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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Downslope föhn winds over the Antarctic Peninsula and their effect on the Larsen Ice Shelves" *by* D. P. Grosvenor et al.

Anonymous Referee #1

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1 General comments

In the article the authors describe an observed strong foehn case over the Antarctic Peninsula in January 2006 and compare it to a WRF-simulation of the same case. In general a good correspondence between the WRF-simulation, aircraft and surface station data is found. Besides a discussion of foehn dynamics, the authors estimate the influence of this particular foehn event on melting of the ice shelf by evaluating the different terms in the surface energy balance.
I think the detailed analysis of the dynamics as well as the influence on surface melting is an interesting contribution to the existing literature on foehn flows over the Antarctic Peninsula. The observation of strong foehn jets, reminiscent of gap flows, sheds

new light on the foehn air flow over the Antarctic Peninsula in blocked situations and illustrates the added value of high resolution modeling in areas of complex terrain.
The points that should be improved before final publication include a discussion of potential effects of the chosen parametrization of surface and boundary layer processes on the energy budget at the surface and a better structuring of the meteorology section. If these issues are adressed in a revised version, I recommend publication.

2 Specific comments

Data and Methods

1. In section 2.1 more details on the flight path and date should be given. These issues are detailed later on in section 3, but for clarity and better reference a full description here would be nicer.

2. In section 2.2 the parametrization schemes used for the WRF-simulations should be named, as particularly the turbulence and surface flux parametrization may have some impact on the results. In addition it should be detailed which observations were used for nudging, as the time shift between the observations and the simulation is important for the latter discussion.

The thermodynamics and meteorology of the foehn flow

This section is really lengthy and the readability could be much improved by shortening and sharpening the argumentation. Particularly in section 3.2 to 3.5 several issues are discussed multiple times. A potential remedy would be merging several sections (some observations like the time shift between observations and simulation are made several times) or reordering some subsection, as particularly the last subsection (3.6.1 and

3.6.2) pertain mostly to the synoptic scale conditions discussed at the very beginning of the section 3. Also the AWS is at the location of the flight leg A-L1 and therefore the two sections discussing both measurements could benefit from combining them. I would suggest first discussing the large-scale flow evolution including the upstream conditions in the model and the observations (currently sections 3.1, 3.6.1 and 3.6.2), then describing the foehn jets and their evolution in the model and the observations and finally concluding the section with a discussion of foehn dynamics (currently section 3.6).
For the discussion of flow patterns at higher and lower levels (300 m and 10 m) vertical cross sections perpendicular to the jet axis would help to connect the different levels (in addition to the 1D profiles you show for the comparison to aircraft ascent and descent). The description of the flight path and the location of the measurements should be moved to the "Data and Methods" section.
Some further comments:

1. **3.2** On page 5780 the potential impact of latent heating on föhn flow is mentioned. Are there any observations that indicate precipitation and / or cloud formation on the windward side of the AP?

2. **3.4.1** You state that the modeled jets extend to the measurement location, which contradicts statements later on in the article.

3. It is several times stated that the flow at 10 meters is decoupled from the flow at 300 meters and that the first is essentially influenced by the surface pressure distribution, while the one at 300 meters is less. You should shortly summarize the dynamical reason for this. Probably a cross-section perpendicular to the jet axis would also help.

4. The time shift of the model simulation to the real world may be more easily identified by comparing the upper level aircraft data to the model wind field at the same

time and elevation. This would also support the argumentation that the time shift is due to the analysis.

5. **3.6.2** It is known that the moisture content has implications for blocking (e. g. Miglietta and Buzzi, 2001). It would be interesting to investigate whether there is a change in the upstream moisture content during 6 January in the model which could lead to a change in the blocking behavior. The rapid change of the wind speed, which is hypothesized to have a major impact is observed at 1 km altitude and therefore still in the blocked air mass (before and after the cessation of the jets).

6. The flow behavior here is different from the one described by Orr et al. (2008) for blocked flow. It would be nice to include a paragraph discussing the differences (in upstream conditions) between their case and yours and speculate on the reasons for the different behavior.

The effects of the föhn jets on surface melting and the surface energy budget of the Larsen Ice Shelves

1. One of the main statements is that reduced cloud cover due to the foehn air drying is one major reason for enhanced melting. However, there is no figure illustrating the dryness of the air. Are there any measurements of cloud cover or relative humidity from the AWS or even a satellite picture to illustrate this? Alternatively also WRF model output could be used to this end.

2. The WRF model estimates for ground heat flux, the sensible and latent heat flux might be dependent on the chosen parametrization of boundary layer, turbulence and surface processes and the involved assumptions. Could you add a section where you discuss this issue and the quality of the parameterizations over ice / snow covered surfaces?

3 Technical corrections

1. page 5776, line 3: “described by **King et al. (2008)**”
2. page 5776, line 18: Leave out the first part of the sentence (or detail instead which vertical coordinate system is used by the model). In the second part the “increase with height” should be replaced by “decrease with height”, if the vertical resolution is ment.
3. page 5776, line 20: “where it remained **constant** throughout ...” (?)
4. page 5777, line 14: “by circumpolar flow”
5. page 5777, line 15: “(05:00 UTC on 5 January **2006**)”
6. page 5778, line 6: AP should be defined somewhere before
7. page 5778, line 20: “with **this** system” unclear reference
8. page 5780, line 4: “descent of dry air that orginiated”
9. page 5780, line 12: “but above (between 600 and 2000 m) the wind had roated”
10. page 5781, line 12: “föhn flow [...]” replace by “föhn onset occured before 00 UTC on 5 January”
11. page 5781, line 23: “At 09:00 UTC (Fig. 7a) three main jet formed, which extended eastwards”
12. page 5782, line 21: “evolved **such** that”
13. page 5784, line 24: “this is likely due to”
14. page 5784, line 25: “compared to 12:00 UTC”

15. page 5785, lines 7-12: Split this sentence it is fairly long and therefore difficult to understand.
16. page 5785, line 20: Hardly visible in Fig. 7d due to the chosen color
17. page 5787, line 4: Add reference to section in the last sentence.
18. page 5788, line 8/9: “The **eastward shift** of the small low pressure system [...] **may be** related to the”
19. page 5789, line 22: “on the other side” unclear reference
20. page 5791, line 10: “vertical cross sections **along** the black line in Fig.7”
21. page 5791, line 12: “horizontal windspeed perpendicular to”
22. page 5791, line 14: “hereafter **be** denoted as”
23. page 5791, line 15: “the **cross section** passes through”
24. page 5792, line 22: “Thus **strong** low level blocking [...] observed **in** the simulation”
25. page 5793, line 4-8: Split up this sentence!
26. page 5793, line 15: Why SS87 for Smith (1989)?
27. page 5796, line 3: “within the region of low U followed”
28. page 5797, line 12: increase in h is almost not visible from the graphic
29. page 5797, line 23: “it was associated with”
30. page 5799, line 25: Reference for “similarly”?

31. page 5802, line 11: remove “which are explained shortly”
32. page 5803, line 9: “**second largest term**”
33. page 5803, line 15: “the ice shelf surface **temperature**”
34. page 5804, line 10: “at the southern **model domain boundary**”
35. page 5805, line 11 f: “this trend **is** / **maybe is** mainly driven [...] which is most likely due to”
36. page 5806, line 23 f: “The pattern is strongly anticorrelated ...” Please reformulate this sentence. You are refering to the air content pattern, but it could be misinterpreted to refer to the snow melt pattern.
37. page 5807, line 1: “spatial patter**n**”
38. page 5807, line 5: “might **contribute** to the differences”

4 References

Miglietta, M. M., and A. Buzzi, 2001: A numerical study of moist stratified flows over isolated topography. Tellus, 53A, 1025-1040.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 5771, 2014.