EMS Annual Meeting Abstracts
Vol. 11, EMS2014-**PREVIEW**, 2014
14th EMS / 10th ECAC

Small-scale solar irradiance nowcasting with sky imager pictures

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A method for small-scale nowcasting of clouds and solar irradiance for primarily solar energy related applications is presented. Spatially and temporally highly variable surface solar irradiance caused mainly by broken cloud conditions has been analysed and forecasted by means of a ground-based all-sky camera. For this approach sky images are processed to extract the cloud distribution and motion, the resulting surface shadow and solar irradiance fields. Although the approach has a spatial and temporal limitation due to the camera's field of view it is accompanied with a high resolution of <10s and 3-20m per image pixel for an average cumulus cloud base height.
The processing chain consists of a cloud detection scheme based on an advanced red-blue-ratio threshold method and the transformation to real world coordinates by applying cloud base height information derived from a ceilometer, satellite pictures or estimations from a cloud classification method. The cloud movement is analysed by applying an optical flow technique to subsequent images. The resulting cloud motion vectors are used to extrapolate the future states. In a next step, a cloud mapping scheme using the position of clouds and sun is applied for estimating surface shadow distribution. Incoming solar irradiance is finally derived from these shadow maps.
In a first case study, a 2 hour cumulus cloud scene has been investigated. The performance of the analyses and forecasts has been evaluated by comparing the extracted cloud shadow patterns at the surface to a data set of global horizontal irradiance measurements[1] with a 10Hz acquisition time from >90 pyranometer stations distributed over 10x10km. The results show an overall accuracy of more than 85%.
For the final presentation the analyses will be extended to a data set of more than four weeks of measurements to investigate the performance for different weather and cloud situations characterized by cloud base height, vertical cloud distribution, cloud movement and cloud optical thickness.

[1]Data originate from a measurement campaign in the HD(CP)^2 project