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Polen and spores as cloud condensation nuclei: results from a laboratory experiment

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Aerosol particles play an important role in physical and chemical processes that occur in the atmosphere. On the one hand, these particles are able to modify atmospheric optical properties, causing a significant impact on Earth's energy balance, and consequently their presence is fundamental on the global climate. On the other hand, aerosol particles act as cloud condensation nuclei (CCN) and ice nuclei (IN); making them an essential part of the hydrological cycle.

Atmospheric aerosols can be grouped into two categories depending on their origin: natural or anthropogenic. In our study, we put the focus on atmospheric aerosols of natural origin, in particular on primary biological aerosol particles (PBAPs) such as pollen and spores. These biogenic particles are released in large quantities from terrestrial vegetation into the atmosphere, where they can be transported up to 100-1000 km. Due to their large size (between 10-100 µm pollen grains and 2-10 µm spores) their residence time in the atmosphere is short. For this reason, they are not climate relevant compared to other components in the atmosphere. However, under moist and high humidity conditions or mechanical processes these biological aerosol particles can break into smaller particles known as sub-pollen particles (SPP) and sub-spores particles (SSP). Each pollen grain can rupture releasing a large quantity of these type of sub-particles (10^6). Wozniak et al. (2018) estimated that, for clean background conditions, high SPPs concentrations can suppress average seasonal precipitation by 32% and shift rates from heavy to light while increasing dry days.

In this study, we have investigated the ability of various pollen and spores types to break into sub-particles and be activated as CCN. To this end we used a CCN counter (CCN-100, DMT) coupled with a Scanning Mobility Particle Sizer (SMPS, TSI) to select SPPs and SSPs of 50, 100 and 200 nm. The results show that not all pollen types have the same activation properties, with critical supersaturations varying between species and particle size. Additionally, SEM images have been performed to confirm the rupture of pollen and spores particles into SPPs and SSPs, respectively. Chemical composition of the different species have been investigated as well.

References:

Wozniak,M. C., Solmon, F., & Steiner, A. L. (2018). Pollen rupture and its impact on precipitation in clean continental conditions. Geophysical Research Letters, 45, 7156–7164. https://doi.org/10.1029/2018GL077692

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