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Investigating the impact of clouds on solar energy production – Analyzing different photovoltaic technologies on different time scales

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Solar energy is one option to serve the rising global energy demand with low environmental impact.1 Building an energy system with a considerable share of solar power requires long-term investment and a careful investigation of potential sites. Therefore, understanding the impacts from varying regionally and locally determined meteorological conditions on solar energy production will influence energy yield projections. Clouds are moving on a short term timescale and have a high influence on the available solar radiation, as they absorb, reflect and scatter parts of the incoming light.2 However, the impact of cloudiness on photovoltaic power yields (PV) and cloud induced deviations from average yields might vary depending on the technology, location and time scale under consideration.
This study aims to predict the impact of different cloud situations on PV power yields to ensure a higher investment reliability. For this purpose, an integrated model - coupling cloudiness, radiation and its impact on PV yields - is created. As an atmospheric column model the libradtran library3 is used while the determination of the PV power yield is undertaken with the two-diode-model4 (see poster by Neher et al. for details). For cloud information the satellite based APOLLO5 methodology is applied. In addition local cloudiness information from an all sky cam is used to validate the data. Various timely resolutions (from yearly averages to 15min time steps) will be analyzed with regard to cloud impacts on average PV yields and the deviation in comparison to lower-resolutions will be determined. Furthermore, the model will be resolved in a spectral dimension to consider the certain response of different PV cells. Model results will be compared to measurements of solar radiation (global, diffuse and direct normal) and PV yields, which are set out at the location of Bonn-Rhein-Sieg University (50°46’47"N, 7°10’58"E).

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