

## Reviewers Comments

**Title:** Observed and simulated turbulent kinetic energy (WRF 3.8.1) over large offshore wind farms

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### General comment

This paper describes observed and simulated wind speed and TKE over offshore wind farms in the North Sea. Three case studies are analysed by means of airborne measurements and real case WRF simulations to investigate the impact of offshore wind farms on the boundary layer flow and the generation of TKE. The observations are used to verify a large number of sensitivity tests with focus on the TKE production of the wind farm parameterization (WFP) available in WRF.

The paper is well written and the test site, the observations and the numerical setup are described in a clear and understandable way. The analysis of the three cases demonstrates the importance to simulate the upstream boundary layer correctly, which was not the possible in the cases I and III probably due to the interaction between land and sea surfaces. The study is very helpful to optimize the use of the WFP in numerical simulations and shows possible room for improvement of this parameterization. I don't have any major comments and recommend minor revision for the submitted manuscript.

### Minor comments

1. Title: Is it necessary to show the WRF version in the caption (WRF 3.8.1)? I would let it out in the title.
2. P1L11: I think „deficit“ is missing and it should be: „... which in turn causes an underestimation of the wind speed deficit above the wind farm“.
3. P2L8: „...the wind speed reduction caused by the wind turbines upwind can be only balanced by the vertical momentum flux.“ I would omit this sentence, as it repeats the info given in the sentence before.
4. P2L22-L24: I think the two sentences are a little bit confusing. Can you rewrite them, maybe something like: „It is therefore necessary to evaluate TKE of mesoscale wind farm parameterizations with observed TKE over large offshore wind farms.“

5. P2L29: Are you only interested in TKE above wind farms or also in TKE behind them (downstream in the wake)?
6. P3L2: I would omit „version 3.8.1“ and add this info to section 2.3.
7. P3L5: „horizontal and vertical grid resolution“
8. P3L9 and P3L25: I think an article is missing: ...in the vicinity of the...
9. P5L9: Please add: Figure 4a) shows the 10m wind speed ...
10. P9 Table2: I don't understand the differences of the three control simulations CNTRa, CNTRb, CNTRc. Is it right that the setup of these runs is the same and they only difference is the case study (I, II and III). For me it's a little bit confusing to have these three control simulations and I would suggest to have just one CNTR setup in Table 2.
11. P10L4: I don't understand the explanation of „Warm air advection was associated with a stably stratified atmosphere according ...“ Normally, warm air advection is associated with an anticyclonic turning of the geostrophic wind with height (on the northern hemisphere turning to the right). Can you add one sentence here to explain in more detail where you can see that warm air advection occurred?
12. P10L6: Can you explain where the FINO1 tower is located or add it maybe in Fig. 1?
13. P11L13: Can you replace „the airborne measured TKE“ by „the observed TKE“?
14. P11L13: The sentence „The TKE over the wind farms MSO and ONO...“ is a little bit long and difficult to understand. Can you please simplify this sentence?
15. P13L13: I don't understand the explanation with the warm air advection. My explanation for the slight disagreement between WRF and the observation is that for case study I we are close to an approaching trough advecting cold air from northwest. It might be that the location of the trough is slightly shifted in the model and that we are located already in colder and different airmasses compared to the observations. This is, however, just a guess...
16. P17L11: Fig. 11 should be mentioned in the text before Fig. 12. You could add a hint to Fig. 11 the sentence „A summary of all sensitivity tests...“.
17. P18L1: Please add (see Fig. 12) at the end of the first sentence.
18. P20L3: Replace the number 80: „...the effect of the 80 vertical levels...“
19. P24L5: Please simplify the sentence „Given the results of this study, ...“, as it is difficult to read.
20. P24L8: „... difficulty in parameterizing...“

### Figure comments

1. Fig. 2: Please make a link to Table 2 in the caption in line 5: ... for the sensitivity studies: DX5, DX16, ... (see Table 2).

2. Fig. 8 and Fig. 10: I'm wondering, if it is possible to add an arrow in each panel, which indicates the mean wind direction along each flight leg. In leg AB the mean wind along the cross section is blowing from B to A, in leg CD from C to D and in leg EF from F to E (please correct me if this is not right). For leg CD it's maybe difficult as the leg seems to be nearly perpendicular to the approaching wind. I think such arrows could help to identify up- and downwind region of the wind farms. Anyway this is just a suggestion...
3. Fig. 7, 9, 11, 13: Is it possible to add the letters A, B, C, D, E, F which label the cross sections? I know that they are in Fig. 1, but it would help to see at a glance how the legs were oriented?