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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of along-valley terrain heterogeneity on exchange processes over idealized valleys" *by* J. S. Wagner et al.

Anonymous Referee #2

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The manuscript "Influence of along-valley terrain heterogeneity on exchange processes over idealized valleys" by Wagner et al. presents a series of high-resolution numerical simulations to answer the question of how and how much valley geometries influence the transport of air masses originating over the adjacent plain into the valley atmosphere. Furthermore, subsequent exchange with the free troposphere is discussed. The applied numerical methods are sound and the manuscript is well organized and written and is easy to follow. My remaining concerns focus on the included trajectory analysis and a few minor motivating and more technical points. After these points have been dealt with the manuscript will be fit for publication in ACP.

Major comments:

There are two issues about the trajectory analysis which I would like to be addressed by the authors.

1) If I understand correctly your trajectories are computed based on the 10 minute (instantaneous?) WRF-ARW output fields and are not forced by additional (parameterized) turbulent motions. Which would mean that you are missing part of the non-resolved (temporal or spatial) turbulent mixing. However, in section 3.3 you are using the analysis of trajectory positions to discuss exchange between the PBL and the free troposphere. For this exchange I would think that the unresolved turbulence might still be of some importance. How do you justify neglecting it.

2) Your trajectories are initialized in the center of the domain in a relatively small box compared to the valley widths (ratio 0.2). How representative are these trajectories then for the total inflow into the valley? Wouldn't a wider box make more sense, in order to cover most of the inflow? This problem seems to be most obvious when looking at the wide valley geometries (W40N, W40NI) where basically all current trajectories remain in the valley atmosphere and don't make it up the slopes. Personally I think that this leads to the wrong conclusion in the following that for these valley geometries no vertical export takes place. I agree it might be smaller than in the narrow valley cases but it will still be present along the slopes, but is simply missed by the current trajectory approach. I would encourage that you either repeat the trajectory calculations with a wider release box or that you discuss the limitations of the current approach in more detail.

Minor comments:

P417: In the introduction you motivate why there might be a need for a vertical exchange parameterization in complex terrain for common NWPs. However, present (even operational) NWPs are getting closer to the 1 km margin and are already able to resolve even more narrow valleys. Will there still be a need for a parameterization and will we get the parameterization before computational improvements allow kilometer

scale operational simulations? There will always be a remaining unresolved sub-grid orography contribution, but does this still need a parameterization considering the large number of influence factors and unknowns?

P417: Is there additional evidence that tilting and narrowing valley are the more realistic valley geometries compared to homogeneous along-valley geometries. Some examples are given later on page 421. But this information would be useful as motivation as well.

P417: Can you summarize some more details on previous findings using homogeneous along-valley geometries. Especially concerning important influence parameters like stability, ridge height, etc. that are not discussed in this study. Then in the discussion: Is it possible to put your results more into context with these previous studies? Basically trying to answer a question like: What are the most important influence factors that a parameterization will need to consider: tilting valleys, ridge height, stability, etc. ?

P418: It is not exactly clear if WRF was used in LES mode or not. Only the mentioning of the LES simulations in the author's previous works suggests the use of the LES mode.

Figure 4: It is very difficult to distinguish the different isolines of potential temperature and along-valley wind speed. I suggest to omit the latter since it is displayed in more detail in Figure 5 as well. Also it is not explained in the caption what the arrows, which are barely visible, illustrate.

Figure 6-9, 13, 14: Again, it is very difficult to distinguish all the line plots for all the different sensitivity runs. The use of different colors instead of line type and thickness would largely improve these figures.

Technical comments:

P18L22: "Extention" should be "extent".

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 415, 2015.