Documentation of MeteoSwiss Grid-Data Products

Daily, monthly and yearly satellite-based global radiation

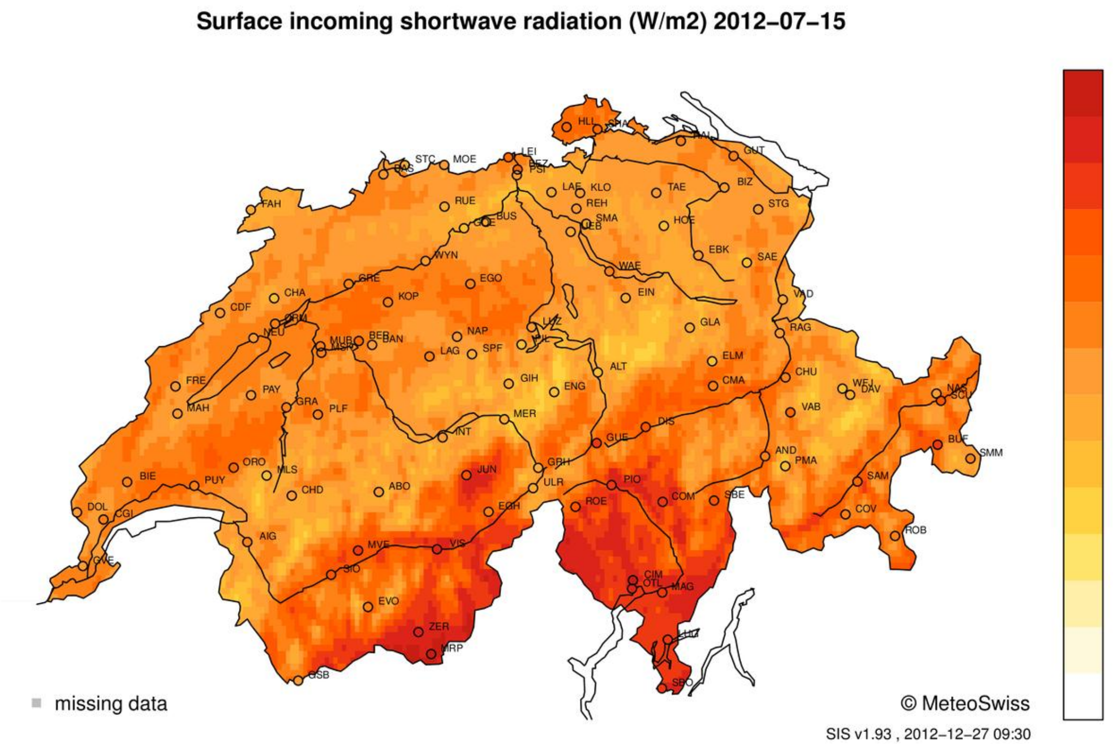

Figure 1: Daily Global Radiation over Switzerland from 15 July 2012

Variable	Surface Incoming Shortwave (SIS) Radiation (also known as Global Radiation) in Watts per Square Meter (W m^{-2}), Direct beam (SISDIR, W m^{-2}) and diffuse (SISDIF, W m^{-2}) radiation components as well as Direct Normalized Irradiance (SISDNI, W m^{-2}). Mean daily, monthly and yearly quantities.
Application	Planning of Infrastructure, Renewable Energy, Agricultural Modeling, Hydrological Applications, Tourism, Climate Analysis, Weather- and Climate Model validation.
Overview	The dataset provides global radiation on a high resolution grid with validated accuracy. The dataset is entirely derived from Meteosat Second Generation (MSG) satellite measurements by use of a semi-empirical model for cloud forcing and physically-based radiative transfer model for the clear sky forcing. The method has been calibrated and validated using ground-

observations over Switzerland, Europe, Africa and the Middle East. Since ground-based measurements of global radiation are sparse, satellite-derived global radiation provides a superior data source especially over areas with significant terrain such as the Alps and for areas of low ground station coverage such as Africa.

This data set is linked to our our international collaboration with the EUMETSAT sponsored Satellite Application Facility on Climate Monitoring (CM SAF) where we derive global radiation for the full Meteosat disk for the whole range of Meteosat satellite sensors from 1983 until now.

Data base

The SEVIRI (Spinning Enhanced Visible and Infrared Imager) sensor on board the EUMETSAT Meteosat Second Generation (MSG) satellite serves as the foundation for this data set. For the processing the SEVIRI Level 1.5 data from channels 1, 2, 3, 9, 10 (0.6, 0.6, 1.6, 10.8, 12.0 um) and the channel 12 (broadband High Resolution Visible) are used. The data is processed at 15 minute intervals at the native satellite resolution. Data gaps might occur during satellite calibration, satellite maneuvers or technical failures in the transmission or EUMETSAT processing facilities.

Method

The derivation of the global radiation is based on the Heliosat algorithm (Cano et al. 1986, Beyer et al., 1996; Hammer et al., 2003). The algorithm is based on an empirical correlation between a satellite derived cloud index and the radiation at the surface and exploits the relationship between top of the atmosphere albedo and the atmospheric transmittance.

In order to retrieve the cloud index, a clear sky composite of the surface has to be performed. A novel probabilistic cloud mask algorithm (Khlopenkov and Trishchenko, 2007) is used to composite both the VIS reflectance and the IR brightness temperature over cloud free pixels. This information is then used to calculate the cloud index (~0: no clouds, ~1: overcast) that accounts for radiation reflected from snow in addition to attenuated radiation due to clouds. The surface radiation is calculated by scaling the modeled clear sky radiation with the cloud index. The clear sky radiation depends on the sun’s elevation, surface altitude and the atmospheric state. The latter describes the radiative impact of water vapour, atmospheric aerosols, ozone, etc. on the atmospheric transmission. The atmospheric state is derived from time-varying boundary conditions (6-hourly total column water vapor and ozone by ECMWF and a monthly aerosol climatology by Kinne et al. 2008).

MeteoSwiss has furthermore implemented corrections for effects of the surrounding terrain such as shadowing, albedo, horizon and sky view. A digital elevation model from SRTM with a spatial resolution of 100 m is used to determine the topography and the horizon of each pixel.

The standard HELIOSAT algorithm is not able to distinguish between snow and clouds. This would lead to an underestimation of the surface radiation on a clear-sky day because the wrongly detected clouds cause a reduction of the incoming radiation and the additional reflections of the snow are not considered. Modifications of the algorithm by Dürr and Zelenka (2009) have introduced a snow detection. This snow detection was recently enhanced by a Infrared-based cloud index for bright surface targets such as snow or desert that is especially suited for the winter period in the Alps.

The final algorithm is fully described in Stöckli (in review).

Target users

Photovoltaic Infrastructure and Solar Heating Planners, Energy Suppliers, Hydrologists, Construction Engineers, Architects, Agricultural Modelers, Climate Modelers, Climate Researchers, Tourist Resorts,

Accuracy and interpretation

The accuracy of the dataset is characterized in Stöckli (in review). Monthly global radiation estimates are better than 5 W m^{-2} in flat areas and better than 10 W m^{-2} in complex terrain.

Related prod-

The station based ground-observations global radiation data from SwissMetNet.

ucts

Grid structures The dataset is available in the following grid structures:

ch02.lonlat: A grid in regular longitude and latitude increments covering the territory of Switzerland (5.75-10.75 deg E, 45.75-47.875 deg N). The grid spacing is 1.25 deg minutes (0.02083 deg) in longitude and latitude, corresponding to approximately 2.3 km (1.6 km) in the West-East direction (South-North direction).

Versions Actual version: 1.98

Previous versions: 1.61, 1.93, 1.94

Update cycle The daily, monthly and yearly dataset is updated every day, month and year with around 5-10 days lag time. Please note that this is not a real-time dataset.

Data format NetCDF (CF-1.4 standard)

Future developments Several by-product variables from the MSG processing could be made available on the same spatio-temporal resolution. These are: snow cover extent, cloud index, surface albedo, surface radiative temperature, cloud mask, global radiation for inclined surfaces or sun-following targets.

The algorithm undergoes substantial development continuously in the area of the clear sky compositing, cloud masking, clear sky radiative transfer modeling, cloud shadow, snow albedo effects, near-realtime production and cloud index calculation, which should enable even higher accuracy and timeliness of the product in the future.

Contact point Data service at MeteoSwiss (dataservice[at]meteoswiss.ch)

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Reto Stöckli, February, 2013