

Assessing lidar-based classification schemes for Polar Stratospheric Clouds based on 16 years of measurements at Esrange, Sweden

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During late winter and early spring polar stratospheric clouds (PSCs) provide the surface for heterogeneous reactions which transform stable chlorine and bromine species into their highly reactive ozone-destroying states. Therefore, PSCs are important for severe depletion of ozone during polar winter at high latitudes. The formation of PSCs depends strongly on temperature. PSCs are classified into three types (PSC Ia: nitric acid di- or trihydrate crystals, NAD or NAT; PSC Ib: supercooled liquid ternary solutions, STS; PSC II: ice) according to particle composition and physical phase.

The majority of observations of PSCs - especially long time series - are based on lidar measurements of their optical properties. Lidar measurements of PSCs are commonly analyzed in classification schemes that apply the backscatter ratio and the particle depolarization ratio. This similarity of input data suggests comparable results of different classification schemes - despite of measurements being performed with a variety of mostly custom-made instruments. Based on a time series of 16 years of lidar measurements at Esrange (68°N, 21°E), Sweden, we show that PSC classification differs substantially depending on the applied scheme. The discrepancies result from varying threshold values of lidar-derived parameters that are used to define certain PSC types.

The resulting inconsistencies could impact the understanding of long-term PSC observations documented in the literature. We identify two out of seven considered classification schemes that are most likely to give reliable results and should be used in future lidar-based studies. For all classification schemes considered in this study, we conclude that improved confidence regarding the occurrence of certain PSC types can be achieved by accounting for the effect of measurement uncertainties to the classification in a more comprehensive way than is currently the case.