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Interactive comment on "Mapping snow-depth from manned-aircraft on landscape scales at centimeter resolution using Structure-from-Motion photogrammetry" *by* M. Nolan et al.

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The paper entitled "Mapping snow-depth from manned-aircraft on landscape scales at centimeter resolution using Structure-from-Motion photogrammetry" by Mat Nolin et al. describes the application of airborne photogrammetry to accurately map the depth of shallow snowpack in three test sites in Alaska. This work demonstrates the big potential of digital photogrammetry for spatially continuous snow depth mapping, which is of great value for numerous applications. Even though in most parts of the world it is not as easy as in Alaska to get suitable airplanes, it is still a very interesting option.

The paper is well written and interesting to read, however I see the following major issues that should be resolved before publishing this paper:

1. The whole assessment of the product quality is based on the terms “accuracy” and “precision”. The essential terms should get carefully defined in the beginning of the paper and be illustrated by examples and/or figures. These essential terms should then be used consequently through the entire paper and no new or changed terms should appear. This would help the readers to better follow the large descriptions of quality assessment.

2. The structure-from-motion technology is the base for the presented methodology. The description in section 2.1 Software is too short and incomplete. A section should be added under chapter 3 Methods describing the applied structure-from-motion technology in detail and including figures and examples. Central questions are: What are the parameters, which have to be set? What is the influence of these parameters on the results? Where do the authors find problems? Would a near infrared band result in more matching points on homogenous snow surfaces or is there enough contrast in the RGB? How would it be on fresh snow surfaces? What software packages are available today? Do they have specific strength and weaknesses? I do understand that not all software packages can be tested but it would be nice to have at least a comparison between two different solutions or to cite references, investigation different products.

3. The application of references seems rather occasionally in some parts of the introduction. E. g. at page 337 line 14, the authors list 15 publications but it gets not clear which reference belongs to which application. I suggest checking the cited references carefully throughout the paper and skipping papers, which are not really necessary.

4. The results are described over many pages and it is very hard for the reader to follow all the numbers and names. I think the structure of this part should be reorganized. One option would be to present the test sites in a separate section including the reference data. There is no figure depicting the applied ground control points even though this

would be interesting to see. Also the effect of a high and low distribution quality of the GCP's would be interesting. In a results section the outcome of the accuracy and precision investigation can be presented with the help of tables and figures.

5. The authors use only term GPS. I do not know if they really just used GPS satellites, but I would suggest changing it to GNSS throughout the paper because GLONAS and in the future GALILEO would substantially improve the positioning accuracy in particular within difficult terrain such as the Alps.

6. The conclusions are rather short and weak. What are the major issues of SfM technology? The authors test in mainly quite gentle terrain. What would be the implications for rough terrain (e.g. minimal flight elevation possible, differences in GSD, steep slopes etc.). Are there some plans to apply this technology for further studies?

Specific comments:

Title "landscape scale" is not very precise, is there a better term? The title is rather long and filled with technical jargon

P334 L17 "another photogrammetric system", what is different?

P335 L6 How do you get to the limit of 400 cm, in the Alps we have spots with much more snow!

P335 L27 Why do you loos now word at all on spatial resolution here? This is the major drawback of microwave emissivity!

P336 L 9 In my opinion my paper is cited here at the wrong place. In our study we investigated quite similar topics but in different terrain, so it would be helpful to set your results in context with our previously achieved results (the overworked paper is published now in TC). Again here, the citation of papers seems quite randomly and the reader cannot follow why these references are there.

P336 L22 What is a "sufficient accuracy"? Please specify.

P339 L6 It would be nice to have a table with other devices, which could be used for this approach. It gets not clear why the authors choose the Nikon D800E.

P339 L 23 Here the near infrared option is not mentioned. From our experience, the near infrared bands enable much more contrast over snow-covered areas (e. g. Bühler et al. 2015). This option should at least be mentioned.

Bühler, Y., et al. (2015). "Potential of operational, high spatial resolution near infrared remote sensing instruments for snow surface type mapping." Geoscience and Remote Sensing Letters, IEEE 12(4): 821 - 825.

P341 L15 “manually associated with image filenames” This is an important step in the processing. How time-consuming is it? Do you face some problems there? Would there be other options?

P341 L 21The computer described is extremely well equipped with RAM and cores, can you say something about the processing time needed if you take a standard desktop computer?

P342 L 11 In this chapter you should mention the problems arising, if you compare point measurements to spatial continuous data. Which problems can occur if you localize the probe measurements with a GPS with an accuracy of 5 m?

P344 L5 Why did you not analyze the probe measurements statistically? It would be interesting to compare the statistics to the ones derived from the photogrammetric maps.

P346 L6 How were the GCP’s measured? Why did you not measure GCP’s which have a better distribution?

P347 L1 Why do you have different GSD’s? Different flight heights above ground?

P352 L18 It would be interesting to get more information on these artifacts. When do they occur? What are the reasons for them? Do you have some strategies to limit

artifacts? The 100cm GSD should reduce artifacts because it smoothens the terrain. This point is not clear to me.

P354 L26 There is no clear statement in the paper how well the method works in forested terrain or in areas covered by bushes. Could you specify this?

P357 L26 please describe the possible improvements in more detail.

P358 L4 Geolocation is very important in steep terrain! A small shift in x or y results in a very large error in z. Please discuss this point.

P360 L14 I do not know any satellite application that can map snow depth accurately!

P371 Fig1 You map very deep snow in the very steep slopes of the bluff. Are you sure the snow is that deep in the steep areas. The geolocation is very important here, could it also be error? In the Alps we usually find only small snow deposits on very steep slopes. There might be cornice but I would expect the major snow mass at the toe of the slope. Please check that.

P375 Fig 3b: Where are these errors located? Why do they occur? This information would be interesting.

P374 This caption is very long, can't you take some information to the text? This applies for all long figure captions.

P376 Fig 4a: a scale bar would be helpful Fig 4d: Where are the big differences around probe 120, 380 and 450 coming from?

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