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Validation of Sentinel-5p TROPOMI cloud data with ground-based Cloudnet and other satellite data products

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Space-born atmospheric composition measurements, like those from Sentinel-5p TROPOMI, are strongly affected by the presence of clouds. Dedicated cloud data products, typically retrieved with the same sensor, are therefore an important tool for the provider of atmospheric trace gas retrievals. Cloud products are used for filtering and modification of the modelled radiative transfer.

In this work, we assess the quality of the cloud data derived from Copernicus Sentinel-5 Precursor TROPOMI radiance measurements. Three cloud products are considered: (i) L2_CLOUD OCRA/ROCINN CAL (Optical Cloud Recognition Algorithm/Retrieval of Cloud Information using Neural Networks; Clouds-As-Layers), (ii) L2_CLOUD OCRA/ROCINN CRB (same; Clouds-as Reflecting Boundaries), and (iii) the S5p support product FRESCO-S (Fast Retrieval Scheme for Clouds from Oxygen absorption bands for Sentinel). These cloud products are used in the retrieval of several S5p trace gas products (e.g., ozone columns and profile, total and tropospheric nitrogen dioxide, sulfur dioxide, formaldehyde). The quality assessment of these cloud products is carried out within the framework of ESA's Sentinel-5p Mission Performance Centre (MPC) with support from AO validation projects focusing on the respective atmospheric gases.

Cloud height data from the three S5p cloud products is compared to radar/lidar based cloud profile information from the ground-based networks CLOUDNET and ARM. The cloud height from S5p CLOUD CRB and S5p FRESCO are on average 0.6 km below the cloud mid-height of CLOUDNET measurements, and the cloud top height from S5p CLOUD CAL is on average 1 km below CLOUDNET's cloud top height. However, the comparison is different for low and high clouds, with S5p CLOUD CAL cloud top height being only 0.3 km below CLOUDNET's for low clouds. The

radiometric cloud fraction and cloud (top) height are compared to those of other satellite cloud products like Aura OMI O₂-O₂. While the latitudinal variation is often similar, offsets are encountered.

Recently, major S5p cloud product upgrades were released for S5p OCRA/ROCINN (July 2020) and for S5p FRESCO (December 2020), leading to a decrease of the ROCINN CRB cloud height and an increase of the FRESCO cloud height on average. Moreover, a major change in the ROCINN surface albedo treatment leads to a clear improvement of the comparison with CLOUDNET at the complicated sea/land/ice/snow site Ny-Alesund.