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Forecasting direct and diffuse irradiance with the use of hemispheric sky images

Thomas Schmidt, John Kalisch, Elke Lorenz, and Detlev Heinemann

Carl von Ossietzky University Oldenburg, Physics, Energy Meteorology, Oldenburg, Germany
(john.kalisch@uni-oldenburg.de)

The use of sky imagers for cloud detection and shortest-term local solar irradiance forecasts is a growing field in research and industry. Accurate local predictions of surface solar irradiance fluctuations up to 20 minutes ahead are essential for a variety of solar energy and power grid applications.
One year of measurements at the University of Oldenburg was used as a robust data basis for new approaches to estimate the radiative components of the insolation. The data sets consists of direct, diffuse and global horizontal irradiance measured with a sample rate of 1 Hz. In order to account for diurnal and seasonal variations radiation measurements are normalized to the clear-sky conditions. Hemispheric images were taken every 10 seconds by a sky imager mounted close to the radiometers.
In a first approach, the surface solar irradiance was retrieved from the binary cloud masks with the use of clear sky and overcast irradiance calculations. With the proposed new method, a forecast quality could be achieved, which was outperforming persistence models especially for broken cloud conditions.
In order to estimate normalized direct and diffuse radiation from sky images, a k-nearest neighbor (kNN) regression algorithm is applied. As input for the machine learning process it uses a large variety of image features, that characterize and quantify the pattern properties of the cloudy sky. The validation was performed on an independent data set. The correlations between the estimations and the instantaneous measurements are greater than 0.85 for both the direct and the diffuse radiative components.
Cloud motion vectors have been calculated using the optical flow technique in consecutive images. The combination of cloud motion and the analyzed direct and diffuse irradiance is used to determine short-term forecasts of the radiative components of the insolation.
Here, the analysis procedure, the forecasting scheme and first results of the performance of this new approach are presented.