Characterizing and modelling a "Dunkelflaute" event

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Abstract

In the coming decades, both wind and solar power production will be playing increasingly important roles in Europe's energy economy. It is envisaged that these renewable sources may even be able to supply baseload power at certain locations. Under such high-penetration renewable energy scenario, it is absolutely essential that our power grids are resilient against any unusual weather phenomena which can lead to sustained reduction of wind speed and/or incoming solar radiation.

In this presentation, we will discuss one such meteorological phenomenon which is causing serious concern to the renewable energy industry. The word "Dunkelflaute" has been coined to describe this phenomenon which is primarily characterized by calm winds and overcast conditions. For over one hundred years, meteorologists have been calling it "anticyclonic gloom" as it is typically associated with persistent high pressure system and poor ambient air quality conditions.

The capabilities of the contemporary mesoscale models to reliably simulate or forecast a complex atmospheric phenomenon like Dunkelflaute is not known in the literature. In this work, we fill this void by simulating a nine-day-long Dunkelflaute event near the coast of Belgium utilizing the state-of-the-art Weather Research and Forecasting (WRF) model. In addition to measured wind power production data, a diverse suite of observational data (e.g., platform-based and floating lidars, radiosondes, weather stations) are used for comprehensive validation.

Keywords: mesoscale modelling, power reliability, solar energy, wind energy

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