Surface radiation climatology derived from Meteosat First and Second Generation satellites

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A 25 year long continuous and consistently validated surface incoming shortwave (SIS) radiation climate data record (CDR) from METEOSAT satellites is MeteoSwiss' contribution to CM SAF (Satellite Application Facility for Climate Monitoring). CM SAF is is a joint activity of several national Meteorological Services within EU-METSAT's satellite data processing (SAF – Satellite Application Facilities). CM SAF generates, archives and distributes widely recognized high-quality satellite-derived products and services relevant for climate monitoring in operational mode with a special emphasis on the retrieval of climate variables such as cloud parameters, radiation budget and water vapor.

The SIS CDR by MeteoSwiss and DWD is generated using an extended Heliosat algorithm which exploits the attenuation of radiation by clouds from the METEOSAT visible channel, and using the MAGIC (Mesoscale Atmospheric Global Irradiance Code) radiative transfer model that accounts for water vapor, ozone and aerosol absorption on clear sky radiation fluxes. The dataset is compared to reference surface radiation datasets from ISCCP, GEWEX and ERA interim. Ground based measurements of the BSRN (Baseline surface radiation network) and ASRB (Alpine surface radiation budget) network are used as validation sources to estimate the uncertainty of the SIS CDR and of the reference datasets.

In order to satisfy the dataset accuracy required for climate variability and change studies, discontinuities due to changes in satellite instrumentation must be avoided. Therefore, a selfcalibration technique within the Heliosat algorithm is applied. It uses the 95% percentile of the measured radiance distribution obtained in a selected (nearly) always cloudy region in the southern Atlantic. The overlap period between two satellites/instruments (Meteosat7 and Meteosat8 in 2005) is used to examine and validate the performance of the selfcalibration. First validation results show a good agreement for both satellite generations (within +/- 4Wm^{-2}). Larger differences are mainly apparent in highly vegetated regions (Tropics, summer Europe) which are due to different spectral characteristics of the satellite instruments.

Special attention is also drawn to the radiative influence of snow. Snowy and cloudy areas have to be separated and the reflective properties of snow have to be considered. Multispectral approaches are not applicable in the generation of a long surface radiation time series as former satellite generations had less spectral channels and the whole time series should be generated with the same algorithm. Thus, a time-series approach is applied which employs only a visible channel and is based on the very low temporal variability of snow compared to clouds. In case of snow the Heliosat algorithm is slightly altered in order to account for reflected solar radiation. It is however found that this algorithm is not able to decide whether a bright pixel is due to snow (on a clear day) or clouds which results in an underestimation of the surface solar radiation in those regions.

The SIS CDR is available at satellite resolution (for the Meteosat First Generation Satellites (Meteosat 2-7, 1982-2005) about 2.5 km horizontally (at the subsatellite point) every 30 minutes; for the Meteosat Second Generation Satellites (Meteosat 8-9, 2005-present) about 3 km (at the subsatellite point) every 15 min) . It will be made available to the research community through the CM SAF website (www.eumetsat.int) in Fall 2010.