Infrared limb detection of large HNO_3-containing PSC particles in the Arctic winter stratosphere

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Growth, sedimentation and sublimation of nitric acid trihydrate (NAT) particles larger than 10 µm in polar stratospheric clouds (PSCs) are known to affect polar stratospheric ozone loss [1]. Parameterizations of large NAT particles in atmospheric models are uncertain, since the particles are difficult to access and only few field observations are available. Satellite-borne MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) infrared limb observations were shown to be sensitive to PSC composition and, specifically, to spherical β-NAT particles with diameters below 6 µm in high volume densities [2]. Based on radiative transfer simulations involving the Mie model it was shown that the ν_2 mode of NO_3^- at 820 cm^{-1} allows a specific detection. However, larger spherical NAT particles with sizes critical for irreversible denitrification are not accessible, since the characteristic signature flattens out. The combination of Arctic airborne MIPAS and in situ field observations in December 2011 suggests that large NAT particles are highly aspherical. Using IIM+SOV (invariant imbedding T-matrix method and separation of variables method) calculations [3], a characteristic red-shifted spectral signature below 820 cm^{-1} in the MIPAS spectra was attributed to highly aspherical β-NAT particles [4].

In the presented study, we analyze capabilities of infrared limb observations of detecting large NAT particles. Our detection algorithm is based on radiative transfer simulations involving IIM+SOV calculations of highly aspherical β-NAT particles. Using MIPAS observations, large NAT particle populations during the Arctic winter 2011/12 are identified vortex-wide. The results are compared with gas phase HNO_3 modulations observed by MLS (Microwave Limb Sounder).

References

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