2704 - O

Laboratory studies of the ice nucleating ability of pollen and model simulations of the effects of biological aerosol particles on cloud microphysics.

Diehl, Karoline
University of Mainz, Institute of Atmospheric Physics

Martin Simmel
Leibniz-Institute for Tropospheric Research, Permoserstrae 15, 04318 Leipzig, Germany

Sabine Wurzler
North Rhine Westphalia State Environment Agency, Schederhofstrae 6, 45145 Essen, Germany

Nadine von Blohn
Institute of Atmospheric Physics, Becherweg 21, 55099 Mainz, Germany

Subir Kumar Mitra
Institute of Atmospheric Physics, Becherweg 21, 55099 Mainz, Germany

Literature studies reveal that biological aerosol particles are most likely involved in cloud and precipitation processes. Leaf litter, fungi, lichen, bacteria, and marine plankton act as ice nuclei at temperatures not far below 0C, i.e. at definitely higher temperatures than other atmospheric ice nuclei such as mineral dust and soot. This was also demonstrated for a number of pollen species showing that the ice nucleating ability of pollen is not restricted to single pollen types. These laboratory experiments were undertaken at the facilities of the Mainz vertical wind tunnel where single droplets are freely floated at their terminal velocity. By different experimental techniques immersion and contact freezing of super-cooled droplets were investigated. The results show that droplets containing pollen froze at temperatures up to 9 C (immersion mode), and drops colliding with pollen froze at temperatures up to 5 C (contact mode). It was further observed that pollen types released earlier in the year show a higher ice nucleation efficiency which implies that an explanation for their ice nucleating ability might be a biological freezing tolerance: extra-cellular freezing protects the interior of the cells. The results confirm the potential importance of biological aerosol particles in cloud and precipitation processes in their ability to act as ice nuclei at relatively warm temperatures. To estimate the possible effects of biological particles on cloud microphysics model simulations were performed using an air parcel model with a detailed sectional description of the cloud microphysics. Ice formation proceeded by drop freezing in immersion and contact modes. The descriptions of these freezing processes in the cloud model are based on laboratory results and allow to investigate the dependence of freezing on the type of ice nuclei. Sensitivity studies were performed for various types of ice nuclei to show their effects on ice formation and, thus, on the vertical cloud dynamics. The ice nuclei were bacteria, lichen, leaf litter, pollen, and, for comparisons, montmorillonite, kaolinite, and soot. The fractions of active ice nuclei during the model simulations were 1% for the biological particles, 20% for mineral dust, and 10% for soot; these values are based on field measurements of the proportioning of atmospheric aerosol particles. Although the amount of biological particles as active ice nuclei was much lower than the ones of mineral dust and soot, the effects on ice formation and vertical cloud dynamics were in the same order of magnitude. This indicates the importance of biological particles for cloud microphysical processes, and hence, they should not be neglected against mineral dust and soot.