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Reply to RC1

Mark Kelly et al.

Author comment on "Statistical impact of wind-speed ramp events on turbines, via observations and coupled fluid-dynamic and aeroelastic simulations" by Mark Kelly et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-40-AC1, 2021

Thanks to the reviewer whom gave their input in RC1. Below we respond to the three comments issued by that reviewer in RC1.

- As mentioned in the second paragraph of section 2/footnote 2, this turbine was chosen because the original study was designed for comparison with the offshore Rødsand 2 windfarm, which employs a very similar turbine and controller (Siemens 2.3MW). The latter was not available due to proprietary reasons, and the NM80 has been previously used for this purpose.
- Good point. The ramp events are not simply modelled as normal wind fields, but as background turbulent flow plus event, via constraints. As written in the draft/to repeat: the vertical shear is controlled per the observed event space, with zero horizontal shear and veer, and the the turbulence length scales corresponding to the background flow; the coherences of the background turbulence are dictated by the Mann model/LES. I also remind that we mention in the draft that the simulated events were taken to have no vertical tilt, though this can occur (Hannesdóttir *et al*., 2019). The spatial characteristics of the ramp events were not the focus of this work, though our previous student (Alcayaga [2017], referenced in the draft) did examine their vertical structure and turbulence around them. In the 2017 study it was confirmed that the TKE and anisotropy during events is increased, and the length scale decreased, as postulated by *Hunt et al*. (2010). However, these effects are not dealt with here: σ_u is dominated by the ramp amplitude, so our results are slightly conservative. The change in anisotropy negligibly affects the streamwise component considered (c.f. Kelly, 2018), as does the smaller effective length scale during events. However, these are subject to further research.
- The earlier works of Hannesdóttir & Kelly (2019) and Hannesdóttir/Kelly/Dimitrov (2019) dealt with this aspect; the former showed that the rise times of ramp events are longer than prescribed in the IEC standard, while the latter found that tower-base fore-aft moments can exceed the standard's DLC 1.3 for ramps crossing rated speed. The current paper follows after this: now we focus on how the ramps travel (persist) through wind farms, the sensitivity of thrust-dominated loads to the ramps (for single turbines or within farms), and the statistical implications of such, given the ramp joint probability space.
  Regarding fatigue loads, their assessment (e.g. per bin) is a current topic being researched now e.g. in the Hiperwind project (https://www.hiperwind.eu/).