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Detection of high-residual days of incoming shortwave radiation and its limitations

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Forecasting the photovoltaic (PV) power produced by a plant implies large financial gains or losses for companies. The PV power forecasting skill mainly depends on solar radiation, one of the most challenging variables to predict due to its extreme temporal and spatial variability. For instance, two recurring weather phenomena in midlatitudes are spring-summertime convective thunderstorms and fog. The first are characterized by strong spatiotemporal variability: grid resolution of a forecasting model is thus often too coarse to resolve them, and parametrisation schemes are required. The second is of strong local nature, depending on soil type, orography, and soil water content, which, if not represented correctly in a model, may lead to strong overestimation of solar radiation forecast. The vertical resolution in NWP models does not allow to correctly predict the fog's upper limit while the horizontal resolution is typically incapable of fully resolving water bodies. Such weather events thus lead to large errors in day-ahead forecasts for solar radiation. In this study, the meteorological causes for particularly bad solar radiation forecasts - the so-called high residual days (HRDs) - have been investigated and a technique to detect them in advance with good reliability has been developed. The analysis was performed comparing one year (May 2021 - April 2022) of hourly values for incoming shortwave radiation at surface from a multi-model combination of NWP models (forecasts) and from SARAH solar radiation data retrieved from the EUMETSAT Climate Monitoring Satellite Application Facility (measurements). To identify which variables could reveal HRDs, five distinct locations in north-west Switzerland, corresponding to ground weather stations were selected, for which, imposing specific conditions, a set of HRDs was defined. For each set, various meteorological variables from multiple models, combinations, and measurements were investigated. We found that over 65 % of HRDs are associated with shifts or mistakes in precipitation forecasts. To identify HRDs forecast, we consequently selected two quantities based on the standard deviation of precipitation; specifically: (i) days with high spatial standard deviation – at fixed forecasting model, spotting high variability between the examined and surrounding grid cells, and (ii) days with high standard deviation between different models within the same grid cell. Combining these two sets with a proper choice of parameters, 75% of HRDs were detected. A spatial investigation showed that this approach scores good in central Europe and even better in desertic and tropical areas. Although the standard-deviation-based approach does not determine the sign of the residuals, the

prediction of HRDs is nonetheless advantageous: on HRDs, users should favour a multi-model over a single-model forecast, to be able to better assess the uncertainty and the possible range of solar radiation and PV power.