A045-13 - Elucidating Ice Nucleating Particle Concentrations in the Arctic: Investigating Predictability from Parameterizations and Fresh Snow Samples

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Abstract

Temperatures rise most in the Arctic, where also climate projections predict the strongest increase over the next decades. Projecting the extent of this warming is linked to uncertainties in the climate simulations which are caused by, amongst other influencing factors, the shortwave radiation scattering ability of Arctic mixed-phase clouds (MPCs). MPCs featuring both supercooled droplets and ice crystals have a highly variable radiative effect depending on their ice-to-liquid ratio. Additionally, the ice phase has a key influence on precipitation initiation and cloud lifetime. Ice crystals in MPCs are initially formed by heterogeneous nucleation on sparse aerosol particles called ice nucleating particles (INPs) or from existing ice crystals via secondary ice processes (e.g. rime splintering or collision fragmentation). The scarce data of observed INP concentrations show variation spanning orders of magnitude in both space and time which often is represented by simplified INP parameterizations in weather and climate models thus limiting their accuracy.

During two field campaigns in autumn 2019 and spring 2020, INP concentrations were monitored in-situ at Ny-Ålesund (Svalbard, Norway) in the framework of NASCENT. First, using an offline drop-freezing technique and an online continuous flow diffusion chamber, INP concentrations down to -20 °C and at -30 °C, respectively, were measured at high temporal resolution over a period of six weeks per season. By comparing our observations to predictions based on existing parameterizations, we found that different parameterizations are needed to match the seasonal observations. Here we present a novel approach modelling the observations by a set of log-normal distributions as a function of (cloud) temperature to predict ambient INP background concentrations for the Arctic. Second, we compared in-situ ambient INP concentrations in air to INP concentrations retrieved from fresh snow fall – a method frequently used in recent studies. In the non-polluted environment of the Arctic, we assess the reliability of this method and highlight obstacles caused by in-cloud processes and meteorological factors. Our results will contribute to the understanding of INPs as well as providing the scientific community with field data in regions of limited data availability.

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