Geophysical Research Abstracts
Vol. 13, EGU2011-7549, 2011
EGU General Assembly 2011

Ice nucleation efficiency of clay minerals in the immersion mode

Valeria Pinti, Claudia Marcolli, Bernhard Zobrist, Christopher Hoyle, and Thomas Peter
Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland

Up to 5700 Tg dust from deserts are emitted every year into the atmosphere (IPCC, 2001). These aerosols may reach high altitudes and can be transported over long distances. They further may act as ice nuclei (IN) and thus can modify the optical properties of clouds and their lifetime (indirect effect). Ice nucleation in the atmosphere can either occur by homogeneous or heterogeneous ice nucleation. While the first process occurs typically at temperatures below ∼238 K, the latter one takes place at higher temperatures (De Mott *et al.*, 1997).

Desert dust aerosols are mainly composed of illite (Illite NX; Illite SE), kaolinite (KGa-2; KGa-1b; Kaol) and montmorillonite (Mont SWy-2; Mont K-10; Mont KSF; Mont STx-1b). These three clay minerals from different suppliers (Fluka, Clay Mineral Society and Arginotec) were investigated in order to study their behaviour as ice nuclei in immersion mode. Additionally a Saharan dust sample (Hoggar) was investigated.

A commercial Differential Scanning Calorimeter (DSC, TA Q10) was used. The emulsified samples were prepared with 80 wt% of a mineral oil/lanoline mixture and 20 wt% of aqueous clay suspensions. This led to aqueous droplets of roughly 1.5 μm diameter with immersed clay particles. For every clay mineral we investigated aqueous suspensions with six different clay concentrations (from 0.01 to 10 wt%).

The studied samples showed three different types of behavior (case a, b and c). Characteristics of each case are listed below, samples which belong to the case are in brackets:

1. Case **a**: shifting of the onset of freezing toward higher temperatures with increasing amount of dust in the suspension (KGa-2, Clay Mineral Society).
2. Case **b**: constant freezing onsets with increasing amount of dust in the suspension (KGa-1b, Mont STx-1b, both from Clay Mineral Society; Illite NX, from Arginotec; Hoggar).
3. Case **c**: second heterogeneous peak appears for higher wt% suspensions (Kaol., Mont Mont K-10, Mont KSF, all from Fluka; SWy-2, Clay Mineral Society; Illite SE, from Arginotec).

The heterogeneous freezing temperatures depend on the type but also on the source and pretreatment of the different clay minerals. Thus, Kaol. showed freezing onsets in the range from 238 K to 248 K while KGa-1b and KGa-2 only started to freeze in the range from 238 K to 240 K.

This shows how the same type of clay can behave in a highly different way and highlights the need to better understand which property is important for the heterogeneous ice nucleation.

For comparison with literature studies where heterogeneous onset temperatures were much higher (Hoffer et al. (1961) and Pitter and Pruppacher (1973) for kaolinite), we performed a series of freezing cycles with the pan filled with the Kaol. suspension leading to a similar sample volume (∼20 mm^3) as in the second literature study. This data agrees nicely with literature suggesting that large sample volumes contain some highly potent IN. This indicates that some of the high freezing temperatures reported in the literature result mainly from the large volume of the samples, and might lead to an overrating of IN efficiencies when applied to the atmosphere.

References

De Mott, P. J., Rogers, D. C. & Kreidenweis (1997), *J. Geophys. Res.* 102*,* 19575–19584.

Hoffer, T. E., *Journal of Meterology*, 18, 766–778, 1961.

Pitter, R. L., and H. R. Pruppacher (1973), *Q. J. R. Meteorol. Soc.*, 99, 540–550, doi:10.1002/qj.49709942111.