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Solar irradiance nowcasting based on a network of all-sky imagers: the value of high-resolution data on variability information

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The transition to a fossil-free energy system requires the rapid installation of photovoltaic (PV) systems. For Germany, the government is targeting an installed PV capacity of 215 Gigawatts (GW) by 2030 (70 GW today). This target is associated with an increased installation rate of 22 gigawatts PV per year (around three times compared to the 2021 rate). In urban areas, the majority of systems will be installed on rooftops connected to the low-voltage grid. It is therefore likely, that the majority of suitable rooftops will be equipped with PV systems in the next 10 years. In parallel, significant changes in load patterns (e.g. e-mobility, heat pumps) and the integration of battery storages can be expected.

The efficient integration of the additional PV systems into the electrical grid also requires a detailed understanding of the generation profiles at different levels from the household to the transformer. Therefore, the impact of very short-term solar irradiance variability on ramp rates and balancing effects should be investigated for scenarios with decentralized, but much denser PV generation than today. Since this variability is mainly caused by small scale cloud dynamics, high resolution information on temporal and spatial cloud cover and irradiance distribution is needed.

In northwestern Germany, DLR has installed and is operating Eye2Sky, a dense network of allsky imagers (ASI). At 30 different locations, high-resolution fisheye images of the sky are taken every 30 seconds. At 10 locations, the images are complemented by radiation and meteorological measurements. The Eye2Sky network covers about 100 km x 100 km centered at the city of Oldenburg. It has a low ASI density in rural areas and a high density in city of Oldenburg, thus providing an almost complete coverage of the city.

Eye2Sky is used to study solar irradiance variability in the city of Oldenburg at a high spatial (50 meters) and temporal (30 seconds) resolution. This enables simulations of single rooftop PV systems. Compared to state-of-the art radiation data sources like satellite images or numerical weather models (NWP), the camera information in Eye2Sky resolves cloud details that cause solar irradiance fluctuations on small scales down to household level.

In this work, we would like to present a solar irradiance nowcasting validation from the ASI

network in Oldenburg and its comparison with methods based on satellite (MSG) as well as NWP (ICON-D2) data. Emphasis will be made on the ability of the different methods to reproduce the spatio-temporal variability under different cloud conditions.