Spatial Distribution, Sources and Cloud Processing of Aerosol Particles

B04

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1. Summary

- Aerosol particles influence the radiative budget and the radiative properties of Arctic clouds by affecting cloud microphysical properties and phase state.
- Interactions between clouds and aerosols may play a key role in Arctic amplification.
- We plan to perform a combination of airborne and ground-/ship-based investigations concerning the abundance, physical and chemical properties, and sources of cloud condensation nuclei (CCN), ice nucleating particles (INP), and black carbon (BC).

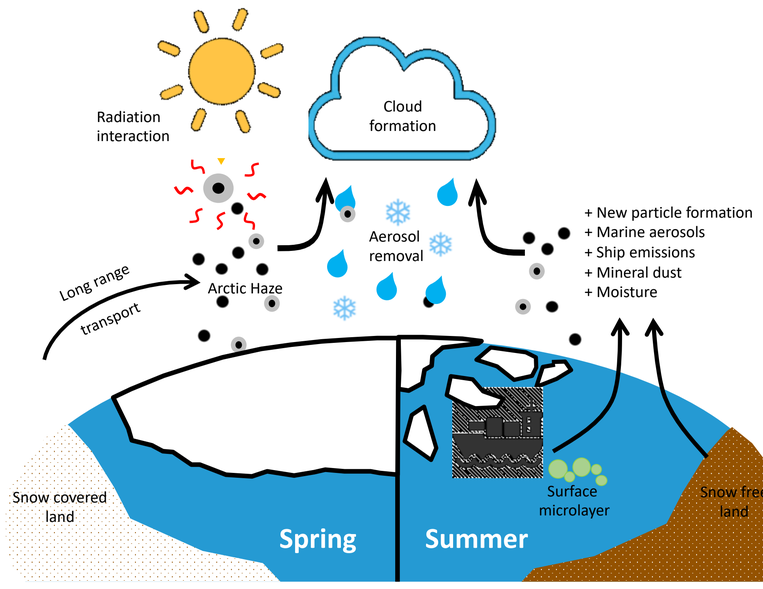


Fig. 1: *Connection between surface ocean , atmosphere (aerosol particles, INP, CCN, BC) and cloud processes.*

Hypothesis

Arctic aerosol acting as CCN and IN is strongly influenced by biogenic emissions and together with BC from burning emissions their vertical distribution is strongly affected by cloud processing.

2. Achievements phase I

Discovery of most likely marine biogenic INP during late Arctic winter

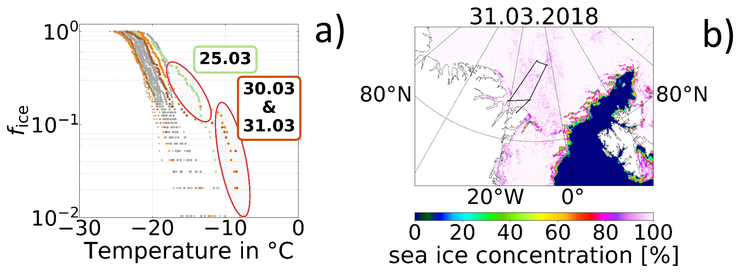


Fig. 2*: PAMARCMiP18 INP observations: a) ice fraction (directly related to INP concentration); b) sea ice concentrations (Hartmann et al., GRL, 2019).*

Different sources and atmospheric processing (i.e. cloud removal) strongly modify the microphysical properties of BC

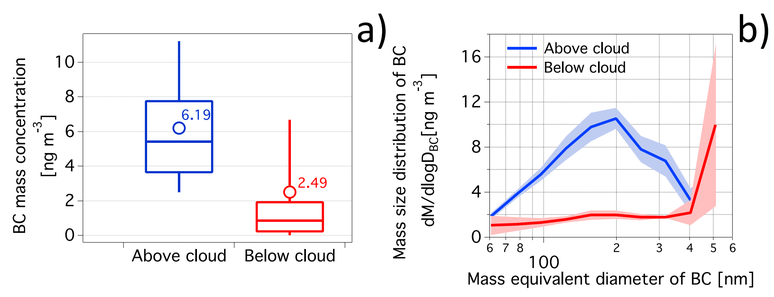


Fig.3*: ACLOUD BC observations: a) BC mass concentration above and below clouds; b) BC mass size distribution above and below clouds (Schulz et al., ACP, 2018).*

Glucose may serve as an tracer for ice nucleating activity

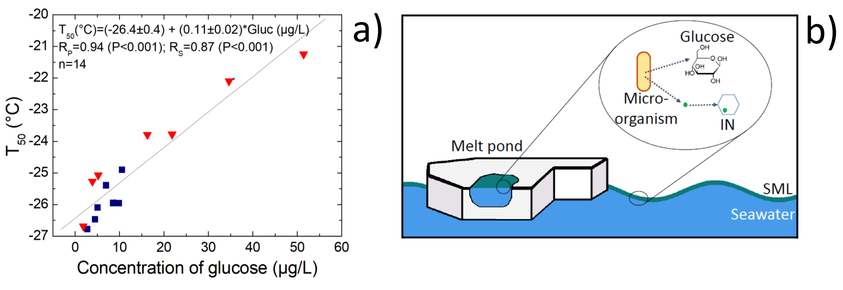


Fig. 4: *PASCAL surface water observations: a) correlation of glucose with IN concentrations in sea water and surface microlayer (SML); b) potential release of glucose and biologically-produced IN (Zeppenfeld et al., ES&T, 2019).*

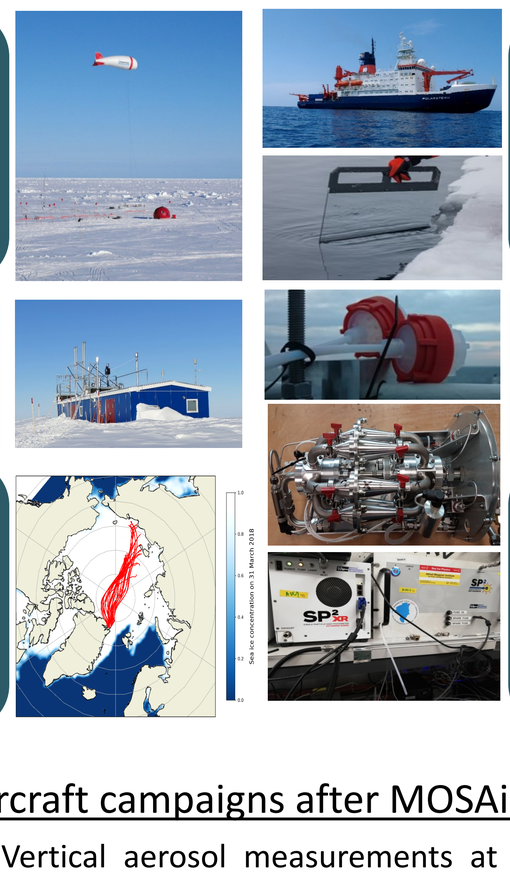
3. Research plan phase II

Scientific Questions

- What are the spatial (vertical and horizontal) and temporal distributions of the abundance and the physical and chemical properties of Arctic aerosol particles in general, and CCN, INP, and BC, in particular (WP 1)?
- What are the abundance and the physical and chemical properties of INP from the oceanic and cryospheric compartments (WP 2)?
- What are the sources (long-range transport vs. local, marine vs. terrestrial, biological vs. mineral) of aerosol particles, CCN, INP, and BC in the Arctic (WP 3)?
- What are the influences of clouds on the vertical distribution of aerosol particles, CCN, INP, and BC (WP 4)?

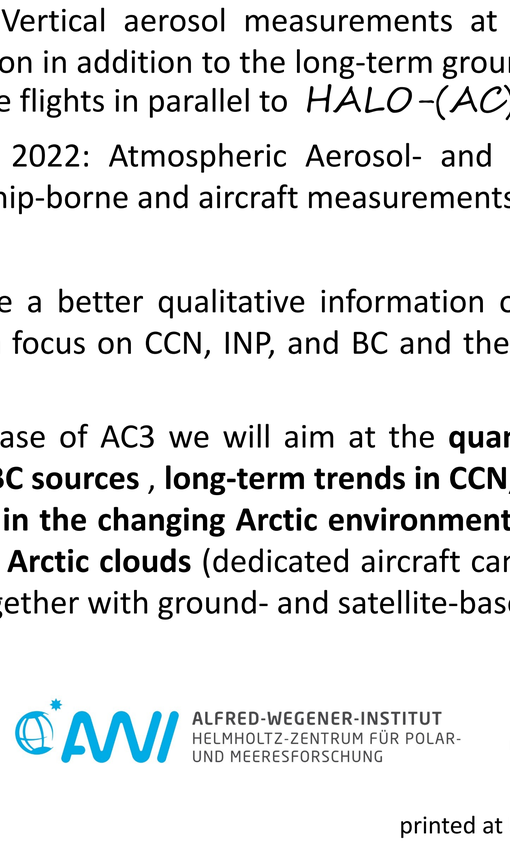
Objectives and Methods

WP1: Measurement and characterization of atmospheric particles in 4D



WP2: Sampling and characterization of cryospheric and oceanic INP

WP 3: Identification, and apportioning of the sources of Arctic aerosols



WP 4: Quantify effects of cloud processing on the distribution and properties of Arctic aerosols

4. Role within (AC)³ & perspectives

Alternative aircraft campaigns after MOSAiC

- Spring 2021: Vertical aerosol measurements at Ny-Ålesund and Villum Research Station in addition to the long-term ground based measurements and coordinate flights in parallel to HALO-(AC)³.
- Late summer 2022: Atmospheric Aerosol- and Cloud Study, based on coordinated ship-borne and aircraft measurements (ATWAICE).

Perspectives

- We will achieve a better qualitative information on the sources of Arctic aerosols with a focus on CCN, INP, and BC and the influences of clouds on these particles.
- In the third phase of AC3 we will aim at the **quantitative understanding: CCN, INP, and BC sources** , **long-term trends in CCN, INP, and BC** abundance and properties **in the changing Arctic environment**, the **influences of CCN, INP, and BC on Arctic clouds** (dedicated aircraft campaign on aerosol cloud interactions together with ground- and satellite-based remote sensing)

External collaborations/links

Aarhus-University (Denmark, aerosol particles), British Antarctic Survey (England; INP), Brookhaven National Laboratory (USA; BC), Environment and Climate Change Canada (Canada; BC), and the Paul Scherrer Institute (Switzerland; particle size distribution, CCN and BC).

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