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Combined MIPAS (airborne/satellite), CALIPSO and in situ study on large potential NAT particles observed in early Arctic winter stratosphere in December 2011

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The understanding of the characteristics of large HNO_3-containing particles (potential 'NAT-rocks') involved in vertical redistribution of HNO_3 in the polar winter stratosphere is limited due to the difficult accessibility of these particles by observations. While robust polar stratospheric cloud (PSC) classification schemes exist for observations by the space-borne lidar aboard CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) as well as for the passive mid-infrared limb observations by MIPAS (Michelson Interferometer for Passive Atmospheric Sounding), these observations are hardly exploited for the detection of large (diameter >10 μm) NAT particles. This is due to the facts that these particles have low overall number densities, resulting in weak detectable signatures, and that the physical characteristics of these particles (i.e. shape, morphology, HNO_3-content and optical characteristics) are uncertain.

We investigate collocated and complementary observations of a low-density potential large NAT particle field by the space-borne instruments CALIPSO and MIPAS-ENVISAT as well as the airborne observations by the limb-sounder MIPAS-STR and the in situ particle probe FSSP-100 (Forward Scattering Spectrometer Probe 100) aboard the high-altitude aircraft *Geophysica*. The observations aboard the *Geophysica* on 11 December 2011 associated to ESSenCe (ESa Sounder Campaign 2011) provided us the unique opportunity to study in detail the lower boundary region of a PSC where large potential NAT particles (>20 μm in diameter) were detected in situ. We analyse the ambient temperatures and gas-phase composition (HNO_3 and H_2O), the signatures of the observed particles in the CALIPSO and MIPAS observations, the HNO_3-content of these particles suggested by the FSSP-100 and MIPAS-STR observations, and focus on the spectral fingerprint of these particles in the MIPAS-STR observations. While the spectral characterisation of the observed particles is subject of ongoing work, our results support that these particles consist of NAT and that the particle shape plays a crucial role.