

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.

Anonymous Referee #2

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The manuscript, "Mapping snow-depth from manned-aircraft on landscape scales at centimeter resolution using Structure-from-Motion photogrammetry" From Nolan, Larsen, and Sturm presents a new approach to the collection of snow depth information using photogrammetry techniques from manned aircraft. The presentation of the technique and characterization of the results achieved indicate that the method is quite suitable and in fact could be transformative in the the cryospheric sciences.

The authors present a system which is largely made from 'off-the-shelf' components and 'black box' software, and apply the system to three case study test locations. Overall the results are compelling and indicate that the method is more than suitable for most present day requirements of snow-depth change.

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Rigorously, portions of the technique are not detailed. As the portions of the system rely on proprietary software there are some details that cannot be accurately assessed. However, the authors do a very good job of presenting a characterization of the accuracy and precision of their results and demonstrate the suitability of the method. Further, the manuscript demonstrates that the method in general will provide users greater information - particularly with regard to spatial extent - than typical snow observation platforms employed today.

However, as this paper's stated goal is that "[Their] chief contribution has been to integrate these components into a simplified and low-cost system." there are a few shortcomings that should and could easily be addressed prior to publication.

First, with regard to the method, this reviewer feels that too little information is provided with regard to any photographic 'preprocessing' or otherwise that may have been required to achieve appropriate images for the determination of the point-clouds. It is stated that a benefit of modern-day DSLRs is the wide dynamic range and ability to use the camera over snow covered surfaces. While images may have been collected without complete distortion or over exposure, the authors do not describe whether they enhance the contrast, or alter the image in any way prior to the Photoscan workflow pipeline. It seems likely that in order for the software to distinguish features, it would be a required pre-processing step. Overall, while the processing by the software is a 'black box' step, but there should be more complete information provided on what is done throughout the workflow.

A second place this point arises with with reference to the intervolometer, and ,over all, the entire hardware description. The system itself needs to be detailed more accurately. As reviewers, we are not able to assess the proprietary components of the system – if so, this manuscript should be submitted to a geomatics or image processing journal. Rather, the authors preport to present a 'system', but in the manuscript, only the results from a system are actually detailed. It is recommended that greater care be taken with regard to the specific hardware used, specifications about any control

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software, on board computer requirements, etc.. A figure of the system itself would be useful. By way of example, regarding the TTL pulse event marker, this would indicate that the camera and GPS were connected. Is this connection via a microcomputer or is the camera connected directly to the GPS? A complete hardware specification should be provided.

Finally, a few minor editorial comments are provided. Overall, this manuscript is written exceptionally well. The use of English language is very good, and the sections follow clearly. In general, the text could be shortened, and with the addition of point 2 above the text may grow. If there are page limit restrictions or other issues, then it is recommended to reduce some of the results descriptions that are somewhat repetitive in favor of a proper description of the system. Throughout the text the authors use the terms "outstanding", "remarkable", and "excellent" – indeed, the results are impressive and the technique may greatly benefit the cryospheric community, but these judgements should be left to the reader to determine. Rather than making judgemental phrases it would be better to provide a comparison to other comparable types of datasets and indicate whether the errors are within the ranges or better than methods previously employed.

p337, l21: Abstract states $\pm 30\text{cm}$, here $\pm 10\text{cm}$

p339, l20: more detail here on image processing workflow is required.

p340, l18 - p341, more detail here on hardware and system configuration is required.

p341, l18: what are 'most metrics'?

p341, l20: Suggestion, change MAP Construction to DEM Construction for title heading.

p349, l27: Where is the 50cm difference? On figure max is 40, and even there it seems closer to ± 30 .

p351, l4: "This difference in scatter" is unreferenced. To what exactly is the author re-

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ferring. Also, showing a point-cloud example of conic tree features could be of interest.

p351, l17: such gridding artifacts → the trees?

fig4b, surprising that snowshoes sink the deepest – more than boots?

p355, l14: "and that determining co-registration below the 30 cm level can be overcome using ground control points." seems awkward, perhaps: "can be achieved" "overcome" refers to to 'determining co-registration' not 'primary errors'. Suggest rewriting sentence.

Sec6.3, Fig 5 not referenced before Fig 6 or Fig 7. In fact, it seems Fig 5 is not mentioned at all until later in the text (p356, l24). Also the inset boxes in Fig 5 are not so clear, some small text could aid in labeling the boxes.

General Figure Comment: Probe Transects – it is unclear how these are shown as lines. Shouldn't the probe be point locations (and given as a bar with +/- of location accuracy)? For example, the variation shown in the probe transect in Fig 6e indicates a continuous measurement, but aren't these point measurements? Was interpolation used?

Fig 7a refers to (see island inset in Fig. 1), but this is not present (or not clear). Perhaps it should be ('see island inset in Fig. 5')

Legend in Fig 7b needs to indicate both colors of probe

p358, l19: can be ignored – maybe better to say 'can be accepted'?

p358, l20-...: This issue of contrast adjustment should be better addressed in the methods section. Examples, of images used, and if any contrast enhancement or adjustment was applied prior to SfM processing it needs to be detailed.

Interactive comment on The Cryosphere Discuss., 9, 333, 2015.

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