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A study of Mie scattering modelling for external mixtures of NAT and STS Polar Stratospheric Clouds

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Mie scattering codes have long been used to study the optical properties of Polar Stratospheric Clouds, once the particle size distribution (PSD) is known and a suitable refractive index is assumed. However, PSCs are often composed as external mixtures of STS and NAT, making questionable the use of Mie theory with a single refractive index. Furthermore, the NAT particles are non-spherical, while strictly speaking the applicability of Mie theory is limited to particles with circular symmetry along the direction of propagation of the incident light.
Here we consider a set of 15 coincident measurements of polar stratospheric clouds above McMurdo Station, Antarctica, by ground-based lidar (backscatter and depolarization) and balloon-borne Optical Particle Counters (PSD), and apply Mie theory to the measured PSD, to seek matching with the observed optical parameters.
In our model, we consider the PSD particles as STS if their radius is below a certain threshold value R and NAT if above it, assuming the corresponding refractive indexes known from literature. Moreover, we reduce the Mie calculation for the NAT part of the PSD by multiplying it by a factor C <1, which takes into account the backscattering depression expected from aspheric particles. Finally, we consider the fraction X of the backscattering contribution of the NAT part of the PSD as polarized, and the remaining (1-X) as depolarized.
The three parameters R, C and X of our model are then chosen to provide the best match with the observed lidar backscattering and depolarization.