The paper analyses the perturbation of the atmospheric pressure field due to wind farms based on a linear, hydrostatic, two-layer model. Two scenarios are considered. The first scenario corresponds to a realistic case in which the atmosphere above the wind turbine layer is stably stratified. In this scenario, flow divergence in the wind turbine layer leads to a vertical displacement of the layer above and hence supports the formation of atmospheric gravity waves. The second scenario is the limit in which the stable stratification is so strong that the vertical displacement of the atmosphere above the wind turbine layer is zero so that the stratification effectively acts as a rigid lid. This second, asymptotic case is analyzed in depth to better understand the role, cause, and impact of the pressure field. For this case, the paper offers insight into how and why the atmospheric pressure field is perturbed by wind farms, and simple expressions for the pressure and velocity in the far field are derived. I believe the paper addresses an important aspect of wind farms that is not well understood, and the insights it presents could therefore potentially be very useful to the wind energy community. However, I miss a deeper discussion on how the findings of the rigid lid case translate back to the first realistic scenario. Moreover, while the theoretical analysis is sound, some intermediate steps and results need to be made more clear to better guide the reader. Please find a detailed list of comments and suggestions.

Main comments

1. At the end of the introduction I miss an outline of the paper. As no outline is presented, it is currently not clear how the paper is structured. This makes it harder to understand the relevance and significance of the paper.

2. The comparison of the case with atmospheric gravity waves versus a rigid lid scenario is also interesting in light of the two main approaches for large-eddy simulations of wind farms that can be found in the literature, i.e., either resolving the atmospheric boundary layer and part of the free atmosphere (which supports the formation of gravity waves) or using a pressure-driven boundary layer with a rigid lid condition. A short literature survey and a quantitative discussion on how different the two approaches are would therefore be useful.

3. The description of the model in section 2 is too limited. Part of the governing equations are in fact shown in section 3, so why not present them when introducing the model? Furthermore, on line 109 it is stated that "the pressure field p(x,y) is derived using the hydrostatic assumption," but it is not clear to me what is meant by this.

4. Sections 3-10 all seem to focus on the rigid lid case, but the link back to the realistic case is missing a bit. What do the conclusions for the rigid lid case mean for the more realistic case? How different are the results when the inversion is not a perfect rigid lid?

5. I have the impression that some of the theoretical results are in line with previous findings in the literature. For example, equation 25 shows that upstream flow blockage increases with farm width, and this has been found before (e.g. Allaerts & Meyers (2019). Same for the decay of the perturbation away from the farm (see eq 19 and 22), has this behavior been observed before (not sure myself)? It would be worthwhile to tie obtained results with what has been found before.

Specific comments

1. Line 19: "... the wind slowing by these farms ... . This issue has an extensive literature, ..." I find this statement about the wind slowing a bit vague. Do you refer to the upstream flow deceleration, the wind deficit behind individual turbines, slowing down of the atmospheric boundary layer above the wind farm? All of these? Please make this more clear.

2. Line 25: "In a stably stratified atmosphere, ..." I think this statement can be misleading for the reader. Gravity waves only form in regions where the flow is stably stratified, but you can get gravity waves also above neutral and unstable boundary layers. The statement could be misinterpreted as if gravity waves only occur when the atmospheric boundary layer is stably stratified (i.e. when the surface heat flux is negative).

3. Line 28: I believe the term used by Bleeg (and many others) is blockage rather than blocking.

4. Line 29: "... over the farm, it can fight back against the turbine drag, ... Finally, it alters the recovery of the wake." Have these effects been observed in the literature? Please cite relevant studies.

5. Line 33: "According to Gribben and Hawkes (2019), the local non-hydrostatic pressure disturbances decay inversely ..." Please clarify whether this result is for a single turbine or for a farm.

6. Line 34: "The farm-generated hydrostatic pressure disturbance is more far-reaching." What do you base this statement on? Evidence from literature (if so, add references), or is this based on your own findings (then say something like "as will be shown in this study, ...").

7. Line 43: Is there a specific reason why the model is limited to hydrostatic gravity waves?

8. Line 53: Specify what you mean by "wrapping"

9. Line 54: Please define "DAR" more clearly (I assume rotor disk area to covered surface area, where the latter is assumed to be $s_x s_y D^2$).

10. Line 86: "When N=0, the displacement approaches zero as 1/g' and when g'=0 it approaches zero as 1/N." This relationship would be more clear when plotted in a figure.

11. Improve caption of table 2. Currently, it is not clear what is listed and how some of the parameters are defined (e.g. for the definition of Gamma one needs to refer to the main text).

12. Line 109: "When this equation is solved for the perturbation wind, the scalar wind deficit is computed from ..." This transition is too fast, I needed to look up the definition in Smith (2022) to understand that the definition results from a linearization. Please explain more clearly how the scalar wind deficit is obtained.

13. Line 116: "Because the pressure field p(x,y) decays at infinity, it does not influence TD ..." Again, going a bit fast. The pressure term vanishes because of the divergence theorem and the fact that p decays at infinity, but for this you also need the continuity equation to go from $\mathbf{U} \cdot \nabla p$ to $\nabla \cdot \mathbf{U} p$.

14. Line 122: "In 2-D non-divergent flow ..." The assumption of non-divergent flow can be made because of the rigid lid case, or does this also hold in the GW case? Please clarify.

15. Figure 3: Why do you apply a low pass filter to (b)? What high-frequency content are you filtering out? Noise due to the low resolution?

16. Line 146: "The linearized Bernouilli equation ... is approximately valid upwind, ..." Upon what is this statement based? Did you check whether this approximation is valid?

17. Line 156: "The magnitude of this ratio increases with aspect ratio ..." Not clear to me why this would be the case. Did you try other aspect ratios?

18. Line 170: "... the wake decay length (L=U/C) ..." Is this wake decay length defined in literature? If not, it should be made clear why the wake decay length is defined like this.

19. Line 174: "In incompressible or non-divergent flow, ..." In the GW case, the flow is also incompressible, but flow divergence is allowed and leads to inversion displacement. Does that mean that the role of the pressure as you describe only holds for incompressible *and* non-divergent flow?

20. Line 281: "The stability values need to be an order of magnitude larger before the rigid lid approximation becomes quantitatively accurate." What criteria is this statement based on? When is the rigid lid approximation considered quantitatively accurate? This needs more explanation.

21. Line 296: "... including the change in ocean surface wind stress caused by turbine induced boundary layer turbulence." Not very clear, and also not sure why this is relevant (not discussed anywhere else in the paper).

Technical comments

1. Line 28: so call "Blocking" → so call*ed* "Block*age*" (see also earlier comment)

2. Table 2, entries for parameter A for cases g'=0.05, 0.1, and 0.2 with N=0: The value for A is exactly equal to zero. Is this correct or is this a typo?

3. Section 4 is missing?