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Retrieving direct and diffuse radiation with the use of sky imager pictures

Thomas Schmidt, John Kalisch, and Elke Lorenz
Carl-von-Ossietzky University of Oldenburg, Oldenburg

A machine-learning approach for retrieving direct and diffuse irradiance from pictures taken by a ground-based whole-sky imagery (sky imager) is investigated in the present work. The use of sky imagers for shortest-term local solar irradiance forecasts is a growing field in research and industry. Accurate predictions of surface solar irradiance fluctuations up to 30 minutes ahead are important for a variety of solar energy and power grid applications.

Sky imager picture analyses provide very high resolution binary cloud masks, but have limitations in deriving aerosol and cloud optical properties. In a first approach, surface solar irradiance was retrieved from the binary cloud masks with the use of clear sky and overcast irradiance calculations. With this method, forecast performance improvements over persistence could be achieved especially for broken cloud situations. These situations are characterized by inhomogeneous cloud patterns contributing to surface solar irradiance deviating from the clear sky or overcast levels. The accurate estimation of the radiative components will therefore improve the irradiance retrievals.

One year of measurements at the University of Oldenburg was used as a robust data basis for this new approach. 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 s by a sky imager mounted close to the radiometers.

The proposed approach uses image features like the average pixel intensity of the whole image and the circumsolar area, analyses of the gray-level co-occurence matrix (GLCM), information of the RGB and HSV color space and the analysed cloud fraction. In order to estimate normalized direct and diffuse radiation, a k-nearest neighbor (k-NN) regression algorithm is applied. The performance of this model is evaluated by cross-validation.

Here, the analysis procedure and first results of the performance of this new approach are presented.