Properties and sources of Arctic ice nucleating particles and cloud condensation nuclei

B04

Frank Stratmann, Hartmut Herrmann, Alfred Wiedensohler, Paul Herenz, Manuela van Pinxteren, Andre Welti

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UNIVERSITÄT LEIPZIG · Universität Bremen · University of Cologne · TROPOS Leibniz Institute for Tropospheric Research · AWI

1 Summary

- Comprehensive physical and chemical characterization of the Arctic aerosol during a RV Polarstern cruise (PASCAL)
- Special focus on ice nucleating particles and cloud condensation nuclei
- Laboratory studies of sea-surface microlayer material as a potentially important local marine source of ice nucleating particles

Hypothesis

Local oceanic sources influence the populations of Arctic ice nucleating particles and cloud condensation nuclei.

2 Research rationale

Current state of understanding

- Number and chemical composition of Ice Nucleating Particles (INP) and Cloud Condensation Nuclei (CCN), may significantly influence the properties of Arctic clouds.
- Possible sources for Artic INP and CCN are long–range transport and local sources (e.g., primary marine organic matter from the sea surface microlayer, SML, anthropogenic and "natural" combustion emissions).
- In a changing Arctic climate both, particle sources and particle properties are changing.

→ **Strong need for investigating the physical and chemical properties of Artic aerosol particles, their possible sources, and effects as INP and CCN**

Preliminary work

- TROPOS has a long history in carrying out worldwide land– and ship–borne field studies characterizing aerosol physical properties.

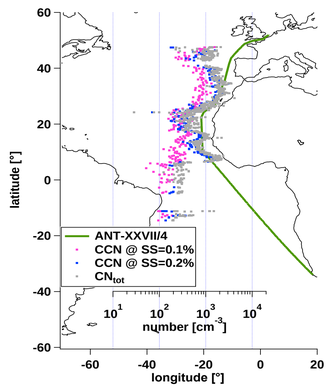


Fig. 1: CN and CCN number concentrations during the ANT XXVII/4 Polarstern cruise

- TROPOS is one of the world-wide leading institutions in the field of heterogeneous ice nucleation.

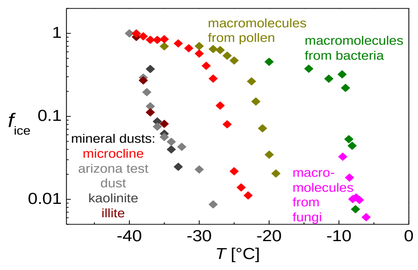


Fig. 2: Ice fractions as function of temperature for various dusts and biological materials

- TROPOS is highly experienced in the chemical characterization and source apportionment of aerosol particles.

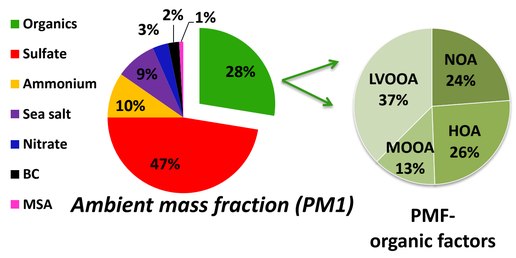


Fig. 3: Source apportionment based on PMF-AMS method for the ANT XXVII/4 Polarstern cruise

3 Research plan

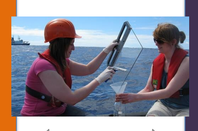
Scientific Questions

- What are the INP and CCN number concentrations in the Central Arctic Atmospheric Boundary Layer (ABL), can we draw conclusions concerning the Arctic INP's and CCN's nature (mineral, organic), and are there INP in the sea surface micro layer and/or the bulk seawater, which could possibly contribute to the arctic INP population? (WP1)
- What is the chemical composition of Arctic aerosol particles, the Artic sea surface micro layer, and the bulk seawater, and are there relationships with observed CCN and INP? (WP2)

Methods

Ship-based comprehensive physical and chemical characterization of the Arctic aerosol, the sea-surface micro-layer, and the bulk seawater

WP1: Physical Aerosol Properties:
- INP/CCN concentrations
- Number size distribution
- Volatility
- Hygroscopicity
- Mixing state
- Scattering and absorption coefficients



WP2: Chemical Aerosol, SML and Bulk Sea-Water-Properties:
- Offline and online aerosol measurements (filter+AMS)
- Source apportionment: mineral and organic constituents
- SML as INP/CCN source

Expected Results:
- INP's and CCN's abundance and properties (e.g., freezing onsets, hygroscopicity)
- Clear indications concerning the existence and the chemical nature of INP in the SML and/or the bulk seawater
- Chemical nature of the INP in the ABL and their source(s)

4 Role within (AC)³ & perspectives

Project synergy:

B04 Ship in-situ INP/CCN
WP1 INP/CCN conc.
WP2 Aerosol and sea water comp.

- **A01** Ship & ground aerosols, clouds, rad. · **A02** Airborne radiation, aerosol · **B03** Airborne clouds & aerosol → **Complementary data at sea & cloud level**
- **B01** Satellite clouds · **B02** Satellite aerosol · **B06** Ship water vapour & aerosol · **C02** Ground snow & BC · **E02** Ground rem. sens. aerosol, clouds & rad. → **Data provision for validation & and interpretation of experimental results**
- **D02** Model aerosol & clouds · **E01** Model climate feedbacks · **E03** Model clouds → **Modell input & evaluation**

Perspectives

- Measurements on longer time and larger spatial scales (e.g., MOSAiC)

MOSAiC
Multidisciplinary drifting Observatory for the Study of Arctic Climate
IASC

www.mosaicobservatory.org

- Determine aerosol effects on clouds (extend ground-based measurements into the vertical: balloon, HALO, UAV)
- Quantitative insights into the chemical nature of Arctic INPs
- Measurements of INP fluxes (if concentrations permit)

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