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Nowcasting of Direct Normal Irradiance with the High Temporal and Spatial Resolution of MSG/SEVIRI

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An algorithm has been developed to calculate Direct Normal Irradiance (DNI) and forecast its evolution for the successive 5-120 minutes. As clouds are the main reason for the extinction of DNI in the atmosphere, detection and forecast methods for water and ice clouds using satellite data from SEVIRI (Spinning Enhanced Visible and Infrared Imager) aboard Meteosat Second Generation (MSG) has been developed. In order to derive ice clouds "The Cirrus Optical properties derived from CALIOP and SEVIRI during day and night" (COCS, Kox et al. [2014]) algorithm and for water clouds the APICS ("Algorithm for the Physical Investigation of Clouds with SEVIRI", Bugliaro et al. [2011]) cloud algorithm is applied. The forecast rests upon an optical flow method determining a motion vector field from two consecutive images (Zinner et al., 2008) with a certain time interval.

With the aim of determining the ideal time interval for every timestep in the forecast horizon the potential of the better temporal resolution of the MSG Rapid-Scan-Mode (5 instead of 15 minutes repetition rate) has been investigated. Therefore for the period from March to June 2013 forecasts up to 4 hours with a time interval of 5 min, 10 min, 15 min, 30 min and timesteps of 5 min have been created. The results for ice clouds show that the Rapid-Scan-Mode produces a small error reduction for a forecast horizon up to 30 minutes. For the following timesteps forecasts generated with a time interval of 15 min provide the best results.

For a better spatial resolution the HRV-channel (High Resolution Visible, 1km instead of 3km maximum spatial resolution) has been integrated into the forecast. To detect clouds the difference of the measured albedo from SEVIRI and the clear-sky albedo provided by MODIS has been used and additionally the temporal development of this quantity. A pre-requisite for this work is an adjustment of the inter-satellite geolocation between SEVIRI and MODIS by shifting the MODIS data and quantifying the spatial correlation between both data sets.

The DNI is finally calculated directly from the optical thickness of clouds under additional consideration of molecular Rayleigh scattering and water vapour absorption of the atmosphere. The result is a map of DNI and the forecast of its development with a high spatial ($\sim$1km) and temporal (5min) resolution.