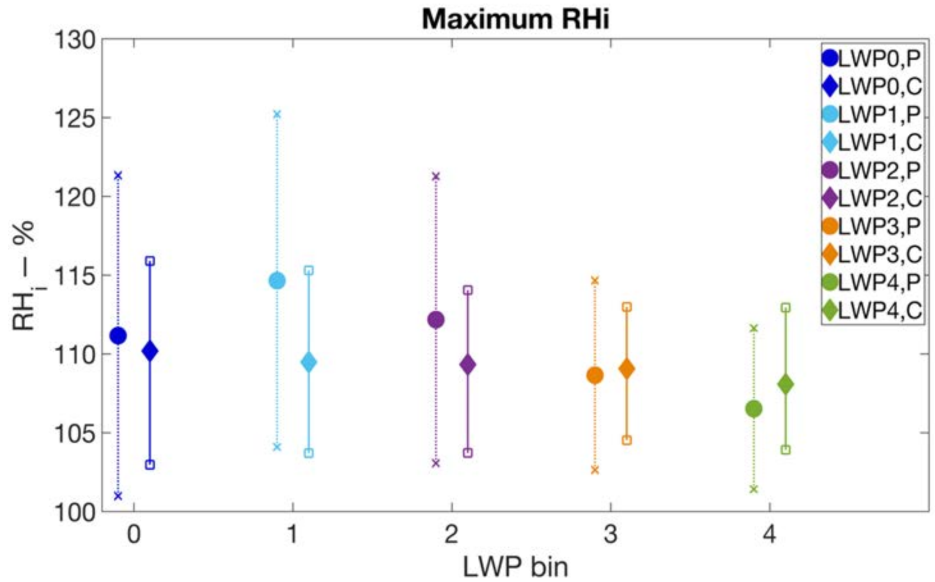


Fitch and Garrett, 2021

Observed Aerosol Influence on Precipitation

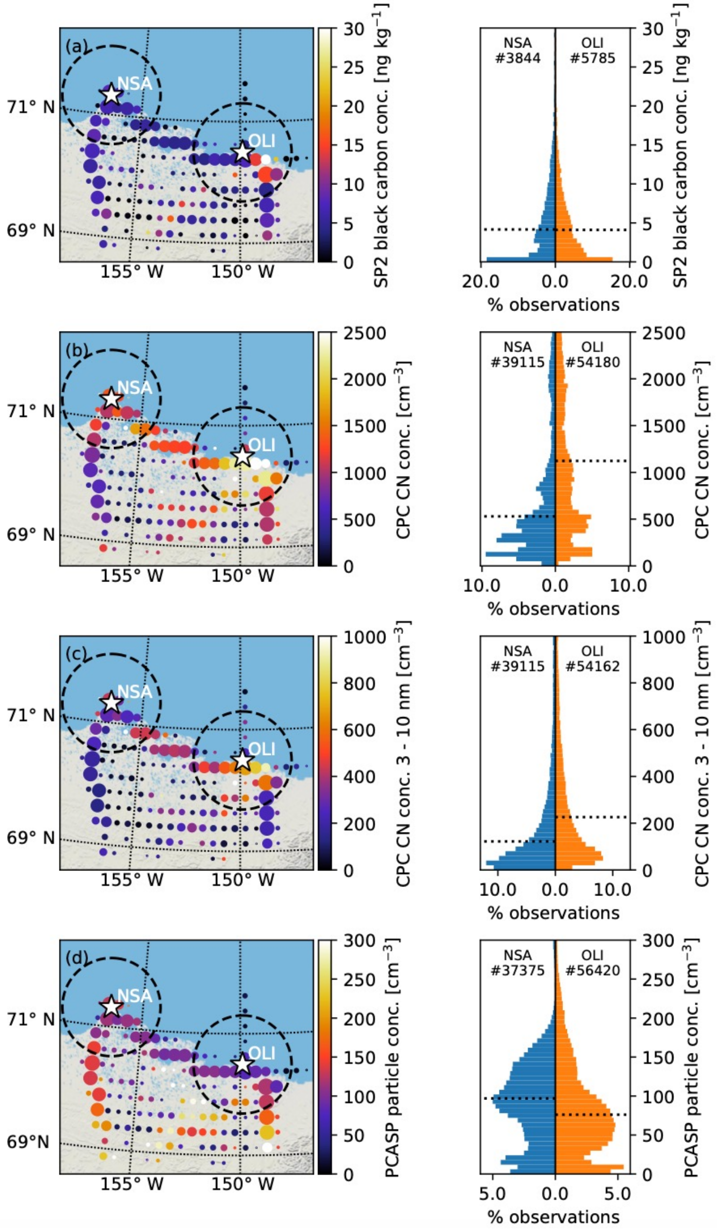


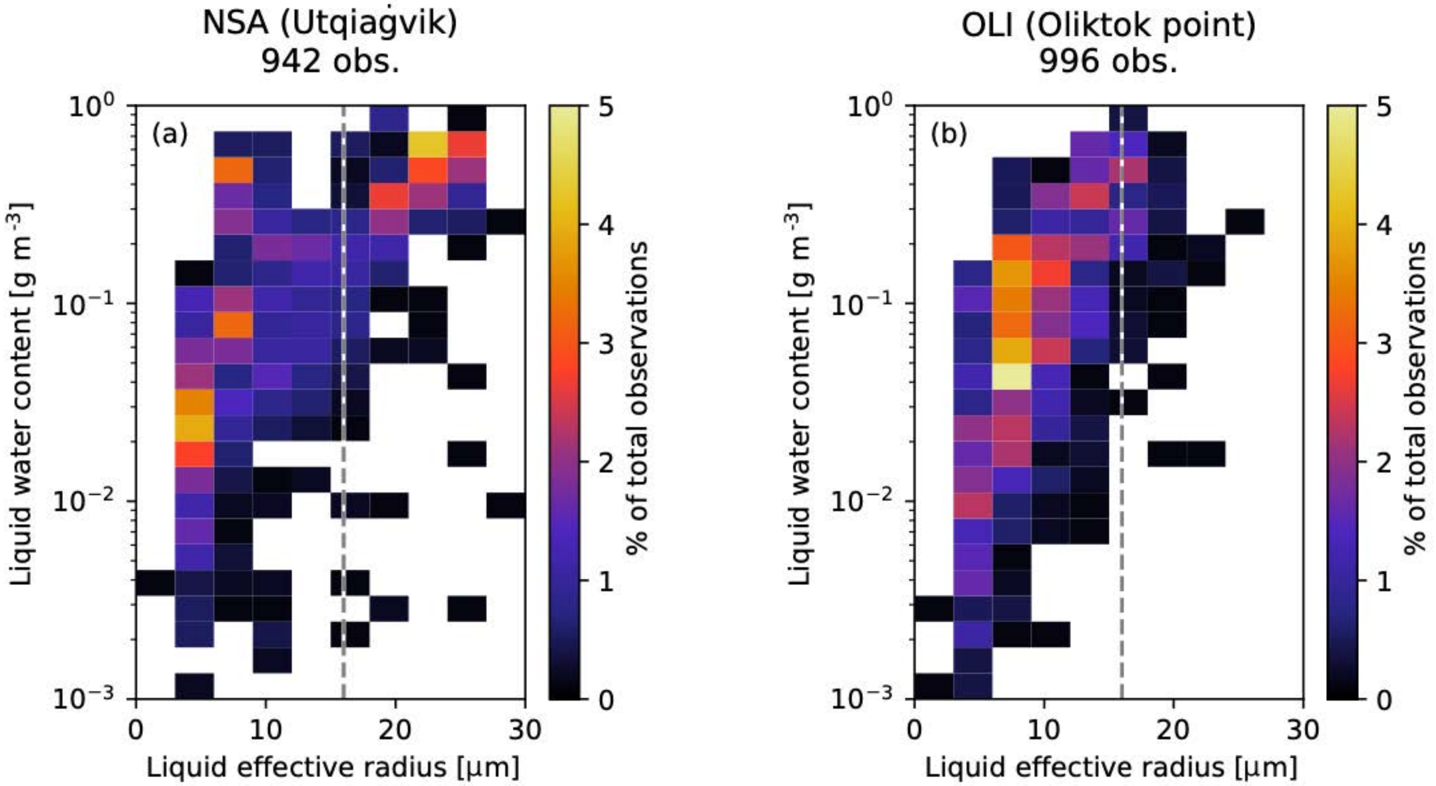




Norgren et al., 2018

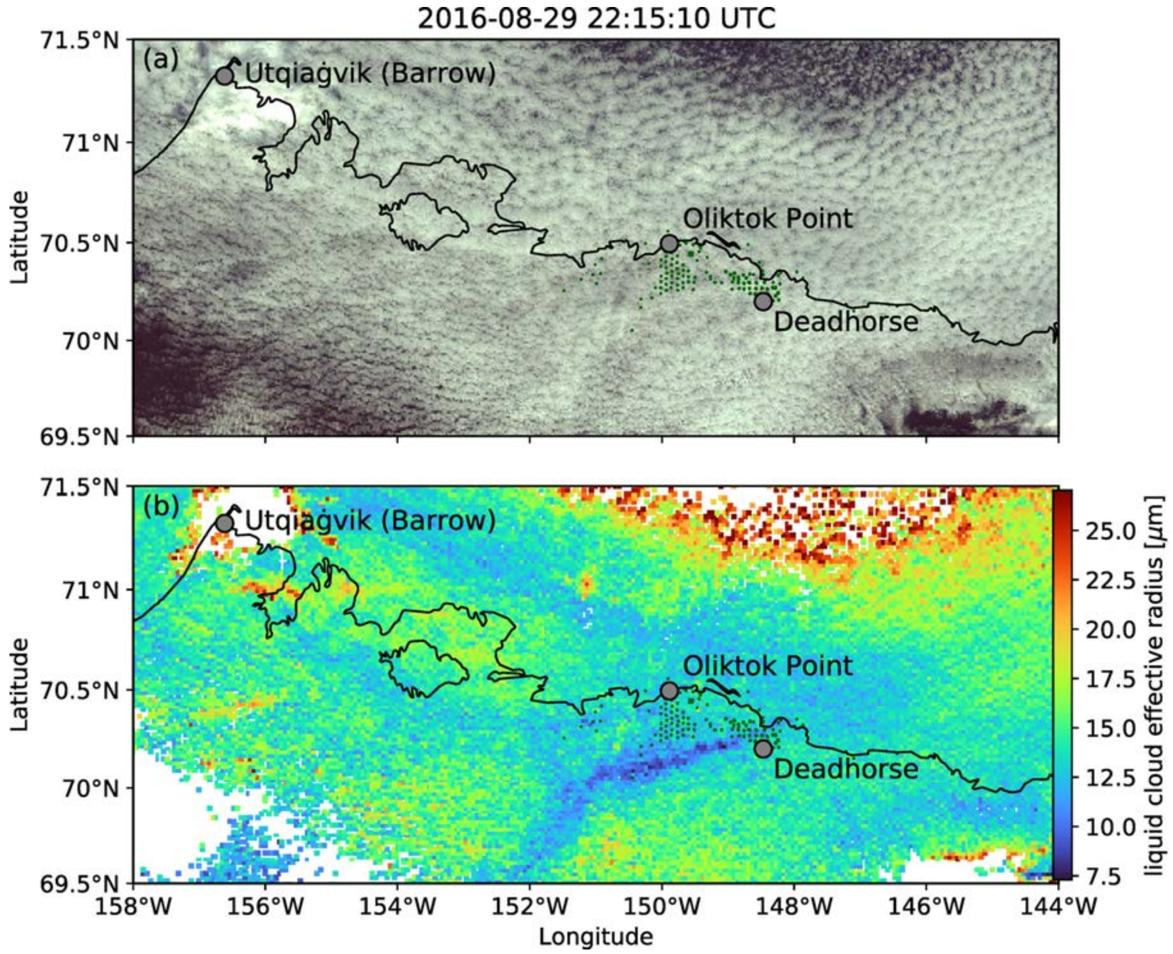
Clouds in Industrialized Arctic

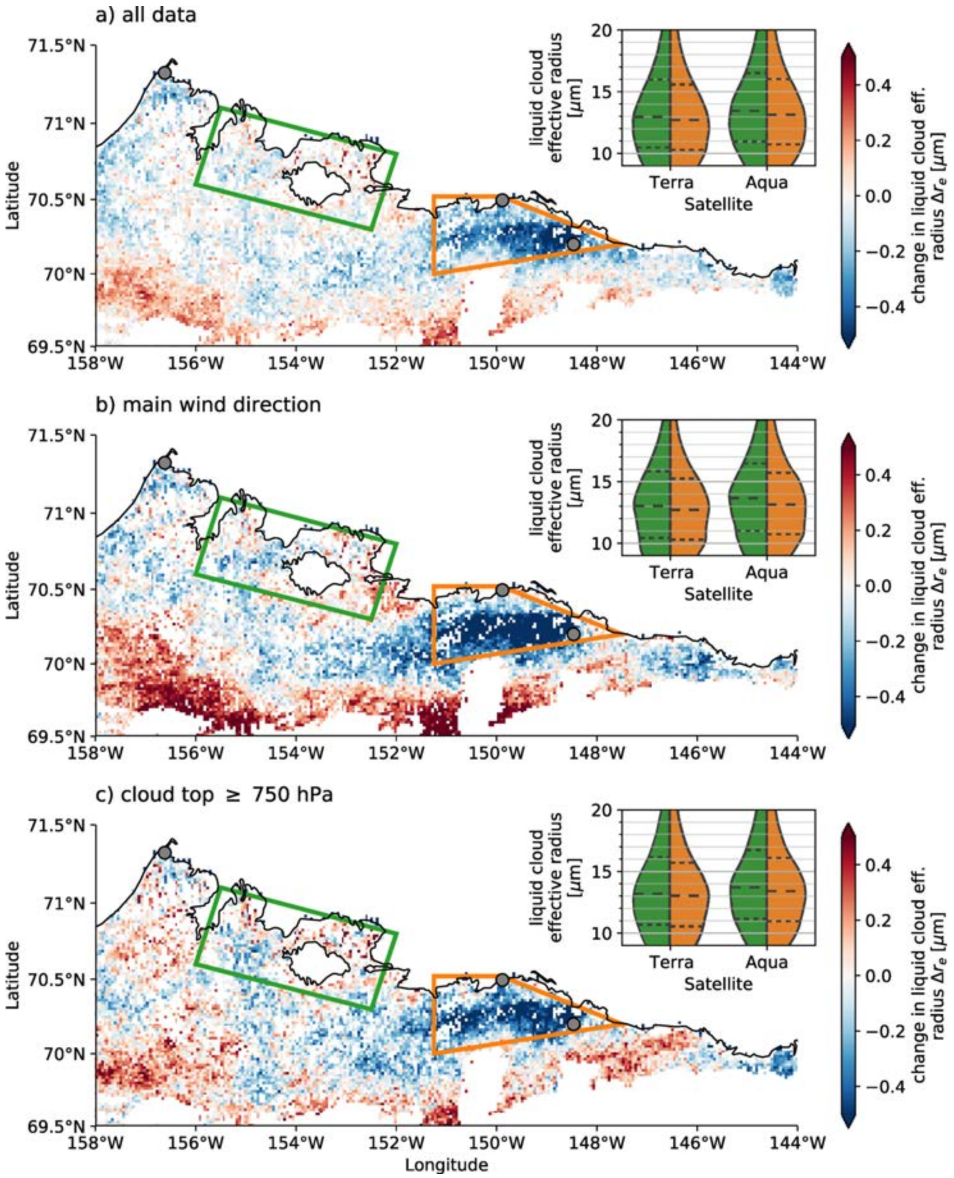




Maahn et al., 2017

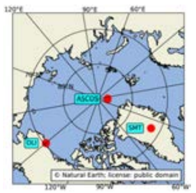
Clouds in Industrialized Arctic

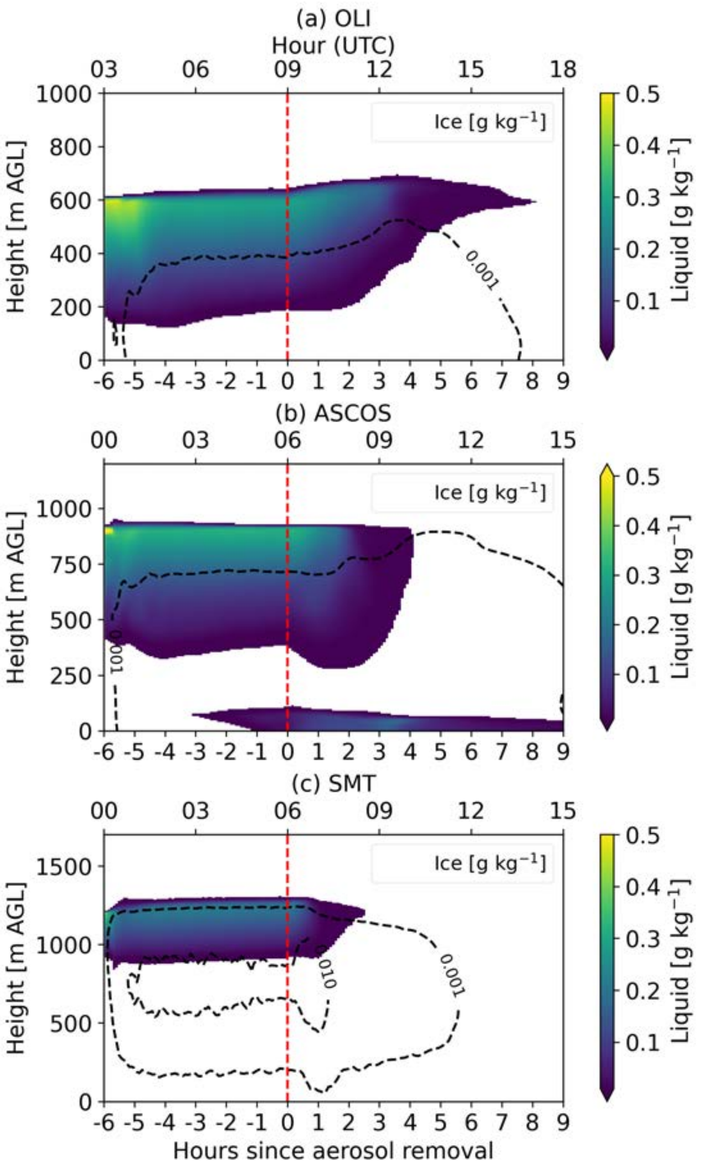


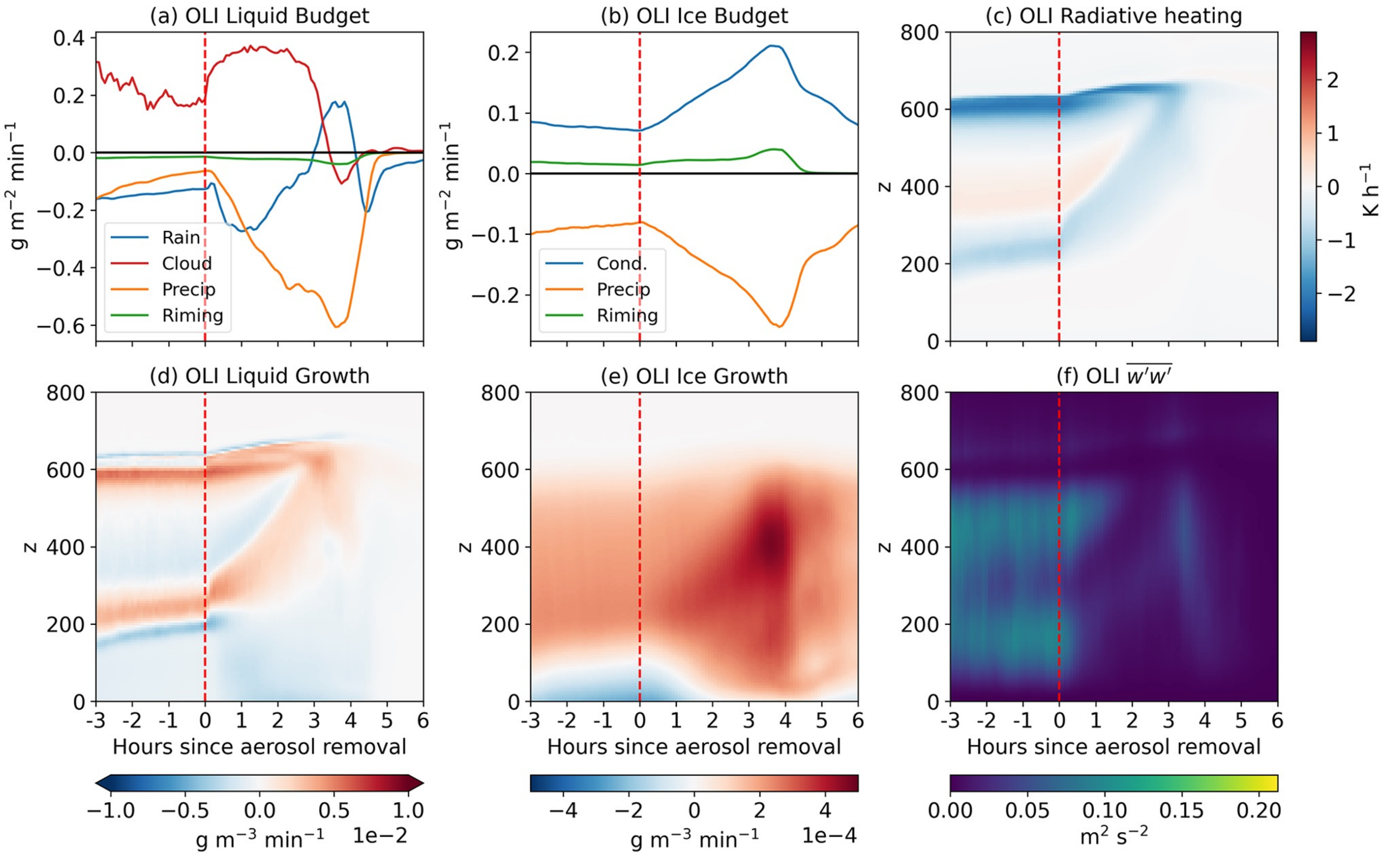


Maahn et al., 2021

Understanding Aerosol-Limited Cloud Regimes

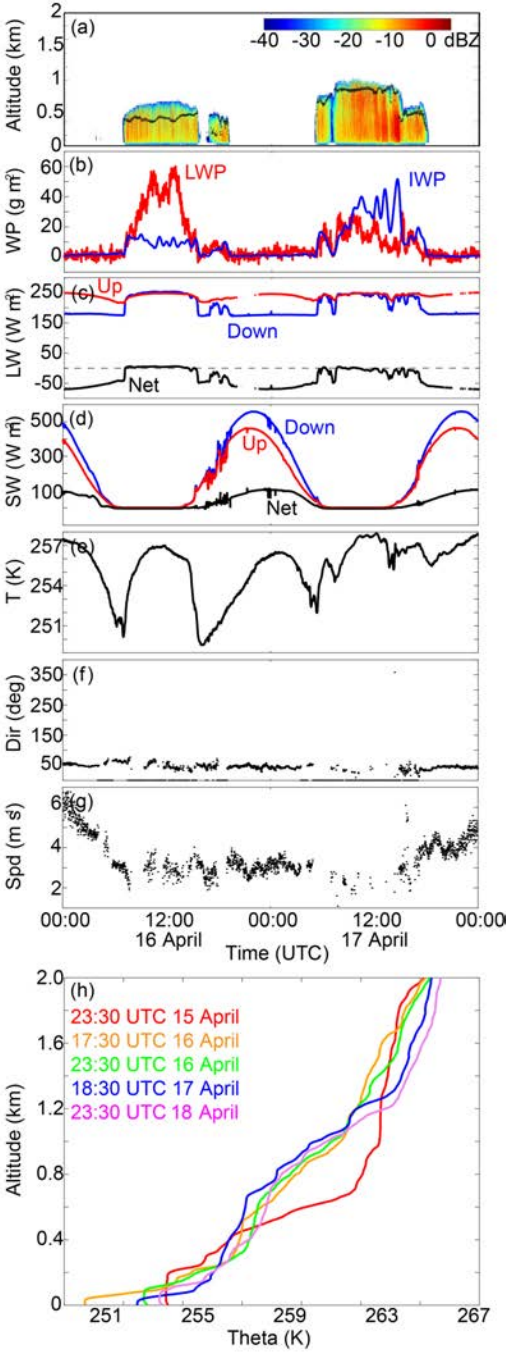


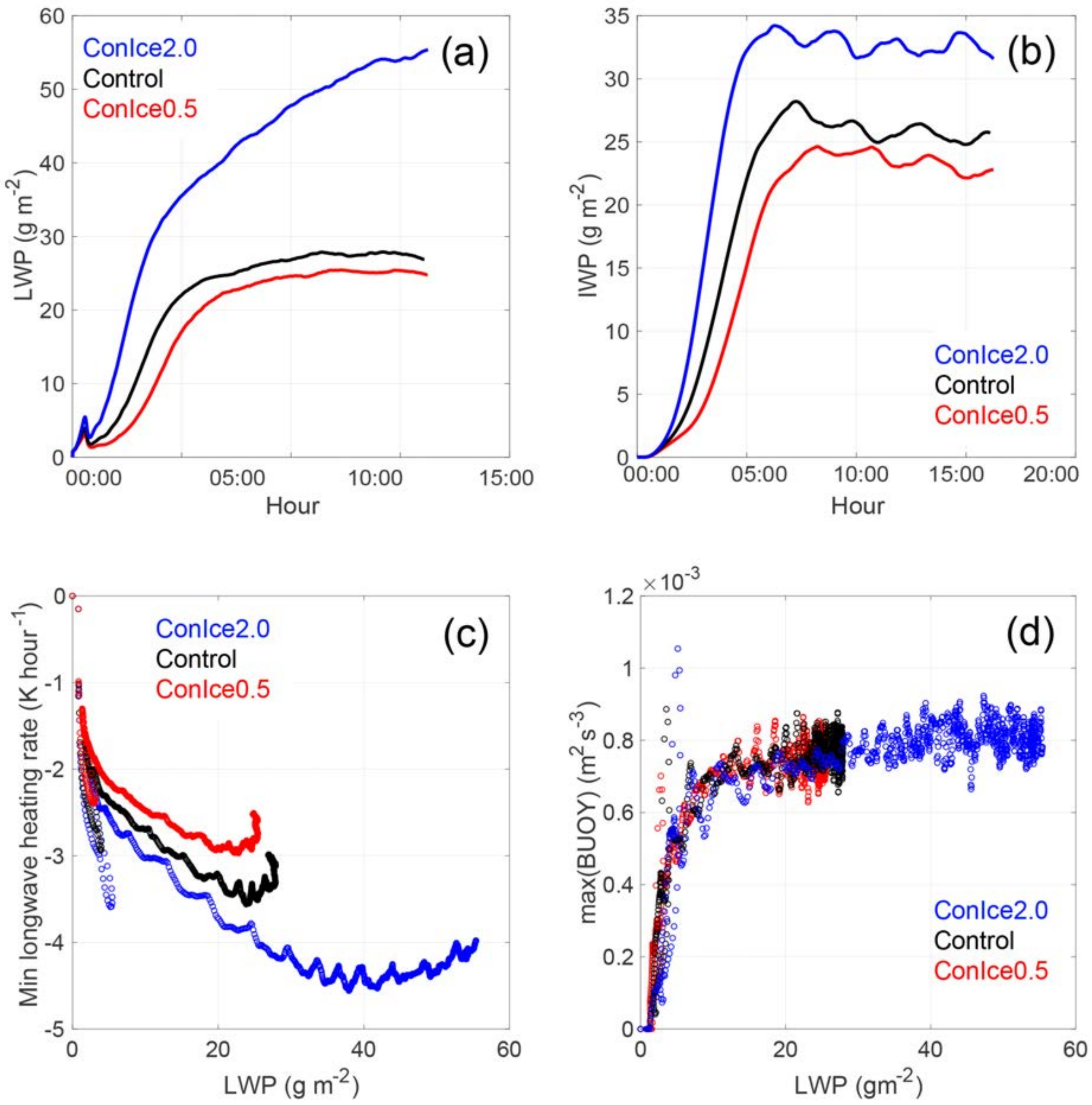


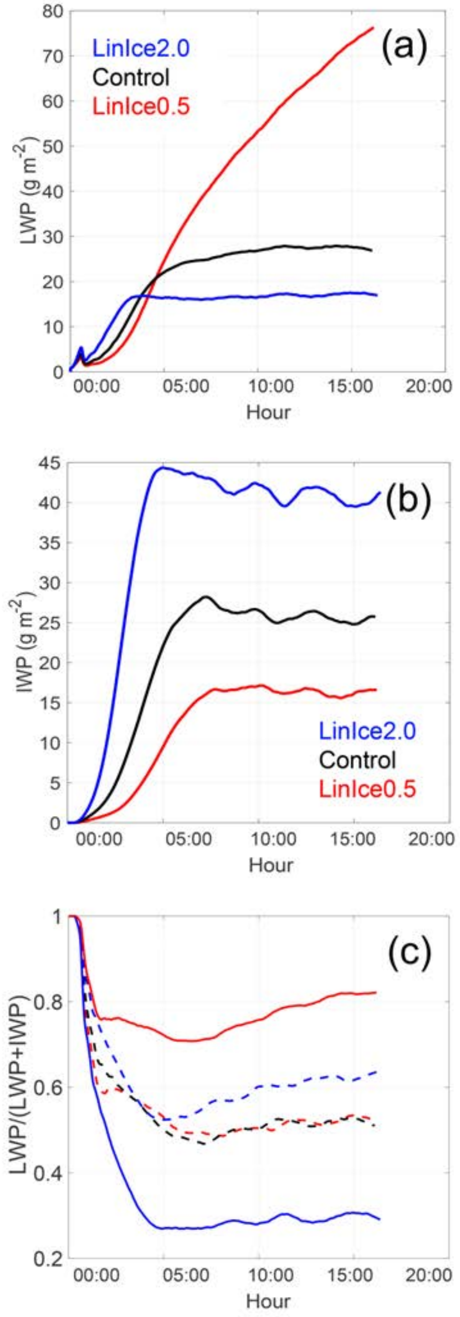


Sterzinger et al., 2022

The Importance of Aerosol Type

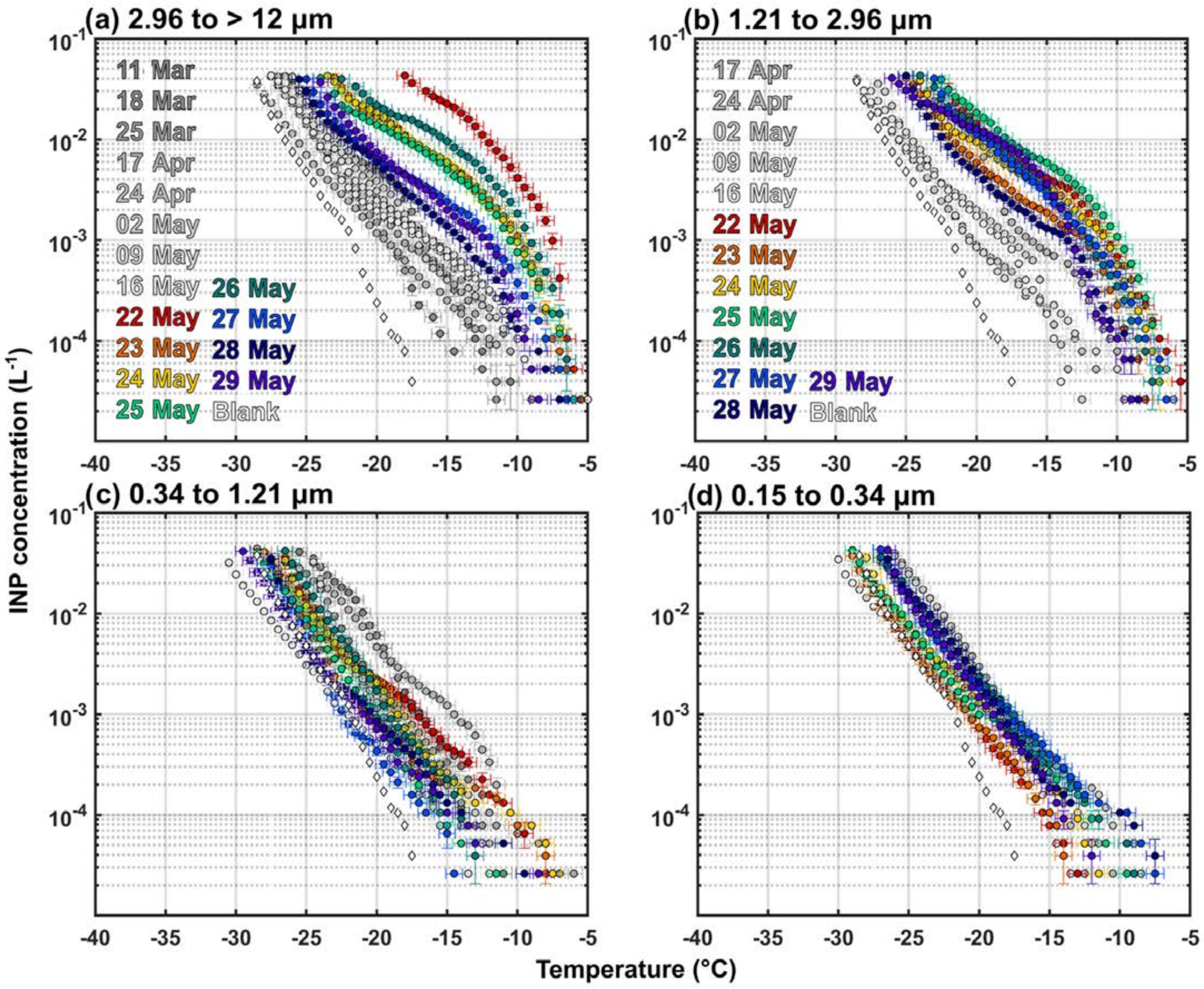


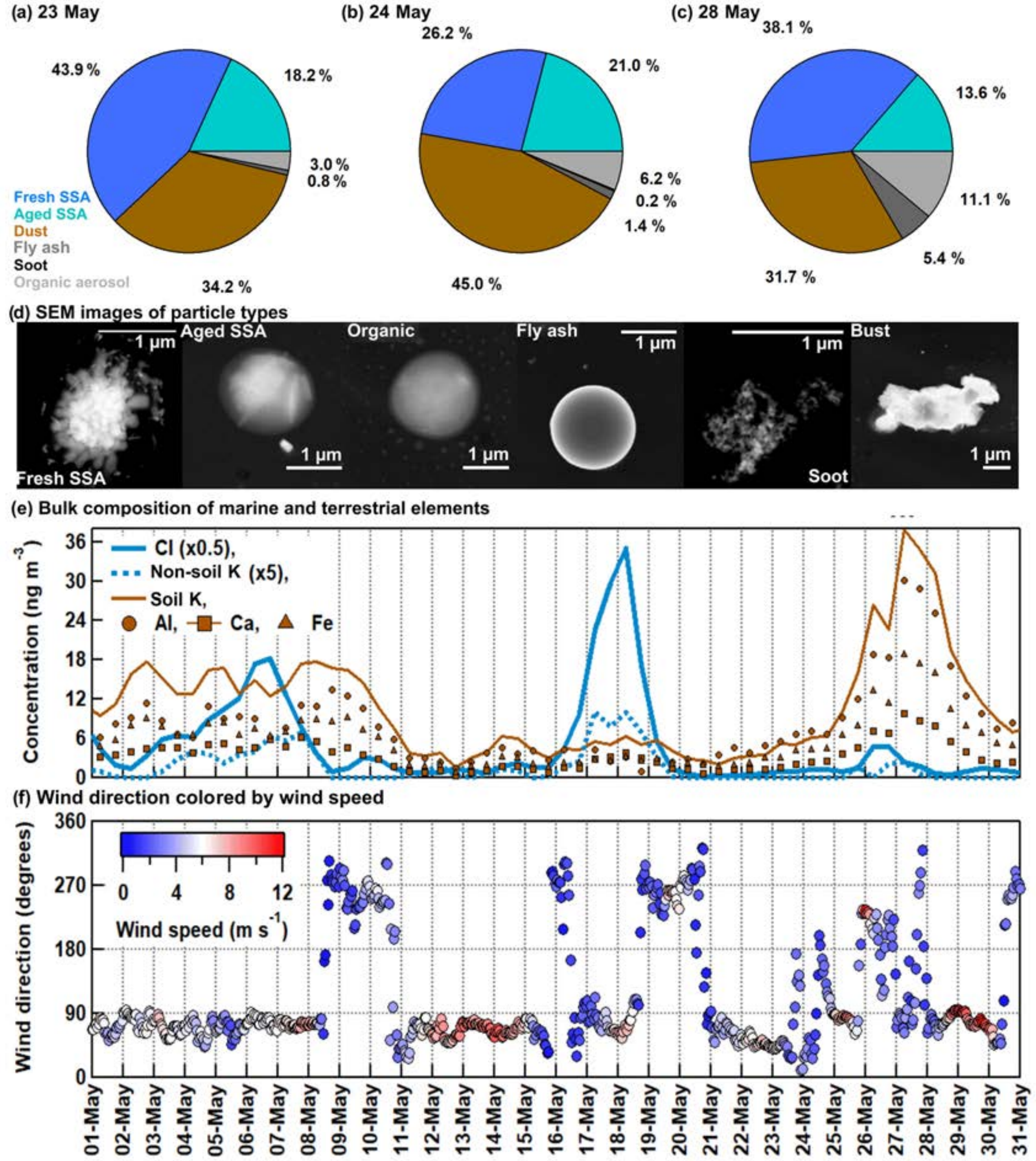




Solomon et al., 2018

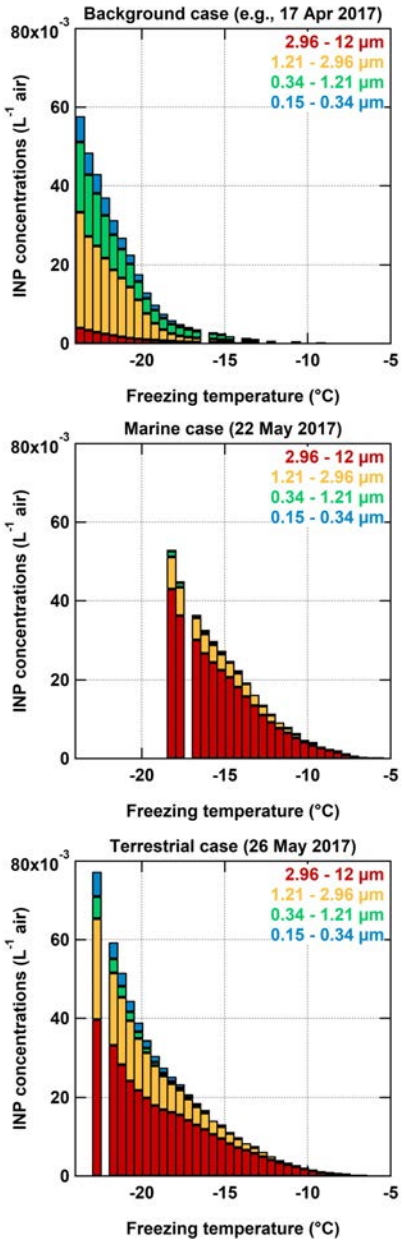
INPs in the Industrialized Arctic

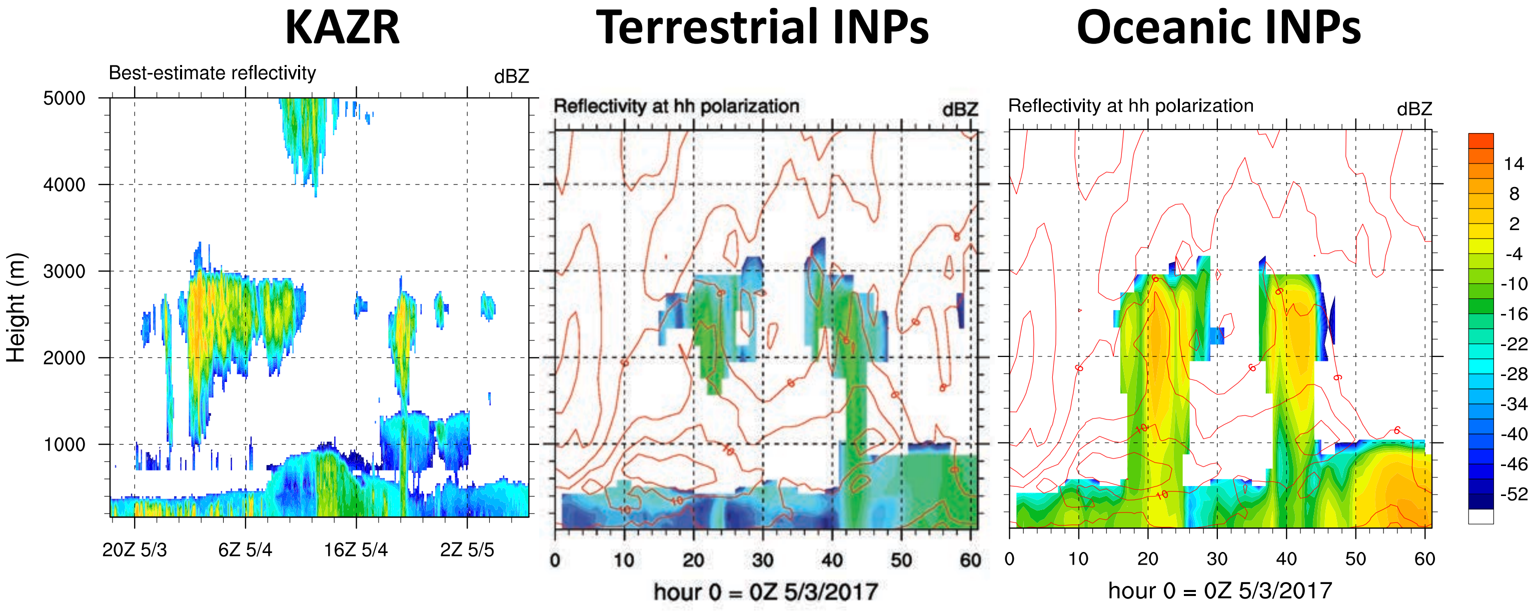


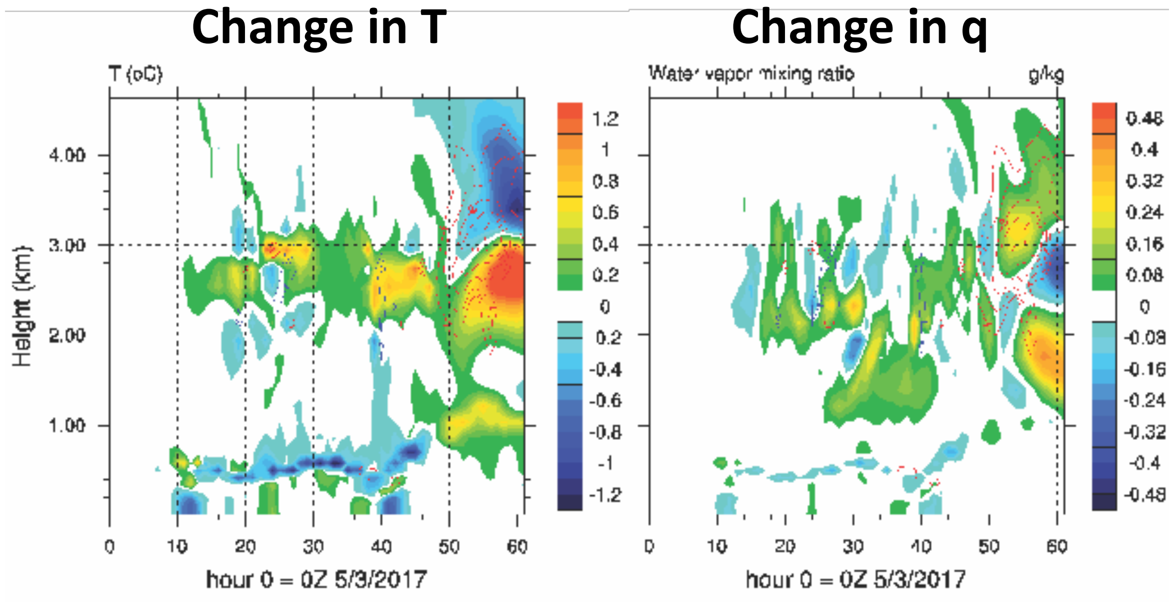


Creamean et al., 2018

Climate-Induced Changes in Natural Aerosol

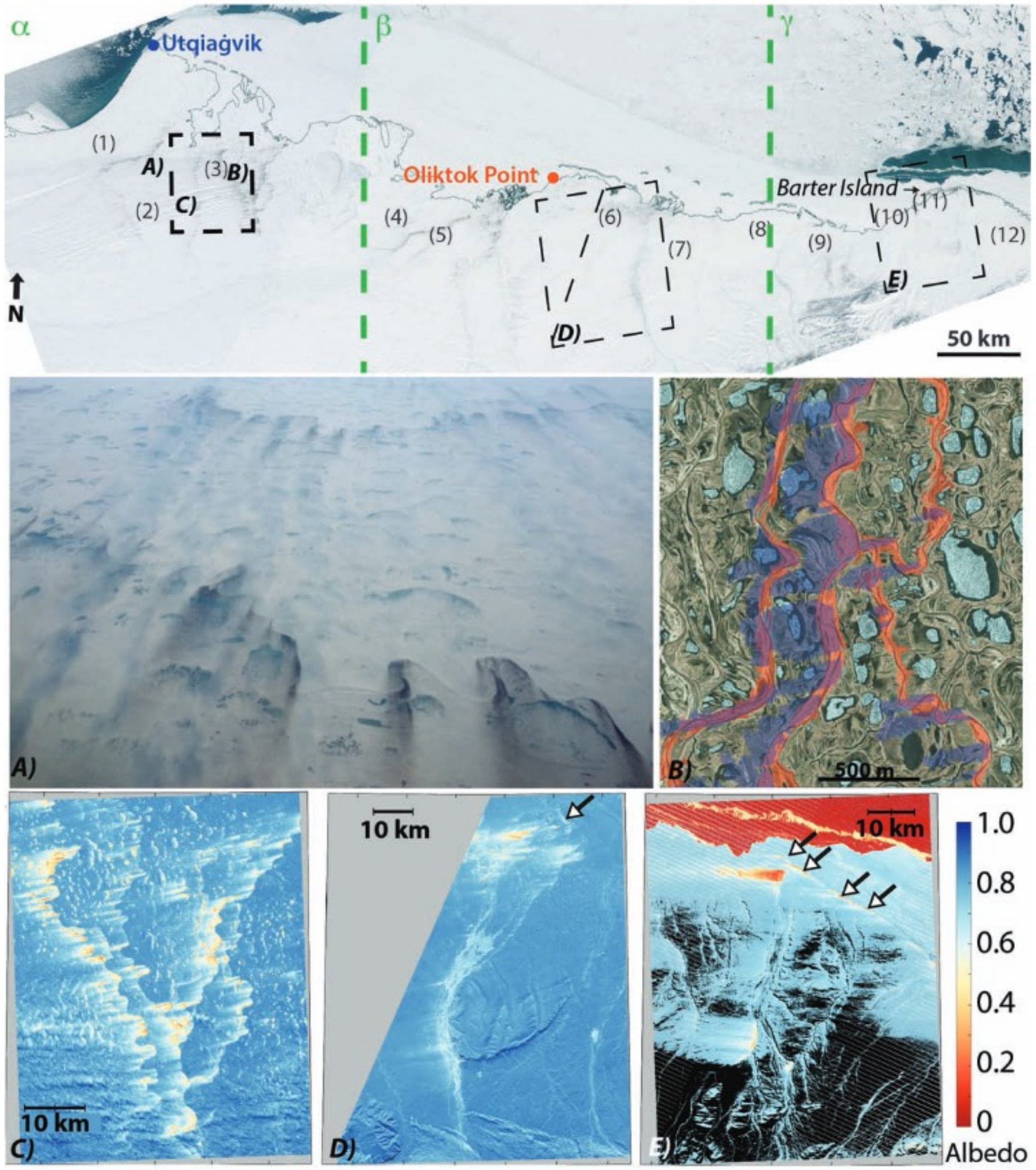


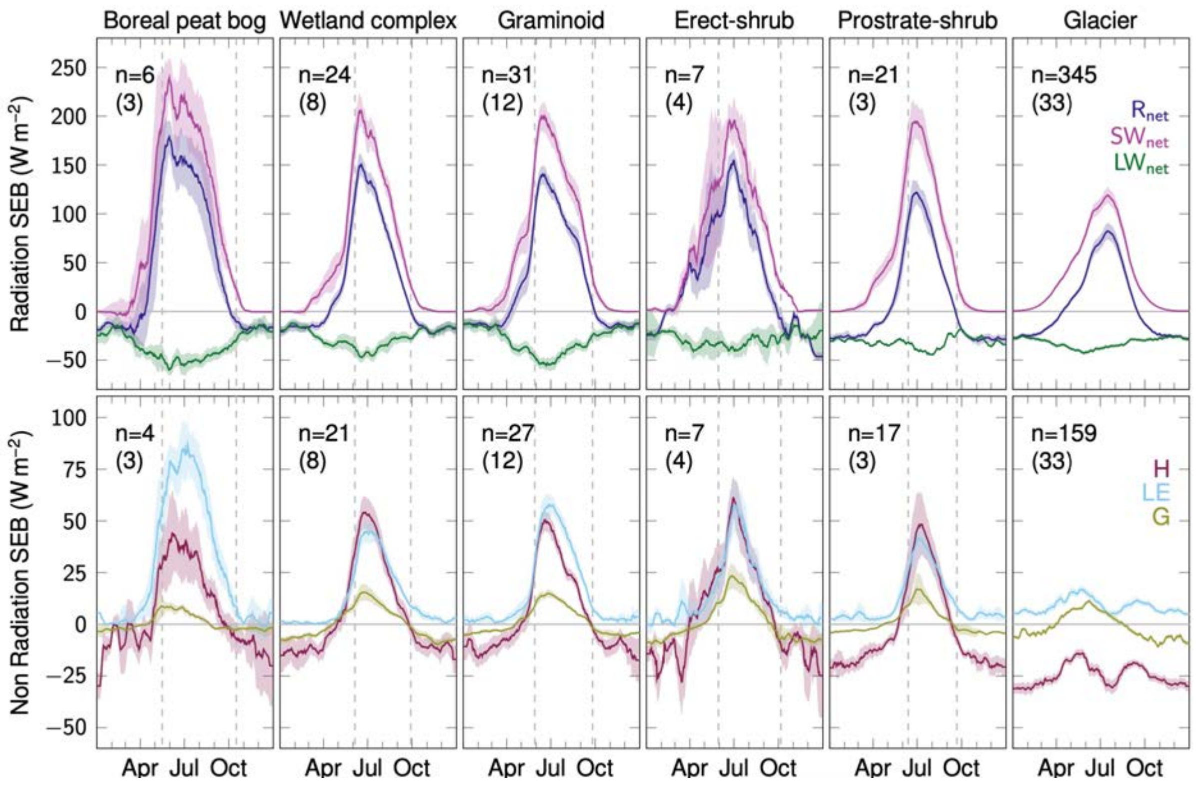


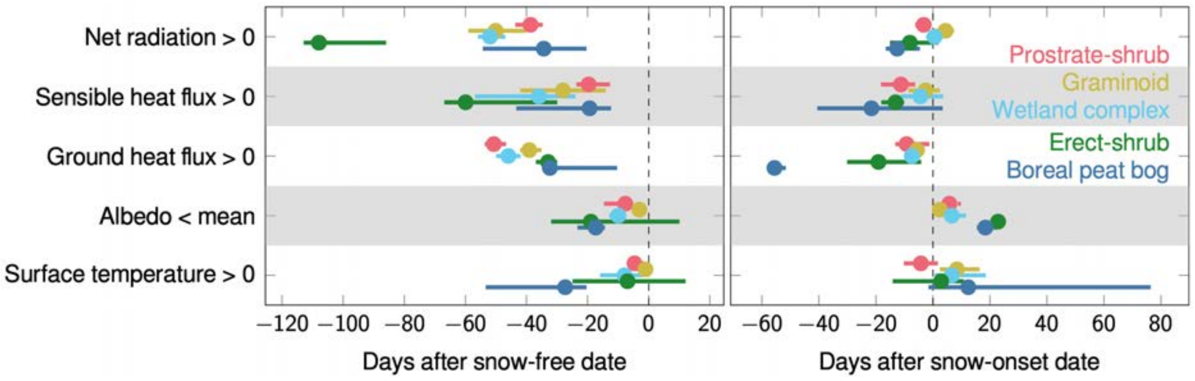


Creamean, Solomon, Pers. Comm.

Understanding the Surface Energy Budget

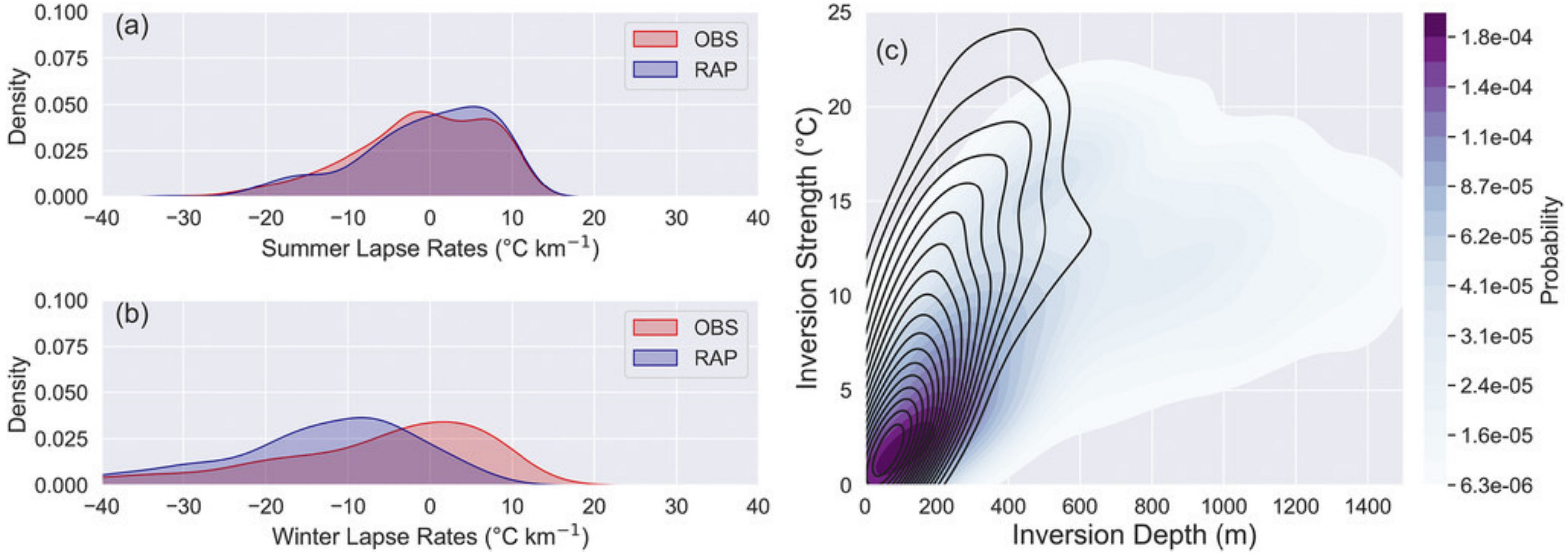


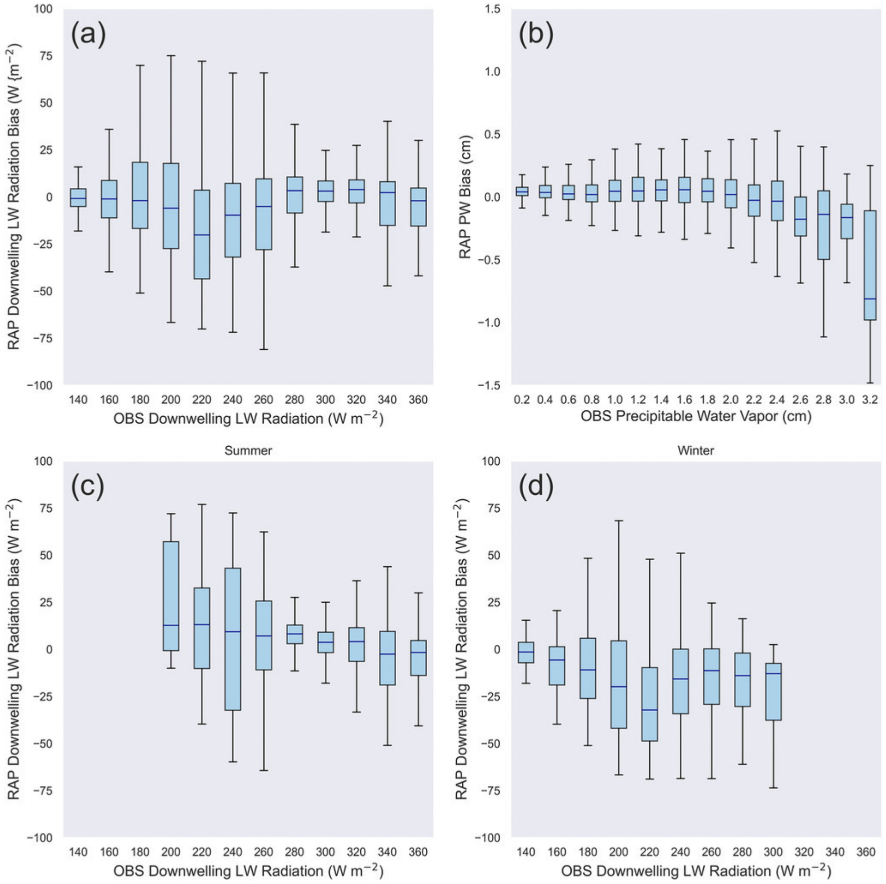


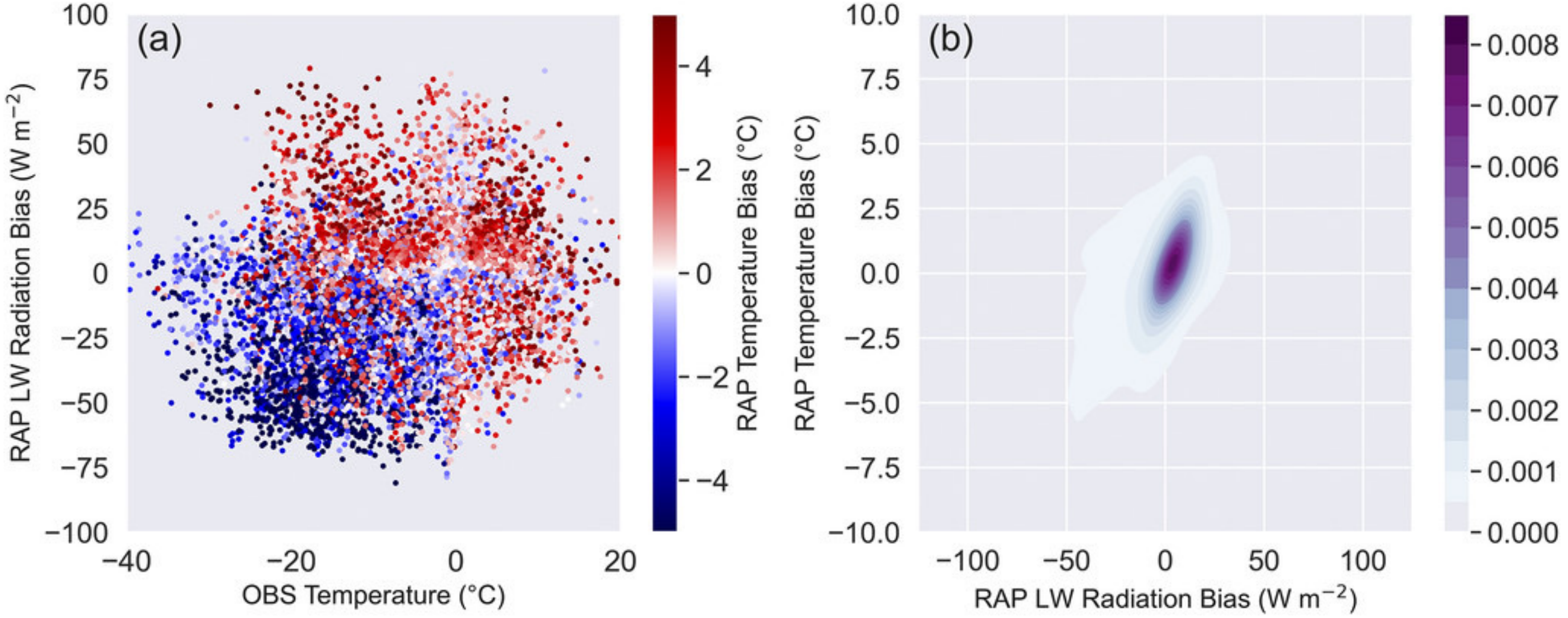


de Boer et al., 2019; Oehri et al., 2022

Evaluating and Improving Numerical Models

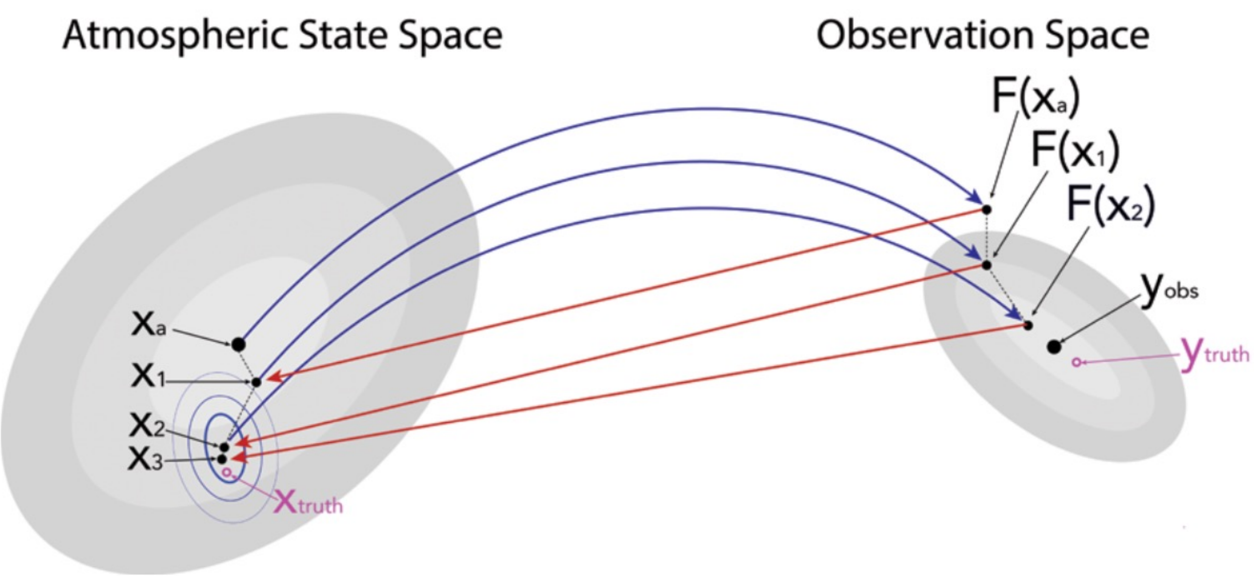


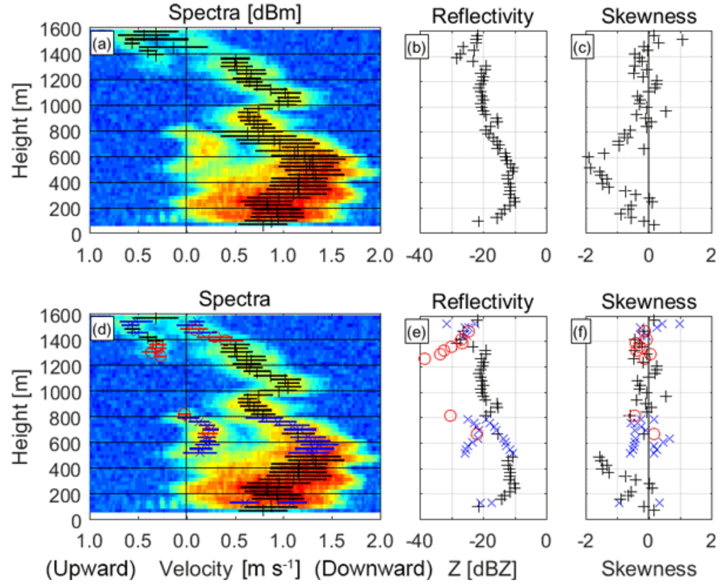


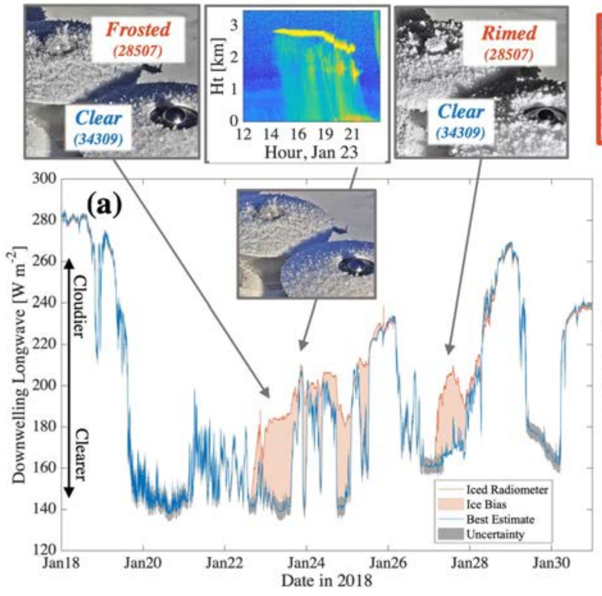


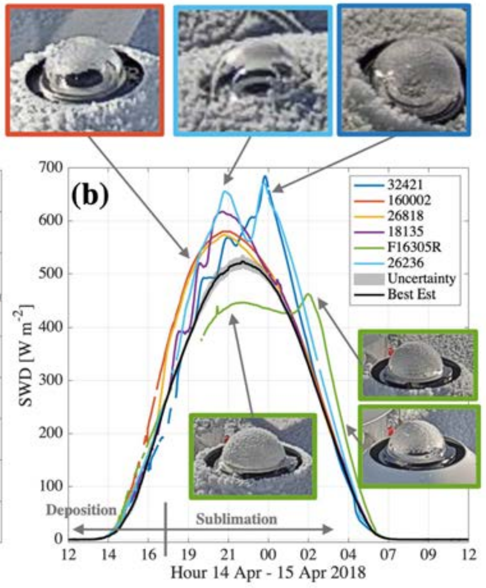
Bray et al., 2021

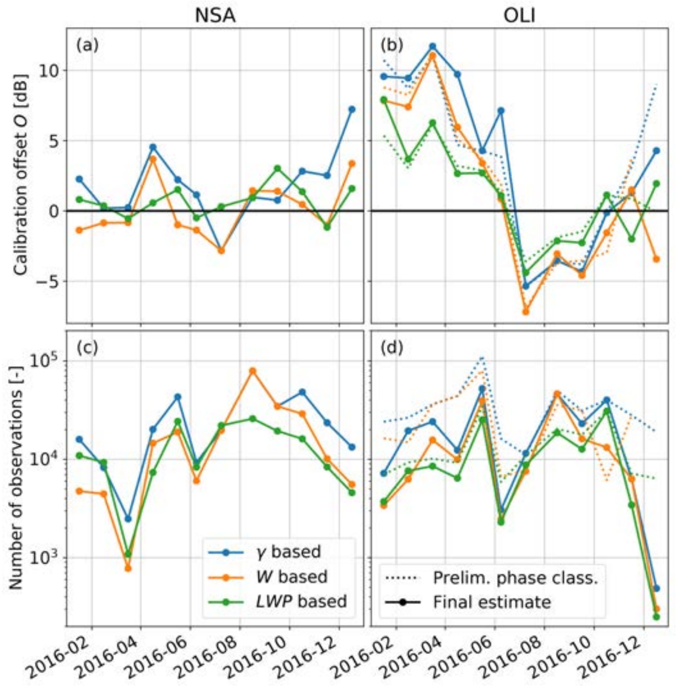
Data Product Development





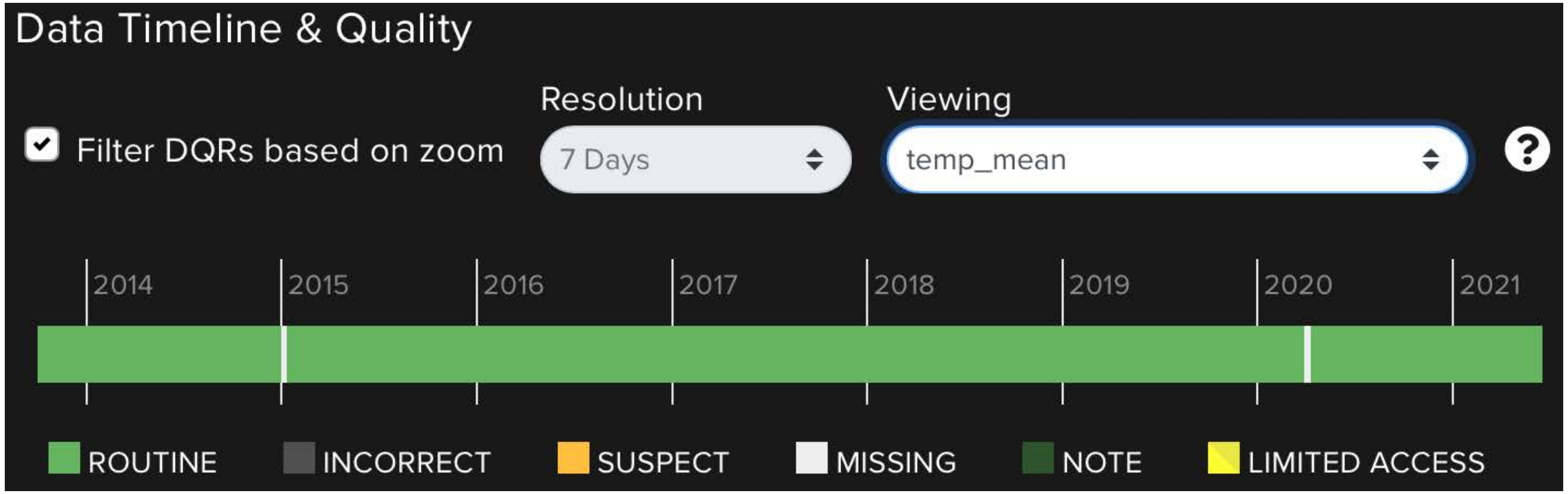


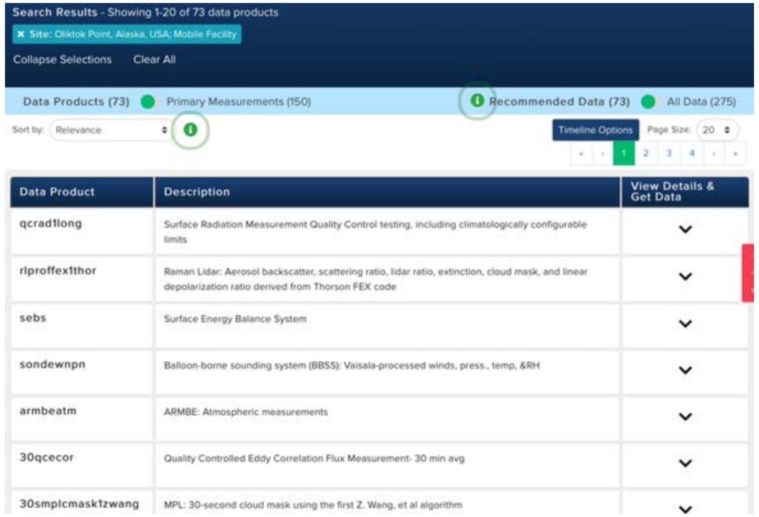


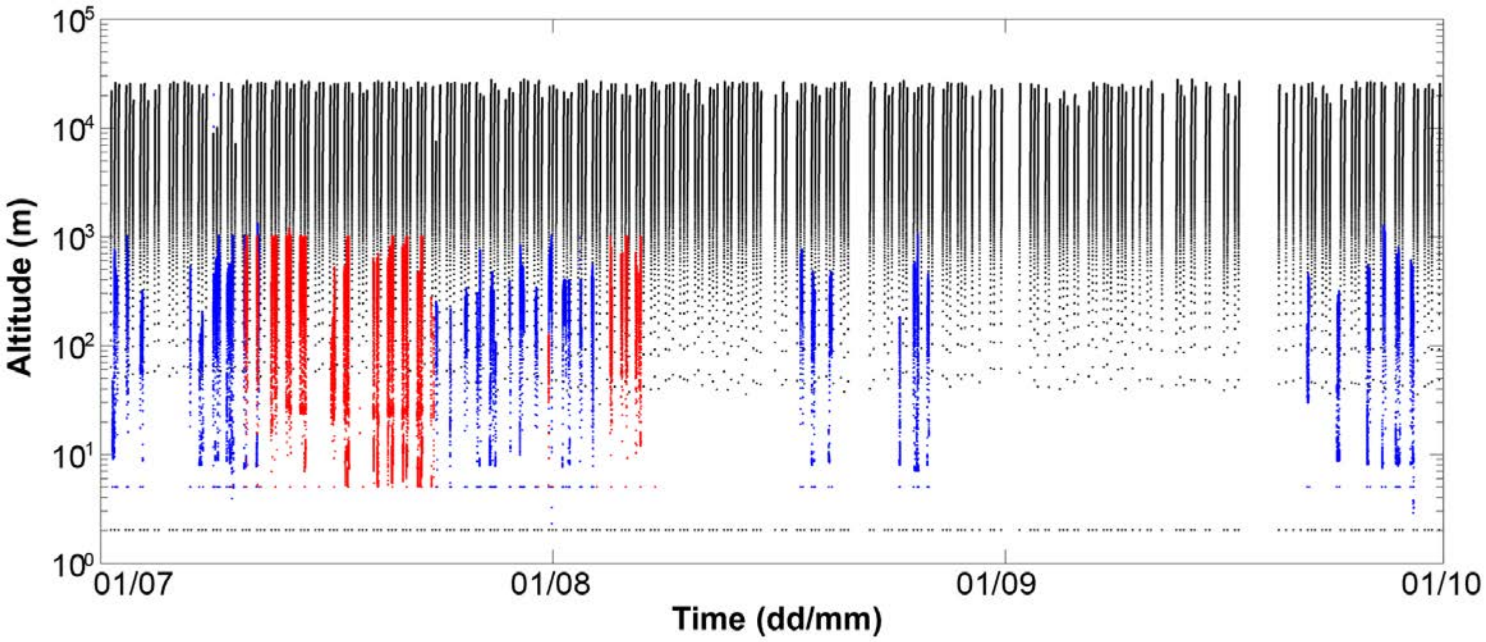


Matrosov and Turner, 2018; Maahn et al., 2020 and 2019;
Cox et al., 2021; Williams et al., 2018;

A Legacy of OLI Data







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Summary

- The AMF-3 deployment to Oliktok Point has supported science to advance our understanding of clouds, aerosol particles, their interactions, and their influence on the Earth's surface energy budget. Additional work has been conducted to assess industry and meteorological influence on regional air quality.
- Access to segregated airspace has offered opportunities to sample the vertical and horizontal variability of the lower atmosphere using uncrewed aircraft and tethered balloon systems
- Sandia National Laboratories continue to explore and expand opportunities for continued collection of data at the OLI site.
- The OLI AMF-3 deployment leaves behind a legacy of data that leaves a lot to be explored. The AMF-3 and associated IOP and campaign data should continue to be evaluated to further our understanding of the Arctic atmosphere.

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ASR Atmospheric System Research

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