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Regional wind-solar complementarity and atmospheric pressure patterns - a case study for Ireland & the UK

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The future offers significant challenges regarding the choice of energy mix of choice, which will condition the production, transmission and storage of energy from renewable energy sources. A critical feature of wind and solar power arises from their intermittent and variable nature (wind speed/direction and solar radiation). Efficient large-scale deployment of weather and climate dependent renewable energy systems will depend on an improved understanding and quantification of the spatiotemporal variability of renewable energy resources. Importantly, natural variability in these resources occurs on a range of time-scales. Short-term variability affects operational decision but long-term trends and resource variability are of interest to system-level planning decisions.
Here we focus in the Euro-Atlantic sector (specifically, the UK and Ireland), as this region's atmospheric variability is strongly linked to large scale atmospheric circulation patterns such as the North Atlantic Oscillation (NAO), the East Atlantic (EA) and Scandinavian (SCAND) patterns. These patterns reflect large scale sea level pressure (SLP) anomalies, with impacts on several meteorological variables relevant to energy production and demand. Of particular interest in this work is the link between these atmospheric patterns and both wind speed and solar radiation/cloud cover. Recent work has assessed complementarities between wind power and solar power aiming at balancing renewable energy production "from the source". This would greatly reduce the need for storage systems and better inform where to install new renewable energy power plants and transmission cables, amongst other decisions.
In this work we explore how the complementarity between wind and solar resources changes according to the onset of specific phases of those pressure patterns, using observations and both coarse and high resolution reanalysis datasets that enable us to map optimum and non-optimum complementarity conditions of production according to various atmospheric states. These also improve our understanding of the underlying meteorological conditions that drive wind/solar resource variability, which can potentially be linked to previous conditions – predictability of production – or can be used as analysis templates for other sites/regions aiming at integrating renewable energy systems in their energy chains.