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Climatology of low wind and solar power production events in Europe with Grosswetterlagen classification

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Low production of renewable energy for up to several days can cause stress on the electricity system, especially when such events coincide with high demand. Meteorological conditions leading to extremely low production of wind and PV power are known. These are periods of relatively little irradiance and anomalously weak winds. Past work underlined the importance of high-pressure systems over Central Europe during winter for causing such conditions. However, there is less known about low-production periods in other seasons and their regional scale characteristics from a climatological perspective. Despite being probably less severe in summer, low-production events can nevertheless be problematic. One example is the higher electricity demand for cooling systems in summer, which is especially relevant in the context of climate change.

Here we statistically analyse the synoptic meteorological conditions causing low-production events of wind and solar power in Europe for winter and summer. To this end, we use a daily weather regime classification for Europe from the German Weather Service, known as “Grosswetterlagen” (GWL). Our simulation of the production of wind and PV power is based on the reanalysis data COSMO-REA6 for Europe with a horizontal resolution of 6 km, and an established wind and PV power model, developed in the research area “Climate Monitoring and Diagnostics” of the Hans-Ertel Centre for Weather Research. Scenarios of gridded installed capacity of PV and wind power plants in Europe for 2050 are taken from the CLIMIX model to calculate hourly power production. Our composite analysis of the PV and wind power production associated with the different GWLs highlight (1) the regional differences in the power production in Europe across country borders and (2) different regional patterns of anomalies in power production depending on GWLs. Based on our simulations, we derive an atlas of potential PV and wind production associated with different GWLs. This atlas will be helpful to understand which GWLs lead to regionally low-production events, and to what extend the severity of such events can be forecasted in different seasons. Such knowledge is important since the share of wind and solar power continues to increase in the European electricity grid.