Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2020-89-RC1, 2020

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Interactive comment on "The Alaiz Experiment: untangling multi-scale stratified flows over complex terrain" *by* Pedro Santos et al.

Anonymous Referee #1

Received and published: 23 August 2020

General comments:

I enjoyed reading the manuscript. It brings up very interesting flow situations from a modern measurement campaign. It is my impression that the scientists behind the study made a great effort compiling data from, and running, such an extensive campaign. In my judgement the study would be improved by clarifying the aim of the study; Is it to present the campaign? Is it to present important flow phenomena, and in that case, why are they important, and why were these two cases selected? Based on the aim of the study, the background could be improved by focusing on the previous research related to the aim. The basis of distinguishing the hydraulic jump from a lee wave could be strengthened, especially with the RASS showing semi-layered structure in the potential temperature. A linear stability analysis could potentially be useful. I

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Discussion paper

think the climatological consequences of the findings could be highlighted more. The assessment of the prevalence of conditions linked to hydraulic jump was interesting, and it would be valuable with something similar also for the layered flow.

Specific comments:

Abstract L. 2. Although not necessary, temporal information is also interesting.

Abstract l.4, perhaps path is better. The transect line over the valley is shorter than 10, so I guess you are referring to the whole path, which is a bit misrepresented with “line”.

Abstract l.4 For which of the cases, both? That is not clear at this point.

Abstract l.5. Here the reader does not yet know that you are referring to one of your two cases and that the reference to other cases is interesting in terms of similarity.

Abstract. L.9 Perhaps add something on why you think it is well captured by the lidars. So far the reader has only been introduced to the lidar measurements (no other measurements), which means that the flow disconnect could potentially be a measurement problem.

Introduction L1. Does this refer to climatological or time series? For climatological, what is the basis for saying 4 % is low? I understand it may be low compared to historical perspective, but in terms of economy it is perhaps not such a low uncertainty.

P1. L.15. Additional suitable references for this claim. For example Ayotte 2008 for micro scale models, recent work on validation for the NEWA model (perhaps Drenkämper 2020). In terms of analytical work there are also investigations into this by Finnigan and Belcher (2004), and perhaps also the original theory for flow over hill by Hunt.

P1. L.20 As far as I remember the cited literature does not give a summary of the available validation data. I do not so much argue with the claim, but I’m not convinced the cited literature really backs up the claim. In fact, due to the NEWA project, there are quite a few data-sets being produced, so perhaps new data-sets are not so rare

anymore. I do think the cited literature provides a good reference for the need of validation data.

P2. L.16. Please be specific when referring to new insights.

P2. L34 For sure, with such a steep a profile, a linear model is bound be somewhat inaccurate. However, as far as I remember, the performance of the non-linear models was not altogether convincing, which might also be worth mentioning.

P2. L34. As far as I recall, the Bechmann et al (2011) only used neutral conditions. Are you referring to Berg et al. (2011)? In that case variation in flow pattern or something similar might be better, since I don't think there were any flow model validation in that study, and hence errors might be misleading.

P4. L4. Is there a reference for the airborne laser scans?

P.5 L.16. I don't think only WLS70 is enough information to characterize the lidar. Consider also including the brand name.

P5 L.24 I suppose the availability of the WLS70 is also interesting if it is reported for the tower. Tower width and boom lengths are good to report in my view, as they provide good indication on flow distortion magnitude. Also, data acquisition rates and averaging periods are good to report here if they are not reported further down the text.

P6. L2. What type of sonic? And also same as above. Boom length and tower widths are potentially interesting.

P6. L.13. Reference for the RASS system is missing.

P7. L3. Consider moving this reference to the beginning of the instrumentation section.

P7 L10. Consider also mentioning what maximum dz difference this implies. On the other hand, I suppose also errors in the azimuth angle are interesting.

P8 L10. From this I take it you first average the radial wind speeds and then compute

horizontal vectors? This could be clarified in the beginning of the paragraph, as I suppose the option of calculating horizontal wind vectors and then averaging also exist. The earlier mentioning synchronization makes it a bit unclear.

P10 L6. "Can represent the wind climate" is perhaps a bit general. I see what the authors mean, but on the other hand even 8 years leave room for some uncertainty regarding the true wind climate (in terms of for example the true long term average wind speed). In terms of containing a representative set of meteorological conditions I agree with the authors.

P10 l.14 As in 20 % of the slopes higher than 16.7 %?

P10, final line: Which is defined here as. . .

P11 L11. The reference height of 10 m is rather low for the scales of this paper, I suppose? The scales in Berg et al (2011) were much smaller. This means the stratification at levels relevant to wind turbines will generally be much stronger, since those heights are a magnitude larger. I think it is useful also to use 10 m, but some discussion might be warranted. Did the authors try to use Ri number from the RASS to assess large scale stratification?

P11 L15. Are the wind speeds also at 10 m height? The same point as above could be made here as well. One could argue that for wind turbine applications the dependence of wind speed with stratification should be representative for turbine heights. Fig. 7 may give the impression that for higher wind speeds it is almost exclusively neutral conditions, while for wind turbine relevant heights the situation might be different.

Figure 7. Since the experiment was in Spain, it might be good to mention what time is referred to for the x-axis. Local (sun) time, local (Spain) time, or UTC? Why does NU come before U?

Figure 8. In my opinion the figure would be improved by adding confidence bounds and possibly lines connecting the dots. It would also be valuable to know the filtering

criteria for the averaging, or at least which period that is used.

P.11 L26 Move this to P13 l 10, or move what is there up here (what you use as reference temperature).

P13. L15. Reference for this statement? I rather thought of a hydraulic jump as a continuity phenomenon (including a transition to turbulence, linked to the lower velocity), with subsequent increase of potential energy. But I'm not that familiar with theory. I guess I object to that the atmosphere "wants" to recover potential energy.

Figure 9, and accompanying discussion. Do you have any criteria for distinguishing a hydraulic jump from a regular lee wave? The finite length of the low velocity region behind the jump in Fig. 9 (particularly in panel 2) makes it look to me also a bit like a wave (also the shape of the jet in panel 1).

Fig. 10. Confidence bounds (even if estimated) would help the argument made in the text (that the Froude number really decreases at MP5).

P15. L18. Horizontal scale?

Fig. 12. Did you identify the cause of the layers with reverse (negative) wind speed? It is interesting to me that they are on the downstream mountain side. Is it drainage currents from the mountain side?

P18 L5. I think in order to say that this study presents the Alaiz experiment, there should be more substance regarding the experimental details. Perhaps introduces is a better word. Also, I think focusing on the flow patterns is interesting enough.

Technical comments The tempus change throughout the text.

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