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Spatial and temporal (co-)variability in European renewable energy systems

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The share of renewable energy in the electrical grid will likely increase as mitigation measures for future climate change are put into effect. Renewable energy production, from e.g. wind and solar energy sources, largely depends on the weather and is thus subject to variability on daily, weekly and yearly timescales. This weather induced variability in future energy systems is fundamentally different from the current energy system that relies on fossil-fuel/nuclear power stations. Because energy demand has to be met at all times, it is of high importance to understand any variability of energy production. It is frequently assumed that this variability can be compensated by integrating the variable renewable energy sources over a large area ('interconnectivity'), spanning multiple countries, but limited research has been done in this direction.

The aim of the presented work is to characterise the variability and co-variability of renewable energy production in different European countries. We use 2000 years of simulated gridded meteorological data from the EC-Earth global climate model to simulate 2000 years of capacity factors (i.e. daily efficiency of installed wind turbine/solar panels). We will show that the variability of a small geographical regions is larger than that of larger regions and the meteorological drivers that cause this difference. We will then show the co-variability between different regions, both for normal conditions and for cases of extreme low energy production, to identify the usefulness of strong interconnectivity for a secure energy supply in a future, highly renewable, electrical grid.