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Characterization of anomalous wind events in in-situ observations and in the ERA5 reanalysis over the North Sea.

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Many wind energy applications rely on idealized wind characterizations, such as the wind-profile power-law or the logarithmic wind profile. This facilitates, among others, spatial comparison for wind resource assessment, and temporal extrapolation for load assessment. While these idealized descriptions adequately capture the average wind conditions, their application to instantaneous wind fields introduces uncertainties because of oversimplification. To reduce these uncertainties, our objective is to identify and characterize such 'anomalous wind events'. An analysis of observational data up to a height of 315 m over the North Sea revealed that low-level jets (violating the assumption of monotonically increasing wind speed with height) occur frequently, up to 12% of the time in July. Based on the same dataset, we developed methodologies to assess e.g. the frequency and strength of wind ramps (violating the assumption of stationarity) and wind veer (violating the assumption of a uniform wind direction with height). However, the observational analysis was still limited to the observational facility, and did not provide complete insight into the physical mechanisms that govern these events. Here we extend the observational study for the complete North Sea domain based on ERA5 reanalysis data. Preliminary results suggest that ERA5 adequately captures the diurnal and seasonal cycles of low-level jets, although the exact correspondence between model data and observations requires further investigation. Most importantly, we find that the reanalysis data provide much insight into the spatial structure and physical mechanisms governing these anomalous wind events. The low-level jets are concentrated along the coast and are mainly the result of baroclinic forcing, though they sometimes migrate over the North Sea. We will present analogous analysis for other anomalous wind events as well.