Answer to reviewers

Dear Sir/Madam,

We thank the reviewers for the feedback on our manuscript. Below is our answer to the reviewer's comment.

Reviewer 2

Reviewer's summary:

The paper "Turbulence in a coastal environment: the case of Vindeby" by Putri et al., provides measurements of turbulence from a field campaign conducted offshore surrounded by complex terrain at Vindeby. The measurements of non-dimensional shear were compared to similarity theory estimates and show reasonably good agreement. Other estimates of co-coherence and turbulence characteristics relevant to offshore wind turbines is also provided. The paper is well structured but there are some aspects of the paper that are not clearly mentioned and could change the result. Reviewing the other comments received for this paper, the two other reviewers have clearly stated some of my concerns as well (regarding flow distortion, computation of the shear, averaging time periods are not clear etc.). In addition to the previous reviewer comments, some additional comments are provided below which would be helpful if clarified in upcoming version. The topic is of interest to the wind energy community and relevant to wind energy science journal.

Overall response:

We have re-explored the dataset with respect to the transducer-flow distortion. As highlighted by Reviewer 1 and Dr. Højstrup, flow distortion can be detected in the sonic anemometer records. However, we also found that when we ensemble-average the turbulence characteristics over the sector of interest (220° to 330°), the bias from flow distortion is reduced, provided that a sufficiently high number of samples is considered.

As suggested by Reviewer 1, we have shortened the section discussing the applicability of MOST because of the uncertainties associated with the transducer-flow distortion. We have also reformulated our findings regarding the influence of the wave height on the turbulence characteristics. The detail concerning the flow distortion is addressed in the reply to the community comment by Dr. Højstrup. In addition, we have created appendices to accommodate some of the supporting information that were detailed in the main body of the original submission.

Comments

Q 2.1 *Maybe some text related to the initial spectral formulations can be moved to an Appendix. There is nothing new in here, but still relevant to the paper and would reduce the length of the paper.*

Reply: We thank the reviewer for the suggestion. We believe that the text related to the spectral formulations is not necessarily be removed to an appendix since it would provide easiness for the reader to understand the results. Furthermore, the length of the text is considerably shortened.

Q 2.2 *Why is friction velocity averaged within the two levels, if you feel the measurements at 6 m are affected by the wave boundary layer? You should revisit this part or provide more justification.*

Reply: We used the average at two levels because the friction velocity is usually the parameter associated with the largest uncertainties and the spatial averaging helps reduce them. We revisited this part and we found that the measurements are, to some extent affected by the transducer-induced flow distortion. In the revised manuscript, we carefully review our statements that the measurements at 6 m are affected by the wave boundary layer.

Q 2.3 *Figure 6 shows good agreement in non-dimensional shear when using 6 m measurements with similarity theory. This is confusing and I was under the impression that the friction velocity and z/L were estimated from 18 m and not 45 m. Some consistency/clarification is required here.*

Reply: We have clarified in the caption of fig. 6 (fig. 5 in the revised manuscript) that z/L was indeed estimated from the measurements at 18 m.

Q 2.4 *With average significant wave heights (Hs) below 1 m (line 64), and the wave boundary layer is typically 5*Hs, so it would mean most of the time the wave boundary layer is below the lowest measurement height (6 m). There may be instances when the waves can affect the measurements, but this would be very small for such low Hs. Please refer to Hristov et al., 1998 (Wave-Coherent Fields in Air Flow over Ocean Waves: Identification of Cooperative Behavior Buried in Turbulence) for more details on how to assess the impact of the wave boundary layer on measurements. After filtering for nonstationary etc., what is average Hs in Figure 5? Small set of measurements affecting the average shear is somewhat surprising. The deviations observed in MOST are probably not due to the presence of the wave boundary layer impacting measurements, but probably flow distortion. This needs to be investigated further.*

Reply: As pointed out by the reviewer, the results in Subsection 5.4 (Subsection 5.2 in the revised submission) indicate that there are only a few instances where we see a clear interaction between the waves and the wind turbulence. The median H_s value was 0.4 m for the period considered, which supports our initial statement that the number of records located in the wave boundary layer is insignificant. We have reformulated the first paragraph of Subsection 5.2, which now reads as " The objective of this subsection is to identify whether the wave-induced turbulence can be detected in the velocity records at 6 m amsl due to the observed turbulence characteristics in Subsection 5.1. Here, the measurements at 6 m amsl are explored in terms of wind-wave interactions, using the wave elevation data collected by the AWR near SMW. A total of 925 high-quality samples collocated in time with the wind velocity data studied were identified. Each wave elevation record was 30 min long and corresponded to a wind direction between 220° and 330°. There exist methods to filter out the wave-induced velocity component from the turbulent velocity component (e.g. Hristov et al. (1998)), but these methods are not addressed herein for brevity."

Following our reply to Reviewer 1 and Dr. Højstrup, we removed fig. 5 from the manuscript as the uncertainties regarding the transducer-induced flow distortion may be too large.

References

Hristov, T., Friehe, C., and Miller, S. (1998). Wave-coherent fields in air flow over ocean waves: Identification of cooperative behavior buried in turbulence. *Physical review letters*, 81(23):5245.