

# Review of “On the descent of Alpine south foehn“ by Jansing, Papritz and Sprenger

The authors present a climatological study of where along the Alpine ridge foehn descent occurs in high resolution model simulations. They present a novel Lagrangian diagnostic to identify foehn descent and thermodynamic history of foehn parcels during descent (temperature and specific humidity). Further, they discuss present a more detailed analysis of foehn descent for two case-studies centered at the Rätikon.

The paper is mostly well structured and clearly written. If the comments below are addressed, I am recommending the paper to be published.

## Major issue

1. In the abstract the authors claim to investigate the descent process “with unprecedented detail“. Indeed their study identifies foehn descent in a more spatio-temporally extensive data-set than previously, but there is no detailed analysis of the physical processes resulting in the downward motion of the air parcels. Discussion of the physical processes is limited to inference from a few cross-sections for two case-studies. Given the simulation data that they have, it would be very interesting to try and quantify the causes of downward acceleration of air parcels (buoyancy, vertical pressure gradient, ...). They allude to this possibility in the conclusion, which is fine and I would encourage to highlight this even more. Indeed the paper would benefit from a more detailed physical analysis, but at least the abstract needs to be modified to accurately represent the contents of the paper.
2. The section of the introduction starting at p. 4, l.121 is not very well structured and open research questions could be stated more explicitly. Please consider rewriting.
3. Potential model issues in the representation of descent, e.g. potential issues of the turbulence scheme over complex terrain, need to be discussed in a more structured and prominent location (e.g. section in the conclusion / discussion). Hints at potential modeling problems are found throughout the manuscript, but it is failed to present them in structured manner and a discussion of their potential impacts on the results is missing.

## Minor issues

1. p. 2, l. 42: Why would foehn flows ignite forest fires? I would rather expect they are produce atmospheric conditions, that are more conducive to igniting fires.
2. p. 2, l. 60: “foehn wall might inherit a key role for the downward acceleration“: I do not understand this sentence: What is inherited and by what?
3. Section 2.1: in addition to the height of the lowest model level, it would be interesting to state the average vertical grid spacing in the valleys, e.g. the lowest 2 km.
4. Fig. 3: Would be interesting to see the distribution of foehn trajectories passing the locations of descent. I.e. is the distribution mirroring more frequent foehn events / large mass flux, e.g. along the Rhine valley and what is the percentage of foehn air parcels that descent in the specific regions.
5. p. 11, l. 274: „gravity waves [...] force descending motion of air parcels“: The Lagrangian diagnostic are just another perspective of the Eulerian velocity fields and vice-versa. So it cannot be claimed from the evidence presented that gravity waves force descent of air parcels. Descending air parcels in some sense constitute the downward motion in the Eulerian perspective. Maybe a better wording instead of „force“ would be „associated“. Similar statements are made e.g. on p. 13 l. 321 and in a few other places, and also need modification.
6. p. 12, l. 311: „exact relation“: Given the scatter in the data, I do not agree that this is an exact relation.
7. p. 16, l. 349: „and especially the cause for its formation“: I would suggest to drop this statement. The following section does not provide any evidence for why a hotspot should form in particular behind the Rätikon and not other topographic features / locations along the Alpine chain.
8. p. 17, l. 366 ff: I would suggest to first discuss the general characteristics of the foehn event before providing details on the time instances discussed afterwards to reduce repetition.
9. p. 27, l. 548: „constrains“: I am not quite sure what you want to say here. Local terrain determines regions of descent / is anchoring regions of descent?

10. p. 27, l. 551ff: Given the evidence (in the paper and the more general foehn literature), it would be more accurate to state that the elevation difference is an upper limit to the foehn descent and that (at least) in the model this is often (though not always - maybe you can even quantify how often) realized.

#### **Technical / language issues**

1. p. 1, l. 7: „thereby“ seems to be inadequate here, please modify.
2. p. 5, l. 153: „grid resolution“ -> „grid spacing“?
3. p. 5, l. 158: „recent **modeling** studies“
4. p.7, l. 198: „accordingly“ seems to be inadequate here, please modify.
5. p. 8, l. 207: „compiled“ > „computed“
6. p. 14, l. 326: „thereby“ seems to be inadequate here, please modify.
7. p. 17, l. 355: „thereby“ seems to be inadequate here, please modify.
8. p. 17, l. 360: please clarify whether the referred date of foehn break-through is identified in observations or model data (and if the former what observations and with what method). Reference to an older paper is not adequate.
- 9.