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Cloud retrieval algorithm for the imaging spectro-polarimeter on board EUMETSAT Polar System – Second Generation (EPS-SG)

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The atmospheric remote sensing benefits a lot from the use of spectro - polarimetric imagers on board satellite platforms. Due to the movement of the spacecraft, any given scene can be observed from many directions by an imaging polarimeter. This concept has been proven with the measurements of POLDER – 1, 2, and 3 on board ADEOS and PARASOL platforms. POLDER has performed measurements of the Stokes vector (first three components) of reflected light in 16 directions at several wavelengths in the visible and near - infrared. The 3MI (Multi-viewing, Multi-channel, Multi-polarization Imaging) on board of a future (2021) EPS-SG mission is very similar to POLDER. However, the measurements are performed at more spectral channels as compared to POLDER and also at a better spatial resolution (4*4km). In particular, the measurements of the Stokes vector components (I, Q, U) of the reflected solar light are performed at the wavelengths 410, 443, 490, 555, 670, 865, 1650, and 2130nm. In addition, the intensity of reflected light is measured at 763, 765, 910, and 1370nm. The FWHM of the channel at 763nm is 10nm and it is 20 nm at other channels (except at 765nm, 865nm, 1650nm, and 2130nm, where FWHM is equal to 40nm). The imaging spectro-polarimeter enables enhanced retrievals of aerosol and cloud properties using spaceborne observations. In particular, the following parameters of clouds can be retrieved: cloud top altitude, liquid water path, the average size of particles in the clouds, and the cloud thermodynamic state. The cloud albedo, cloud optical thickness, single scattering albedo and other optical parameters of clouds can be derived as well. In this presentation we describe the cloud retrieval algorithm CROP developed at EUMETSAT for the retrievals of cloud microphysical, geometrical, and optical characteristics using 3MI observations. The retrievals are performed only for completely cloudy pixels. The measurements at channels 763 and 765nm are used to get cloud top height. It is known that the measurements in the oxygen absorption band (763nm) enable the cloud top height determination. This is due to the fact that the reflection in the oxygen A-band is lower for lower clouds due to the increased oxygen concentration in lower atmospheric layers. The cloud liquid water path and effective radius of particles in clouds is determined from the measurements in the visible (410nm) and near – infrared (1650nm). The measurements in the visible are mostly sensitive to cloud optical thickness and liquid water path. The channel at near – infrared enables the determination of the effective radius of particles in clouds because the absorption of light is more pronounced (smaller reflectance) for larger particles in the near – infrared. The retrievals are performed in two stages. On the first stage the first guess solution is obtained based on the approximate analytical solution of the radiative transfer equation. Then look-up-tables are used to derive the final cloud products.