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

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ASR Atmospheric System Research

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University of Colorado Boulder

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Why? Arctic amplification, that's why.

- When the Arctic gets warmer, the sea ice extent and snow surfaces are in decline every year and causes compounding effects.
- When the ocean and tundra are exposed…
  - These dark surfaces absorb energy and emit thermal radiation = **additional warming**
- When the permafrost is not longer, well, permanent…
  - Releases GHGs that have been stored for years = **additional warming**
- As a result, the Arctic is warming **twice as much** and impacts air circulation patterns and thus weather all over the globe

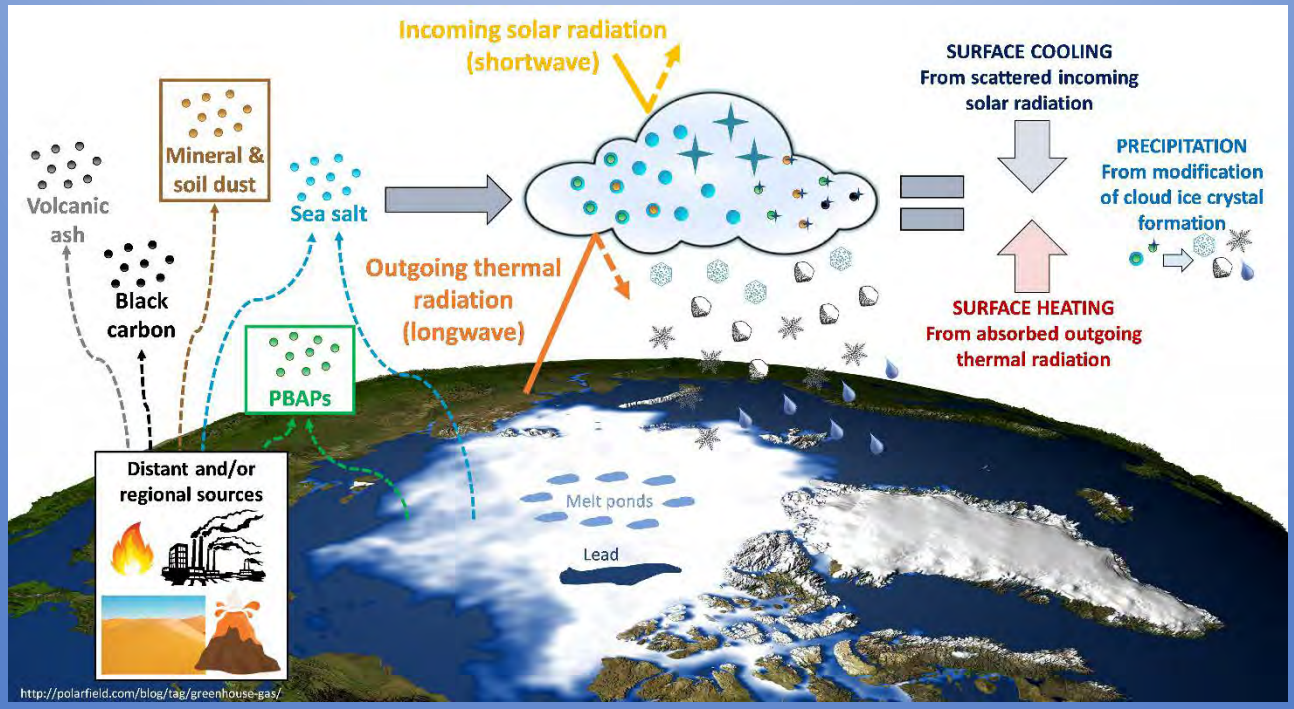




Source: NASA

Importance of studying Arctic aerosols

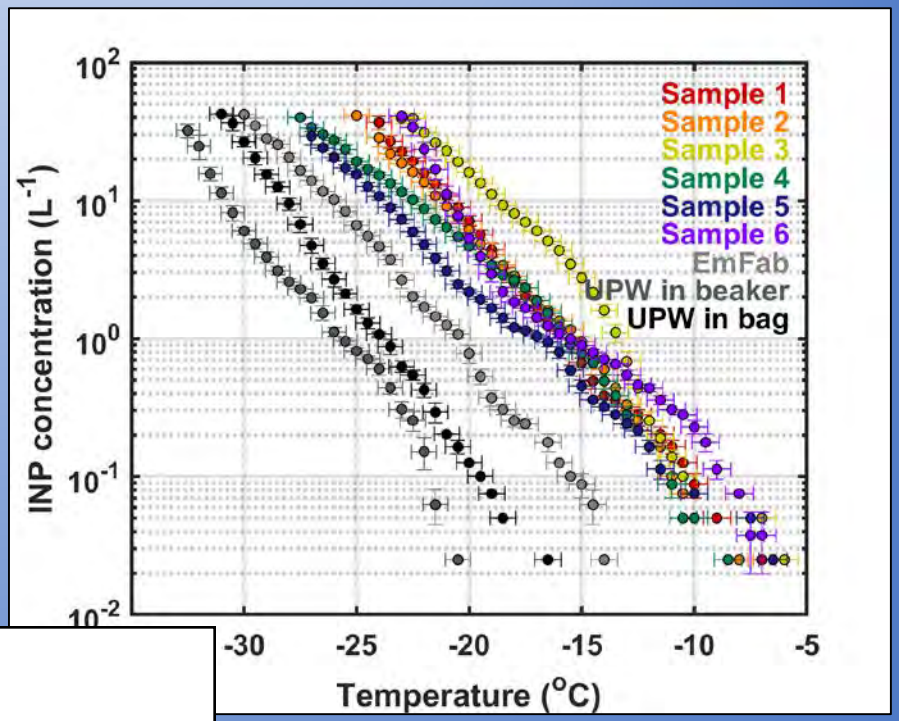
- Aerosols have implications for cloud formation, cloud lifetime, precipitation, and radiative forcing. **Important for energy reaching sea ice.**

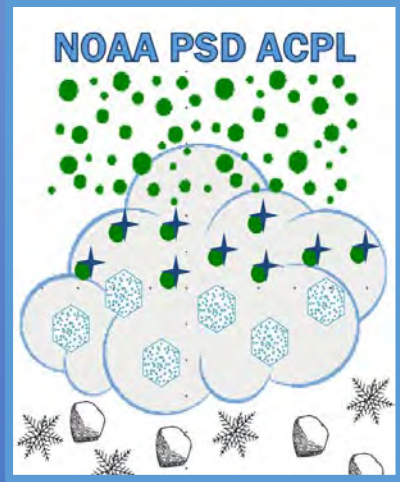


- Arctic Haze in winter/spring, "clean", local aerosol production in summer/fall.
- Many remaining uncertainties exist regarding modeled and observed Arctic aerosols, especially with particles that form cloud ice.
- **A better understanding from advanced observations, specifically of ice nucleating particles (INPs) in the Arctic is needed.**

How do aerosols affect cloud ice formation?: INP sample analysis

- Method: drop freezing assay (DFA)
- Use equation to calculate INP concentrations



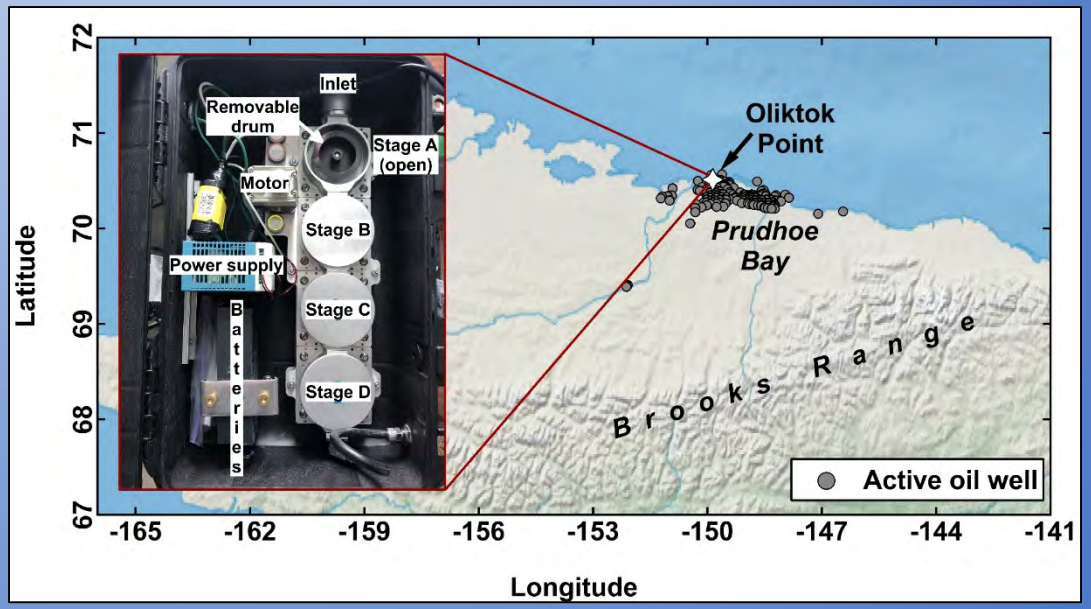


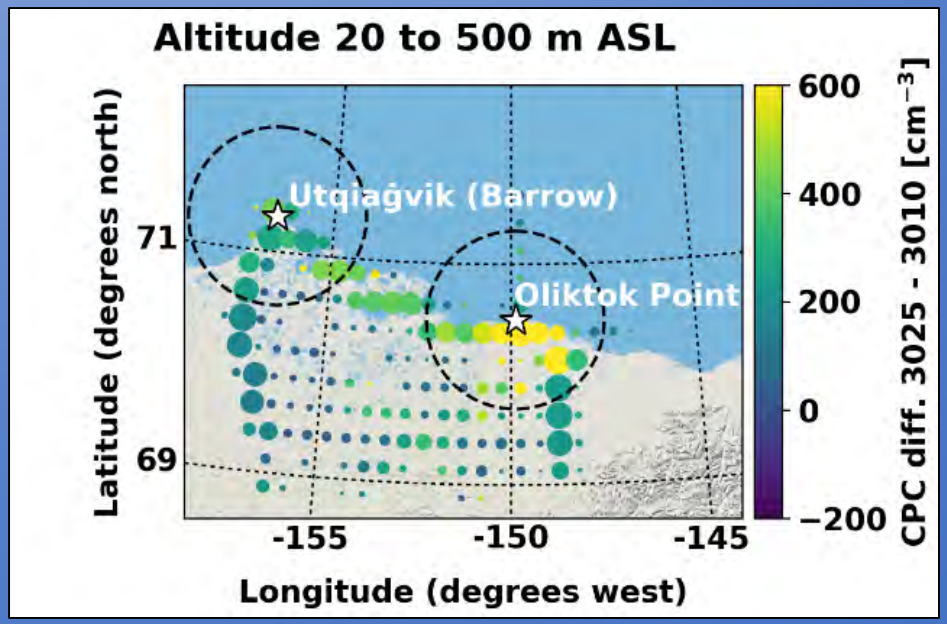
Creamean et al., AMTD, 2018, *in review.*

INPOP: Ice Nucleating Particles at Oliktok Point

Objective: Evaluate sources of aerosol, found in an <u>industrial location</u> and the resulting potential of these aerosols to modify Arctic cloud ice.

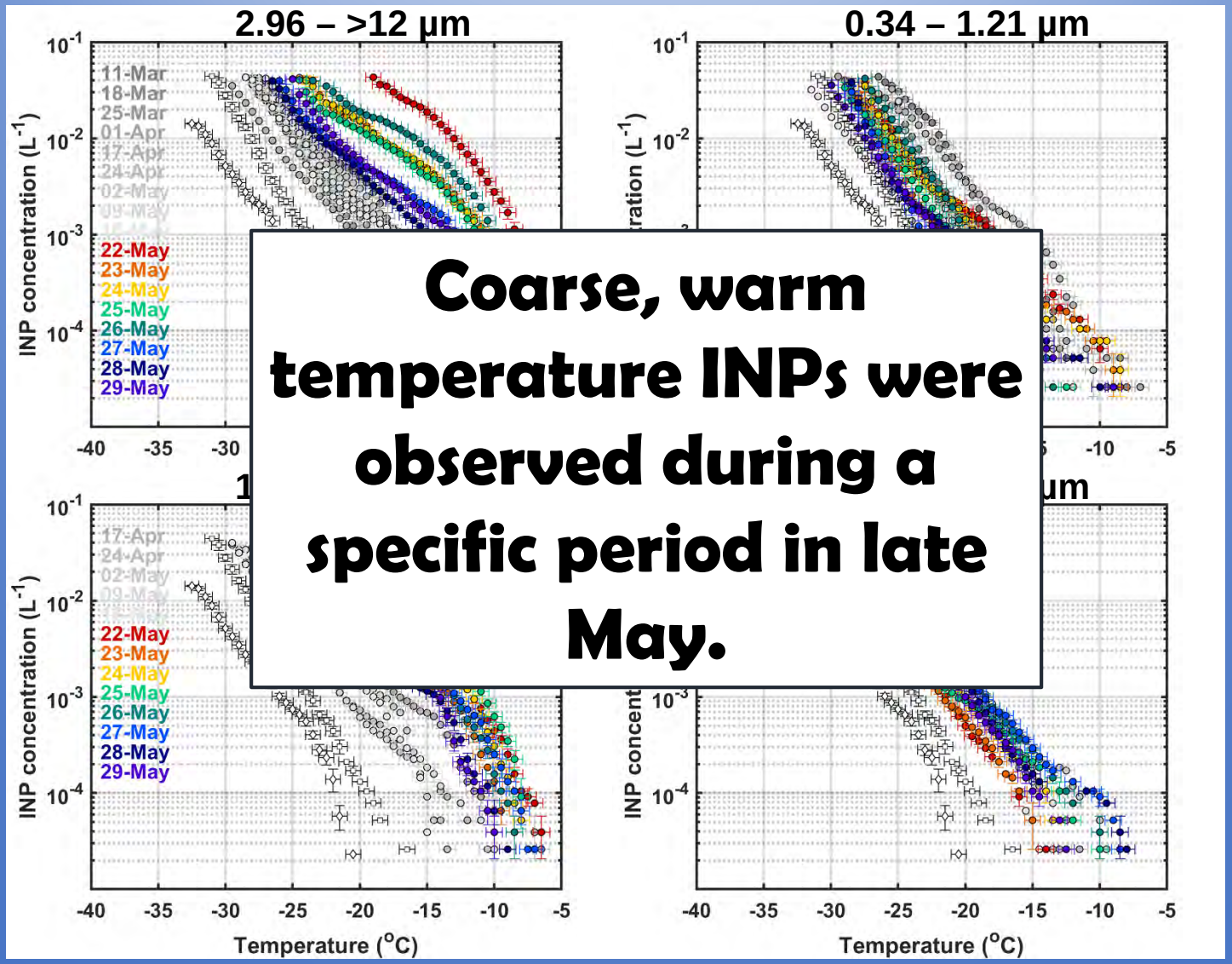
- Collected daily samples using a 4-stage DRUM impactor for Mar to May 2017
- Prudhoe Bay is a large active Arctic oilfield, that is an abundant and consistent source of very small particles formed from gases emitted by the oil extraction activities.
- INPOP is the first INP measurements in an Arctic oilfield.



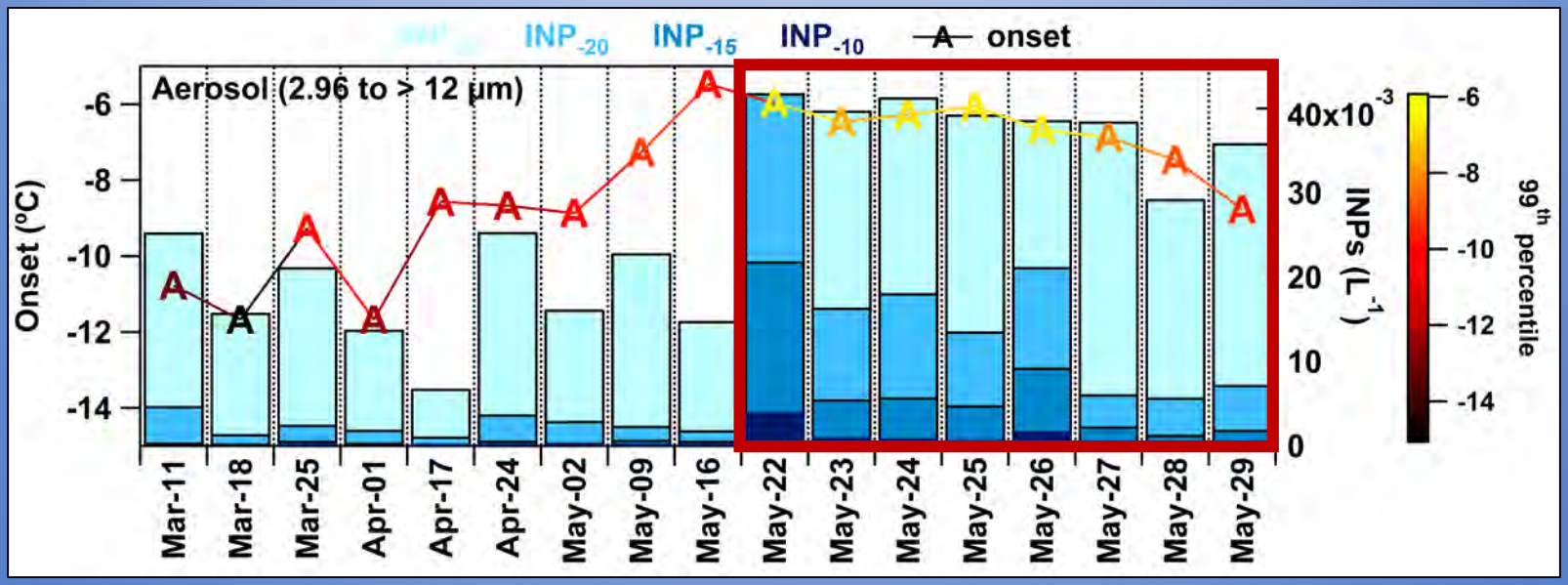


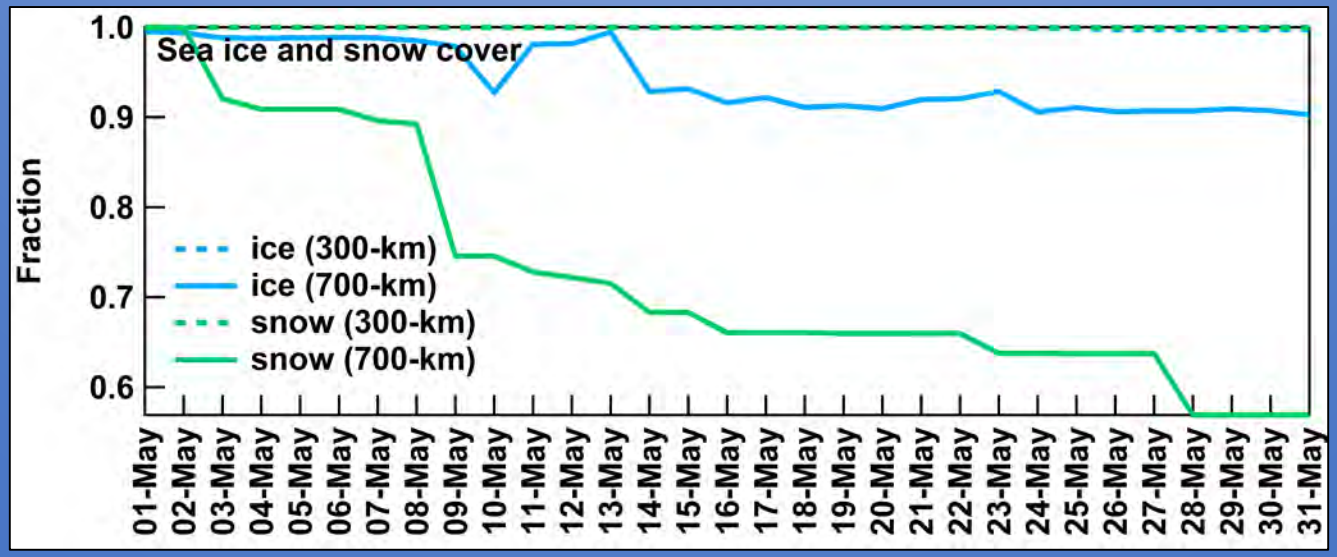
Creamean et al., ACP, 2018, 18, 555–570.
Maahn et al., ACP, 2017, 17, 14709–14726.
Creamean et al., ACPD, 2018, *in prep.*

Preliminary INP results

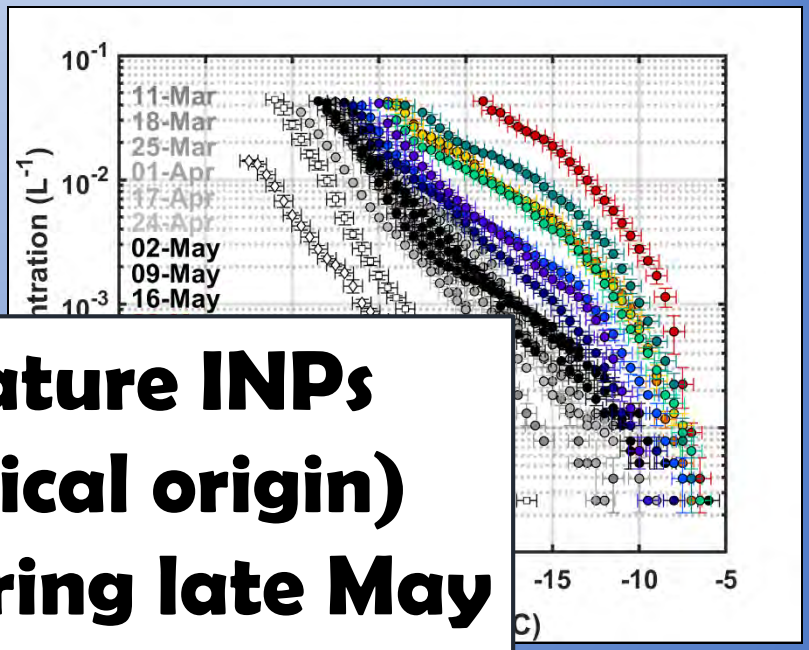


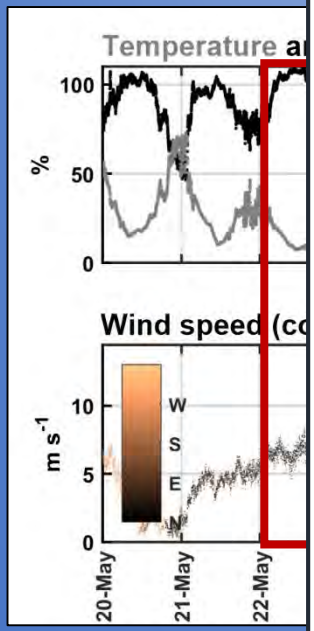
Warmest INPs observed during spring melt



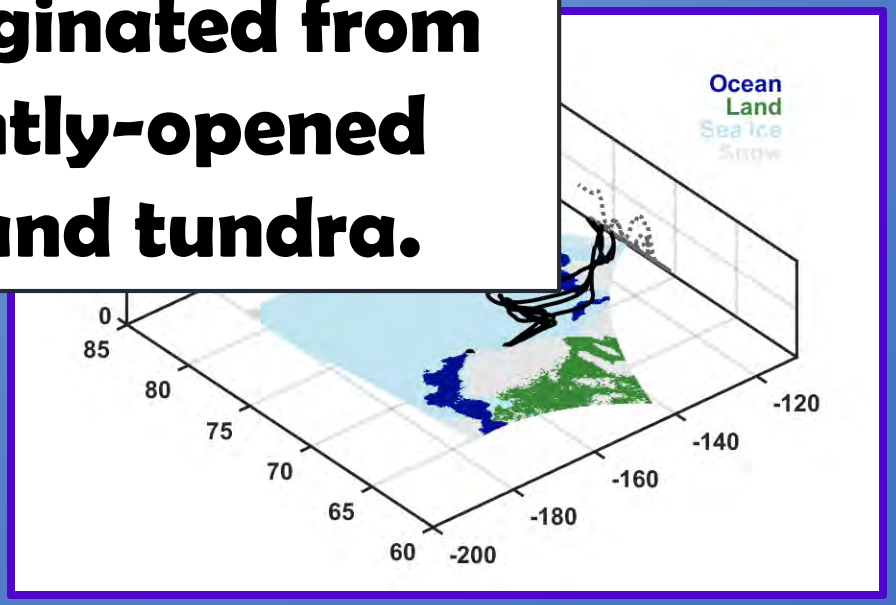


Arctic Ocean and tundra impact INP sources at Oliktok

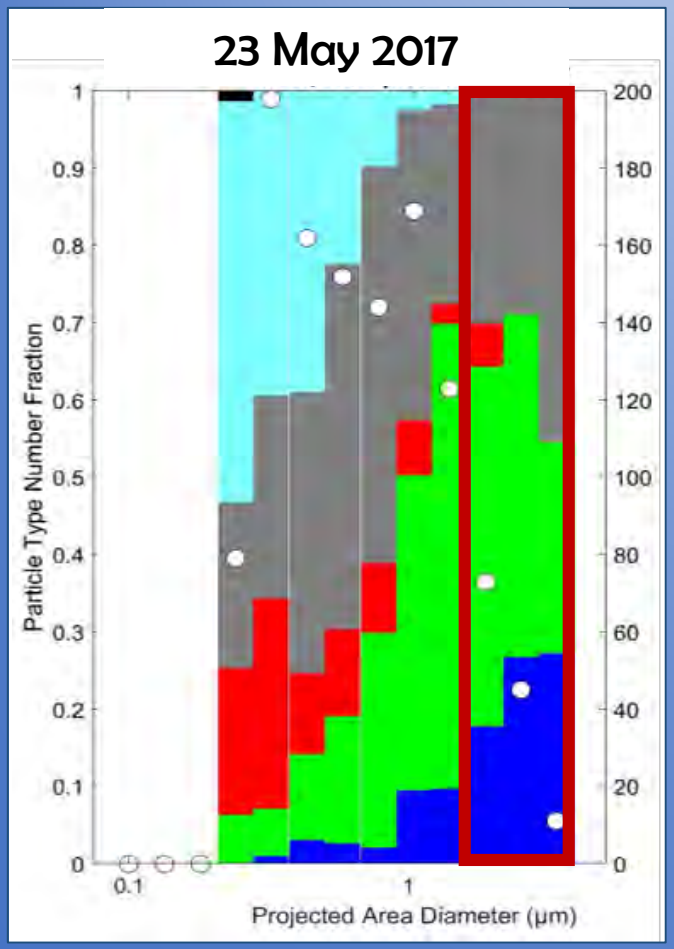




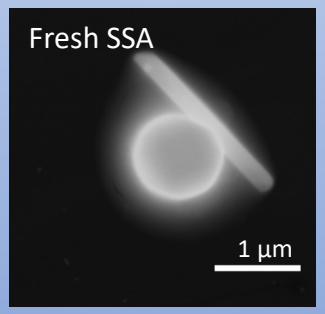
Warm temperature INPs (likely of biological origin) were observed during late May when winds originated from over the recently-opened Arctic ocean and tundra.

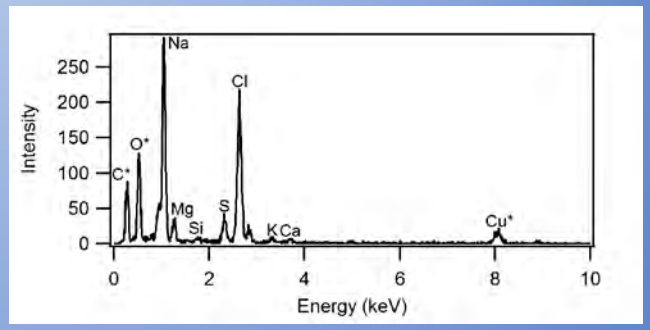


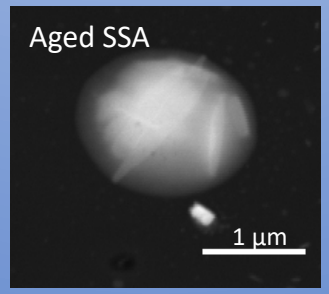
Bulk & single-particle aerosol chemistry supports a marine origin

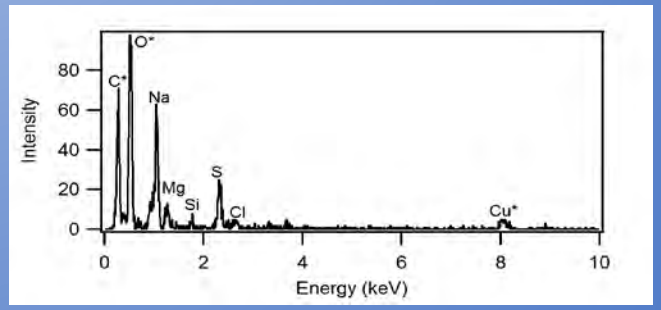


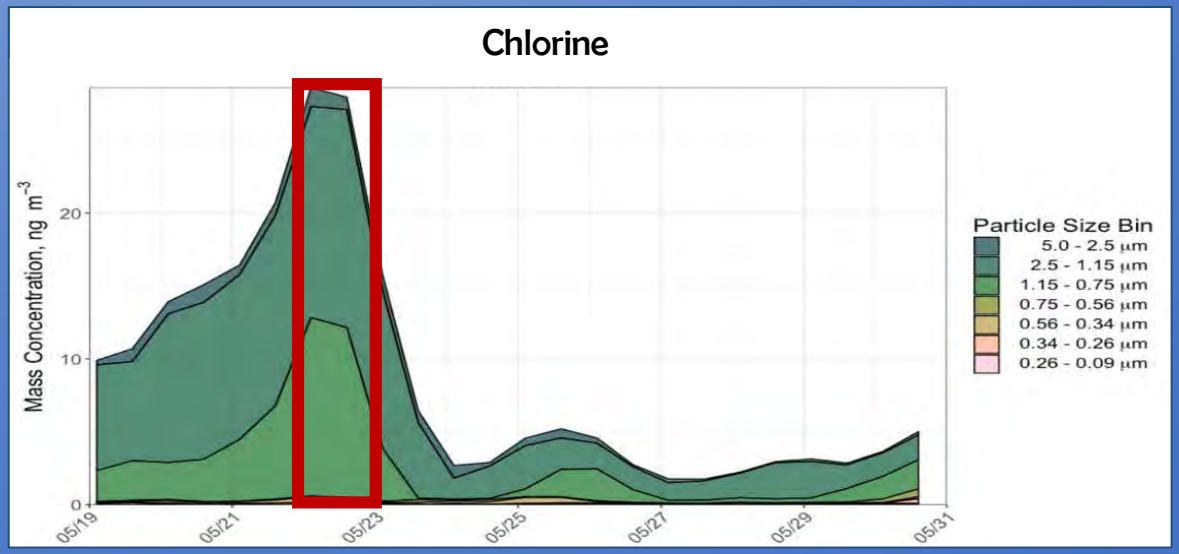
Sea spray, aged sea spray, organic, dust, fly ash, soot





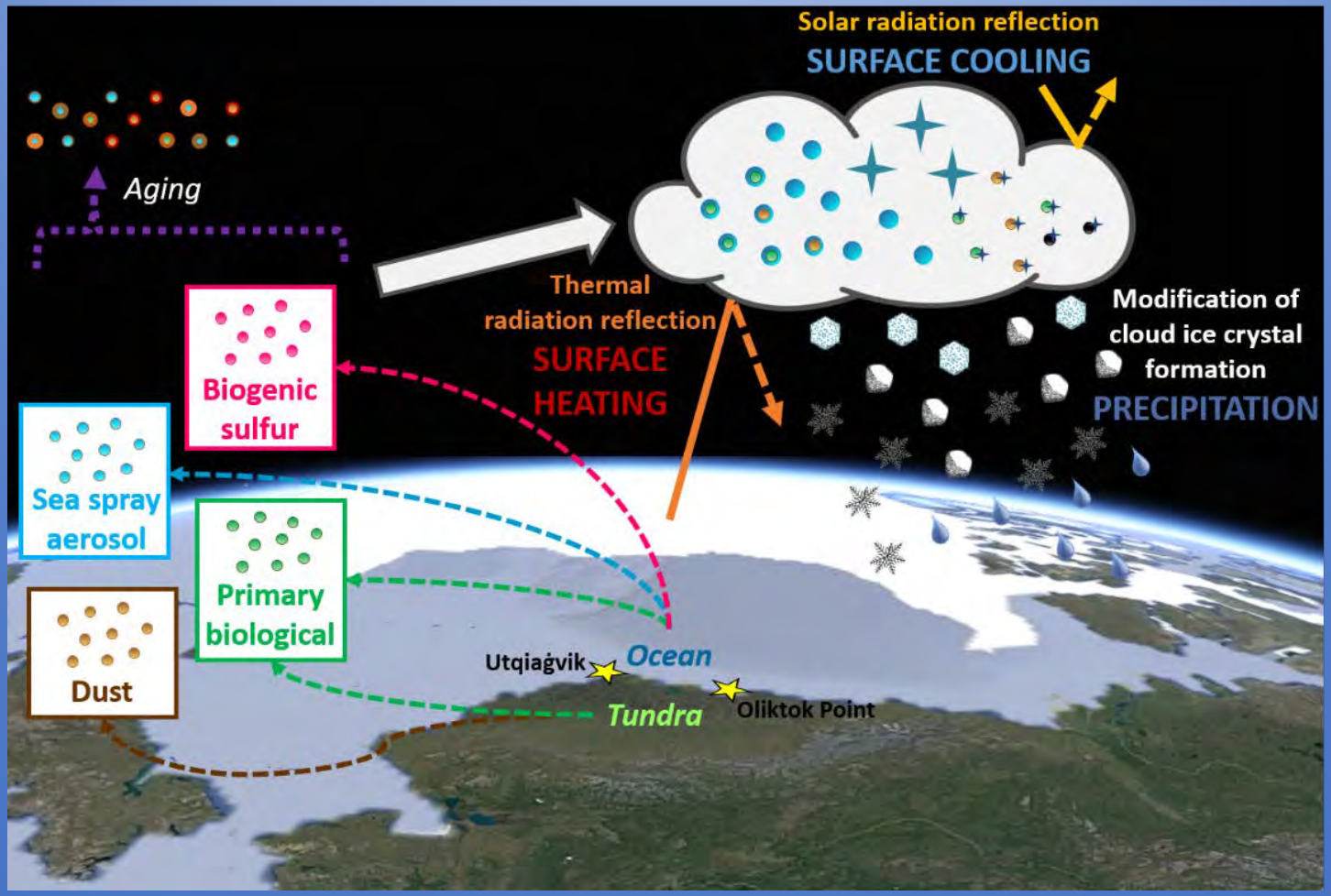


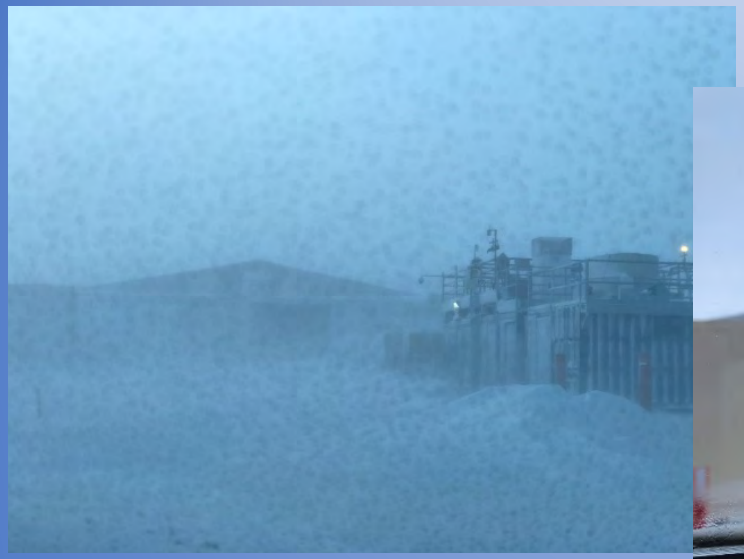




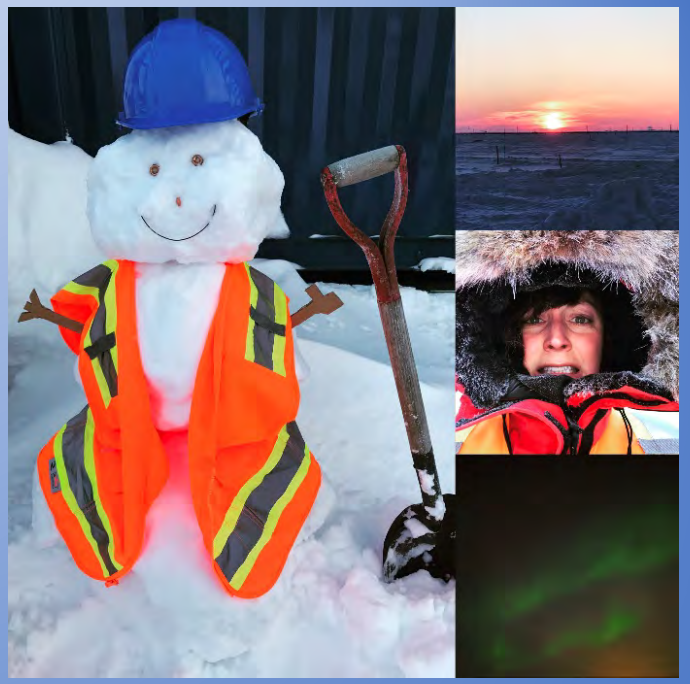
Summary

- INPOP results show the influence of very large, warm temperature marine and terrestrial INPs to a relatively polluted Arctic location.
- Demonstrate the importance of natural, regionally-transported INPs in the Arctic.









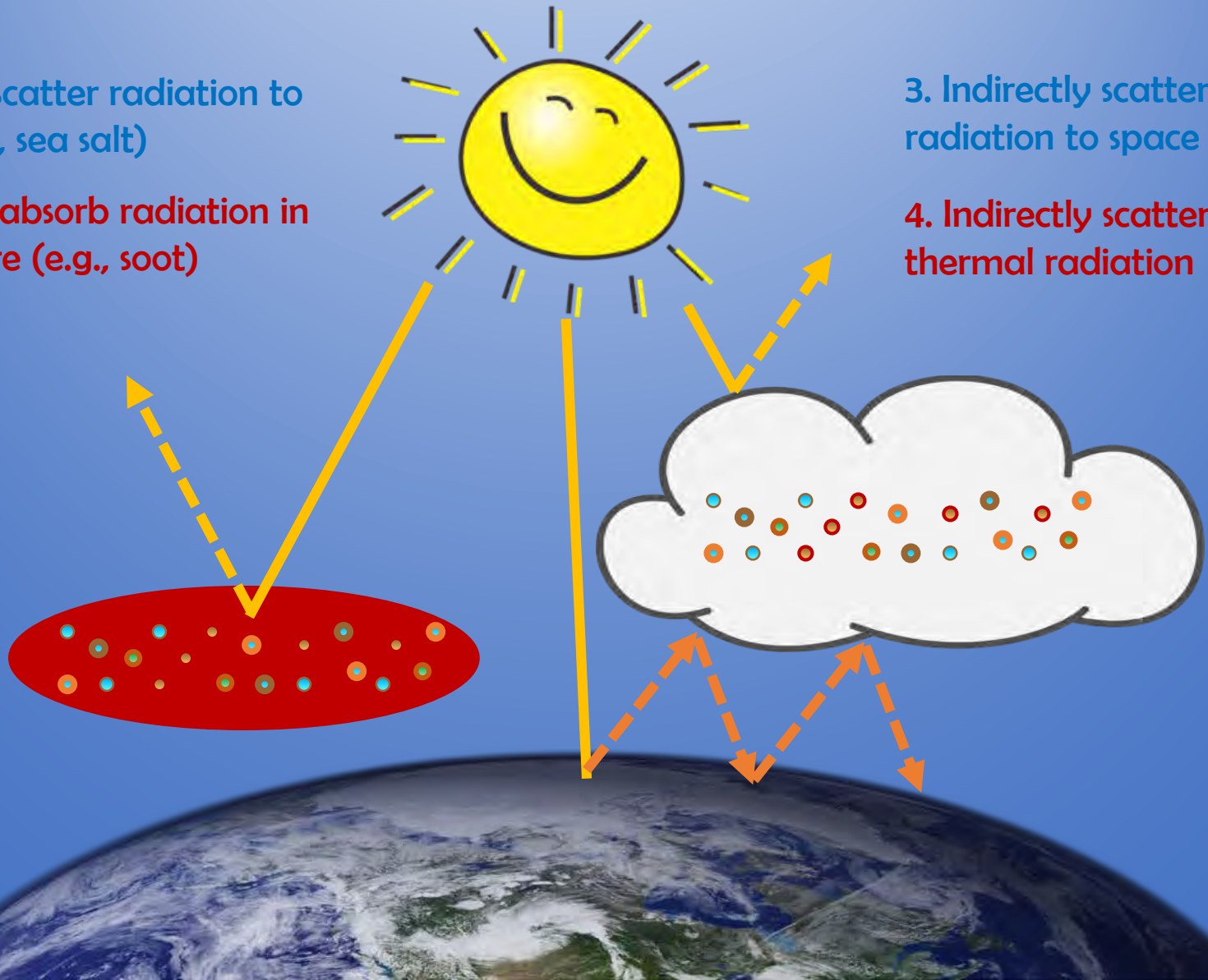


Thank you for listening!

How do aerosols affect the energy budget?

1. Directly scatter radiation to space (e.g., sea salt)

2. Directly absorb radiation in atmosphere (e.g., soot)



3. Indirectly scatter radiation to space

4. Indirectly scatter thermal radiation

How do aerosols affect precipitation?

Delay onset of precipitation

cloud condensation nuclei

or "CCN"

Enhance precipitation

ice nucleating particles

or "INPs"

In general, the radiative effects and cloud forming capabilities of aerosols depend on their composition, size, and number.

