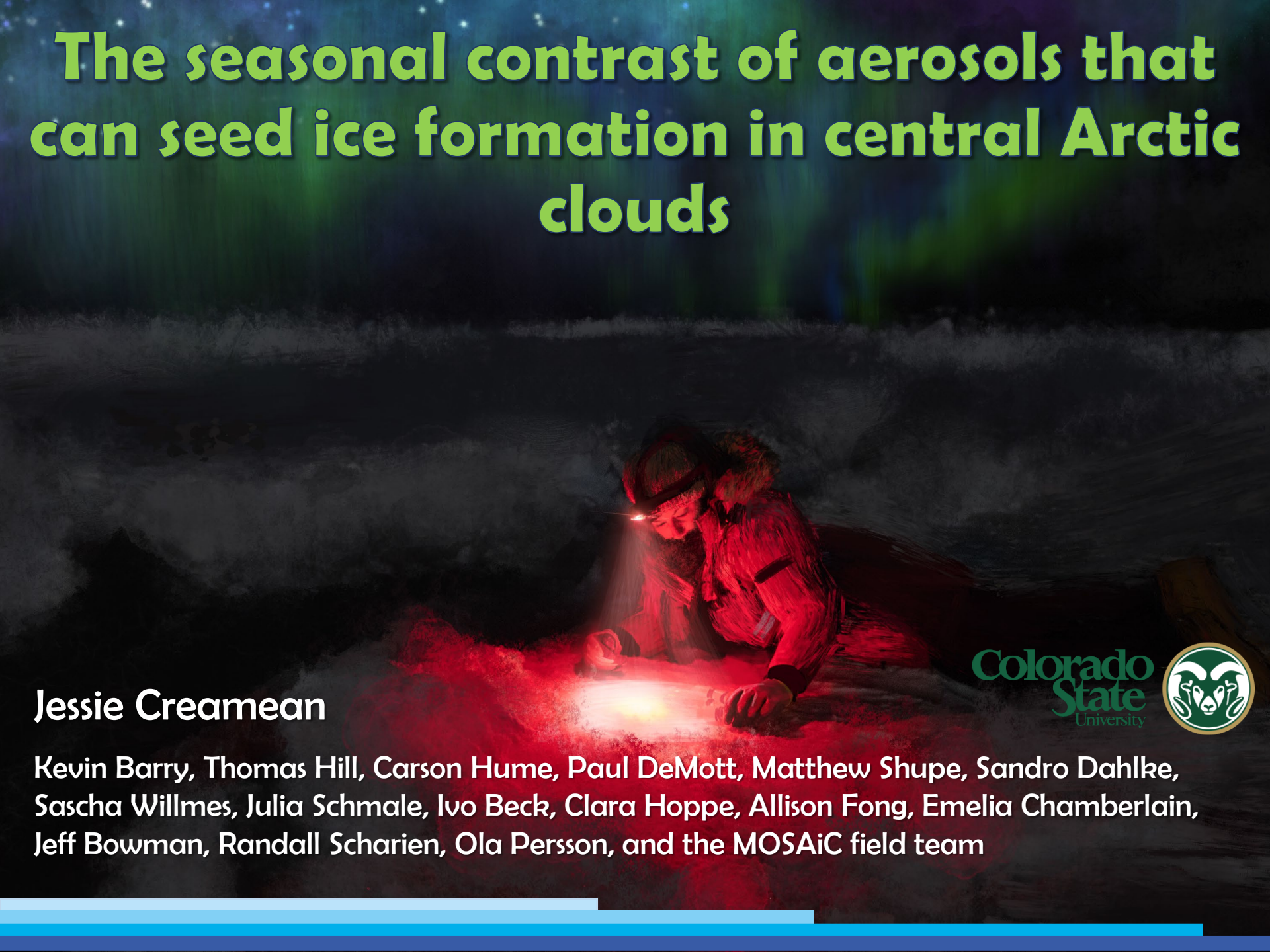
The seasonal contrast of aerosols that can seed ice formation in central Arctic clouds



Jessie Creamean

Colorado State University

Kevin Barry, Thomas Hill, Carson Hume, Paul DeMott, Matthew Shupe, Sandro Dahlke, Sascha Willmes, Julia Schmale, Ivo Beck, Clara Hoppe, Allison Fong, Emelia Chamberlain, Jeff Bowman, Randall Scharien, Ola Persson, and the MOSAiC field team

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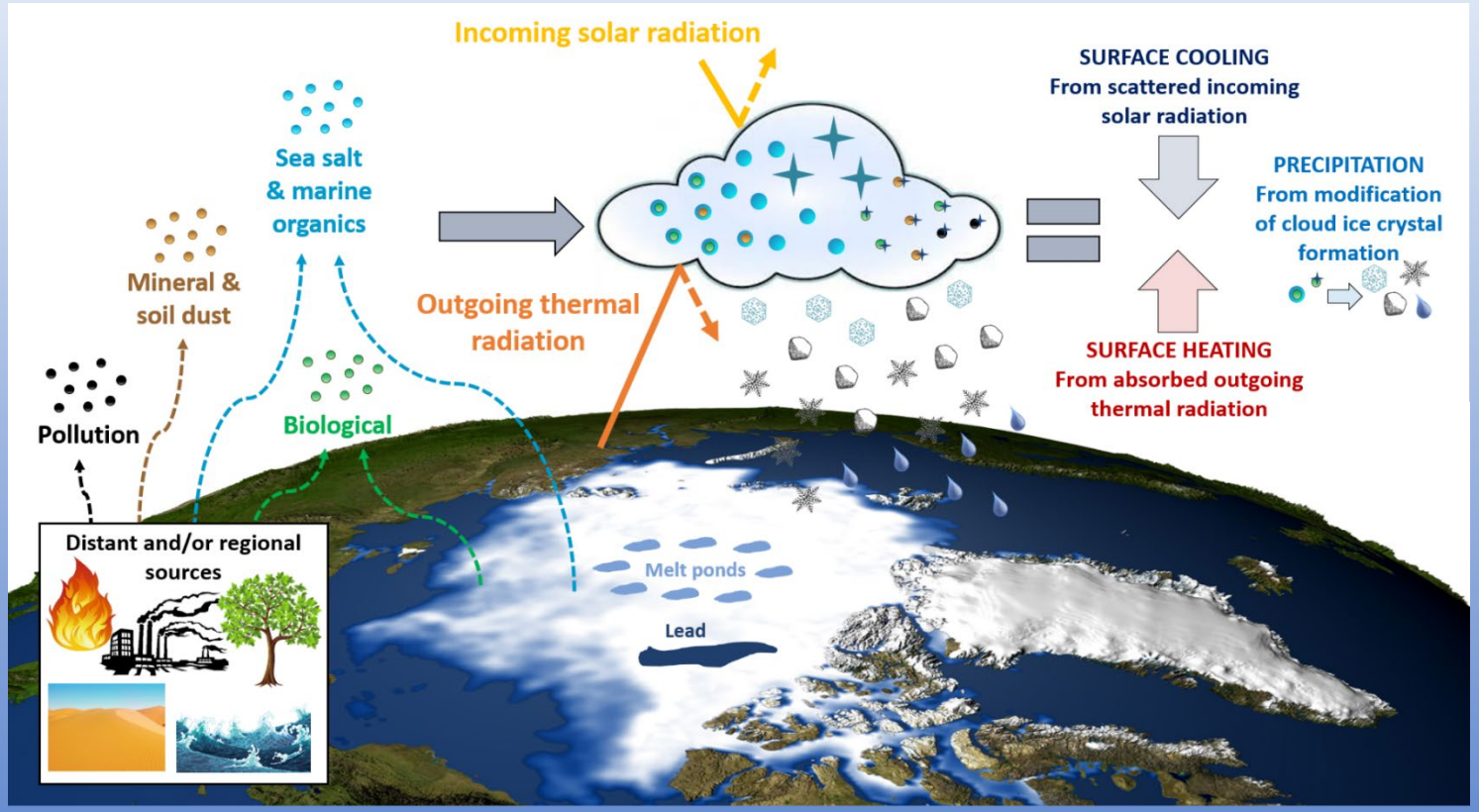
Importance of Arctic aerosols



Aerosols impact cloud formation and energy budget globally.

Important for light and heat reaching frozen Arctic surfaces, especially over the declining sea ice.

Observations are limited in the central Arctic directly over sea ice pack and particularly of **ice nucleating particles (INPs).**

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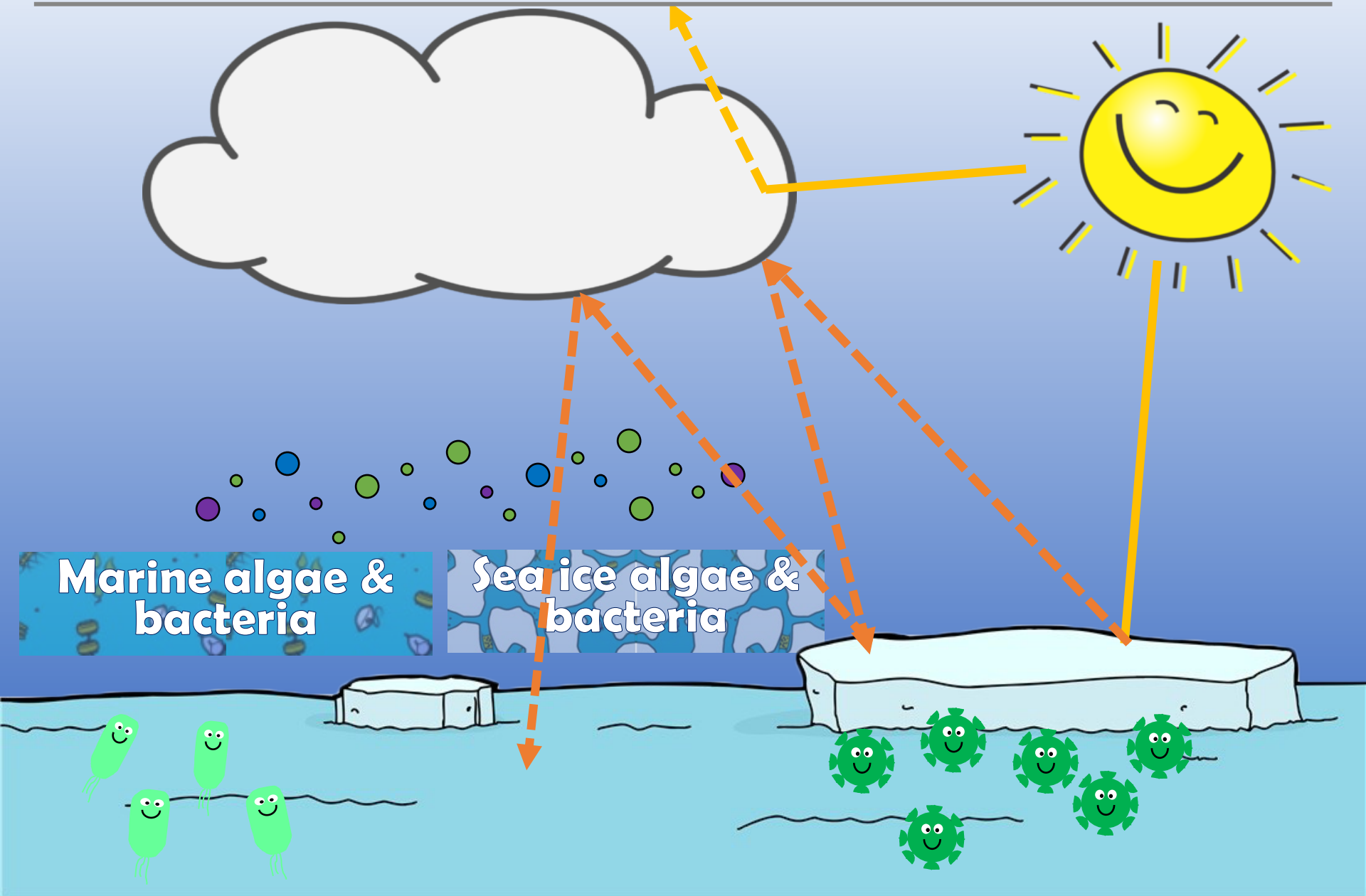
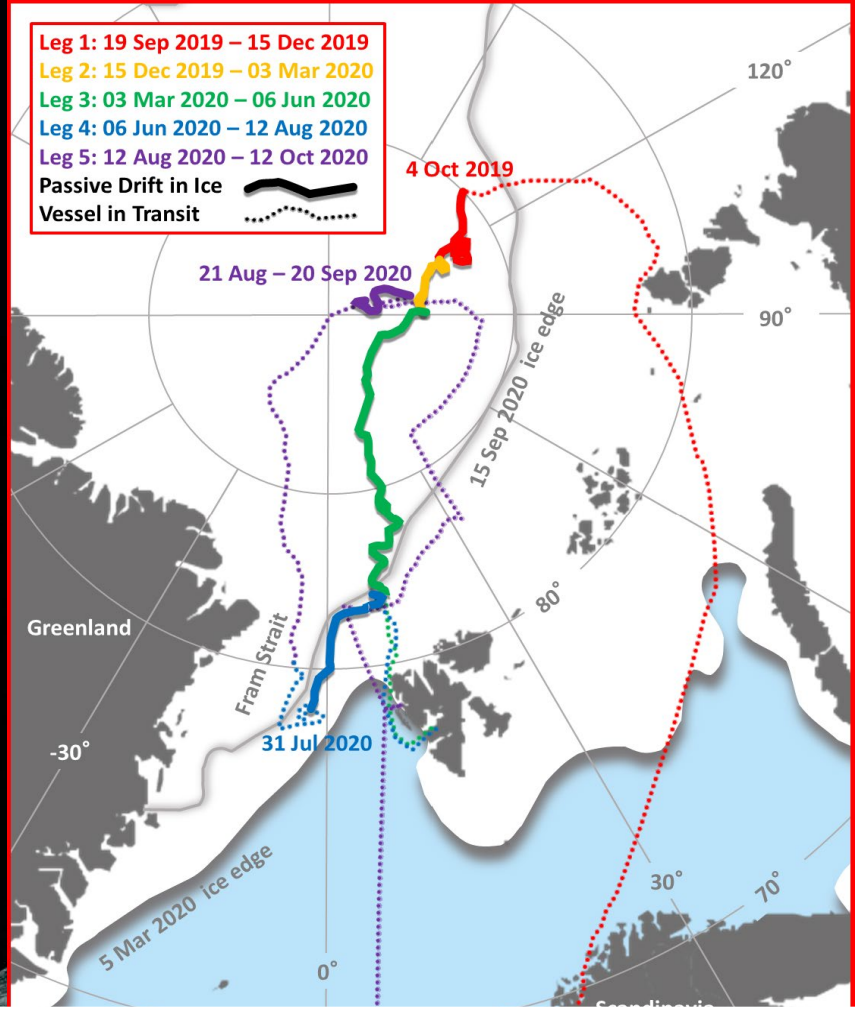
Biology impacts cloud formation



MOSAiC: Multidisciplinary drifting Observatory for the Study of Arctic Climate



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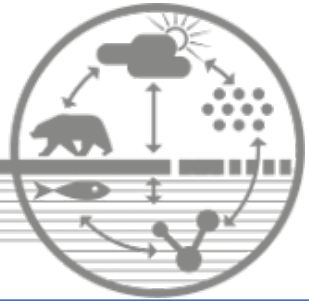

Largest polar expedition IN HISTORY

The understudied central Arctic INPs

No INP annual cycle in the central Arctic before MOSAiC

Overarching objective: Improve understanding of the sources, efficiency, and abundance of INPs in the central Arctic over a full annual cycle.

Targeted questions:

1. How do seasonal changes in sea ice and air masses influence INPs?
2. Is marine and sea ice biology a significant source of INPs vs. terrestrial sources?
3. Are leads and melt ponds viable sources of INPs and do they exchange INPs with the atmosphere?

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Discrete sample collection

~5000 samples of...

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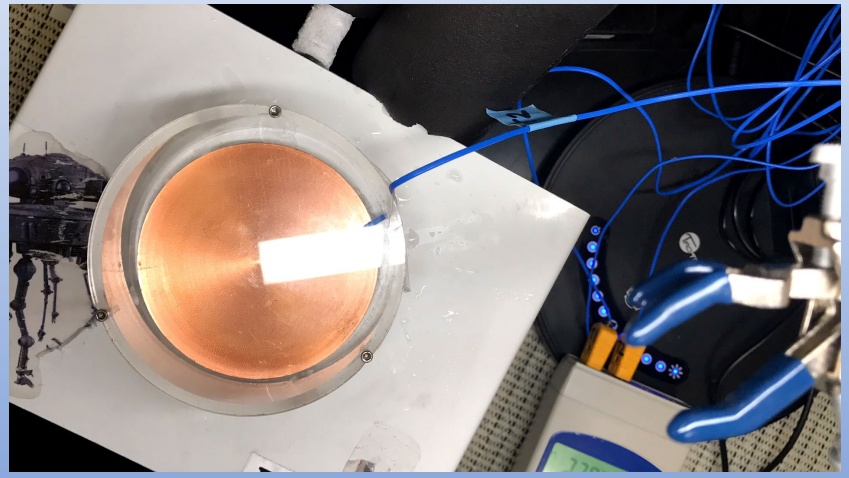
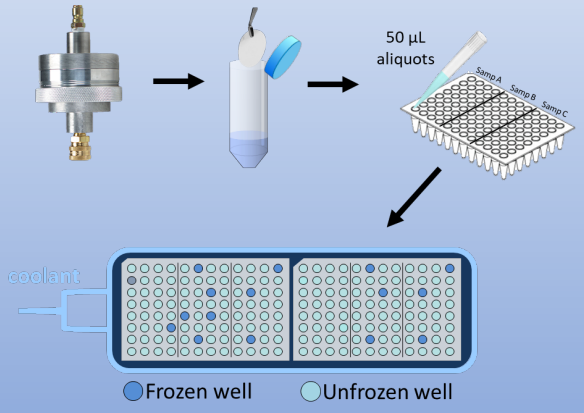
Measuring INPs at CSU

1. Cold plate

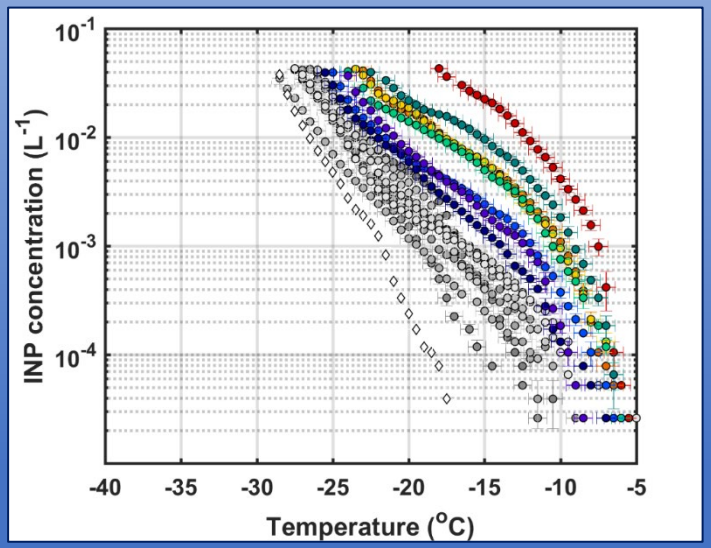


2. Ice spectrometer



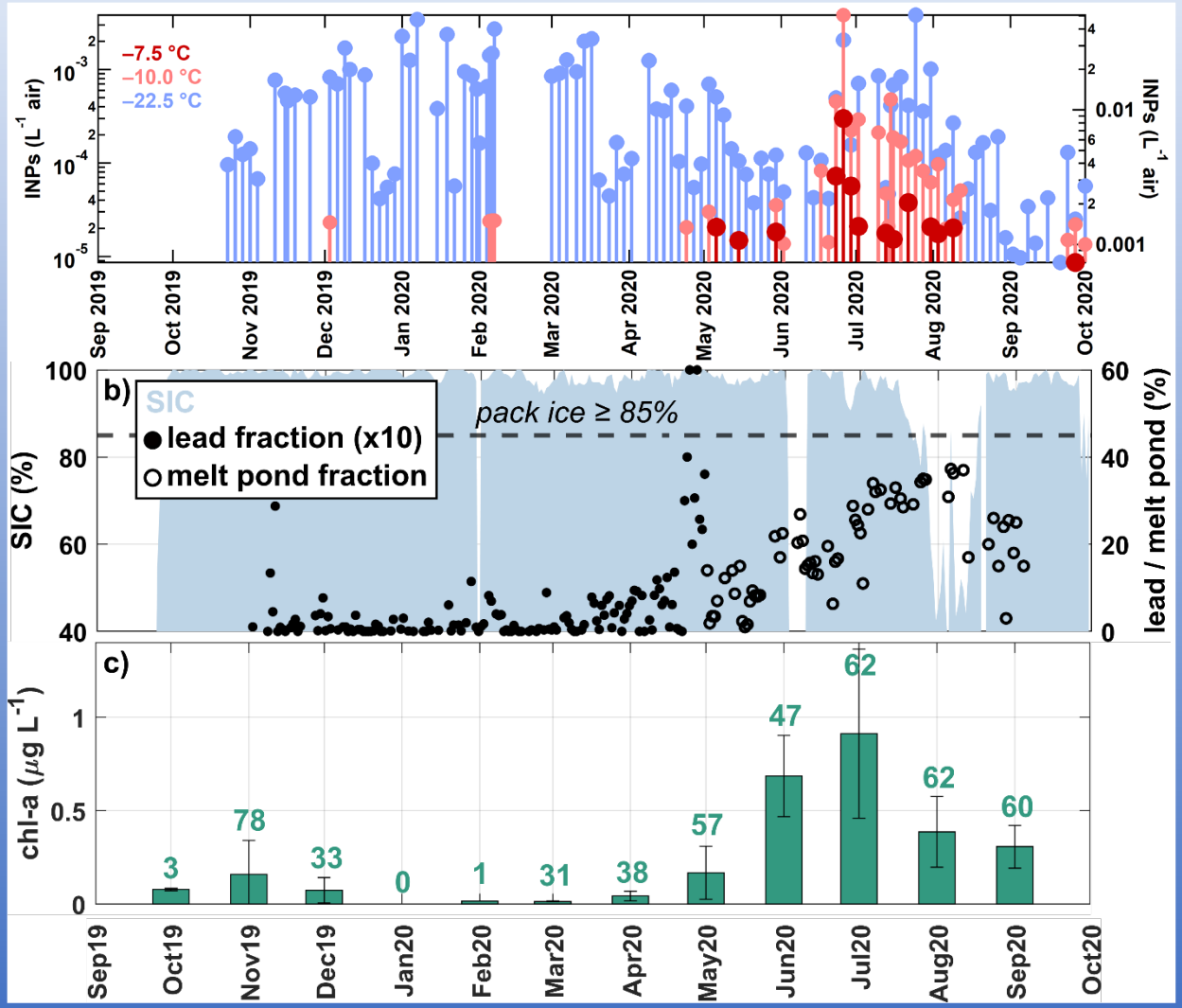
Processing schematic cred: Kevin Barry

Aerosols collected on filters, seawater, melted sea ice, melted snow



Creamean et al., AMT, 2018; Creamean et al., ACP, 2018; Hill et al., 2014, AEM; Hill et al., 2016, ACP; Beall et al., 2017, AMT

The MOSAiC INP annual cycle



INPs were generally colder during fall/winter & warmer in the summer.

Warmer INPs were observed during more open water with more biological activity.

Creamean et al., *Nat. Commun.*, 2022.

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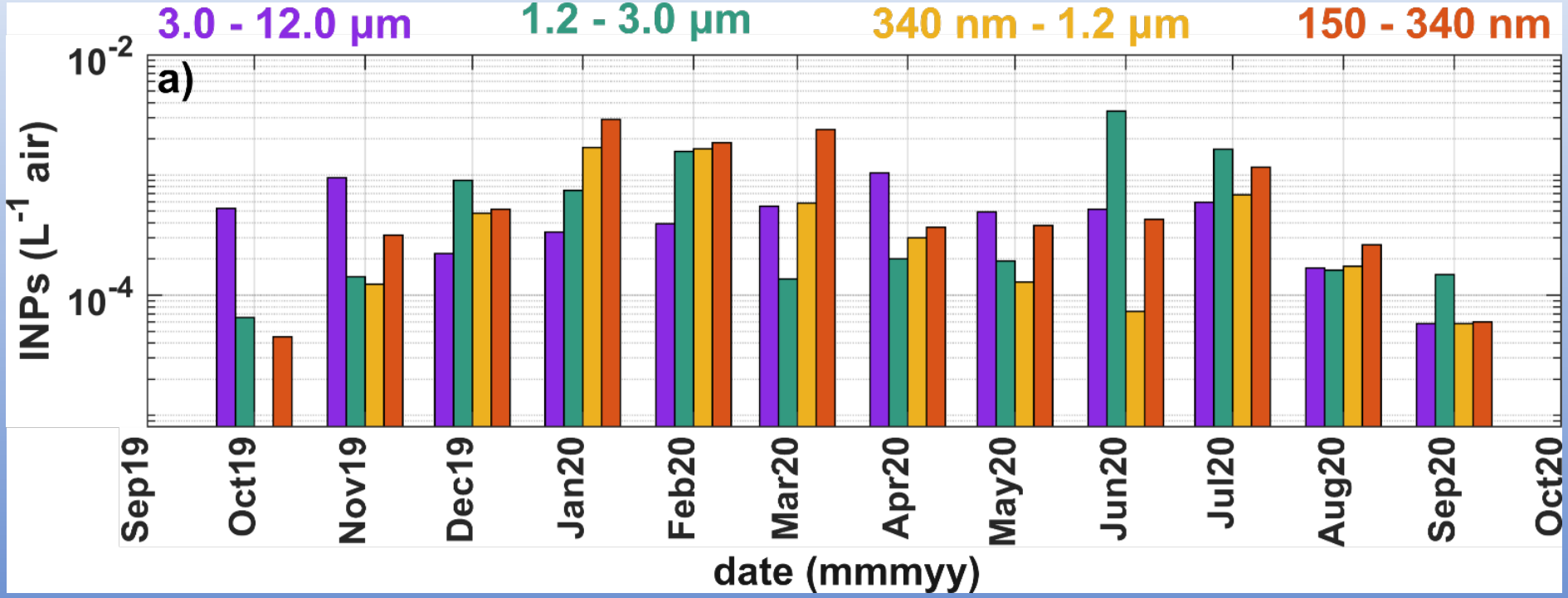
Variability in INP sizes



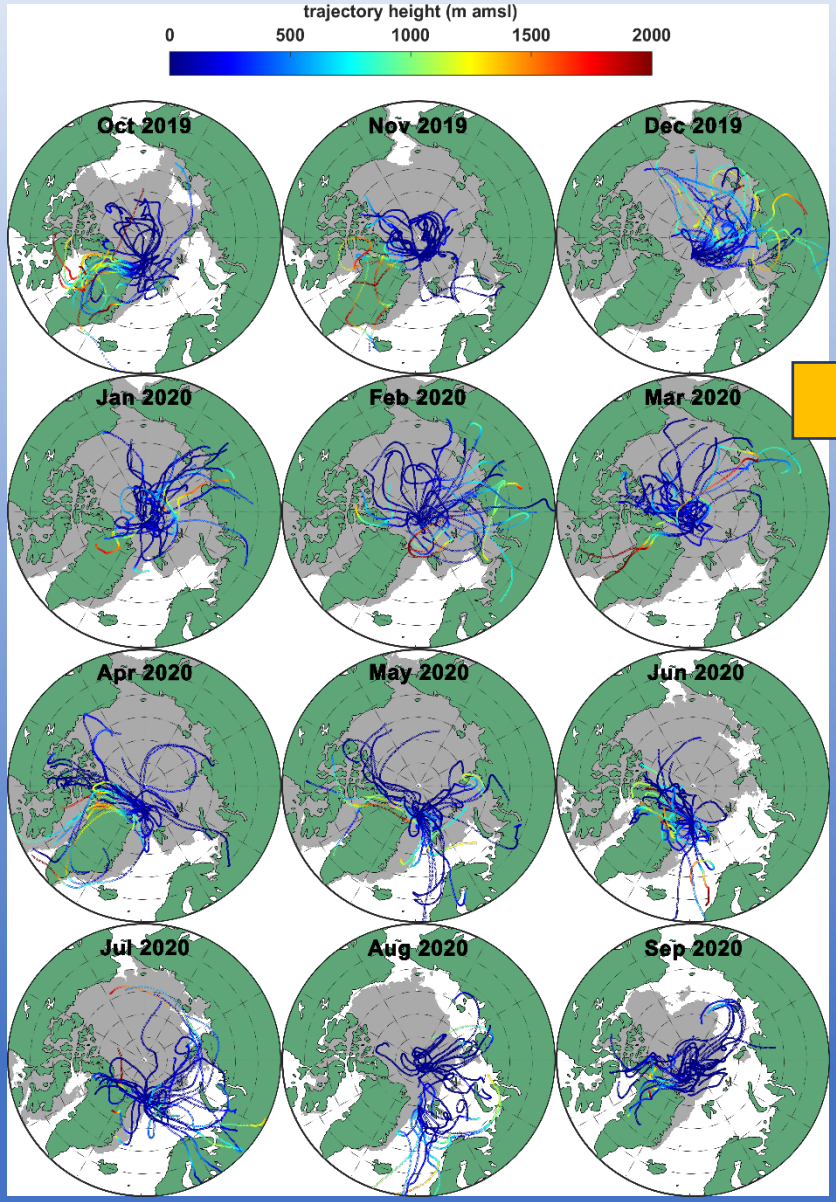
Autumn / spring: coarse INPs (>3 µm)

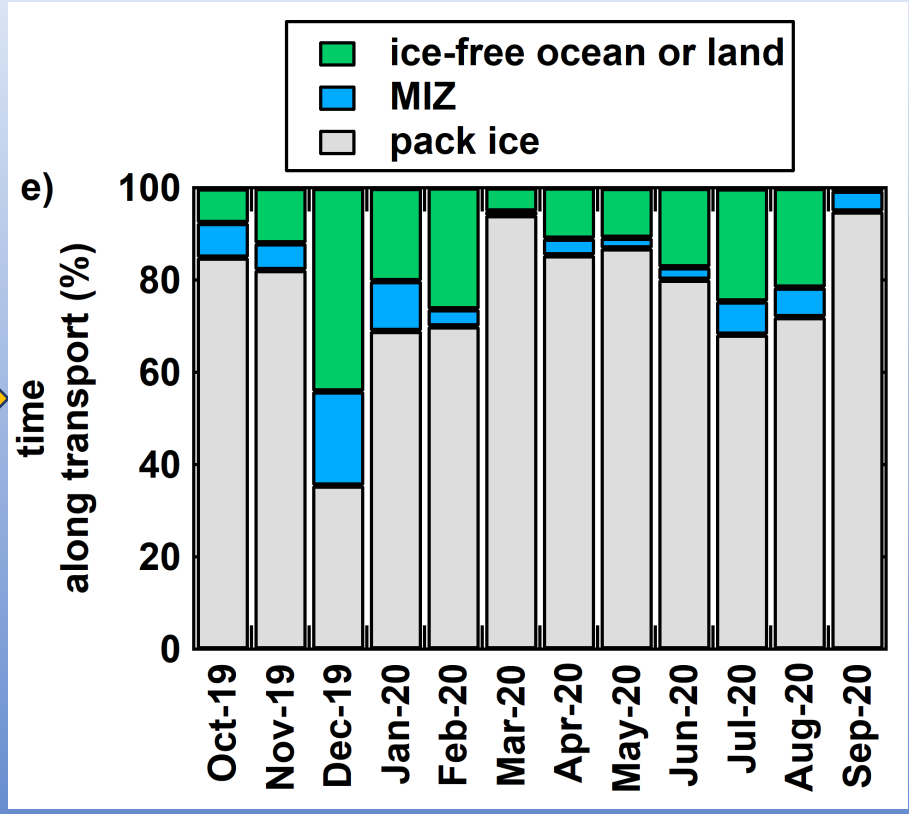
Winter: submicron INPs (< 1 µm)

Summer: supermicron INPs (1-3 µm)

Creamean et al., *Nat. Commun.*, 2022.

Validating sources with transport





Most transport from over the pack ice, except during Arctic haze.

Creamean et al., *Nat. Commun.*, 2022.

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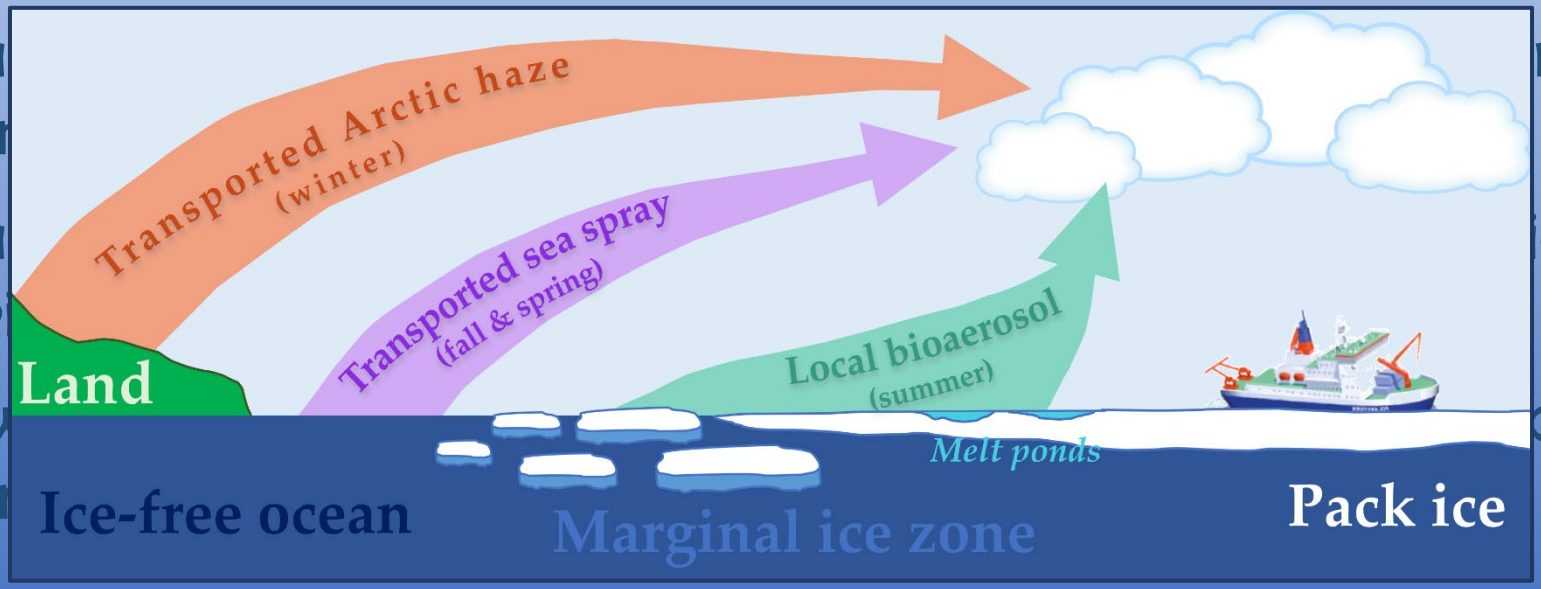
Take home points

- Combo of data corroborate that INPs were likely…
  - Coarse sea spray from lower latitudes in autumn & spring
  - Submicron haze from continental sources in winter
  - Supermicron biogenic materials from local open water in summer
- Gra… rosol & lif…
- Gra… ies link…
- Nev… o w/ Kerr…



Thanks for funding & logistics:

ARM CLIMATE RESEARCH FACILITY

ASR Atmospheric System Research

AWI

NSF

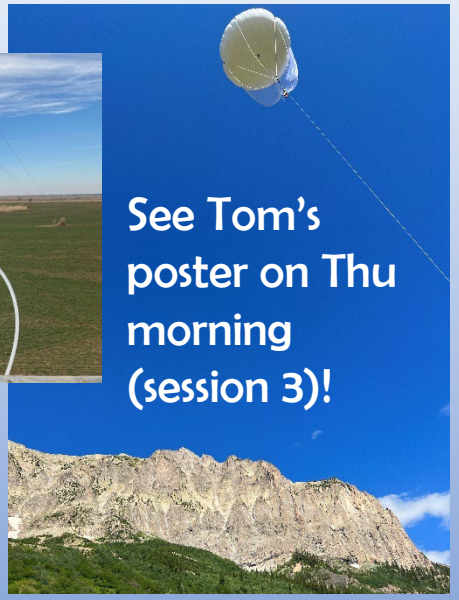
New INP data available through ARM!

ARM CLIMATE RESEARCH FACILITY

Jessie Creamean

Tom Hill

Carson Hume



	2020					2021											2022									
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
SGP																											
Oliktok																											
SAIL																											
TRACER																											
SGP TBS																											
SAIL TBS																											

data available data pending/some analysis complete sample analysis pending

Scan for direct link to data OR go to ARM Data Discovery and search for "Measurement: Ice Nucleating Particle (INP) Concentration"

Scan for link to our Ice Nucleation Spectrometer (INS) ARM instrument page