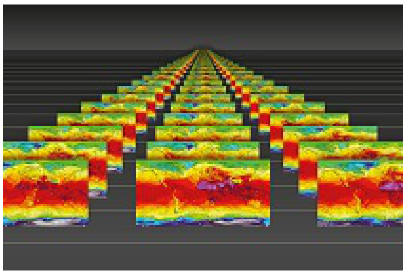

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Stratospheric influences on subseasonal predictability of European energy-industry-relevant parameters

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Surface weather variability on subseasonal timescales influences energy production, demand, and prices. Improving the skill of subseasonal predictions of surface weather is thus of high interest for the energy industry. This is particularly the case for near-surface wind due to the ongoing shift toward more wind power generation. Anomalous states of the stratospheric polar vortex during winter are one important source of enhanced subseasonal predictability, because they are typically followed by persistent large-scale flow patterns over Europe. We thus investigate how the state of the stratospheric polar vortex affects month-ahead wind power generation in Europe during winter and how this effect influences the skill of subseasonal numerical weather forecasts of various energy-relevant surface parameters. In a first step, we use the ERA-Interim reanalysis and the wind power dataset "Renewables.ninja"to demonstrate a strong correlation between the strength of the lower-stratospheric circulation and month-ahead wind power generation in different regions of Europe. This relationship exists due to episodes of troposphere–stratosphere coupling, which lead to prolonged periods resembling positive or negative phases of the North Atlantic Oscillation (NAO). Since these persistent NAO-like periods are associated with strong near-surface wind anomalies, they have an important impact on wind power generation, in particular in Northern Europe. Motivated by this empirical relationship, we develop a simple statistical forecasting approach based on the strength of the lower-stratospheric circulation, which provides skillful forecasts of month-ahead wind power generation in Europe. In a second step, we investigate the skill of the ECMWF subseasonal model from the S2S database in predicting month-ahead 10-m wind speed, 2-m temperature, and precipitation as three energy-industry-relevant model parameters. The skill of the ECMWF model is generally higher than the skill of the simple statistical forecast for wind power generation, particularly for short lead times. It is substantially driven by the strength of the lower-stratospheric circulation at initialization time and the associated NAO-like phases throughout the forecast, which reflects the empirical relationship from the reanalysis data also in the model. However, there are substantial differences in the skill between different European regions as well as parameters, with implications for both the energy industry and the numerical modeling community.

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