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## ***Interactive comment on “Seasonal controls on snow distribution and aerial ablation at the snow-patch and landscape scales, McMurdo Dry Valleys, Antarctica” by J. W. Eveland et al.***

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### Overview

The authors present an interesting dataset on snow extent in the Dry Valleys, Antarctica. Snow distribution seems to have important implications of the ecology of the Dry Valleys, which makes this manuscript relevant for the cryospheric community.

It is, however, not clear how the main conclusions of this paper (e.g. that snow patches form at the same locations every year) are different from existing literature on that topic (e.g. Erickson et al. (2005); Deems et al. (2008); Schirmer et al. (2011) and references

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Discussion Paper



therein). A more detailed study of the "microtopographic influences over snow depth and exposure", as mentioned in the abstract would greatly improve this paper and give it a new focus besides what is already known. Based on the high resolution of the data and the relatively high resolution of the digital elevation model, there is great opportunity to look at some topographical factors as for example curvature or "shelter and exposure" (Winstral et al., 2002; Schirmer et al., 2011) and discuss them in the context of Dry Valleys. My major comments are summarized in the below and followed by more detailed line comments.

### General comments

- Comment 1: The word "seasonal" and "seasonality" seems to be used incorrectly and is therefore misleading throughout this manuscript. The authors are actually not looking at seasonal variability, but rather at inter-annual variability. Seasonality usually has to do with differences between seasons and not with comparisons of the same season. This should be changed in the manuscript, because it is misleading.
- Comment 2: Looking at two summer seasons does not seem to be enough data to be talking about "inter-annual" variability, as is done in this manuscript. The authors might want to change the focus and rather discuss the spatial patterns in more detail.
- Comment 3: The different scales are a bit confusing. The "landscape scale" should be renamed "regional scale". The snow-patch scale (1 km<sup>2</sup>?) should be renamed "local scale". There also seem to be a third scale, which is also called snow-patch scale (and also has 15 different snow-patches, as does the 1 km<sup>2</sup> scale (e.g. Fig. 3)) and it is now always clear, which snow-patch scale is being discussed. This should be clarified.

Interactive  
Comment

- Comment 4: It is surprising that the authors discuss topographical influence without mentioning the curvature, despite emphasizing how important those features are (sheltered spots). I recommend that they should try to correlate the locations of the snow-patches to curvature or "shelter and exposure", which would be a large contribution to this manuscript.
- Comment 5: The citation of relevant literature in this manuscript is poor. The authors seem to be unaware of the large body of literature that has been done outside of the Dry Valleys on snow distribution, on how snow distribution effects on vegetation, and on the ablation of patchy snow. For a start, the authors should consider following publications and references therein: Pomeroy and Gray (1995); Liston (1995); Liston and Sturm (2002); Winstral et al. (2002); Essery and Pomeroy (2004); Erickson et al. (2005); Deems et al. (2008); Gruenewald et al. (2010); Schirmer et al. (2011); Mott et al. (2012).
- Comment 5: It is not clear what the reason was for the ablation modeling, which is a bit lost in the manuscript. It seems that the conclusions that the authors get from the modeling is that it "shows the same temporal trends" is quite obvious, because the snow cover as well as SWE will decrease during the summer season. I am not sure what additional information is gained from the model. The authors might want to consider either taking the modeling out of the paper or discussing it in more detail, so it is actually supportive for their findings.
- Comment 6: The manuscript needs generally more references to Figures, particularly in the Results and Discussion sections.

## Line comments

- P3824, L7: "aeolian redistribution" is usually referred to as "wind transport" in snow literature. Change "... topographic lees along valley bottoms" to "topographic lees and along valley bottoms..."

C2202

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Comment

- P3824, L10: Change "spatial and temporal dynamics" to "spatial and temporal distribution".
- P3825, L10: delete "very".
- P3825, L11–26: There is quite a bit of repetition in these two paragraphs, and they should be rewritten in a more concise way. E.g. 1) argument of thermal insulation on L18 and on L26, 2) influence of meltwater on biology on L13, L23 and L28.
- 3856, L16: example for "inappropriate " use of "seasonally" in "...understanding the temporal dynamics of ablation seasonally...". It should either be "...understanding the temporal dynamics of ablation during the ablation season..." or "...understanding the difference in temporal evolution of ablation between two different ablation seasons...".
- P3827, L10: I assume that "nivation hollows" can also be described as "concave areas", in which case they would be easily identified using digital elevation models. Including such an analysis would be a useful addition for this manuscript.
- P3827, L17–19: "With respect, ..., underlying topography": This sentence is lacking proper references that have discussed snow distribution with regard to topography before 2012. See Comment 5 in "General comments" for more details and possible citations.
- P3827, L19–21: "This implies, ..., landscape scale": This sentence is not clear and conflicts with the sentence that follows. Please rewrite.
- P3827, L26–28: There are many studies that link elevation to ablation that should be cited here.
- P3828, L14: A short summary of the method should be given here, additional to the reference.

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Interactive  
Comment

- P3829, L3: Change "dynamics" to "temporal evolution of the extent of individual snow patches".
- P3829, L17: Change "snow" to "temporal and spatial evolution of snow patches".
- P3829, L18: What does "explicit basis" mean? You might want to consider removing it.
- P3829, L27: Please quantify "fine enough".
- P3830, L5: "greater accumulation" should be replaced with "greater spatial snow cover", because there is no information on how big the accumulation is (due to lack of snow depth/ density information).
- P3830, L6: "and the dates ..." is a repetition from L2 and can be removed.
- P3831: See also Comment 3 in "General comments": the third scale is somewhat confusing. The plot area sometimes referred as the "snow-patch scale", as in Figure 3. But there seems to be the scale that talks about 15 different snow patches (L15), which is also somehow the snow-patch scale. This should be clarified. Also how were those latter snow patches chosen (L15) to be representative of the region? It would seem to be quite hard to pick a "representative" patch.
- P3831, L21 – P3832, L6: It is not clear how this analysis is done and the sentences seem to be very complicated.
- P3832, L14: Change "times series" to "time series".
- P3832, L13–15: "For both seasons, ..., the season": I had to read this sentence multiple times to understand what it means. It should be rewritten in a simpler way, e.g. "The aerial ablation rates from both seasons were calculated using the time series of snow-covered area".

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- P3832, L21: Two years are not enough to be talking about "trends".
- P3832, L27–28: Please specify what the characteristics are for the 5 regions, how they were determined, and subsequently what the characteristics of the 5 modeled snow patches are.
- P3833, L6–7: The assumption that the snow temperature is equal to air temperature is not necessary correct and the implications of this assumption should be briefly discussed.
- P3833, L13: "generally held belief" need to be referenced.
- P3834, L8: Why was the 2009–2010 snow covered area used as a baseline here, when all other calculations (Eq. 1–3) use 2010–2011 as baseline?
- P3834, L11: It is not clear to me why you assume that most snow patches in 2010 have ablated by the time the first images were taken. Why could it not be that the snow never accumulated in that season? Please explain.
- P3834, L25: I do not understand the sentence "The modes of the distribution, ..., single season".
- P3836, L4–5: "Temporal changes, ..., landscape scale". This sentence/ conclusion seems a bit obvious in the ablation season, because the snow usually ablates at all scales, so the trend will always be the same. There is no reason to assume that the snow at the local scale will not ablate while the snow at regional scale does, because once ablation occurs at large scale it is obvious that this ablation reflects the ablation at the small scale. I am therefore not sure what the point of that conclusion is. It might need to be rephrased.
- P3836, L27–28: "There is clearly, ..., distance from the sea.": Assuming that the scale "Along-valley distance" in Fig. 10a means that a distance of zero is the

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- distance from the sea, this sentence does not make sense, because the snow-covered area is decreasing along-valley distance. Please either correct or clarify.
- P3838, L25: Please specify "milder".
  - P3839: See also Comment 5 in "General comments".
  - P3840, L20–21: "shallow snow patches have been observed to ablate faster.": I assume "ablate faster" refers to "aerial ablation", in which case this sentence is redundant, as it is quite clear that a shallower snow patch will disappear faster than a deeper snow patch. I might be misunderstanding the sentence, in which case it needs to be rewritten and clarified.
  - P3842, 5–7: Please see suggestion of references (Comment 5), which have come up with identical conclusions.
  - P3843, 5–9: I do not follow the argument that similar temporal trends (increasing ablation (SWE and areal) during ablation season) leads to the conclusion that the snow-covered area is proportional to the mass of ablated snow. E.g. If the snow consisted of deep snow patches, then the area would be losing mass but there would be no aerial ablation.
  - Figure 5, caption: Does "smoothed over weekly timescales" mean using a running mean over 7 days?
  - Figure 6 A: What are "total snow patches". Is that all available data? Please define.
  - Figure 10, caption: There is no location in this caption.

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