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Immersion freezing on mineral dust particles

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Mineral dust is considered to play a major role in ice cloud nucleation in the troposphere. More than 1.000 Tg of mineral dust are aerosolized from the ground every year, 1-10% of these reach the upper troposphere [1]. At an altitude of about 8 km ice residual particle analysis has shown that about 50% of all ice nuclei (IN) are mineral dust[2]. In principle, natural occurring dusts may either be IN-active themselves or are carriers of organic and/or biological IN. Up to now the ice nucleation, i.e. cloud glaciation, has not been quantized. However, different authors report a high IN-activity for many mineral dust samples, although a systematic comparison between different minerals is still missing. Therefore, we studied selected mineral dust samples which were characterized by X-ray diffraction, FTIR spectroscopy, and scanning electron microscopy before use.
Oil immersion measurements were performed on the most common minerals, clay materials and volcanic ash. The median freezing temperatures range from -21°C up to homogenous freezing at 38°C. Even though quite a few dust samples show a reasonable high IN-activity, their median freezing temperatures are low compared to biological samples [3, 4]. Furthermore, heat treatment of the dusts was applied in order to decompose and to denaturize organic and/or biological surfactants. Finally, some dust samples had a high loss of activity and thus were subjects of further experiments. These mineral dust particles were suspended in water and after an incubation time were removed. In some cases the washing water had become IN-active, but lost its activity after enzymatic treatment. The observed high IN-activity can thus be explained by adsorbed biological materials. The results suggest that some mineral dusts are IN-active, and if it is not intrinsic they may even enhance IN-activity of organic and biological IN if these are adsorbed on the dust particle surface. A relatively high IN-activity of the pure mineral dusts was only observed in quartz, clays, and mixed natural dusts (ATD), which are mainly composed of SiO_2 and clays.

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