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Satellite-based surface solar radiation estimation over Finland: an analysis of estimation bias by cloud type

Viivi Kallio, Aku Riihelä, and Anders Lindfors
Finnish Meteorological Institute, Finland

The importance of accurate knowledge of the amount and spatial distribution of solar surface radiation (SSR) is increasing as solar energy applications are becoming more common. Satellite based methods are widely accepted for retrieving information on SSR variations, however, the methods are known to be unable to reliably capture the effects of some types of cloudiness. In this study we verify the initial estimates of a satellite based SSR forecast system originated in the Heliosat-SPECMAGIC method developed for the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) instrument on board Meteosat Second Generation (MSG) satellites. We focus particularly on the effect of cloud type on SSR retrieval errors. The estimates are verified against in situ measurements from five FMI (Finnish Meteorological Institute) stations in Finland for May-August 2016. In order to define the mean bias error per cloud type, the errors are divided into categories according to cloud type retrieved from the NWC SAF Cloud Type product.
SSR estimates and forecasts are commonly verified for hourly or daily averages, whilst here the full 15 minute temporal resolution of the MSG satellite is used. In addition to the short time scale, the cloud categorisation enables the study of the algorithm accuracy with short term variability associated with cloudiness. The study is conducted over the high latitudes, which are often overlooked in SSR estimation studies despite their considerable solar energy potential during the summer period.
The mean bias error is found to be dependent on overall cloudiness and cloud type. A dependence is also found in location, caused by both latitude and distance to the coast. Interestingly, the lowest clouds produce highest SSR estimation errors, while semi-transparent clouds cause far less error in line with a priori expectations.