

## Review of “Classification and Properties of Coastal Wind Profiles with Negative Gradients – An Observational Study”

General Comments: This study presents multi-year datasets combined to address differences in the wind profile characteristics throughout the year as a function of sea state, stability, season, and turbulence (via spectral analysis of inertial subrange and the encompassing scales). The different approaches toward conditioning the data made for an interesting read. The results were well discussed; however, there are areas that need further explanation and details before formal acceptance can be made. I would vote acceptance with minor reviews. The specific comments below are mostly related to the science within the paper and areas where additional explanation is needed. There were a lot of grammar/typo issues, and the reviewer likely missed many throughout the paper. It is suggested that the authors use the examples below in the technical corrections section to improve other areas of the paper beginning at the results section and continuing to the end.

### Specific Comments:

1. The authors investigate a multi-year dataset comprised of a tower, buoy, and a continuous wave lidar. Given the distribution of wind profiles and the discussion of “normal” v. “non-normal” profiles, where the latter includes profile types resembling LLJs as well as negative gradients, then it is strongly recommended that the title is adjusted so that it would not seem that the authors are specifically focusing on wind profiles of negative gradients. After all, that’s only part of the story
2. Comment of usage of “normal” v. “non-normal”: I would argue that using “normal” v. “non-normal” to describe wind profiles is related to the region of interest. Certain regions, for example the great plains, experience LLJs during a fairly large proportion of days throughout the year. The same can be said with the great barrier jet off the coast of California. I would instead recommend the authors change “normal” to “idealized” and “non-normal” to “non-idealized” to describe departures from the ideal planetary boundary layer (PBL) model and the anticipated wind profile structure therein.
3. Your section 3 is entitled “Methods” and yet it goes over the sites and the measurements used in addition to methods. I would change the title to reflect this. Something like “Site, Measurements, and Methods”
4. Lines 161-164: I don’t quite understand this sentence fully. Are you also saying the buoy can measure turbidity? No results related to ocean turbidity is reported in your study. You do mention that wave properties have been evaluated against the turbulent state of the lower-atmosphere, but that is by making comparisons with the mast data. The sentence is confusing in other ways, too. Please improve your point here.
5. Line 218: It’s important to be sure that the linear interpolation is done over small time gaps. You probably should make that clear in the paper. Plus, I doubt that linear interpolation was done over large data gaps. You probably want to comment on any impact this could have on the results and what your gap threshold is. There are ways to approach this statistically as well if gaps are numerous and you have periods of similar turbulence intensity – with and without

data gaps – then you can compare those data and apply statistical randomization such as what is used when solving for the p-values.

6. Lines 345-347: It's hard to tell that the reason the wave age is higher is because of lower wind speeds. Clearly that could be born out the formulation that is used, but it is not shown clearly enough in Figure 3. The wind distribution over open seas is smaller during DJFM and the winds appear comparable when visually comparing the open sea sector distribution from DJFM with AMJJ. If you go ahead and multiply your wave age by  $U$ , then you should be able to compare the phase speeds between these periods to support this claim. Note your Figure 5 showing wind speed distributions and sea state. The AMJJ shows a much higher percentage of swell and more negative profiles, which weighs down the distribution toward lower wind speeds. The distribution, of course, can cannot easily be used to infer the wind rose distribution for open sector in figure 3.
7. Lines 406-409: The mechanisms behind the LLJ were not determined in this paper which makes determining why LLJ-type profiles existed during different stability regimes and for different sectors difficult. The Gotland sector has more LLJs for neutral-to-unstable conditions while the open sea has more LLJs during stable conditions. The site that this data was collected is small, so it is likely to impact the vertical structure of the LLJ over the island but not cause it. Another tricky part of this analysis is differentiating between what the local stability is over land compared to the stability over the ocean. The air being advected over the land site would also impact stability, too, in addition to surface heating/cooling, and this relative impact on stability is not easily characterized with the Monin-Obukhov framework.
8. Spectral Analysis: I know that the focus is mostly the inertial subrange and frequency from which we depart from the inertial subrange into larger eddies. I agree with much of the discussion related to the spectral analysis, but I see that almost all “non-normal” profiles have lower energy containing eddies at the low frequency end. My guess is that one cause stems from dealing with much smaller sample sizes with the “non-normal” cases. It is interesting to note that only the negative profiles have examples where the largest energy containing eddies are larger than the “normal” profiles despite having the smallest wind shear and lightest wind conditions. Both Figure 8 and 9 show this. The production of turbulence is typically rooted in buoyancy or wind shear. Wind shear is small for the negative shear profiles so the thought is that buoyancy production should be responsible. However, the spectral energy is larger for stable conditions as well (Figure 9). Island meteorology and boundary layer internal advection is difficult. Can this be discussed or addressed in the paper?
9. Line 538-539: There are studies that look into turbine wake characteristics as a function of stability. Look at these such examples: [Zhan et. al. \(2020\)](#) and [lungo et. al. \(2014\)](#)

Technical Corrections (T and G will denote typos (T) v. grammar (G); grammatical suggestions will be marked by S):

T1 (Line 8). Change “...that the the zone with strong shear during low-level...” to “...that the strong shear zone of low-level...”

S1 (Lines 15-16). Change “...This variation, the wind shear, plays a...” to “The vertical structure of the wind profile (i.e., wind shear and wind veer) plays an...” With this statement you could lump the two sentences mentioning wind shear and veer together

G1 (Line 22). Change "...grow with an..." to "...grow at an..."

G2 (Line 23). Change "...scenario and that..." to "...scenario since it is anticipated that..."

S2 (Line 27). Change "...Either replace the commas at the beginning and end of "a high latitude semi-enclosed" with hyphens or insert "which is" after "The Baltic Sea,"

G3 (Line 30). Insert "of" between "GW" and "offshore"

S3 (Lines 32-33). Recommend replacing "... and expansion has to be performed with care." To "...and therefore expansion must be handled with care."

T2 (Line 35). Change to "increases". Forgot to add "s"

G4 (Lines 36-37). Change "...are prone to have wind profiles with partly negative gradients that can occur under certain meteorological and..." to "...are prone to having wind profiles with partly negative gradients under certain meteorological and..."

S4 (Line 40). Suggest changing "Note that also wind..." to "Note, also, that wind..."

G5 (Line 44). You use "both" to mention three additional factors. Both would apply to two additional factors. Perhaps change the following "...effects, both to assess the longevity of the turbines, the extension of the wake behind a single turbine and behind the park, and..." to effects; as well as to both to assess the longevity of the turbines, the extension of the wake behind a single turbine and behind the park, and..."

S5 (Line 53). Change "...what are the driving mechanisms for this." To "...what are the driving mechanisms that lead to turbulence production."

G6 (Lines 58-59). Change "In addition to this, not only the turbulent characteristics of the LLJs compared to normal profiles are analyzed..." to "In addition, not only are the turbulent characteristics of the LLJs compared to normal profiles..."

S6 (Lines 69-70). The sentence starting with "Already in 1957,..." is awkward. It just so happens that this is the year where this phenomenon was rigorously documented. I would consider starting this sentence with "One of the first proposed mechanisms related to the formation of..." You can fill in the rest.

S7 (Line 71). Instead of "During the evening and night,..." I would argue to use "During the evening transition,..."

S8 (Lines 74-75). The sentence beginning with "As a consequence..." is a bit of a mouthful. Perhaps make the following change: "...gradient force unbalanced, with a subsequent..." to "gradient force unbalanced. This imbalance subsequently leads to an acceleration of the wind: a process known as frictional decoupling."

G7 (Line 80). Change "As an effect..." to "As a result..." and change "compared to a water..." to "...compared to the water..."

S9 (Line 86). Recommend changing "at least if the swell and the wind direction are aligned which is the most studied case." to "...if the wind is approximately aligned with the swell direction"

T3/G8 (Lines 91-92). Change "...on these matters, but for an introduction to uncommon wind profiles over the Baltic Sea and North Sea, we refer to Kettle (2014) and Moller et. al. (2020)." To "...these different wind profile types. We refer to studies by Kettle (2014) and Moller et. al. (2020) for a description of less common wind profiles of this type."

G9 (Line 119). Change "In a following..." to "In the following..."

T4 (Line 169). Remove "is" after "as" and before "possible"

G10 (Line 185). Do not need comma after "properly" and you remove "those" after "remove"

G11 (Line 210). I was confused with the wording here: "...site of especially swell conditions." Were you trying to say "...site, especially during swell conditions."

G12 (Line 228). Change "on" after "laser" and before "a" to "at"

G13 (Line 246). I would change the sentence starting with "In this additional..." to something like "Application of additional quality controls led to the removal of 6.7% of the data."

G14 (Line 253). Replace "on" between "depth" and "buoy" with "at"

General comment: When introducing a variable, say,  $C_p$ , it is common to stick two commas between the variable.

G15 (Line 257). Replace "in" between "10.4 m" and "the" with "from"

G16 (Line 258). Don't need a comma between "sector" and "since"

G17 (263). Replace "on" between "mast" and "Ostergarnsholm" with "at". I've seen this for multiple occasions. I would make sure that this checked elsewhere.