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Surface activity of pollen coatings and analysis of the importance for cloud activation using two different surface models

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Pollen is an important class of bioaerosol, with annual emissions to the atmosphere on the order of 47-84 Tg. Both whole pollen grains and their fragments, formed by rupture during atmospheric processing, can act as nuclei for cloud droplets and ice crystals and potentially impact Earth's hydrological cycle and radiative balance (Fröhlich-Nowoisky et al., 2016). Pollen grains are often coated with a viscous, hydrophobic liquid called pollenkitt, which is thought to play several distinct roles in pollen dispersion and adhesion (Lin et al., 2013). The exact composition of pollenkitt is distinct between different plant species, but typically comprises a hydrophobic mixture of saturated and unsaturated lipids, carotenoids, flavonoids, and proteins and carbohydrates (Pacini and Hesse, 2005).

Hydration at high humidity has been found to change pollenkitt properties and capillary adhesion, which may in turn affect the atmospheric lifetime of pollen and its ability to act as atmospheric condensation nuclei (Lin et al., 2015). The molecular and functional composition of pollenkitt components suggest that several constituents may be surface active in aqueous solution, as is also the case for many other environmental organics. This may in turn affect the pollenkitt mixture's response to hydration via mechanisms analogous to those found for e.g. marine fatty acids (Prisle et al. 2008; 2010). However, a thorough analysis of pollenkitt water uptake properties is complicated by insufficient knowledge of its exact thermodynamic properties (Prisle et al., 2011).

Here, we present measurements of supersaturated hygroscopicity and surface tension of pollenkitt extracted from the pollen of six different species. Scanning Mobility CCN Analysis (SMCA) is used to make rapid measurements of size-resolved CCN distributions of the pollenkitt extract for supersaturations between 0.1-1.4%. Surface tension of aqueous pollenkitts and their mixtures with ammonium sulfate salt were measured via axisymmetric drop shape analysis of pendant drops in air with a ramé-hart goniometer. The measurements confirm the surface activity of pollenkitt in water and demonstrate presence of salting out effects by ammonium sulfate at high salt concentrations. Two different surface adsorption models (Prisle et al., 2011; Malila and Prisle, in prep) are used in a Köhler framework for detailed thermodynamic characterization of the impact of surface activity on warm cloud activation potential.

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