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The ice nucleation activity of biological aerosols

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Primary Biological Aerosol Particles (PBAPs), including bacteria, spores and pollen may be important for several atmospheric processes. Particularly, the ice nucleation caused by PBAPs is a topic of growing interest, since their impact on ice cloud formation and thus on radiative forcing, an important parameter in global climate is not yet fully understood.

In laboratory model studies we investigated the ice nucleation activity of selected PBAPs. We studied the immersion mode freezing using water-oil emulsion, which we observed by optical microscopy. We particularly focused on pollen. We show that pollen of different species strongly differ in their ice nucleation behavior. The average freezing temperatures in laboratory experiments range from 240 K to 255 K. As the most efficient nuclei (silver birch, Scots pine and common juniper pollen) have a distribution area up to the Northern timberline, their ice nucleation activity might be a cryoprotective mechanism. For comparison the ice nucleation activity of Snomax, fungal spores, and mushrooms will be discussed as well.

In the past, pollen have been rejected as important atmospheric IN, as they are not as abundant in the atmosphere as bacteria or mineral dust and are too heavy to reach higher altitudes. However, in our experiments (Pummer et al. 2011) it turned out that water, which had been in contact with pollen and then been separated from the bodies, nucleates as good as the pollen grains themselves. So the ice nuclei have to be easily-suspendable macromolecules (100-300 kDa) located on the pollen. Once extracted, they can be distributed further through the atmosphere than the heavy pollen grains and so augment the impact of pollen on ice cloud formation even in the upper troposphere. It is widely known, that material from the pollen, like allergens and sugars, can indeed leave the pollen body and be distributed independently. The most probable mechanism is the pollen grain bursting by rain, which releases material, like allergens (Schäppi et al., 1999). As a consequence allergenic material was found in aerosol particles smaller than 5 μm, which contained no pollen or bigger fragments (Solomon et al., 1983). The release of material by bursting of wet pollen has been observed by electron microscopy (Swoboda et al., 2001). Not only allergens, but also sugars originating from pollen can be detected in the atmosphere (Yttri et al., 2007). These authors see pollen rupture and wood burning as their main sources in the atmosphere. The contrast between the hydrophilic properties of many of the surface components and the relative hydrophobia of the sporopollenin boosts the suspension of surface components in water droplets. According to that we conclude that the impact of pollen on the global atmosphere might have been underestimated. Additionally, our experiments lead to the conclusion that pollen ice nuclei, in contrast to bacterial and fungal ice nucleating proteins, are non-proteinaceous compounds.

References

Pummer, B. G., Bauer, H., Bernardi, J., Bleicher, S., and Grothe, H., Atmos. Chem. Phys. Discuss. 11, 27219-27241, doi:10.5194/acpd-11-27219-2011, 2011.
Schäppi, G. F., Taylor, P. E., Pain, M. C. F., Cameron, P. A., Dent, A. W., Staff, I. A., and Suphioglu, C., Clin. Exp. Allergy, 29, 633-641, 1999.
Solomon, W. R., Burge, H. A., and Muilenberg, M. L., J. Allergy Clin. Immunol., 72, 443-447, 1983.
Swoboda, I., Grote, M., Verdino, P., Keller, W., Singh, M., B., DeWeerd, N., Sperr, W. R., Valent, P., Balic, N., Reichelt, R., Suck, R., Fiebig, H., Valenta, R., and Spitzauer, S., J. Immunol., 172, 6490-6500, 2004.
Yttri, K. E., Dye, C., and Kiss, G., Atmos. Chem. Phys., 7, 4267-4279, doi:10.5194/acp-7-4267-2007, 2007.