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Surface solar radiation forecast for Finland based on geostationary weather satellite data

Viivi Kallio-Myers, Aku Riihelä, Panu Lahtinen, and Anders Lindfors
Finnish Meteorological Institute, Meteorological Research, Finland (viivi.kallio-myers@fmi.fi)

The solar energy industry needs SSR (Surface Solar Radiation) forecasts to combat the complications caused by the natural fluctuation of solar irradiance. The use of solar energy is growing in Finland, however, the forecasting methods used for solar energy are often developed and validated for lower latitudes than that of Finland. Satellite-based methods have been found suitable for nowcasting, but particularly with these methods, a high latitude location causes the satellite-borne imagers to have high satellite zenith angles, which causes uncertainty in their performance. NWP (Numerical Weather Prediction) methods have been found to be appropriate for irradiance forecasting with a forecast time above a few hours, but these also have not been extensively tested in the area in question.

We have developed an SSR forecast method based on measurements from the SEVIRI imager onboard the geostationary MSG weather satellite, and CS (Clear Sky) estimates from the CS model Pvlib Solis. The forecasts, as well as the CS model and the produced all-sky irradiance estimate, have been validated against in situ SSR measurements in southern Finland. Additionally, the forecasts were compared to 'smart' persistence forecasts, where the effect of clouds is held constant.

Various CS models were initially compared, and all evaluated models showed good performance in the area. The all-sky estimate was found to be sufficient for use as the initial point of the forecast, despite the high satellite zenith angle of the SEVIRI imager. The forecast also performed well compared to the persistence forecasts, particularly in an environment with changing cloudiness.

To achieve the best accuracy also for a longer time step, a forecast based on NWP data will be adapted for Finland. The NWP forecast will be compared to the satellite-based method to study their relative performance with an increasing forecast time. The satellite-based method has so far performed well in the beginning of the forecast, but the NWP-based forecast is expected to have higher accuracy after 1 to 4 hours.