SoDa

Product and service description

Meteosat images are received every 15 min by Armines. Only the two channels in the visible band are kept. The images are stored into a database. The near-real-time processing is triggered at the end of the day by the reception of the last images at 21:00 UT. The first operation is the control of the quality of Meteosat images. It consists in looking for the missing lines if any and in the check of the position of extreme lines and columns in each image. If a failure is observed, the processing stops.

Meteosat images are calibrated using the calibration coefficients supplied in the flow emitted by Meteosat, resulting into two images of radiance every 15 min. MSG visible images are then combined to create an image of broadband radiance (Cros et al. 2006).

Inputs to the method Heliosat-2 are the latitude, longitude, and elevation of the current pixel. Another input is the Linke turbidity factor characterising the optical state of the clear atmosphere. It is read from a database containing monthly values and interpolated for the day under concern. The clear-sky irradiation for the 15 min period is computed by the ESRA model, (Rigollier et al., 2000; Geiger et al., 2002). Then, using a database of ground albedo, the cloud-index, then the clear-sky index, and finally the irradiation G15 for the 15 min period are computed. The irradiation is stored in the HelioClim-3 database.

Request for products are made through the Web site of the SoDa Service (www.soda-is.com). There are two types of requests: manual and automated. Manual requests are made by the means of a browser. Automated requests are emitted by computers. They typically request for hourly values of irradiance every day for large numbers of geographical sites.

A request can be for a time-series (the standard product) or for a map. For the time-being, the processing is the same; a map is considered as made of independent pixels that are processed separately.

Automated requests are processed in the same way than the manual requests, except that their processing is part of the near-real-time processing and takes part immediately after the updating of the HelioClim-3 database.

Product generation and validation

The principles of Heliosat rely on the fact, that in most cases, a cloud exhibits a larger reflectance than the ground. The magnitude of the difference between both targets is related to the depletion of the downwards radiation by the atmosphere. Heliosat comprises a modelling of the SSI that should be observed by the sensor if the sky were cloud-free for any pixel. The method Heliosat is divided into two parts regarding the physical modelling: converting the satellite image into a cloud index and converting the cloud index in irradiance.

Rigollier et al. (2004) designed Heliosat-2 using calibrated Meteosat images instead of gray values. The irradiance is the irradiance for the clear-sky case multiplied by the clear-sky index quantifying cloud extinction. The clear-sky index is derived from a cloud index comparing the pixel's reflectance versus brightest clouds and the ground. The cloud index is close to 0 when the observed reflectance is close to the ground reflectance, i.e., when the sky is clear. The cloud index increases as the clouds are appearing. It can be greater than 1 for clouds that are optically very thick. An empirical relationship was derived from coincident ground measurements linking cloud index and clear-sky index.

The database HelioClim-3 is constructed by the means of the clear-sky model ESRA (European Solar Radiation Atlas). It is based on Kasten's (1996) Rayleigh optical depth parameterization and the Linke turbidity factor at air mass 2. Details can be found in Rigollier et al. (2000) with revision proposed by Page and Remund and reported in Geiger et al. (2002).

Quality control

There are a number of control points in the workflow for monitoring the smooth running of the near-real-time processing. Each time a failure is observed, detailed reporting is made to the management, written in a log file and sent by e-mail as well. A visual monitoring is in place to perform visually a gross check of the computed irradiance. It comprises a graph of the irradiances for the last two days for three selected sites: Sophia Antipolis where the chain is operated, and two extreme locations in the East and the West on the Equator. A Web page is updated that provides access to the archive of log files and graphs.

Multiple benchmarking activities demonstrated a few biases in the raw irradiation data contained in the database. A posteriori corrections are brought to the raw values. In order to cope with gaps and to compute direct and diffuse components, the clear-sky index is interpolated every minute. ESRA algorithms are used to compute direct and diffuse components from the global irradiance every minute. Finally, the 1-min values are summed up to yield the requested aggregation period, e.g. hour, day, month.

Comparison between irradiance products and measurements at ground by well-calibrated instruments is made as often as possible. This is not systematic as the access to such data is limited. The results of such comparisons are used:

- to document the uncertainty in the retrieval displayed on the Web site,
- to set up a posteriori correction procedures if possible, to improve the quality,
- to detect possible flaws in the method or processing workflow, and correct them,

to establish the model of uncertainty allowing to allocate uncertainty values to each irradiance value.

The usual way of assessing the quality of retrievals of SSI derived from satellite images is to compare these SSI to coincident measurements performed at ground level. The typical accuracy of SSI measured in the global meteorological network is 3 to 5 % in terms of root mean square error. Therefore, the ground measurements can be seen as an accurate reference against which one may compare the SSI derived from satellite.

However, the actual situation is not that simple. Several limitations exist that make the assessment of the quality of retrieved irradiances a very difficult task. Zelenka et al. (1999) analyzed the real accuracy of satellite estimations of hourly SSI. They suggest that for a relative deviation of 23 % (root mean square error) between ground measurements and satellite estimations, only half of it is due to the estimation method itself. The difference comes from:

- error on the measurements provided by the pyranometer (3 to 5 %);
- error due to the spatial variability of solar radiation within the pixel (5 to 8 %)
- error due to spatial and temporal heterogeneity of the compared data, e.g. assuming ergodicity (3 to 5 %).

Guidelines of the benchmarking procedures of solar radiation products derived from satellite data, have been proposed by the MESoR project, in order to measure the quality of these products with a common scheme (Beyer et al., 2008). The quality of a product is defined by various statistical quantities that measure the discrepancies between products and ground data considered as a reference.

References

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