SURFACE SOLAR IRRADIATION MAPS FROM SEVIRI MSG DATA

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ABSTRACT

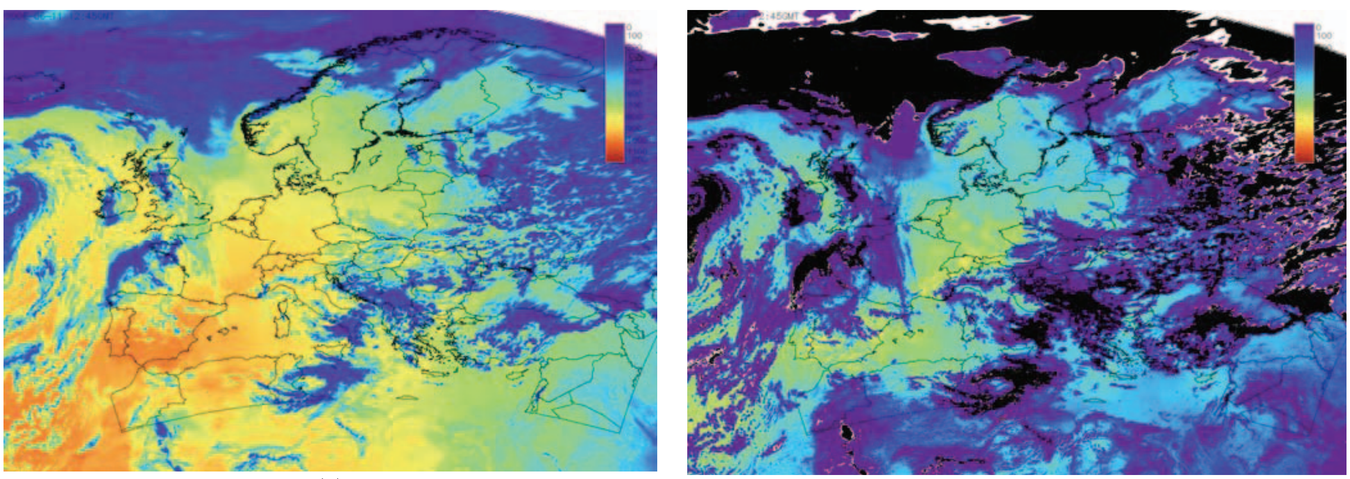
Geostationary satellites, such as Meteosat Second Generation (MSG) or GOES, represent a key element in monitoring and forecasting the state of the Earth's atmosphere [1]. Nevertheless, these satellites are useful for the estimation of solar irradiance, since the knowledge of the radiance reflected by clouds is the basis for the calculation of the transmitted irradiance. As a matter of fact, an accurate estimation of the downward solar irradiance is not only of particular importance for assessing the radiative forcing of the climate system, but also absolutely necessary for an efficient planning and operation of solar energy systems and the estimation of the energy load. Solar irradiance schemes using weather satellites provide accurate solar irradiance data with a high spatial and temporal and constitute a powerful alternative to a meteorological ground network for both climatological and operational data for solar resource assessment [2].

Different methods exist to derive the solar surface irradiance from satellite data. A first class of methods, mainly used for data from geostationary satellites, uses normalized reflectance measurements to determine the cloud transmission or cloud index. A clear sky model is used afterwards to calculate the solar surface irradiance based on the retrieved cloud index. One example for this type of methods is the Heliosat method [3]-[4]. Another type of method relates top of atmosphere reflected radiation flux density to the solar irradiance at the surface. One prominent and widely used approach in this class is the method of Pinker and Lazlo [5], which uses look-up tables (LUT) for the retrieval of solar surface irradiance. In the last years new generations of retrieval schemes are based on Radiative Transfer Model (RTM) algorithms [6]. The main motivation for such trend is that RTM based retrieval algorithms have the potential to exploit the increased information on the atmospheric state, ranging from new satellite systems to improvements in numerical weather prediction analysis data. However, it must be noted that for operational processing a high computing performance of the algorithm is a pre-requisite.

As a consequence of the above mentioned aspects, a new scheme for solar irradiance retrieval for the Europe from MSG data is here proposed. The algorithm to derive solar irradiance is based on the approach proposed by Verdebout [7]-[8]. The calculation scheme, originally developed for UV irradiance, is adapted for calculation of shortwave radiation from MSG satellite data. According to this scheme the surface irradiation is obtained by

interpolation of multidimensional LUT relating surface irradiance to set of input parameters. The LUT is generated using the radiative transfer code libRadtran [9] for a variety of atmospheres and cloud conditions described by total ozone column amount, near surface horizontal visibility, effective surface albedo, cloud optical thickness and atmospheric water vapor. The horizontal visibility is used to approximate the atmospheric optical depth and was derived on daily basis from 1000 meteorological stations over Europe. The variability of water vapor is simplified to one constant value. In addition to these parameters, the LUT describes surface irradiance for a range of surface elevations and solar zenith angles.

The cloud optical thickness as estimate of radiation attenuation by clouds is derived from MSG data using a second LUT that simulates the "at sensor radiance". The actual cloud optical thickness is calculated by inversion of LUT, and interpolation between pre-calculated values for the actual image digital count, effective surface albedo and solar and satellite geometry. In this approach, the lowest value in 30-days image stack is used to calculate effective surface albedo for snow-free pixel. The algorithm also accounts for reverse response of image digital counts to increasing cloud thickness at pixels with high effective surface albedo, e.g. snow. For snow detection algorithm, additional spectral bands from middle infrared and thermal bands of MSG instrument are used. The results of this model are layers of shortwave irradiance with spatial resolution of 3 arc minutes in 15 minutes time step (see Fig.1).



(a) (b)

Fig.1: retrieved Global Horizontal (a) and Direct Horizontal (b) components relevant to the MSG data set acquired on 01 June 2006 12:00 GMT. Data are in WGS84 coordinate system. Extent is 20:00W 48:00E 25:00S 73:00N. Resolution is 00:03 (0.05deg).

Currently, satellite model development is the validation phase. This phase will be based on set of 25 ground stations with measurements of global solar irradiance for year 2006. The time step of measurements data ranges from 1 to 60 min. All ground data have been subject of quality checking procedures and all erroneous data have been excluded from analysis. The map of stations is on the Fig. 2. Satellite model quality assessment results will be shown at the conference.

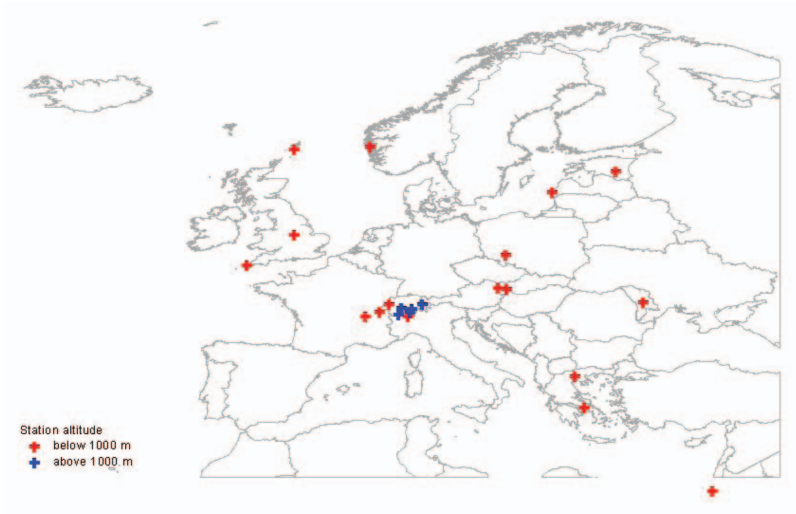


Fig. 2: Ground measurements stations used in model.

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