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Detectability of polar stratospheric clouds using the colour index retrieved from ground-based spectroscopic measurements

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Polar stratospheric clouds (PSCs) are an important component of the ozone stratospheric chemistry in polar regions. Although satellite observations nowadays provide high spatial coverage, continuous long-term spectroscopic measurements from the ground with high temporal resolution remain a valuable complement. Moreover, the presented method allows the detection of PSCs even in the presence of tropospheric clouds, while this is not possible with ground-based lidar measurements in such cases.

For a comprehensive interpretation of measurement data, the well-established radiative transfer model McArtim is used and spectra of scattered sunlight at different solar zenith angles are simulated for various atmospheric conditions. Investigating the ratio between observed intensities at two wavelengths, i.e. the so-called colour index (CI), enables the detection of PSCs during twilight. Due to the wavelength variability of scattering processes, the choice of the wavelength pair is determining the effect which PSCs exhibit in the spectra. Likewise, the optical properties, altitude and extent of the PSC layer are decisive parameters that are investigated in detail with the help of 3D simulations. In these, the PSC layer is not simulated as horizontally extended, but as a confined area with different sizes.

The findings are then compared to measured spectra from a MAX-DOAS (Multi AXis-Differential Optical Absorption Spectroscopy) instrument, which has been operating at the German research station Neumayer (70° S, 8° W) in Antarctica since 1999. While the simulations already provide insight into the sensitivity of ground-based spectroscopic measurements for the detection of PSCs, the comparison to measurement data confirms the good applicability of this method.