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An innovative approach for the simulation of the regional photovoltaic power generation in energy scenarios

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Accurate calculation of the power generated by photovoltaic (PV) plants in a region requires the knowledge of the detailed characteristics of the plants, which are most often unavailable to public. Within the Copernicus ECEM project, an innovative approach was developed with the objective to reach the best possible accuracy of the power generated in many regions to feed energy scenarios without having to collect detailed information on PV plants.
Approaches were proposed that consist in collecting the characteristics of numerous plants in the studied domain to simulate the regional PV generation with a physical model [1]. Such approaches are likely to yield accurate results but the exhaustive data collection practically needed makes them very consuming in human and computer resources. Other approaches consist in selecting a very simple PV model, with a very limited number of unknowns. The implementation is much easier at the expense of the model accuracy.
The innovative approach is based on a physical model coupled with a statistical distribution of the parameters of a model describing the configuration of a PV plant. The PV power generation is first calculated for all configurations frequently found in the region and then aggregated under consideration of the probability of occurrence of the plant configurations. A statistical distribution evaluated for several thousands of PV plants located in Germany has been used to estimate that of other European countries. This has been achieved by adjusting the distribution using the latitude- and weather-dependent optimal PV tilt angle.
Time series of PV power generation have been calculated with the innovative approach using adjusted ERA interim data for 33 countries in a 3-h time resolution. The irradiation data used are ERA-interim data adjusted to the Helioclim3v5 data [2] and the temperature data is taken from the ERA interim dataset. The model output has been compared to production data provided by transmission system operators for Germany and France for the year 2014. Relative RMSE of 4.2 and 3.8 % and relative biases of -2.4 and 0.1 % were found for France and Germany.
[1] Saint-Drenan, Y.-M., Good, G., Braun, M., 2017. A probabilistic approach to the estimation of regional photovoltaic power production. Sol. Energy 147, 247-276
[2] Jones P. D., C. Harpham, A. Troccoli, B. Gschwind, T. Ranchin, L. Wald, C.M. Goodess, and S. Dorling, 2017. "Using ERA-Interim Reanalysis outputs for creating datasets of energy-relevant climate variables", Earth Syst. Sci. Data Discuss., doi:10.5194/essd-2016-67, in review.