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The Cryosphere
Discussions

Interactive comment on "Summer valley-floor snowfall in Taylor Valley, Antarctica from 1995–2017" *by* Madeline E. Myers et al.

Anonymous Referee #2

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This paper addresses an important subject of the temporal and spatial patterns of snowfall in a polar desert in Antarctica, with implications for assessing climate change and relevance to local ecosystem processes. The paper essentially updates and expands the record of snowfall in Taylor Valley. It is a worthy effort and they add a new measure - persistence of snow cover.

While I heartedly endorse the publication of the report, it has many important flaws that need to be corrected. Overall, the science is fine, but the writing needs major major improvement, as indicated by my extensive comments below.

In short, the entire manuscript has to be rewritten paying close attention to grammar, flow, and definitions. A number of broader issues stand out.

1. Precipitation and snowfall are used interchangeably. No rain falls in this region so why not just use snowfall? By including both words, sometimes in the same sentence, the reader gets the impression that rain is ignored.

2. Some care should be taken to distinguish between snowfall and snow accumulation because they are different. Also snow cover is a bit ambiguous and is typically used to refer to snow at a point rather than across a landscape, except at the end of the report then its used to mean the latter. I think the use of snow cover can be avoided except for meaning across a landscape.

3. Often the authors refer to snowfall volume, yet they use one dimensional units of cm. Normal practice is to refer to precipitation amounts as depth in mm or cm. I suppose the authors could refer to specific volume, which also has units of mm or cm, but why complicate things. Unless they want to calculate volume of snow in a watershed, I'd stick with depth.

4. One important issue that is glossed over is uncertainty. If the data are compared then uncertainty needs to be included or the comparison has no context. Assessment of uncertainty, of both snowfall depth and duration, should be addressed in a separate paragraph.

5. Finally, I have a problem with the notion that one station can predict the snowfall at another station the following season. Do the authors think there is a teleconnection extending the 10-20 km between stations? By what physical process explains this phenomenon. Why aren't other station pairs predictors? How well are the stations correlated? How are we to know that this predicator is not a spurious correlation?

Detailed comments

Line Comment

4 This is only part of the reason. The other part is the strong rain shadow exerted by the TransAntarctic Mountains. See, Monaghan AJ, Bromwich DH, Powers JG and

Manning KW (2005) The Climate of the McMurdo, Antarctica, Region as Represented by One Year of Forecasts from the Antarctic Mesoscale Prediction System*. Journal of Climate 18(8), 1174–1189 and see, Fountain et al., 2010

22 This reference is for sea ice, a more local refence, highlighting the effects on runoff from glaciers in the Dry Valleys, including the energy balance causes, is needed

Page 3

7 A more apt citation here, based on the physics of energy balance is Hoffman et al., 2016, already included in the reference list.

29 "They excluded. . .." It is not clear whether this study also excluded windy events or not.

Page 4

1 Abrupt and confusing transition from automatic measurements to a brief study of snow? It is unclear what you are trying to measure, not density, that is assumed to be 83 kg/m3, but then density was measured. Please clarify

9 "with Winter excluded for the same reason" Same as what? "Spring begins with first light. . ." When is that?

10 "ends with final sunset" When is that? "Dates coincide with statistically distinct climate conditions" Climate is a very broad umbrella, which conditions, specifically?

21 'Instrumental' rather than "meteorological"?

29 Why Commonwealth Glacier rather than Canada Glacier, which is adjacent to Lake Hoare? And why stake 23>

Page 5

5 "Precipitation". Is this a better descriptor or is snowfall? There is no rain and all precipitation is snow, so should the general term be used? I think not, it has a vagueness

to it that is unnecessary.

7 "Again"? When was it focused previously? Also considering that the seasons are partly defined by first and last light, if I understand the methods correctly, why is a 'light season' necessary? It's confusing. Also, this sentence underscores the confusing issue between precipitation and snowfall. Here you, 'focus on snow. . .', but the subheading is about precipitation, so the inference is rain is being ignored.

13 2007? Does this coincide with the results of Obryk on temporal break points?

18 This sentence doesn't seem logically connected. How is seasonal variability connected with differences in atmospheric influences? What influences are being considered?

20 "spatial control" or spatial difference? Controls at this point in Results are unknown, but differences are known.

21 You don't really mean 'volumes' right? Then it begs the question over what area are you measuring the volume. For precipitation, depth is the normal dimension used. Furthermore, the units of mm w.e. are not volume but a linear distance, so the dimensions of volume are wrong. Also, are these values averages? Please clarify. If yes, what is the standard deviation?

23 If a third of w.e. snow occurs in spring and another third occurs in autumn (two-thirds, not 'totaling over half', then one-third occurs in summer. If this is right, it doesn't square with the measurements at either the coastal or inland stations. Or am I confused?

25 "Bias". This brings up a couple of good points. First, do the authors mean 'bias' as in the measurements tend to be too high or too low? Second, do the authors mean 'uncertainty'. Considering they are comparing values, to make the comparison meaningful, they need to report uncertainty.

27 Looks like HOEM has a consistently lower seasonality than BOYM. Or is my inter-

pretation due to missing data?

28 Revise, “where Summer precipitation (9.5 mm w.e.) is nearly” to “when Summer. . ..was nearly”.

29 Again, another example of precipitation vs snowfall, “Low average precipitation and the occurrence of large snow events”. So little rain and large snowfall?

Page 6

1 Looks to me that EXEM has the greatest variability, not FRLM. Is that due to missing data at FRLM? It looks like prior to 2003 FRLM received no snowfall.

6 “stations are not predictors”. I assume the authors do not mean the stations are correlated because in the following sentence Spring snowfall at FRLM predicts high summer snowfall at BOYM. I would have thought that a correlation matrix between stations would be included or perhaps referred to in supplementary data to support the notion that the station snowfall is not correlated between stations (is this right?). There is no physical reason for one station to predict snowfall at a later date at another station, unless it does so at the same station. Given the stations are only few km apart the prediction is not based on the movement of air mass systems or a teleconnection. Its just persistence in the system.

12 “snow cover heatmap”? Awkward, revise.

14 “may inaccurately portray low snow cover for those seasons”. It can’t portray low snow cover, because like you say, the data is missing.

15 “more gradual” than what? No rapid increase was identified.

17 replace ‘high’ with ‘long’

23 “snow cover at Lake Hoare is highly variable’, clarify, snow cover persistence?

25 Delete the last two sentences in the paragraph, they don’t say anything.

Page 7

29 Replace ‘ground’ with ‘soil’ or ‘rock and soil’

Page 8

1 Delete the sentence about sub-ice ecosystems, it doesn’t go anywhere and is a distraction from the subject of the paragraph snowfall versus accumulation. If the ecosystem issue is important, develop in a separate paragraph.

4 Delete ‘necessary’. I’m sure one could figure a work-around if needed.

6 Replace ‘dissipation’ with ‘ablation’, replace ‘from’ with ‘based on’

10 Replace ‘pick up’ with ‘detect’

13 The last two sentences sort of repeat the last sentence in the previous paragraph. Can the influence of high winds be more fully addressed in a single paragraph rather than partly in two paragraphs?

18 ” from cooling to no trend” Awkward. Rather than a ‘shift’, how about “a changing trend from cooling to no trend”?

19 Delete the rest of the paragraph starting with, ‘While the reconstructed. . .’ The ablation and melt in the ablation zone vis a vis Hoffman et al., 2016 has nothing to do with snow cover. The text awkwardly summarizes the model and at the end of the paragraph, the authors back into a suggested process, reduced snow cover. Hoffman et al., do not argue that the lack of snow causes increased melt, they argue increased sediment on the ice surface. So, I don’t know the purpose of these sentences.

27 Delete this paragraph, it doesn’t make much sense. It starts to make an argument for snow cover vs snowfall relevance to local ecology. But that subject is dropped, and the subject shifts to the importance of winds again. It ends with an unsubstantiated statement about the best approach to measure snowfall and snow cover. Strangely, the ecosystem argument ignores an important aspect of snowfall and snow cover, its

spatial distribution. In any case this paragraph doesn't really say anything important to the paper.

Page 9

3 "lowest relative loss of snow-covered area (72%)" What does this mean? And what is 72%? Does this mean that the area of Lake Hoare lost 72% of its snow cover? On average? Or is 72% of the Lake Hoare area covered in snow?

4 "least radiation" nuclear radiation?

6 "may buffer reduced persistence associated with climatic conditions" Vague. What associated climate conditions?

7 volume, not depth? And the last sentence is very confused. How does snow at Lake Hoare inform on snow at the coast? "snow likely plays the larger role. . ." in what? And makes its monitoring increasingly important? Why not important, why is it increasing in importance? I might argue that it is more important to monitor snow up valley where there is less moisture.

9 Delete section 4.2? It doesn't come to any substantial conclusion. Given that the region is a desert and one large snow event can change the season of maximum snow fall, clearly the statistics will be very noisy and regressions and teleconnections will be insignificant. If the authors feel that this section is important, reduce it to one small tight paragraph.

23 Delete 'sea ice extent' In the previous paragraph it was shown to be irrelevant to snowfall.

Page 10

3 Delete section 4.3. This section lightly argues for the relevance of snow to the hydrology and ecology of Taylor Valley. Unfortunately, its not particularly insightful and the topics have been better covered by the authors in the introduction. Also, there are

several conceptual mistakes in 4.3 summarized below.

7 "high-humidity areas which will experience greater melt" These areas will melt? Surely you don't mean that. Do you mean snow in those areas?

"Sublimation is the greatest contributor to ablation of snow" Not true, in most temperate regions of the world melt is the biggest factor with sublimation playing a very small role.

8 "Under these assumptions, reduced snow volume and increased snow persistence will further reduce the soil moisture contribution of snow which could have mixed effects on subsurface ice and soil

10 communities. While there would be less melt to recharge subsurface ice, the increased duration of snow cover could act as a buffer and slow ablation." These two sentences are wrong showing a misunderstanding of the heat and mass transfer of snow over soil, particularly a relatively warm snow over much colder permafrost at depth.

29 The predictive capability of high spring snowfall at FRLM to indicate high summer snowfall at BOYM only a short distance away is odd. This appears to be a case of correlation without causation, and not examined carefully by the authors. Furthermore it is very odd that no other station pairs show this, which makes me think this is specious and not worthy of inclusion in the conclusions.

Page 11

8 This sentence is unsubstantiated by anything prior in the report and should be deleted.

11 This paragraph should be deleted it doesn't say anything substantial.

Figure 1. I've always thought that no acronyms should be included in a figure without explanation, otherwise, the reader has to search the text for interpretation. I recommend AWS be spelled out too.

Figure 2. This is a confusing figure. The caption says the monitored area is outlined in red, but I only see a red line, not a polygon, so no 'area' is outlined. After some inspection I realized it was at the bottom of the photo. It would help the reader if the photo was cropped to minimize much of the sky in order to emphasize the monitored area. 4 'perennially melted moat'? It is always melted? The moat is part of the lake? Unclear The last sentence is awkward, please revise for clarity

Figure 4 I think it is important here to show missing data. Otherwise the plot is misleading, no bar is interpreted as zero snowfall. For example, it appears HOEM had snow snow accumulation between 1994 and 2006. The bar graph to the right, are these averages? If so, what is the sample size of each? It bears on the statistical differences between seasons and between stations.

Figure 6. In the legend the mean is indicated by X-bar. But X-bar would be a snow year. Persistence is on the y axis, Y-bar? Why is the resolution of the photo +/- 0.5 days? This was not explained in the Methods.

Figure 7. (b) where is the scale for accumulation? The tick marks suggest a scale different from (a).

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