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High-resolution global irradiance monitoring from photovoltaic systems

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Reliable and regional differentiated power forecasts are required to guarantee an efficient and economic energy transition towards renewable energies. Amongst other renewable energy technologies, e.g. wind mills, photovoltaic systems are an essential component of this transition being cost-efficient and simply to install. Reliable power forecasts are however required for a grid integration of photovoltaic systems, which among other data requires high-resolution spatio-temporal global irradiance data. Hence the generation of robust reviewed global irradiance data is an essential contribution for the energy transition.

To achieve this goal our studies introduce a novel method which makes use of photovoltaic power generation in order to infer global irradiance. The method allows to determine high-resolution temporal global irradiance data (one data point every 15 minutes at each location) from power data of operated photovoltaic systems. Due to the multitude of installed photovoltaic systems (in Germany) the detailed spatial coverage is much better than for example only using global irradiance data from conventional pyranometer networks (e.g. from the German Weather Service).

Our designated method is composed of two components: a forward component, i.e. to conclude from predicted global irradiance to photovoltaic (PV) power, and a backward component, i.e. from PV power with suitable calibration to global irradiance. The forward process is modelled by using the radiation transport model libRadtran (B. Mayer and A. Kylling (1)) for clear skies to obtain the characteristics (orientation, size, temperature dependence, ...) of individual PV systems. For PV systems in the vicinity of a meteorological station, these data are validated against calibrated pyranometer readings. The forward-modelled global irradiance is used to determine the power efficiency for each photovoltaic system using non-linear optimisation techniques.
The backward component uses the power efficiency and meteorological parameters (e.g. from the model COSMO-DE) to calculate global irradiance by means of the generated power of individual photovoltaic systems.

For the year 2012, our method is tested for PV systems in the Allgäu region (south Germany), the distribution area of the system operator “AllgäuNetz GmbH & Co”. The test region includes 215 online-monitored photovoltaic systems and one pyranometer station located at the DWD (Deutscher WetterDienst) weather station Hohenpeißenberg (operated by the German Weather Service). The present talk provides an introduction to the newly developed method along with first results for clear sky scenarios.

(1) B. Mayer and A. Kylling (2005): Technical note: The libRadtran software package for radiative transfer calculations - description and examples of use. In: Chemistry and Physics Chemistry and Physics. Page: 1855—1877