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- towards climate change services

Improvement in the spatio-temporal distribution of surface solar radiation data over Belgium by merging ground-based and satellite measurements

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Appropriate information on solar resources is very important for a variety of technological areas, such as: agriculture, meteorology, forestry engineering, water resources and in particular in the designing and sizing of solar energy systems. As an example, time-and space-dependent global solar radiation on horizontal surface at the location of interest is the most critical input parameter employed in the design and prediction of the performance of a solar energy device. Solar radiation is observed by means of networks of meteorological stations. Costs for installation and maintenance of such networks are very high and national networks comprise only few stations. Consequently the availability of observed solar radiation measurements has proven to be spatially and temporally inadequate for many applications. Mapping the solar radiation by interpolation/extrapolation of measurements is possible but leads to large errors, except if the network is dense. A global coverage of solar radiation can however be inferred from space-based observations.

In the present study, we evaluate the potential benefit of merging global solar radiation measurements from the Royal Meteorological Institute of Belgium (RMIB) solar measurements network with the operationally derived surface incoming global short-wave radiation products from Meteosat Second Generation (MSG) satellites imageries to improve the spatio-temporal resolution of the surface global solar radiation data over Belgium. Within the Satellite Application Facility (SAF) network supported by the European Organisation for the Exploitation of Meteorological Satellites (Eumetsat), the downwelling shortwave radiation at the surface of Belgium is operationally retrieved from MSG imageries by two decentralized SAFs: the Satellite Application Facility on Climate Monitoring (CM-SAF) and the Land Surface Analysis Satellite Application Facility (LSA-SAF). To retrieve the same parameter, the different SAFs use their own algorithms and different ancillary input data.

We first compared these two SAF products against ground measurements from 13 locations in Belgium at several temporal and spatial resolutions on the basis of two years of data (2008 and 2009). We also analyzed the distribution of the error statistics with respect to various parameters such as the sky conditions and the season. In overall, the CM-SAF product exhibited a better agreement with ground measurements than the LSA-SAF product. We then evaluated several merging methods with various degrees of complexity (from mean field bias correction to geostatistical merging techniques) together with the spatial interpolation of ground measurements and the satellite-derived values. The performance of the different methods was assessed by leave-one-out cross-validation. We also analyzed the influences of the temporal resolution, the sky conditions and the season. It appeared that the distribution of surface solar radiation inferred by merging ground and SAF data was systematically more accurate than when using each data source separately. We finally analyzed the spatial distribution of the solar surface irradiation over Belgium for the year 2009.