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Quantifing the influence of meteorological and large-scale atmopsheric drivers on energy compound events

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The transition towards decarbonized power systems requires to account for the impacts of the climate variability and climate change on renewable energy sources. With the growing share of wind and solar power in the European power system and their strong weather dependence, balancing the energy demand and supply becomes a great challenge. In this study, we assess energy compound events, defined as periods of simultanous low renewable production of wind and solar power, and high electricity demand. Using a country-based logistic regression approach, we model the binary occurrence of energy compound events and we examine the effects of meterological and weather regimes. Then, we quantify the meteorological conditions resulting in the highest probability of occurrence of energy compound events. We found that the combination of extremely low temperatures (below the 5th percentile) and low wind speed (below the 10th percentile), along with moderate-high solar radiation (above the 50th percentile), lead to the highest probability of occurrence of energy compound events over most European countires. Furthermore, we show that blocked weather regimes lead to the weather conditions that can have a major risk in the European power system. In particular, the Greenland blocking and the European blocking were associated with widespread energy compound events that affected multiple countries at the same time. Our results highlight the importance of the weather regimes that result in spatially compounding energy events, which might a major impact within a potential fully interconnected European grid.