Geophysical Research Abstracts
Vol. 12, EGU2010-12351-1, 2010
EGU General Assembly 2010

Glassy aerosols heterogeneously nucleate cirrus ice particles

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Ice clouds in the tropical tropopause layer (TTL, ∼12-18 km, ∼180-200 K) play a key role in dehydrating air entering the stratosphere. However, in-situ measurements show that air within these clouds is unexpectedly supersaturated(1); normally the growth of ice crystals rapidly quenches any supersaturation. A number of explanations for high in-cloud humidity have been put forward, but recent research suggests high humidity may be related to the low numbers of ice crystals found within these clouds(1). Low ice number densities can be produced through selective nucleation by a small subset of aerosol particles. This is inconsistent with homogeneous nucleation of ice in liquid aerosols. However, droplets rich in organic material, ubiquitous in the TTL, are known to become glassy (amorphous, non-crystalline solid) under TTL conditions(2,3). Here we show, using a large cloud simulation chamber, that glassy solution droplets nucleate ice heterogeneously at low supersaturations. Using a one-dimensional cirrus model we also show that nucleation by glassy aerosol in the TTL may explain low TTL ice number densities and high in-cloud humidity. Recent measurements of the composition of TTL cirrus residues are consistent with our findings(4).

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