RAD-SOLAR

Product and service description

Setting up an operational information system with new capabilities and new processing methods is a lengthy process spanning over a few years. In order to exploit as soon as possible and efficiently the outcomes of the MACC project and other initiatives as they are flowing, a number of intermediate steps are being taken to implement these outcomes. Actually, it is too early to describe in detail many aspects of the transition chains and the operation chain in the RAD-SOLAR Service. An overview can be provided only.

Several data on atmospheric conditions (clouds, aerosol, water vapour, and ozone) and ground albedo will be received from various sources, pre-processed and stored in several databases. These intermediate databases (or tables) will constitute the HelioClim-4 database.

The delivery deadline from each source is still unknown. It could amount to several days. Therefore, the term 'near-real-time' has to interpreted as within 24 hours (preferably) or longer. Operations are triggered by successfully received input data sets.

Currently, the concept to produce products is that the processing is made on-request (on-the-fly). When a request is made for a time-series for a given site and a given period, the irradiance processor will invoke the McClear model with inputs extracted from the database "atm". Extinction coefficients are then obtained by the cloud processor using inputs from the database "cloud". Finally, the contribution to the diffuse irradiance due to the ground albedo is computed.

Tests have been made that demonstrate that such an on-the-fly processing is sustainable in the perspective of the RAD-SOLAR Service. Nevertheless, it is likely that databases of irradiance will be pre-computed, at least to best answer to request for maps of daily or monthly values of irradiance.

Presently, there are two series of products in the RAD-SOLAR Service:

- ARCH products: the first series is an archive: 1984-2005, based on Meteosat First Generation (MFG) data. It is denoted by the letters ARCH (for Archive),
- MSG products: the second series is based on Meteosat Second Generation (MSG) series of satellites, starting from 2004 and on-going. It is denoted by the letters MSG.

For both series currently available, core products in the RAD-SOLAR Service are time-series of solar radiation available at ground surface, also called surface solar downward irradiance (SSI).

This includes the total global irradiance (GHI), i.e., the SSI integrated over the whole spectrum available at ground level, on a horizontal surface; the total diffuse irradiance (DifHI), i.e., the diffuse part of the SSI integrated over the whole spectrum available at ground level, on a horizontal surface; and total direct (beam) irradiance (DirHI), i.e., the direct part of the SSI integrated over the whole spectrum available at ground level, on a horizontal surface.

From a practical point of view, and beyond the various issues related to being a recognised customer of the information system, the inputs by users needed to trigger a request for a selected MACC product will be:

- the geographical coordinates of the site of interest, or the name of this site,
- the elevation of this site above sea-level. By default, the application uses well-known digital elevation models, such as NASA-SRTM,

- the period of time: begin data, end date.

Delivery deadline is the time lag between the moment the request is made and the instant of delivery. The delivery deadline depends on the series of products: ARCH or MSG.

The ARCH products are computed on request and are not available as such on the shelf. Once the request for a product is made, DLR, the author of the products ARCH, selects the best suitable auxiliary data set for the site among global atmospheric data sets (aerosol, water vapour, ozone) from different earth observation sources and climate models. The atmospheric data is gridded to a resolution of 1°x1° and the cloud data from Meteosat has a nominal resolution of 2.5 km x 2.5 km at the sub satellite point. The geographical coordinates (latitude, longitude and height above sea level) in decimal degrees and meters have to be delivered to DLR. The product is delivered per e-mail within two weeks.

The MSG products are computed on-the-fly from the database HelioClim. The request is made through the Web site of the SoDa Service (www.soda-is.com) and the answer is provided within a few minutes.

Product generation and validation

The new Heliosat-4 method is based on the principle that the SSI for a cloudy atmosphere can be considered as equal to the product of the irradiance obtained under a clear sky and a function modelling the extinction of the radiation by clouds and the contribution due to the ground albedo. The possibility of considering several spatial and temporal resolutions is of practical importance in MACC. MACC outcomes should be daily values or every 3 h but by no means every hour. The expected spatial resolution should be in the range 50 km - 200 km. The cloud properties can be derived from the processing of Meteosat images as done by DLR with the adapted APOLLO chain. Such products will be available every 15 min for each Meteosat pixel.

Recent initiatives from NCAR (USA, MATCH scheme) and the EU-funded project GEMS yielded to more accurate and detailed assessments of optical properties of the aerosols with capability of producing daily maps. MACC will produce aerosol properties using a method similar or enhanced if compared to GEMS. Therefore, the expertise gained with these GEMS products will be efficiently used in the RAD-SOLAR Service.

In the meantime, other parameters such as the column content in water vapour or ozone are available daily over the world. MACC is producing such parameters as well as other sources. In the same manner than for the aerosol properties, these recent results will be ingested.

The availability of these atmospheric parameters as well as the increase in computing power advocate for an increase in the complexity of the models used to compute the clear-sky models, which should result in an increase in accuracy. Such a model is being developed, called McClear. Inputs to this model will be outputs from MACC, except for site coordinates, solar angles, elevation, atmospheric profile, and ground albedo. The current ESRA model will be replaced by this new model McClear. This will be a major step towards the operational RAD-SOLAR Service. It will lead to major changes in the workflow though it is too early to provide details.

Quality control

A quality control must be performed everyday by comparing the core products to measurements performed by ground stations and to re-analyses. The first aim of this quality control is to monitor possible trends in products and decide for appropriate corrections. In that sense, what is important is the change of differences between products and measurements or re-analyses with time outside the expected range of variation. To do so, a model should be available that explains these discrepancies as a function of known explanatory variables such as the solar zenithal angle or the temporal variability of the SSI. Therefore, the distance between products and re-analyses can be predicted. It will be used to monitor the quality of products: large values should indicate suspect products.

The second aim of this quality control is to perform a benchmarking of the products against a reference. This can be done only with quality-proven measurements. By comparison, one will obtain the uncertainty parameters synthesizing the difference between products and reference following the methodology recommended by the projects IEA SHC 36 and MESoR. These uncertainty parameters will be displayed on the Web pages of the RAD-SOLAR Service to support the documentation on the quality of products.

Based on the results of such comparisons, a model of uncertainty can be established or improved that provides for any instant the plausible uncertainty level of the SSI, given known explanatory variables.

To perform the quality control, operations should be established to collect in an automatic way re-analyses values from ECMWF and ground measurements from selected sites or from the World Radiation Data Center. Quality control procedures must be also implemented that apply onto these measurements and re-analyses.

Reference

User's Guide to the SODA and SOLEMI services – Towards the solar energy radiation resources RAD-SOLAR service, deliverable D_R-RAD_2.2_1, v1.0, MACC project.

December 2011