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The multi-viewing, multi-channel, multi-polarisation imager on board the future EUMETSAT Polar System - Second Generation and its application for the aerosol retrieval

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Atmospheric aerosol is a global phenomenon. Due to the small size of aerosol particles (typically, 0.1 – 10 micrometers) they are rarely observed by the naked eye. Nevertheless aerosol particles are present in atmospheric air in variable numbers (typically, 100-1000 particles per cubic centimeter of atmospheric air). The particles have different chemical composition, origin, shapes, and internal structure (e.g., dust particles covered by ice, etc.). They influence human health, air quality, climate, downwelling and upwelling radiation, clouds, and precipitation. It is therefore important to monitor aerosol properties on a global scale. Global scale information can only be provided by satellite observations and algorithms for the production of satellite-based aerosol products have been in use already for more than 40 years. In this work we present an update on the recently developed operational EUMETSAT aerosol retrieval algorithm for the Multi-viewing, multi-channel, multi-polarisation Imager (3MI) which will fly on board the future EUMETSAT Polar System Second Generation (EPS-SG), planned for launch in the 2021 timeframe. The 3MI is a two – dimensional push – broom radiometer dedicated to aerosol and cloud characterization for climate monitoring, air quality forecasting and numerical weather prediction with heritage from the POLDER instrument. The first three components of the Stokes vector of the reflected light (I, Q, and U) will be measured at 9 channels in the spectral range from 410 to 2130nm for up to 14 observation directions. Intensity measurements only will be performed at 763, 765, and 910nm. This enables the determination of the degree of linear polarization of reflected light and also the direction of the oscillations of the electric vector in the light beam. The 3MI design consists of a filter and polariser wheel rotating in front of the detectors. For design purposes the spectral channels have been split into VNIR and SWIR filters and polarisers with dedicated detectors and optical heads. The multi-polarisation (3 acquisitions within 1 s for the polarised channels) and multi-spectral acquisitions are done during a wheel rotation of less than 7s. The multi-viewing capability will be achieved by successive images of the same spectral band observing the scene under different angles, allowing up to 14 views per target. To satisfy the speed requirements for operational processing (1-10ms per pixel) , the developed aerosol algorithm is based on a look-up-table approach, where the aerosol model and aerosol optical thickness for fine and coarse aerosol modes are selected by minimizing the difference between the observed and simulated Stokes vector of reflected solar light. In this work we also discuss the validation of the algorithm performed using synthetic 3MI observations for several satellite orbits.