EMS Annual Meeting Abstracts
Vol. 14, EMS2017-199, 2017

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 (PV) 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. On a local and regional basis these data are however largely lacking, since at the ground global irradiance is only measured at some sparsely distributed meteorological stations, or on occasions inferred at medium spatiotemporal resolution from satellites observations or meteorological analysis. Further a validation of the inferred global irradiance from both resources has only been undertaken yet in some dedicated studies.

Here the study proposes to use power records of a manifold of PV systems to infer the global irradiance on a regional basis. The designated method is composed of two components: a forward model, i.e. to calibrate the power of individual PV systems from predicted global irradiance, and a backward inversion model, i.e. to infer from the recorded PV power global irradiance as function of some relevant meteorological parameters. The forward process is modelled by using the radiation transport model libRadtran (1) for clear skies to infer the characteristics (orientation, temperature dependence etc.) of individual PV systems. For PV systems located in the vicinity of a meteorological station, PV power data are validated against calibrated pyranometer readings. The forward-modelled global irradiance is used to determine the power efficiency as function of the relevant installation parameters for each photovoltaic system. The backward component uses the power efficiency of individual photovoltaic systems to calculate global irradiance as function of meteorological parameters.

The present talk provides an introduction to the newly developed method along with first results for clear sky observations and 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