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Cirrus cloud retrieval from MSG/SEVIRI during day and night using artificial neural networks

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By covering a large part of the Earth, cirrus clouds play an important role in climate as they reflect incoming solar radiation and absorb outgoing thermal radiation. Nevertheless, the cirrus clouds remain one of the largest uncertainties in atmospheric research and the understanding of the physical processes that govern their life cycle is still poorly understood, as is their representation in climate models.

To monitor and better understand the properties and physical processes of cirrus clouds, it's essential that those tenuous clouds can be observed from geostationary spaceborne imagers like SEVIRI (Spinning Enhanced Visible and InfraRed Imager), that possess a high temporal resolution together with a large field of view and play an important role besides in-situ observations for the investigation of cirrus cloud processes. CiPS (Cirrus Properties from Seviri) is a new algorithm targeting thin cirrus clouds. CiPS is an artificial neural network trained with coincident SEVIRI and CALIOP (Cloud-Aerosol Lidar with Orthogonal Polarization) observations in order to retrieve a cirrus cloud mask along with the cloud top height (CTH), ice optical thickness (IOT) and ice water path (IWP) from SEVIRI. By utilizing only the thermal/IR channels of SEVIRI, CiPS can be used during day and night making it a powerful tool for the cirrus life cycle analysis.

Despite the great challenge of detecting thin cirrus clouds and retrieving their properties from a geostationary imager using only the thermal/IR wavelengths, CiPS performs well. Among the cirrus clouds detected by CALIOP, CiPS detects 70 and 95 % of the clouds with an optical thickness of 0.1 and 1.0 respectively. Among the cirrus free pixels, CiPS classify 96 % correctly. For the CTH retrieval, CiPS has a mean absolute percentage error of 10 % or less with respect to CALIOP for cirrus clouds with a CTH greater than 8 km. For the IOT retrieval, CiPS has a mean absolute percentage error of 100 % or less with respect to CALIOP for cirrus clouds with an optical thickness down to 0.07. For such thin cirrus clouds an error of 100 % should be regarded as low from a geostationary imager like SEVIRI. The IWP retrieved by CiPS shows a similar performance, but has larger deviations for the thinner cirrus clouds.