The seasonal cycle of biogenic ice-nucleating particles in a boreal forest environment

Julia Schneider, Kristina Höhler, Paavo Heikkilä, Jorma Keskinen, Barbara Bertozzi, Tobias Schorr, Nsikanabasi Umo, Franziska Vogel, Zoé Brasseur, Yusheng Wu, Simo Hakala, Jonathan Duplissy, Tuukka Petäjä, Michael P. Adams, Benjamin J. Murray, Kimmo Korhonen, Erik S. Thomson, Dimitri Castarède, Thomas Leisner, and Ottmar Möhler

1 Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research, Atmospheric Aerosol Research, Germany (julia.schneider2@kit.edu)
2 Aerosol Physics Laboratory, Physics Unit, Faculty of Engineering and Natural Science, Tampere University, Tampere, Finland
3 Institute for Atmospheric and Earth System Research/Physics, Faculty of Science, University of Helsinki, Helsinki, Finland
4 Institute for Climate and Atmospheric Science, School of Earth and Environment, University of Leeds, Leeds, UK
5 Department of Applied Physics, University of Eastern Finland, Kuopio, Finland
6 Department of Chemistry and Molecular Biology, University of Gothenburg, Gothenburg, Sweden

By triggering the formation of cloud ice crystals in the atmosphere, ice-nucleating particles (INP) strongly influence cloud properties, cloud life cycle and precipitation. Describing the abundance of atmospheric INPs in weather forecasts and climate projections remains challenging, as the global distribution and variability of INPs depend on a variety of different aerosol types and sources. Although widespread field measurements have been conducted, neither short-term variability nor long-term seasonal cycles have yet been well characterized by continuous measurements. In 2018, the University of Helsinki and the Karlsruhe Institute of Technology (KIT) initiated a field campaign HyICE to perform comprehensive long-term INP measurements in the Finnish boreal forest. The campaign took place in Hyytiälä, Southern Finland at the University of Helsinki SMEARII research station (Hari and Kulmala, 2005). KIT provided the INSEKT (Ice Nucleation Spectrometer of the Karlsruhe Institute of Technology) to analyse the INP content of ambient aerosols sampled on filters. INSEKT is able to measure INP concentrations in the immersion-freezing mode at temperatures between 273 K and 248 K. The measurements started in March 2018 and ended in May 2019, which provides a unique continuous long-term time series of INP concentrations for over more than one year with a time resolution of about one to three days. This long-term observation record is used to examine systematic seasonal trends in the INP concentrations and to find meteorological and aerosol related parameters to describe the observed trends and variabilities. These findings will enable to find new parameterizations of atmospheric INP concentrations, as current parameterizations do not reproduce the observed seasonal cycle yet. In addition to INP concentration measurements, heat treatment tests of the aerosol samples have been conducted providing additional indications about the INP types dominating the INP population in the boreal forest, also in dependence on the season. Finally, this contribution will
summarize and discuss major findings and implications from the HylCE long-term INP observation.