

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2022-33

Bas Altena (Referee)

Referee comment on "Empirical correction of systematic orthorectification error in Sentinel-2 velocity fields for Greenlandic outlet glaciers" by Thomas R. Chudley et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-33-RC2>, 2022

The authors present an implementation/ workflow description, to use displacement products from different orbital tracks of Sentinel-2. They are not alone, as such efforts are becoming popular in other fields of remote sensing of the cryosphere as well e.g.: [Lavergne et al. 2021]. For this work the authors have opted for a more methodological approach, instead of a paper looking at the physical drivers, which fit into a journal such as TC. Seen in this light the work does not go deeper than a description, at several places the reader is left in the dark why certain steps are taken. The work would become more interesting when such heuristics and rationale are explained or appropriate earlier work is mentioned as implementation argument.

major comments

Looking more detailed to the work, the advancement made by the authors is less clear to me. Though it is a valid implementation, through setting of a hypothesis and testing through empirical relations, it reads as an isolated piece of work. As such relations for Sentinel-2 (and Landsat 8) have already been set out by [Kääb et al. 2016] and [Altena & Kääb, 2017]. A brief description is given about a vector projection method as presented in [Altena & Kääb, 2017]. Though this is a stripped down version, for large scale processing pipelines, as demonstrated in this work. While the major work presented in [Altena & Kääb, 2017] deals with a framework of harmonization of different orbits and elevation offset. Which later is extended to changing topography over time [Altena et al. 2019]. The limitations of the projection method are correct (which is a stripped version), but these do not apply to the core framework. Hence, the presented work is halfway the work presented previously by others. If one assumes stable topography and a perfect co-registration (which is done by the authors), all cross-orbit displacements observing a region on the ground are related. Why are they then isolated? It does not look like an improvement...?

In general context is missing, as other efforts like presented in e.g.: [Rosenau et al. 2015] are not mentioned. Results of the change in temporal baselines is mentioned and a decision is taken, but an assessment is missing, while [Millan et al. 2019] do show interesting results on this aspect. Hence, why is such knowledge not taken into account, and do the authors branch off?

As a final note, this review needs to be done on paper, but if done in speech, it would have been on a friendly tone. I do think the authors present nice work, and this work should be seen as work in progress, like any scientific endeavour. My comments are encouragements, with the aim to set this work to a higher level. A potential is present within this effort, but not exploited to its fullest.

minor comments

- most people scan a paper by reading the abstract first, but context is skewed here. Why would people use cross-track data? Typically, this is an exotic way of processing, thus why the authors put much emphasis on stating the presence of enormous errors in ESA products is a bit strange. It misses the overview, as this work is a nice contribution, but has limited impact.
- Gaussian Processes are popularized in our field by [Huggonet et al. 2021], hence this is an argument to use this approach. Now justification is missing.
- Why are these specific glaciers used, if cross-orbits are of interest, Northern Greenland is very interesting, since overpasses almost occur every day, see Fig.1 [Altena et al. 2019].

typos and details

Since I am not a native speaker, I am not able to give any feedback on typos, nonetheless some details might be improved:

p1 l29 Landsat8 is now a fleet together with Landsat9, having same orbit repeat cycle of 8 days

p1 l29 Sentinel-2A and Sentinel-2B, need capital letters

p2 l41 it might be a cultural thing, but please do use words instead of newly introduced abbreviations, especially as this abbreviation is later changed into something else, and not used anymore. If you like abbreviations, then help the reader a bit and include an appendix with a nomenclature.

p2 l56 with the advent of so many same orbit repeat acquisitions, orthorectification errors are not a "significant" issue. The cross-orbit velocities are a "nice-to-have". Please do not oversell.

p3 l67 "is not freely available" -> "is a commercial product"

p3 l81 such a methodology is presented in the [Altena and Käab] study, so what is the unique contribution...?

p4 l93 please consider using a logarithmic colorbar, as most (~95%) of the figures are dark blue now...

p6 l117 AOI, why is this acronym introduced, if it is only used here?

p6 l130 here the newly introduced RO acronym is again replaced, what is the use?

p6 l130 the orbital number is even in the filename, as is also the case for Landsat, so this line is obsolete.

p7 l145 where does this 5x heuristic threshold comes from?

p7 l148 why does the assumption of stable geometry still hold, even for an highly dynamic outlet as Sermeq Kujalleq (Jakobshavn Isbræ) [Joughin et al. 2020 & Riel et al. 2021]?

p7 l157 the description of vertical DEM error is too broad, since it is not random but has mostly a systematic effect.

p7 l162 it is not clear to me if stable ground is used, to co-register the imagery? please write it down, or give a motivation why not

p8 l166 why are velocities used here, while for orthorectification the temporal baseline is almost irrelevant. Please use appropriate units, i.e.: meter.

p8 l169 this is a strange formulation, but why is this classical statistic used and not robust measures like "median of absolute difference" (MAD)? Also, the registration of Sentinel-2 has a flight line dependent positioning error (see fig.15 in [Kääb et al. 2016]), hence treating U and V as uncorrelated delutes the effectiveness of this threshold (see fig.2 in [Altena et al. 2021]).

p8 l174 "errors" > "deviations/differences"

p8 l176 please justify your decision, and have a look at [Millan et al. 2019]

p8 l180 "estimate" > "distill" and what is "true velocity", and are you able to back this claim, please rephrase

p9 l205 please see [Millan et al. 2019]

p9 l207 why are velocity units used as a threshold for variable temporal base line data?

p9 l210 please indicate the flight direction of the Sentinel-2 satellite, similar to inSAR maps.

p10 l223 please give an indication of the intersection angle, how much is the base-to-height or its angle

p10 l228 why so much hypothesis, while cross-track photogrammetry is around for some time?

p11 l231 "true" > "reference"?

p12 l250 the figure can be improved, maybe make most stuff black and let the red points change in colour for different time intervals? As Sermeq Kujalleq (Jakobshavn Isbræ) seems to have several consistent off-sets. Where do they come from, please describe it in the text, this makes it more informative to the reader. Is it also interesting to look at the flow direction? So assumptions on this aspect might propagate into this variance? Maybe scatter plots are not the best to use, thus consider using line plots to draw the temporal baselines as e.g.: fig.4 in [Charrier et al. 2022]

p12 l254 why not compare against off-glacier stable terrain?

p12 l261 this method does not resolve this issue of dynamic thinning, so why so specific about the cause?

p13 l264 "high uncertainty of optical feature tracking", where does this loose claim come from?

p13 l265 please rephrase the GP sentence

p13 l271 this is interesting, why is that? please give more depth to the subject

p17 l346 very vague conclusion, but this can be improved if more in depth analysis are done.

references

[Altena and Kääb, 2017] 10.3390/rs9030300

[Altena et al. 2019] 10.5194/isprs-archives-XLII-2-W13-1723-2019

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[Charrier et al. 2022] hal.archives-ouvertes.fr/hal-03602685
[Hugonnet et al. 2021] 10.1038/s41586-021-03436-z
[Joughin et al. 2020] 10.5194/tc-14-211-2020
[Kääb et al. 2016] 10.3390/rs8070598
[Lavergne et al. 2021] 10.5194/tc-15-3681-2021
[Millan et al. 2019] 10.3390/rs11212498
[Riel et al. 2021] 10.5194/tc-15-407-2021
[Rosenau et al. 2015] 10.1016/j.rse.2015.07.012