

## General comments

Review of “Wind farm blockage in convective boundary layers” written by O. Ndindayino and J. Meyers.

This manuscript investigates the impact of blockage and gravity waves on 1.5 GW offshore wind farm under convective boundary layers, using ERA5 and LES. This study is relevant for understanding and optimizing the performance of future larger-scale offshore wind farms, particularly in relation to atmospheric stability effects. The manuscript would benefit from careful proofreading and more detailed explanations of key terms and methodological choices. Specific comments that authors should address are given below.

## Major Points

### 1. Abstract

The abstract mainly summarizes the methods and results but does not clearly convey the motivation or the main contribution of the study. It is recommended that the authors restructure the abstract to:

- Begin with a broader background on wind farm blockage and its importance,
- Narrow down to the specific focus on convective boundary layers,
- Conclude with a clear statement of the novelty and significance of the findings.

### 2. Description of Atmospheric State

The description of the atmospheric conditions lacks important details and justification:

- (a) Which specific time period from ERA5 was used?
- (b) Why is the analysis limited to wintertime? Is there prior research indicating that convective boundary layer conditions are representative or relevant during winter in this region?
- (c) Among the eight cases listed in Table 2, why are the capping inversion height and surface temperature difference emphasized? Please clarify the rationale and cite supporting literature if applicable.
- (d) In Table 2, the four cases under H480 show slightly different values of  $H$ [m]. What explains these variations? The same question applies to H980.
- (e) The value of  $\Delta\theta_3$  is given as 2 K in Table 2. Please confirm whether this is correct.

### 3. Section 2.4

It is unclear whether the descriptions in the second paragraph of Section 2.4 are:

- Based on previously published studies, or
- Derived from results within this manuscript.

If these statements are based on prior work, appropriate references should be provided. If they are results from this study, the authors should explicitly point to the corresponding figures or sections that support these statements.

## Minor Points

1. There are instances where previously defined abbreviations are not consistently used, and terms are written out instead. Conversely, some abbreviations are used without prior definition. Please ensure that all abbreviations (e.g., LES, CBL) are properly defined and used consistently throughout the manuscript.
2. Similarly, some mathematical parameters are not defined (e.g., “g” in Eq. 1 and Figure 1). Please provide clear definitions for all variables.
3. Figure 1: The color of the curve lines and the mathematical annotations is too light, making them difficult to read. Please use darker colors to improve visibility.
4. Line 70: “ms<sup>-2</sup>” → “m s<sup>-2</sup>”.
5. Section 2.1 lacks a discussion of the performance of the SP-Wind solver based on previous studies. Please include relevant references or a brief evaluation.
6. Please ensure consistent verb tense usage in Sections 2.2 and 2.3.
7. ERA5 should be written out in full at its first occurrence, along with an appropriate reference.
8. In Line 115, Table 2 is referenced before Table 1. Please revise the order or swap the tables for consistency.
9. Figure 3: Please clarify whether any comparison between LES results and ERA5 data has been considered or included.
10. In Figure 2, the red rectangle has the same color as the red diamonds, making it difficult to distinguish between them. Please use different colors.
11. In Figure 4, consider combining panels (a) and (b) into a single 3D box visualization, if appropriate.
12. Line 160: Should this refer to “eight simulation cases” instead of “four cases”?
13. Line 188: “Fig. 6(d)” may need to be corrected to “Fig. 6(e)”.
14. In Figure 6, are there explanations provided for panel (e)? Additionally, please clarify the meaning of the black and green dotted lines.
15. Are Figures 7 and 8 necessary? The flow results, including the wind farm region (x: 20–40 km, y: 15–25 km), could potentially be incorporated into Figure 9.
16. In Figure 11, the y-axis scales in panels (a) and (b) should be aligned.
17. Line 306: The statement “Since variations in  $\eta_w$  are significantly larger than those in  $\eta_{nl}$ ,” is unclear. What is meant by “variations”? In Figure 14, the error bars for  $\eta_{nl}$  appear larger than those for  $\eta_w$ .
18. Lines 331–333: Please clarify the differences between  $\Pi_1$  and  $\Pi_3$ , as well as between  $\Pi_2$  and  $\Pi_4$ .