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Satellite-based solar radiation mapping over complex terrain: Validation in the Alps and possible improvements

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Solar radiation is an essential variable for applications such as the climate monitoring or the planning of systems exploiting solar energy. This study presents a validation of surface irradiance derived from MSG (Meteosat second generation) satellite data with an extended version of the Heliosat algorithm [3] in the Alps. The algorithm implemented by MeteoSwiss is based on the clear-sky LUT (look up table) approach proposed by Müller et al., 2009 [2], and a probabilistic cloud mask adapted to MSG from the scheme of Khlopenkov and Trishchenko, 2007 [1]. The validation study focuses on the accuracy of the diffuse/direct components of irradiance and suggests possible improvements.

We performed a detailed analysis at three locations, i.e. two Alpine sites – Bolzano (IT), at low altitude, and Davos (CH), at high altitude – and Payerne (CH), in the Swiss Plateau, comparing the hourly, daily, monthly and seasonal bias of the satellite estimation against ground measurements. Results indicate, in terms of MBD (mean bias deviation) and MAD (mean absolute deviation), that the algorithm reproduces precisely the yearly cycle, especially for global irradiance (MBD between -1 and 6 W/m2, MAD between 3 and 13 W/m2). On a daily time scale the all-sky MAD is below 15 W/m2 for all the components of radiation, while it is above 40 W/m2 at the hourly scale. In the mean daily cycle diffuse irradiance is overestimated (10-20 W/m2) for the two stations based on a valley floor, while it is underestimated in the other one. We noticed that cloud free conditions are affected by the biggest absolute error, especially in summer. We therefore investigated the role of aerosols in the clear-sky uncertainty. By including in the radiative transfer model adopted for the simulations either ground or satellite daily atmospheric input on aerosol and water vapor, the estimation of the hourly averages of diffuse radiation improves significantly (MAD < 10 W/m2) compared to the satellite estimate.

Consequently it is recommended to include in the clear-sky model more accurate input than the currently used monthly climatologies of aerosol and the operational 1 day forecast of column water vapor amount from the ECMWF model ouptut.

References

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