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Is the ocean enough? – Indications towards the origin of Ice Nucleating Particles from May to July in the Arctic

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Low-level mixed-phase clouds are important factors influencing the energy budget of the Arctic boundary layer. The radiative properties of these clouds are determined by their microphysical properties. Aerosol particles that act as Ice Nucleating Particles (INP), impact the primary ice formation inside clouds and thereby affect cloud lifetime, albedo and precipitation formation. The sources of INP in the Arctic, their properties, nature and concentration are poorly understood which results in substantial uncertainties radiative forcing estimates in climate models.

Here, we present ship-based measurements of INP in different environmental compartments (air, sea surface microlayer, bulk sea water, fog water) in the Arctic. From May to July 2017 the PASCAL field campaign took place around and north of Svalbard (up to 84°N, between 0° and 35°E) onboard the RV Polarstern. INP concentrations were measured online with the SPIN instrument (Spectrometer for Ice Nuclei, DMT) and offline through filter sampling and analysis with freezing array techniques. We assess possible connections between the INP in the sea water and air, as well as between INP in the fog water and air through a closure study.

Generally, INP concentrations in the Arctic were found to be lower than in mid-latitudes with the exception of elevated INP concentrations at temperatures above -15°C and below -30°C. We attribute elevated INP concentrations to the presence of biogenic, probably proteinaceous INP, at the warmer, and to the presence of mineral dust at colder temperatures, respectively. The closure studies revealed that:
a) all INP in the air are activated to fog droplets, and
b) the INP concentration in seawater alone cannot explain INP concentration in air without a substantial enrichment of INP (factor 10^4 to 10^5) during the transfer of INP from the sea surface to the atmosphere.
We present indications for a local, marine source of INP from a case study looking at the period

when atmospheric INP concentrations were highest in the temperature range above -15°C. These findings highlight the need for future studies to assess especially the production mechanisms and source strength for Arctic INP.

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