The Cryosphere Discuss.,
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The Cryosphere Discussions
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Interactive comment on "Monitoring snow depth change across a range of landscapes with ephemeral snow packs using Structure from Motion applied to lightweight unmanned aerial vehicle videos" *by* Richard Fernandes et al.

Anonymous Referee #2

Received and published: 25 June 2018

Review of "Monitoring snow depth change across a range of landscapes with ephemeral snow packs using Structure from Motion applied to lightweight unmanned aerial vehicle videos" by Richard Fernandes et al.

This manuscript uses unmanned aerial vehicles for monitoring snow depth change. Emphasis is placed on the accuracy assessment of the snow depth change between UAV flights and on the expression of expected accuracy from conventional photogrammetric theory. Generally this manuscript provides information on the application of UAV's to quantify snow. There have been several papers in recent years which have

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presented very similar types of work (which are already cited in this manuscript) so at this point for a paper to be accepted there need to be clear novel contributions. In general, specific portions of this manuscript (theoretical error estimation and snow depth change error analysis) are novel contributions but many portions are not and portions of introduction, methodology and discussion are tangential. I would recommend that this manuscript undergo major revision before being considered again. There are various spelling and grammatical errors throughout -I am not noting them here as more major changes are needed before I'd recommend acceptance. Main comments follow.

Length and Level of detail: This manuscript is very long and very detailed. Obviously enough detail is needed to allow for reproducibility but this is too much information as one must avoid having a reader lose interest if it takes too long to get to any results. In addition, the large amount of detail regarding the accuracy assessment and operations is unnecessary in my opinion as previous work on this topic have established that baseline knowledge. My suggestion would be to focus on the novel portions of the manuscript. Specifically, the work on the modelling of the expected accuracy wrt to flight characteristics as determined from conventional photogrammetric theory. This would be very helpful to in flight planning.

In situ snow depth estimation: The approach taken to estimate snow depth in the field - using snow stakes protruding from the surface and determining SD height from photos taken $\sim$ 5 m away- is problematic. SfM is based on features that can be clearly identified in multiple images. Thus a stake in a snow field will render a better sfm solution/point cloud near the stake than further away. The authors need to somehow demonstrate that their in situ SD observational protocol does not bias the point cloud accuracy or density of the sfm solution. Even if stake points are removed from the point cloud the immediately adjacent snow points will also be biased to the more precise stake solution. Are the results of snow depth change valid away from these snow stakes or not? Only if this can be successfully argued can hypothesis 1 be tested.

Specific comments:

Abstract: please synthesize the conclusions.

Page 2 Line 11-24: This is emblematic of the level of detail concerns I have. Is it necessary to have an explanation of the WMO SD network when the focus on the paper is SD from UAV's?

Page 3 Line 6-7: If this is not a focus of the paper why mention this?

Page 3 Line 27-28: Many examples in the literature do this already.

Page 4 Line 6-7: This has been discussed and an example is given in: Schirmer, M. and Pomeroy, J. W.: Factors influencing spring and summer areal snow ablation and snowcover depletion in alpine terrain: detailed measurements from the Canadian Rockies, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-254, in review, 2018.

Page 5 Line 18-19: Why?

Page 5 Line 28: Are these actually 5 study sites? I was expecting 5 sites with different features and locations based on all the preceding text. This seems like 2 sites with a total of 5 stratified sample areas of analysis.

Table 1 and 2: combine

Figure 1 and 2: Google earth citation? Google earth screenshot is not typically publication quality and a better map should be provided prior to any publication.

Page 9 Line 21-26: What is the influence of GCP's being located above the surface of interest. Typically GCP's should be located at same height of surface. How were GCP locations measured? dGPS? What is the accuracy of this measurement?

Table 3: Is this table necessary as DJI Phantom Pro's are extremely popular (not an obscure UAV)?

Page 13 Line 8-9: imagery was nadir?

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Page 14 Line 17-19: Clarify what was optimized.

Page 18 Line 7-8: What are the implications of this? I would expect that this would add a smoothing artefact.

Page 19: Line 6-12: These sentences are repetitive. Remove one and merge paragraphs?

Table 6. A wind speed of 26 ms-1 is crazy high to fly a UAV safely. Are these correct units? Please explain if/how this wind speed observations are different from actual flight conditions.

Figure 7: y label axe units need to be improved. Xlabels could remove the year from each date. Plot areas are also not consistent. Formatting is not publication ready.

Figure 8 and 9: combine into a) and b)? what is the meaning of circle size? Add legend.

Figure 13: Putting AC RMSD at 0.1 when it is actually at 0.42 is misleading even if noted.

Page 34 Line 17: “minimal certification” this is not mentioned elsewhere.

Page 34: Line 19-20: This was tested in Harder et al. (2016) and was determined that even with RTK corrected photo geotags GCPs were still needed.

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