

## ***Interactive comment on “Short Communication: A simple workflow for robust low-cost UAV-derived change detection without ground control points”*** **by Kristen L. Cook and Michael Dietze**

### **Anonymous Referee #1**

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The short communication introduces a workflow to process multi-temporal data for accurate change detection although no GCPs are available. Thereby, images from multiple survey campaigns are processed at once. Afterwards, the orientated images of the individual surveys are split to retrieve the corresponding point clouds of each campaign for change detection. The idea is simple but very effective. The manuscript is well-structured and easy to follow. The results are presented comprehensively and support the introduced method. However, some issues remain regarding the explanation of the approach (especially terminology) that should be addressed in a revised manuscript. Furthermore, the authors should consider the Time-SIFT publication by Feurer & Vinatier (2018) because it describes a similar approach more detailed for

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applications to archival imagery. Please, see below for some detailed comments.

P1L23: It is not clear what the authors refer to with camera optical parameters. Are these the interior orientation parameters. If yes, it should be mentioned that the GCPs are also used to refine the parameters of the exterior orientation besides the interior parameters.

P1L29: It might be better to refer to dGNSS instead of dGPS as also other satellites can be used for geo-referencing.

P1L31: Dietrich, 2017

P1L31: Model errors can also be reduced. . .

P2L33-35: Are these control points tie points or ground control points? If they are GCPs, where does the reliable/accurate 3D information come from? And if they are tie points, I would avoid the term control points.

P3L65-71: This paragraph seems to be a little bit off-topic if it is left as it is. A better explanation why these challenges are displayed should be provided. For instance, why is the changing appearance of the cliff relevant? Does that potentially impact feature detection and matching? Furthermore, a final statement might improve that paragraph, as well, highlighting that this study at the cliff is a very suitable study to demonstrate the usability/necessity/benefits of the authors' approach. Although, this intention is probably meant in the paragraph it might be suitable to mention this explicitly.

P3 chapter Methods: I would suggest to include sub-headings for data acquisition and co-alignment processing to improve the readability.

P3L75-76: Did the authors also consider check points as an independent reference of the reconstruction accuracy? With 14 and 12 GCPs this should be possible.

P3L94: I thought, only the Mavic Pro was used for data acquisition (but also a Phantom is mentioned here)?

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P4L97: What is the unit for the reconstruction uncertainty? According to Agisoft, the reconstruction uncertainty somehow relates to the base-height ratio. But how is the reconstruction uncertainty calculated?

P4L98: How is the adaptive camera model fitting working? What is the difference to the approach without adaptive fitting?

P4L99: The fine registration in CloudCompare is done via ICP (iterative closest point) fitting. Maybe, it might be preferable to state the actual performed algorithm rather than the tool name.

P4L105: The alignment optimization is actually also a bundle adjustment, however considering some refined parameter settings and/or referencing information. Thus, this might be rephrased to avoid confusion of the reader.

P4L116-118: Is it possible to express these differences between both change maps in numbers, e.g. considering the average of deviations between both maps? This question would also be relevant for the Rügen analysis. Furthermore, did the authors also check accuracies at check points? They might be helpful to assess how well changes are detectable with the reference in general.

P4L124-125: However, this depends on how the models are aligned. If GCPs or stable areas are used, I am not certain if this statement still holds. Of course, if ICP is used than these distortions can lead to difficulties in the alignment (depending on how strong these distortions are).

P5L128-129: I am not sure if I understand that sentence correctly. Changes between 1 and 2 m are common at the observed cliff on Rügen? Thus, the noise in the data is higher than the common changes at the cliff?

L123-129: Maybe the entire paragraph can be rewritten to improve clarity regarding model related distortions and issues due to alignment approaches.

P5L130-131: Maybe it is worth to extent the explanation that the simultaneous align-

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ment of all campaigns leads to the circumstance that the highly spatially correlated errors (James et al., 2017), which also depend on the image observations (i.e. tie points), are potentially situated at the same locations in the individual models (because image orientation across surveys are constrained to the same tie-points) and therefore mitigated during point cloud differencing.

P5L135: Figures 4 A-C

P5L153: I would not state that edges are the issue but rather areas outside the tie point region.

P6L160-163: Maybe this statement should be separated more clearly from the previous because another aspect is discussed. The first aspect is referring to too strong changes of the surface and therefore failing to find matches and the second refers to changes of the entire surface but remaining a general similar appearance and thus falsely retrieving matches.

P6L164: What do the authors refer to when they are talking about scaling between numbers of photos?

P6L164-168: I have a little bit difficulty to understand that sentence. Do the authors mean that with each new campaign all the campaigns have to be re-processed?

P6L168-169: Might it not be possible to only compare from one survey to the next to avoid increasing the processing time with each new survey, although this might be less favorable for error propagation? Maybe it might worth testing in a future study how well campaign to campaign processing performs compared to reprocessing everything.

P6L177-178: Maybe the combination of both is most suitable (e.g. as discussed by Feurer & Vinatier, 2018). Align all campaigns in one workflow (this might also improve general model accuracy as more image observations will be available) and scale/geo-reference the whole project with GCPs (from just one campaign).

References: Feurer, D., Vinatier, F. (2018): Joining multi-epoch archival aerial images

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in a single SfM block allows 3-D change detection with almost exclusively image information. *ISPRS Journal of Photogrammetry and Remote Sensing*, 146, 495-506. James, M., Robson, S., Smith, M. (2017): 3-D uncertainty-based topographic change detection with structure-from-motion photogrammetry: precision maps for ground control and directly georeferenced surveys. *ESPL*, 42, 1769-1788

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