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Interactive comment on "Short Communication: Optimizing UAV-SfM based topographic change detection with survey co-alignment" *by* Tjalling de Haas et al.

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General Comments:

The authors advocate for a modified method of change detection using UAV-SfM time series. Whereas the traditional approach uses each survey individually aligned to GCPs, the authors build upon and expand the work of Cook and Dietze (2019) in this journal to suggest a combination of GCPs and co-alignment over many (more than two) time steps. This manuscript is well written and well placed within the context of recent UAV-SfM studies. Despite being a short communication, the manuscript would benefit from some additional details, clarifications, and modifications that should all fall

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Discussion paper

in the realm of minor revisions prior to acceptance.

I understand that the authors lack a control dataset to test absolute accuracies, but I tend to agree with the other reviewer that some GCPs could be used as check points on absolute accuracy between the three approaches, listing (or better tabulating) a simple metric like mean and standard deviation ought to suffice. Furthermore, the issue of GCPs is of great concern especially when surveying large areas where there may be difficulty in finding and reaching stable, clearly visible points to lay out targets and measure using dGPS. I am particularly interested in how increasing the number of GCPs (and their spatial arrangement in the area) affects the quality of CA+GCP method. Figure 3c,d go in this direction with plots showing increasing error with distance from GCPs. Interestingly the z error has the clearest trend with distance from GCP, whereas the xy error trend is less clear and only shows a decrease in accuracy for a few points at distances > $\sim$50 m. Would these trends be better presented in non-log space? It looks like a lot of the accuracies are sub-cm, so they may be "insignificant" (or at least negligible) for most geomorphic change detection studies, thus a linear (or semilog-x) plot would highlight the larger (1 cm - 1 m) inaccuracies that are of greater concern. If a log axis is preferred then the text should at least highlight and state the lower importance of these sub-cm inaccuracies. The xy trend may also be more apparent if less GCPs were used and the x-axis of that plot extended to some higher values (i.e., greater distances). If similar accuracy can be achieved with GCPs placed 80 m apart versus 20 m (e.g., accuracy $\sim$1 cm) then that's a significant improvement in field work time.

If the authors aim for reproducibility and standardization of UAV-SfM change detection then some additional details of the steps taken should be included. I have a couple suggestions here, which I mostly highlight in the line changes below. One point here: in the Section 3.2 Data processing, I suggest a nested alpha-numeric list (e.g., (1), (a), (b),...(2), (a), (b),...) rather than the steps in paragraph form. This will read more like a manual of the steps to follow. If these and previous suggestions are increasing

the length significantly, I recommend removing Figure 2. I think the difference between these methods is quite clear in the text and the flow-chart is not necessary. Alternatively, the current Figure 2 could be replaced by a flow-chart of only the proposed method similar to Figure 2 in Cooke and Dietze (2019). This may negate the need for the alpha-numeric list, but that is for the authors to see and decide.

One missed study from this journal that adds some nice context is Duro et al. (2018). They used the traditional GCP approach without co-alignment on 8 surveys. It would be good to include this reference somewhere in the introduction or in the discussion as an example of the previously used (GCP only) technique for UAV-SfM surveys over many time steps (rather than just two). Table 2 and Figure 6 in that study could also provide some discussion comparisons with the absolute accuracies found using check points in the present study.

A last general comment: Agisoft version 1.6 (in the present study version 1.5.2 is used) added a point confidence based on the number of depth maps a point appears in. I suggest the authors highlight this new feature to call attention to it. For instance this new feature could be used in further filtering of the point clouds to only extract high confidence points and/or as weights in interpolation schemes. There is no need to do any re-processing using the newer version, but this is certainly an important new feature that ought to be explored in future research. This could just be a few sentences in the discussion.

Line Changes:

L33: "differentiated" to "differenced"

L45: should "reduces the accuracy" instead say "increases the accuracy"?

L46-47: I think the terms relative and absolute accuracy (as opposed to comparative and external) are more common. It is fine to continue using comparative and external but maybe quickly define, e.g., "comparative – or relative – accuracy... external – or

absolute – accuracy"

L57: remove hyphen from "common-practice"

L94: Please include the specs of the computer used (e.g., RAM, number of CPUs, presence or absence of a GPU) and approximate processing times (this could come at the end of the paragraph). I'm especially curious about how long the 9 survey block co-alignment took on whatever computer was used.

L95: Were these steps done using the Agisoft Python API or strictly through the Agisoft GUI? If Python, consider including a GitHub repository with the code. Or at least a statement saying whether the API or GUI was used. The iterative steps of tie point removal and re-alignment would be especially ideal for a Python script. As earth surface processes research moves towards increasing reproducibility the move to scripting as opposed to clicking steps is vital, or at least more manual-like details (e.g., the alphanumeric list or detailed flow-chart I suggest in general comment).

L98-99: All GCPs were added between steps 3 and 4? Or just a few and then kept adding more with each iteration? This could be the point where 10, 25, 50, 75, 90% (or so) of the GCPs are added each time to see the improvement / changes in accuracy.

L101 to end of paragraph: include a few more details on the lastools commands used (e.g., lasground, what were all the parameters?), and also include details of the "rasterization" scheme. Here "rasterized" should be changed to "interpolated" and the method of interpolation should be stated (e.g., IDW?).

L103: Should "low noise" say "high noise"? Or maybe just "low accuracy".

L113: "changed" should be "change"

Figure 3: What are the error bars in a and b? I suggest removing the median bars and just use the mean, since the median is never referenced in the text and Figure 4 uses the mean. However, the median error bars show large overlap, which is concerning and would seem to limit the interpretation of significant improvements. Do the authors

have a response to this concern?

Figure 3: In the caption "accuracy decreases with distance" should perhaps be "accuracy decreases with increasing distance"?

L147: In the xy direction this decrease in accuracy is only apparent in the few datapoints > ∼50 m from a GCP (if one considers < ∼1 cm inaccuracies as negligible in this context). Be more specific about these distance breaks in the text, or perhaps use the suggested gradual addition of GCPs to highlight this. Also, what are the fitted lines in Figure 3c,d? Is this a moving average? Please state this.

L146-160: In the results please reference Figures 3 and 4 where appropriate.

L163: The "large errors" in volume change don't refer to any reference data. I'm not sure it's appropriate to refer to the volume change errors without a control (e.g., lidar). Instead these are relatively (compared with the other alignment techniques) large changes in volume that are outside of expectations. Based on Figure 6, it seems that this error is a visual assessment, which is fine but should be clarified.

Figure 6: It would be helpful to just put a colorbar on this and remove the caption description (+/-4 m in color and +/-0.25 m transparency).

L198: "has" should be "have"

References:

Duró, G., Crosato, A., Kleinhans, M. G., and Uijttewaal, W. S. J.: Bank erosion processes measured with UAV-SfM along complex banklines of a straight mid-sized river reach, Earth Surf. Dynam., 6, 933–953, https://doi.org/10.5194/esurf-6-933-2018, 2018.

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