Development, Characterization and Testing of a Drone-based Sampling Method for Investigations of Ice-Nucleating Particles

Paul Bieber¹, Teresa M. Seifried¹, Jürgen Gratzl², Julia Burkart², Anne Kasper-Giebl³, David G. Schmale III⁴, and Hinrich Grothe¹

¹Institute of Materials Chemistry, TU Wien, Vienna, 1060, Austria
²Faculty of Physics, University of Vienna, Vienna, 1090, Austria
³Institute of Chemical Technologies and Analytics, TU Wien, Vienna, 1060, Austria
⁴School of Plant and Environmental Sciences, Virginia Tech, 24061-0390 Blacksburg, Virginia, USA

Terrestrial ecosystems can contribute various particles to the troposphere, some of which are known for their ice nucleation activity. Most of the land-surface in Europe is covered with forests and fields, representing potential sources of ice nucleation active bioaerosols in form of pollen grains, fungal spores and bacterial cells. The presence of biogenic ice-nucleating particles (INPs) in clouds leads to heterogeneous freezing events and therefore influences the hydrological cycle and the Earth's climate. Many studies focus on measurements and characterizations of INPs in clouds using aircrafts or sample on ground with stationary devices. Less is known about the actual emission and transport to high tropospheric layers. We focused on the development of an efficient sampling device that can be attached to small scale drones, such as the DJI Phantom 4 model. The Drone-based Aerosol Particles Sampling Impinger/Impactor (DAPSI) system was developed to sample airborne INPs above emission sources. It includes a cascade impactor that collects particles with size resolution and a self-build impinging system that accumulates INPs in a sterile solution. Additionally, the system contains an electric sensor for environmental data records (temperature, relative humidity and air pressure) as well as an optical particle counter to monitor particular matter concentrations during flight times. This study leads through the building, characterization and test-campaign of DAPSI. We present a validation test, regarding the sampling effectivity to sample aerosols (polystyrene latex spheres and INPs) as well as results from the first field campaign which took place in a rural sampling site in the Austrian Alps. Fluorescence- and cryo-microscopic assays show auto-fluorescent particles and heterogeneous ice nucleation activity of DAPSI samples. We highlight the opportunity to use DAPSI with small un(wo)manned aerial vehicles during field campaigns to sample and identify biogenic INPs in vertical and spatial resolution above emission sources.