Long-term simulation of the boundary layer flow over the double-ridge site during the Perdigão 2017 field campaign

Reply to comments of anonymous referee #1 of manuscript acp-2018-997

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1 Introduction

We thank the anonymous referee for the comments and acknowledge his effort to improve our manuscript.

In the following, comments of the referee are marked with numbers and corresponding replies of the authors are written in bold and labeled with "⇒". In the manuscript we implemented a few new figures (e.g. Fig.4, Fig.7, Fig. 11, Fig. 15) to demonstrate differences in the model results due to different model resolutions (D1 to D3) and to confirm that the main driving mechanism for LLJs were thermally induced pressure gradients and not the inertial oscillation theory of Blackadar (1957). Changes in the new manuscript are written in bold.

2 Summary

Using a 49 days long WRF-LES simulation and experimental measurements, the work studies the flow during the intensive observation period of the Perdigão 2017 field campaign. The authors state that during most of the time the flow was thermally driven and used that to study the occurrence of low-level jets. The content is appropriate for ACP, is innovative and the conclusions relevant. It is well described and the results support the conclusions.

3 Comments

1. My major concern has to do with coupling WRF with large-eddy simulation in the smallest domain. I suppose no mechanism was used to generate fine-scale turbulence at the interface, which leads to small-scales having to be generated inside the domain. The dimensions of the domain and the topography may be sufficient for that, but I would like the authors to show some results supporting that the flow over the double-ridge developed realistic turbulence, such as the comparison of results related to the turbulent field in one of the towers (most likely, T20 or T29).

⇒ **Thank you very much for this comment. Yes, it's right that we did not use a mechanism to generate turbulent perturbations at the lateral edges of our LES-domain such as e.g. the cell-perturbation scheme described in Muñoz-Esparza et al. (2017). We agree that the application of such a method would probably reduce wind speeds of LLJs and could generally improve the model results. The method was, however, not implemented in our model set-up. The intention of our WRF run was not to compute realistic turbulent structures, which are comparable to tower measurements. Our focus was on the simulation of frequently observed daily flow patterns over the double-ridge and to describe their origin and the general meteorological situation during the campaign. In order to resolve the topography properly, a relatively high horizontal model grid resolution of 200 m was necessary. We know that this grid resolution is quite coarse and within the "grey zone" for a LES set-up. Nevertheless, we decided to run domain D3 in LES mode to be independent of a boundary layer parameterization. We used 10 minute values of tower data and set the temporal output interval of our WRF simulations to 10 minutes, respectively. We included this info in section 2 (L52-L57) and emphasized that our focus was not on turbulence characteristics in the conclusions. To illustrate that it is not possible to show realistic turbulence by means of 10 minute tower observations and 10 minute WRF LES data, a power spectrum for cross-valley wind at the location of tower T20 is shown in Fig. 1 (see below). The time resolution of 10 minutes is too coarse to resolve eddies within the inertial subrange. For lower frequencies observed and simulated power curves agree very well.**

2. Also, I think that it would be more convenient that Section 4, model verification, was placed before Section 3, where the results of the model are presented and discussed.

⇒ **We think that this is a good suggestion and rearranged the sections. After the introduction (section 1) and the model description (section 2) we give an overview of the meteorological situation (section 3). It is followed by the model verification (section 4) and a new section 5 about the LLJ-analysis is placed before the conclusions.**

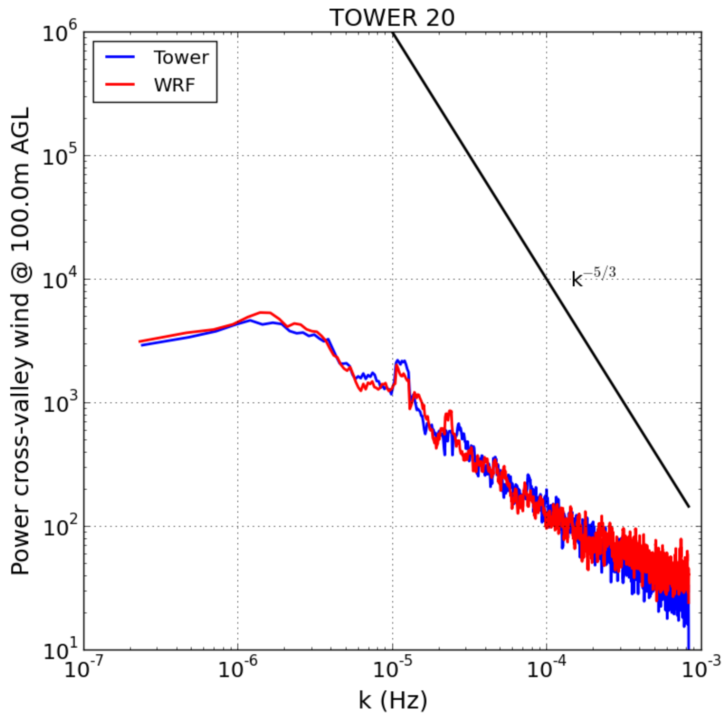

Figure 1: Spectra of cross-valley winds at 100 m AGL for observed and WRF D3 timeseries at tower T20.

3. Finally, a minor suggestion, is that the authors calculate the correlation between the WRF results and the measurements shown in Figs. 8 and 9 and use that to quantify the quality of the agreement, in the text around line 208.

⇒ **We computed correlation coefficients and RMSE-values for the three 100 m towers (T20, T25, T29) for all WRF domains D1 to D3. The values are shown in a new table 2 and the results are described in section 4 (L141-L151).**

4 Technical corrections

4. Line 249: Serra da Estrela is incorrectly written "Estrala"

⇒ **We corrected "Estrela" to "Estrala" in the text.**

References

Blackadar, A. K.: Boundary Layer Wind Maxima and Their Significance for the Growth of Nocturnal Inversions, Bull. Amer. Meteor. Soc., 38, 283–290, 1957.

Muñoz-Esparza, D., Lundquist, J. K., Sauer, J. A., Kosović, B., and Linn, R. R.: Coupled mesoscale-LES modeling of a diurnal cycle during the CWEX-13 field campaign: From weather to boundary-layer eddies, Journal of Advances in Modeling Earth Systems, 9, 1572–1594, doi:10.1002/2017MS000960, 2017.