The effect of organic coating on the heterogeneous ice nucleation efficiency of mineral dust aerosol

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The effect of organic coating on the heterogeneous ice nucleation (IN) efficiency of dust particles was investigated at simulated cirrus cloud conditions in the AIDA cloud chamber of Forschungszentrum Karlsruhe. Arizona Test Dust (ATD) and the clay mineral illite were used as surrogates for atmospheric dust aerosols. The dry dust samples were dispersed into a 3.7m3 aerosol vessel and either directly transferred into the 84m3 cloud simulation chamber or coated before with the semivolatile products from the reaction of α-pinene with ozone in order to mimic the coating of atmospheric dust particles with secondary organic aerosol (SOA) substances. The ice-active fraction was measured in AIDA expansion cooling experiments as a function of the relative humidity with respect to ice, RHi, in the temperature range from 205 to 210K. Almost all uncoated dust particles with diameters between 0.1 and 1.0 µm acted as efficient deposition mode ice nuclei at RHi between 105 and 120%. This high ice nuclation efficiency was markedly suppressed by coating with SOA. About 20% of the ATD particles coated with a SOA mass fraction of 17wt.% were ice-active at RHi between 115 and 130%, and only 10% of the illite particles coated with a SOA mass fraction of 41wt.% were ice-active at RHi between 160 and 170%. Only a minor fraction of pure SOA particles were ice-active at RHi between 150 and 190%. Strong IN activation of SOA particles was observed only at RHi above 200%, which is clearly above water saturation at the given temperature. The IN suppression and the shift of the heterogeneous IN onset to higher RHi seem to depend on the coating thickness or the fractional surface coverage of the mineral particles. The results indicate that the heterogeneous ice nucleation potential of atmospheric mineral particles may also be suppressed if they are coated with secondary organics.

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IN07_22 (2005-10-21 11:35): Illite dust coated with α-pinene SOA as ice nuclei
IN07_23 (2005-10-21 13:33): Illite dust coated with α-pinene SOA as ice nuclei
IN07_24 (2005-10-21 15:30): Illite dust coated with α-pinene SOA as ice nuclei