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Immersion freezing of different kinds of combustion ashes

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Ice particles in the atmosphere influence both, weather and climate. Therefore it is important to know which kind of particles can act as ice nucleating particles (INP) under atmospheric conditions.
In the last years, a lot of effort has been made to investigate the freezing abilities of natural INPs such as dusts and biological particles (Murray et al., 2012, Hoose and Möhler, 2012). However, there are only a few investigations concerning the ice nucleation ability of combustion ashes, which are the remains of fossil fuel and wood combustion and thus a possible source for anthropogenic INPs. Ash particles have similar compositions as mineral dust particles. However, the actual contribution of combustion ash particles to the atmospheric ice nucleation is rather unclear. A recent study by Umo et al. (2014) showed that combustion ashes could have a significant impact on the ice nucleation in clouds and thus should be the focus of further research.
Ash particles can be lifted to the atmosphere by wind (bottom ashes) or directly during the combustion process (fly ashes). In the present study we investigated the freezing behavior of bottom ash particles which originated from wood as well as from coal. Additionally we investigated particles from fly ash from a coal-fired power plant. Particles were generated by dry dispersion and afterwards size selected with a differential mobility analyzer (DMA). The immersion freezing ability of the different ash particles was quantified utilizing the Leipzig Aerosol Cloud Interaction Simulator (LACIS, Hartmann et al., 2011), where exactly one size segregated ash particle is immersed in a droplet.
We found significant differences between the freezing abilities of the different ash types. Particles from wood bottom ashes initiate freezing at rather low temperatures near the homogenous freezing point (around -36°C). Particles from coal bottom ashes show significant higher ice nucleation abilities than the wood bottom ash, with observed freezing temperatures similar to those of clay minerals (around -30°C). The particles from the fly ash showed the best freezing ability, which was significantly higher than the freezing ability of the clay minerals but still not as good as that of K-feldspar.

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