EMS Annual Meeting Abstracts
Vol. 16, EMS2019-330, 2019

Beyond the spherical cow: a North Sea climatology of anomalous wind events

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There is this joke about a physicist proposing that a cow can reasonably be approximated as a sphere. While there is truth in every joke, when the cows are wind profiles and the spheres are power-laws, it's really not that funny. Why? One of the reasons could be that the differences between a cow and a sphere are much more obvious than the differences between a wind profile and its power-law approximation. But these differences are there and as investments in offshore wind continue to grow, they become more and more important.

Over the past four years, we've been characterizing the offshore wind field using reanalysis data and observations over the North Sea. Part of this work focused on validating the measured and simulated wind fields in general[1], but our main focus was on anomalous wind events, conditions for which the usual approximations are inappropriate[2]. A prime example is the low-level jet, for which the wind speed reaches a maximum not far above the surface and then reduces again above it. Neither measurements nor reanalysis were able to reliably represent this phenomenon, but by combining the strength of both datasets, we were able to derive a valuable characterization[3]. Low-level jets are common along the coastlines, especially in spring when there is a large temperature gradient between the land and the sea. With typical wind speeds in the order of 8 m/s and typical heights within the rotor plane of contemporary wind turbines, they have the potential to substantially modify power output.

During the 2019 Annual Meeting of the EMS we will present a selection of recent and antecedent results to make the case that it is time to revisit the way in which we represent the wind field in energy applications.

[1] Kalverla et al. Wind Energy, 22 (1), pp. 34-48, 2019.
[2] Kalverla et al. Journal of Wind Engineering and Industrial Aerodynamics, 165 , pp. 86–99, 2017.
[3] Kalverla et al. Wind Energy Science, 4 (2), pp. 193–209, 2019.