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Discussions

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Interactive comment on "Assessment of NASA airborne laser altimetry data using groundbased GPS data near Summit Station, Greenland" *by* Kelly M. Brunt et al.

Anonymous Referee #2

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This is a short and concise paper on the quality of airborne laser altimetry data over a flat ice sheet surface. The authors calculate error statistics from comparisons with near-coincident surface GPS profiling near the Greenland Summit Station. Considering how often these data are used in ice-sheet change assessments, and how accurate they need to be to detect cm-level elevation changes, I think it is a timely and highly appreciated contribution to the community. It also paves the way for using designated airborne surveys to validate satellite altimetry data, in particular the upcoming ICESat-2 mission.

I have only some smaller comments and questions as given in chronological order below. They all refer to line numbers in the discussion paper, but some are of more

general character and could warrant changes also elsewhere in the manuscript.

P1, L21: I think it's worth to mention that you get equally good correspondence with DGPS and PPP techniques. The latter could simplify fieldwork for many applications.

P2, L7: I would also cite Borsa et al. (2014, The Cryosphere) here since the other papers are prior to that do not all account for the Gaussian-Centroid bias.

P2, L18: I don't think airplanes can really bridge the gap between satellite missions at the scale of ice sheets, so I would add "... in areas of special interest" or something like that.

P2, L31: Write out GEDI.

P4, L20: I don't see the need for this abbreviation since it is only used a few times.

P5, L1: The software incorporates GLONASS, but does any of the actual observations include that? It would be a strength if they did, and in that case you should use the general term GNSS in cases where you do not mean solely the GPS system.

P5, L21: Is GLONASS or GALILEO included in any of this processing? If so, it should be mentioned.

P5, L22: I don't think the term PPP has been introduced yet.

P5, L23: Since MABEL is included for reference, I think it's also worth to describe ICESat-2 in a similar fashion as a part of the same section or a brief separate one. In perspective of future ICESat-2 validation, it would be useful to know roughly how many comparison points one would get with the present GPS survey lines.

P6, L23: Since this PPP software is commercial and many people these days use freely available services like the Canadian CSRS-PPP, it would be nice to see how one of these automatic processors would compare in the validation exercise.

P6, L28: I miss some small details on the processing: Were final IGS orbits used

in all processing cases? Same for clock corrections? How were tropospheric and ionospheric errors dealt with? Was a cut-off angle used for satellite elevation to mitigate multipath?

P7, L4: How were these solid earth tides estimated?

P7, L16: I don't understand this logic. From these numbers I only gather a footprint spacing of 5 m, not the actual size.

P8, L5-12: While uncertainty in the ground-based GPS probably influences the inferred lidar precision, it is also worth to mention that the two surface measurement techniques are partly correlated through their common use of GPS (and partly processing techniques) for vehicle positioning. I don't think this will have a large impact, but it is worth to discuss briefly. The problem could be mitigated by additional or isolated use of GLONASS or GALILEO in one of the platforms, but that might not be possible.

P9, L16: In case of outliers it would make most sense to use the median value in each zone. Did you also try that? Worth to mention whether or not it makes a difference.

P9, L18: How flat is 'relatively flat'? It would be good to provide some kind of information about the summit topography, for example elevation range, mean slope, or average elevation impact of a given geolocation error like 5-10 m.

P9, L27: This is an interesting finding that I think should also be mentioned in the abstract or conclusions.

P11, L16: Credits to the authors for making all data easily available. Exemplary!

Fig 3: The TRACK solutions seem to infer a higher lidar bias than GITAR and PPP. Is this random or could there be a viable explanation related to processing?