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

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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

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 Arctic 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.

Preliminary work

- TROPOS has a long history in carrying out worldwide land- and ship-borne field studies characterizing aerosol physical properties.
- TROPOS is one of the world-wide leading institutions in the field of heterogeneous ice nucleation.
- TROPOS is highly experienced in the chemical characterization and source apportionment of aerosol particles.

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 Arctic 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:

Complementary data at sea & cloud level

Data provision for validation & interpretation of experimental results

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

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)