Influence of along-valley terrain heterogeneity on exchange processes over idealized valleys

Reply to Reviewers' Comments
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1 Introduction

We thank both referees and the editor and acknowledge their efforts to improve our manuscript. After a thorough study of their comments we tried to include all aspects as far as possible. We revised the upvalley wind and mass flux analysis and recalculated the trajectories. Changes in the text are written in red colour in the manuscript.

In the following, comments of the reviewers are written in italic type and marked with numbers. Corresponding replies of the authors are labeled with "$\Rightarrow$".

2 Comments of Referee #1

General evaluation

> *The authors present idealized simulations dealing with the dependence of thermally driven valley winds on various aspects of the valley geometry. The study is interesting and provides new scientific results, is technically well done (with some exceptions mentioned below) and is presented in a far-above-average writing style. I therefore recommend acceptance for publication subject to minor revisions.*

Major comments

1. *The literature review is rather incomplete, giving the wrong impression that there has been no scientific work on valley winds before 2000. In fact, there have been a lot of important*

studies on valley winds in the 1980's and 1990's, e.g. by Egger and Whiteman. At least a few seminal papers should be mentioned and put into context with more recent work.

⇒ We agree and included additional citations (L26-31).

2. *At the end of the introduction, it does not become sufficiently clear which aspects of the present work are entirely new and/or an extension of previous work. This is certainly not the first idealized study addressing the impact of a sloping valley floor or a varying valley cross-section on the thermal valley wind circulation.*

⇒ We cited already existing idealised modelling studies and clarified the new aspects of this investigation (L75-82).

3. *This work is one of many idealized process studies being motivated by the need of improving the physics parameterizations of our numerical models without sufficiently addressing this issue later in the discussion and/or the conclusions. In their concluding sentence, the authors just state "Future boundary layer parameterization schemes ... should consider these valley geometry parameters besides other effects ...". Well ... how is this supposed to work in practice, in particular at model resolutions nowadays used for regional weather forecasting, which marginally resolve large valleys, like e.g. the Inn Valley, and heavily under-resolve smaller tributaries? What actually would need to be parameterized is the difference between the thermal circulation the model produces at its operational resolution and the circulation it produces at a much higher resolution representing the orography reasonably accurate. No one knows if this is possible in a generic way. Some more substantiated thoughts on this issue would be very welcome.*

⇒ Thanks for this comment - we have added some thoughts at the end of the conclusion (L702-715).

Minor comments

1. *p. 424, ln 27: The way by which the contribution of various parameters of the model orography to the valley wind intensity is computed is a bit confusing. Intuitively, I would say that 2.62*REF / 1.62*REF yields a factor of about 1.6, rather than taking 262%-162% (or 162%-62% after subtracting REF) to obtain 100% or a factor of 2.*

⇒ We agree and changed the corresponding paragraph and the numbers in the text (L331-L356).

2. *p. 425, top: The authors report that a wide valley forces substantially weaker valley winds than a narrower valley (comparison REF-W30) and argue that this is because of the smaller fractional volume reduction. While the volume effect is likely the most important reason, I think that the depth/width ratio of the valley also plays a role. What happens when widening the valley and the mountain ridge in between by the same factor (by enlarging the model domain)?*

⇒ Indeed the valley volume effect is the most important reason for weak upvalley winds in wide valleys. We think that enlarging the mountain ridges to plateau-like crests will have an impact on the valley flow (see e.g., Schmidli and Rotunno 2012). In our opinion the introduction of such an additional topography would, however, go beyond the scope of this study.

3. *p. 425, ln. 7: "overestimation" ⇒ "discrepancy"*

⇒ We removed this sentence.

4. *p. 432, ln. 14: Bad wording. Suggestion: "Simulations with inclined valley floors reveal a significant increase of ..."*

⇒ We changed this sentence (L633-L634)

5. *Fig. 2: Please indicate the contour interval in the caption.*

⇒ We added the contour interval in the caption.

6. *Fig. 4: Please use the same θ contour interval in all panels and indicate it in the caption. Moreover, the thick contour lines for along-valley wind speed are barely visible. My suggestion would be to make them green, and to use violet or purple for the present green dashed line.*

⇒ We were using the same intervals in all figures and it seems that there have been technical problems, when including them in the document. We added the contour interval information in the caption, changed the line colour for upvalley wind contours to magenta and removed the arrows.

7. *Fig. 5: Please use the same θ contour interval in all panels and indicate it in the caption.*

⇒ The θ contour intervals are equal in all figures now and we added the contour interval information in the caption.

8. *Fig. 6, 7, 8, 9, 13, 14: The lines are difficult to distinguish. At least, SL should be dash-dotted in order to be clearly distinguishable from Ixxx.*

⇒ We agree and use coloured lines in the corresponding figures now.

9. *In addition, Figs. 4, 5, 9 and 10 should be enlarged. In particular Fig. 9.*

⇒ We tried to enlarge the figures in the pdf document.

References

Schmidli, J. and R. Rotunno, 2012: Influence of the valley surroundings on valley wind dynamics. *J. Atmos. Sci.*, **69**, 561–577, doi:http://dx.doi.org/10.1175/JAS-D-11-0129.1.