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Towards a retrieval of cloud physical properties at SEVIRI HRVIS resolution

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Passive meteorological satellite imagers provide important information for studying clouds and their role in the climate system. Geostationary satellites enable us to fully resolve the diurnal cycle, and thus monitor the development of clouds during the day. However, the spatial resolution of these imagers lags significantly behind that of polar-orbiting satellites, which introduces large uncertainties and biases in the estimation of cloud properties.
To date, the most advanced geostationary imager is the SEVIRI sensor onboard the Meteosat Second Generation satellites. In addition to its narrowband spectral channels, this sensor also contains a high-resolution broadband visible channel (HRVIS). The goal of the present work is to utilize this channel, and estimate the cloud physical properties consistently at the HRVIS native resolution (1x1km^2 at nadir) instead of the narrowband channels native resolution (3x3km^2 at nadir) that is currently used by operational retrieval algorithms.
In KNMI's Cloud Physical Property retrieval the estimation of cloud optical thickness, effective radius and water path relies on the combination of two channels i.e.: one channel with conservative (0.6 micron) and one channel with non-conservative (1.6 micron) scattering by cloud droplets. We will demonstrate that the 0.6 and 0.8 micron reflectances can be accurately downscaled to HRVIS resolution due to the spectral band overlap of these channels with the HRVIS channel. A Fourier-based algorithm, which takes into account the sensor spatial response, and superimposes high-frequency spatial variability from the HRVIS channel on the original narrowband images is introduced for this purpose. The importance of the covariance of sub-pixel variability in the 0.6 and 1.6 micron channel, is discussed, and its link to the covariance of physical properties is established. The accuracies of different assumptions about the covariance are quantified with the help of MODIS data. Moreover, the unscented transform is introduced as method to establish this link. Finally, the role of sub-pixel cloudiness at 3x3km^2 scale is studied, and a simple cloud masking algorithm based on composite images is presented for this purpose. This information can be exploited to correct for the clear-sky contribution to a pixel radiance, and improve the estimate of cloud properties.