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Interactive comment on "Microscale variability of snow depth using U.A.S. technology" *by* C. De Michele et al.

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Overall this paper has a lot of potential. It can make an important contribution to illustrate how inexpensive (much cheaper than lidar) methods can be used to estimate snow depth remotely at fine resolution (sub metre), possibly over large extents; this paper shows a small extent but there seem to be no limitations to going to much larger domains. This is especially true in remote and/or inaccessible areas. This type of data collection system has great promise for snow and ice mapping, building upon work other earth science applications.

However, there are some substantial problems. Crucial components are not explained or poorly described and the comparison of UAS to manual measurements is too simple. The paper needs to be rewritten and re-focused. It reads like a technical note,

as the comparison dataset is very sparse (1 point per 160m or 25,000km2). The authors should consider evaluating the spatial patterns of snow distribution, especially since this dataset is much finer than other similar extent dataset, such as those collected using airborne or terrestrial lidar (e.g., Lopez-Moreno et al., 2015; Hydrol. Proc.; doi:10.1002/hyp.10245). A dataset covering ~300,000 m2 (or ~500m x 500m) does not exist at this resolution (~5cm) in the literature. Pattern analysis would illustrate its utility. The authors suggest the importance of such fine resolution, and while hydrologically this may not be crucial, it is relevant in the context of sampling (e.g., Lopez-Moreno et al., 2013; Advances in Water Resources; doi, 10.1016/j.advwatres.2012.08.010). Contrary to what the authors say on page 1053, line 15-17, there is literature on how many points are need to be representative. The author should consider the NASA Cold Lands Processes Experiment (see Elder et al., 2009; J. Hydrometeorology).

The biggest problem is likely the comparison to the manual measurements. Only 12 measurements were made for the one date when snow was present. It is not possible to go back in time and collect more data, but this could be a fatal flaw of the paper as it is currently presented. It is stated (p1057, line 10) that there is a "slight difference" between the UAS and manual measurements. There is no mention of the horizontal accuracy of the manual depth measurements. I assume that a GPS unit was used to determine the coordinates of the manual measurement. If so or if not, this need to be explained. I highly doubt that the manual measurements are at the same 5-cm resolution UAS pixel. See Lopez-Moreno et al. (2011; The Cryosphere; doi:10.5194/tc-5-617-2011) for 1-m resolution variability and Fassnacht et al. (2009; Ecol. Complex.; doi:10.1016/j.ecocom.2009.05.003) for crystal to metre scale resolution variability.

The three interpolation maps are not shown, likely since they are too simple and not realistic. T

The swingletCAM system is proprietary (sensefly ®) and not explained well. The 3-D locating is mentioned, but with the "georeferencing" present later, its relevance is not stated. We do not all have access to such hardware, so insight would help those who

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want to build such a system, or justify its rental or puchase. Later the Agisoft software is used to created the Digital Surface Maps (DSMs). While this is being used by many, the specifics should be explained.

The contour intervals (10-m), presented from the "local regional administration," are too coarse for the graphical comparison presented in the paper. It is stated on page 1056, line 21 that the UAS DSM is in agreement with the "local regional administration." While those figures are too small to truly compare (make them bigger), they do not appear to be in agreement. I suggest that a digital elevation model (DEM) for the area (e.g., SRTM) should be used to compare the "agreement" quantitatively. This may require transformation of one of the datasets (UAS DSM or SRTM DEM).

In places the writing is quite choppy. For example, the words "automatic" and "autonomous" should be replaced by "automated." Since the authors may not be native English speakers, I recommend that a native English speaker review/proof read the paper before resubmission. There are numerous other examples throughout that I will not highlight.

Specific comments (not grammar) - I don't like the title. By microscale the authors mean centimetre scale. Also, U.A.S. is not a known shortform. - The second survey is at the end of accumulation. This can be misleading, Perhaps say that it is around the time of peak accumulation. - page 1049, line 24: snow pillows are operational not experimental - end of page 1049: consider the work of Rice and Bales (2010; Water Resources Research; doi:10.1029/2008WR007318) and Meromy et al. (2013; Hydrol. Proc.; doi, 10.1002/hyp.9355). - p1050, l12: isn't laser scanning the same as LiDAR? - p1050, l16: the satellite examples are optical not microwave - p1051, l1: is it truly bare soil? - p1051, last paragraph of top section - not needed, delete. - p1051, l20: what is the basis for the "criteria?" - p1053, l6: is it a depth probe to measure snow depth? A probe is very different than a pole. - p1054: the Thiessen polygon has essentially been replaced by the TIN (see Marsh et al. 2014 cited in the paper). - p1054: can't apply any of the global methods since there are too few points. - p1055: Survey "realization:"

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change the second word. In the first paragraph I would normally recommend to be succinct, but since this is a new application, it my be useful to explain the purpose fully. - p1058, l1: at what scale are the “micro-topographic differences?” - p1058: is it “snow pole” or “depth probe?” The former is permanent while the latter is not. - p1059, l4: “snow density ... measured” - provide more information about this. - p1059, l24: not sure that it was actually “assessed?” - Table 1: can’t directly compare the manual measurement to UAS due to error in locating the manual measurements and their support (see Hood and Hayashi, 2008; The Cryosphere). - Table 2: how were these different resolutions of UAS based data derived? - Figure 1: location map within Italy? the “local regional administration” map is not too informative - Figure 2: label the Figure legend and include a scale bar - Figure 3: all images should be larger, as these are difficult to see the detail on

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