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Cloud identification in the Canadian High Arctic using the UV-visible colour index

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In UV-visible spectroscopy, Rayleigh and Mie scattering contribute to the broadband extinction seen in spectra of scattered sunlight. The relative intensity of these two components of scattering is highly dependent on the cloud condition of the sky. The colour index, defined as the ratio of light intensities at different wavelengths, typically 350 nm and 550 nm, provides a means of determining the cloud conditions.

A UV-visible triple-grating spectrometer, the UT-GBS (University of Toronto Ground-Based Spectrometer), was installed at the Polar Environment Atmospheric Research Laboratory (PEARL), at Eureka in the Canadian High Arctic (86.4°W, 80.1°N) in 1999. Since then, the instrument has made daily measurements during spring from 1999-2009, and year-round, with the exception of polar night, from 2010-2013. The UT-GBS measures vertical column densities of ozone, NO_2, and BrO, as well as slant column densities of enhanced OClO, by using the Differential Optical Absorption Spectroscopy (DOAS) technique. We use the colour index data from the UT-GBS to distinguish polar stratospheric clouds and tropospheric clouds.

The UV-visible measurements are supplemented by vertically resolved lidar and radar cloud data products. The CANDAC (Canadian Network for the Detection of Atmospheric Change) Rayleigh-Mie-Raman Lidar (CRL) and the Millimetre Cloud Radar (MMCR) are located at the Zero Altitude PEARL Auxiliary Laboratory (0PAL), which is about 15 km away from PEARL. The CRL uses ultra-short pulses of light from two lasers, operating at ultraviolet (355 nm) and visible (532 nm) wavelengths. The CRL measures the vertical distribution of aerosols, temperature, and water vapour in the troposphere and lower stratosphere. The zenith-pointing MMCR measures equivalent radar reflectivity, Doppler velocity, spectral width, and Doppler spectra, from which information about cloud heights, thicknesses, internal structure and vertical motions can be determined.

Polar stratospheric cloud (PSC) events have been observed during spring by the UT-GBS and the CRL; these will be discussed in the context of the location of the polar vortex relative to Eureka, stratospheric temperatures, and stratospheric ozone loss events. In addition to detecting PSCs, the colour index can be used for the detection of tropospheric clouds. The UT-GBS cloud index results are in good agreement with data from the MMCR. Thus the cloud index can be useful for assessing the quality of DOAS retrievals, which can be greatly affected by tropospheric clouds.