

Review of Lindbäck et al., Earth System Science Data Discussion, 2018

This is a very good manuscript that presents ice thickness and subglacial topography/bathymetry digital elevation models (DEMs) of a series of glaciers in NW Svalbard. The quality of the data is very good, and the methods of acquisition and processing (and their description) are appropriate. Errors and uncertainties are outlined effectively. The DEMs are important for several purposes, the most important being for numerical modelling of glacier behaviour/evolution, with implications for global sea level rise.

I do have some suggestions for ways in which the manuscript can be improved before publication:

1. Abstract and conclusions are very superficial and general at present. Both need improvement so that they actually report/summarise the manuscript and provide more detail. Abstract is currently very short, so there is room to develop it.
2. The figures: (a) have multiple basic errors (e.g. lack easting northing, have bizarre distance scales etc.); (b) could be improved with some simple changes to the GIS (e.g. have discrete/classified colour scales, rather than continuous ones), and (c) are lacking the presentation of certain datasets (e.g. ice surface elevation). Detailed suggestions of how to edit/improve the figures are provided below.
3. Results section is currently perfunctory (7 lines), whilst significant parts of the discussion section simply describe the data rather than interpret or discuss it. I recommend that sections 3&4 are merged into a single section entitled something along the lines of "Description of DEM morphology and implications for future glacier and landscape dynamics in NW Svalbard"
4. The authors should consider including some profiles extracted from the DEMs as figures. This would serve 2 purposes: (a) to illustrate to those not familiar with the study area and dataset the 'morphology' of the ice thickness/bed elevation; (b) to qualitatively demonstrate the quality of the data (e.g. are there any artefacts at critical locations?). I suggest that along ice flow profiles down the centre lines of the glaciers would be useful as (a) such profiles would likely be input data for 2D ice flow models; and (b) the discussion section describes sills and overdeepenings that are not necessarily obvious from the DEMs alone (at least to someone not familiar with the datasets).

Detailed Comments:

Abstract:

- P1. L12-13: "...which will affect fjord circulation and ecosystems...." – how will retreating glaciers do this? If this is the justification for the datasets, then you need to explain how. I'd also suggest adding something about global sea level, which is the most important impact of your dataset (i.e. DEM can be used for numerical modelling of future glacier behaviour, from which future sea level can be modelled), and perhaps about insights into surging glacier behaviour.
- P1. L13-15: it is worth inserting "ice-penetrating radar" into this sentence (i.e. after "ground-based").
- P1. L15: One sentence on findings. This is not enough. I also suggest a re-phrasing to "Three of the glaciers would have to retreat by ~10 km.....". It would also be worth naming those three glaciers.
- P1. L16-17: "...will be valuable for future studies of glacier dynamics, geology, hydrology and fjord circulation". Fair enough, but how and why? The authors never discuss why the data would be valuable for many of these topics in the manuscript, so why make the statement here? Perhaps the discussion section of the manuscript could be expanded to develop this justification though?

Introduction:

- P1. L26-27: Perhaps add "...providing a contribution to rising global sea levels."?
- P2. L1: The glaciers could advance too (particularly if they are of surge-type), so perhaps "glacier dynamics" or "glacier oscillations" rather than "glacier retreat"?

- Do any of the glaciers in the study area surge? It might be worth stating whether this is the case or not. I believe that Kongsvegen is surge-type glacier?

Study area:

- P2. L9: “Maximum depth in the outer part of the fjord....”?
- I’d would have liked to have seen more information on the glaciology of these glaciers (e.g. surging, subglacial sediments, thermal regime etc.), or at least more references to published papers that describe the glaciological characteristics of these in detail (e.g. I am aware of papers by John Woodward/Tavi Murray/Adam Booth on Kongsvegen), and perhaps at least some description of the wider controls on the glacial system in the study area (e.g. temperature/precipitation/ oceanography etc.).

Data and methods:

- P2. L18: No need for “have”
- P2. L19-20: “...high a radar frequency...”?
- P2. L25: “are” rather than “is”?
- P2. L26: There are much better references than Bamber et al and Fretwell et al. I recommend that examples that report individual airborne surveys are referenced, rather than those that report Antarctic- and Greenland-wide DEMs.

Radar data collected after 2014:

- P3. L7: Can the authors provide more information on the transmitter? Later in the manuscript they refer to Kentech and Narod transmitters, but they do not describe this one. Is it a bespoke transmitter built by NPI? Please either state that it is a bespoke system, or, if it is an ‘off-the-shelf’ system, please give its name (e.g. Narod etc.).
- P3. L9: Break this into two sentences: “...different sensitivity ranges. One channel was attenuated by.....”
- P3. L16: still 125 traces stacked (i.e. equivalent to acquisition with airborne system)?
- P3. L19: 15 m in front or behind the midpoint?
- P3. L24: “...rubber-band correction to re-sample the data to a uniform...”?
- P3. L26: “amplify” rather than “reinforce”?
- P3. L28: The velocity of the radio wave through the ice is assumed (and assumes cold ice?). Can the authors justify this assumption in anyway? I note that Woodward et al., Journal of Glaciology, 2003 reports CMP measurements on Kongsvegen that could be referenced.

Radar data collected prior to 2014:

- P4. L6: Delete “possibly”
- P4. L14-15: It might have just been me, but I didn’t really follow this sentence. Consider rewording.
- P4. L23: how much stacking?

Surface and bathymetric elevation data:

- P6. L9: “The offshore bathymetric...”?
- P6. L9: “acquired” rather than “captured”?
- P6. L9-11: are there any references for this dataset (e.g. a technical report). If there are not, then perhaps a more detailed description of acquisition and processing is required within this manuscript?

Results:

- P7. L9: “For Kronebreen.....”?
- P7. L10: Are these 50 m resolution DEMs also available via the NPI data centre website?

Discussion:

- P7. L12-13: Reword to: "...knowledge of the subglacial topography of retreating glaciers..."
- P7. L15-P8. L7: Lots of this material is description of the DEM morphology, so should be in a results section not a discussion section. In addition, there are multiple features (e.g. overdeepenings)/place names (e.g. Steindolpen) referred to that are not annotated on any figure. To improve readability, the authors should annotate appropriate figures.
- Much of the content describing the morphology of the DEMs would be helped by the inclusion of profiles (e.g. along ice flow, down the centre line of the glaciers) that would help to illustrate features such as overdeepenings and sills. You might also want to cite some classic literature in this section too (e.g. Holtedahl 1967 <https://www.tandfonline.com/doi/abs/10.1080/04353676.1967.11879749>)
- P7. L22: Perhaps include a satellite image in the manuscript, and annotate the rock outcrop? I would suggest that a satellite image of the entire study area would be useful (e.g. figure 1).
- P7. L22-24: Might have been me, but this sentence didn't seem easy to disentangle. I suggest the authors consider rewording it.

Conclusion:

- Like the abstract, rather generic and superficial. I suggest that the authors expand the conclusion to report on/summarise the dataset and manuscript in more detail.

Author contributions:

- P8. L21. "was the main responsible"? Do the authors mean "was primarily responsible"?

Table 1:

- Is it also worth reporting standard deviation?

Figures (general comments)

- All maps need 'easting (utm)' and 'northing (utm)'. Currently only figure 5 has this.
- The distance scale on all of the maps should extend upwards from 0, rather than having ranges from negative values to positive values (e.g. fig 1 extends from -5 to 5 km)
- "Grid *projection is* Universal Transverse Mercator Zone 33W"
- Maps should be annotated with features/places referred to in the text (e.g. Steindolpen nunatak)

Figure 1

- I could not make out the location of: (a) 2005 data; or (b) Black lines indicating location of profiles in figure 4.
- A satellite image of the study area would be useful.
- It would be useful to show which survey lines were (a) acquired by helicopter; (b) acquired by skidoo.
- Rather than stating "blue areas are sea, green areas land and white glacierized", why not add these to the legend?

Figure 3

- This (& fig 2) is a really useful figure. It should not be removed from the manuscript. Could figures 2 & 3 be integrated into one figure however?
- There is a little ambiguity to me about the position of the antennas. Do they run from the Tx and Rx outwards to the end of the plastic pipes, or are they just contained within the plastic pipes. Can the authors please make this clear?
- What about a scale bar?

Figure 4

- Where are these radagrams located? I could not see them on figure 1.
- Perhaps the authors could annotate key features in the radagrams for non-experts in ice-penetrating radar (e.g. ice surface, ice-bed interface, internal layering, hyperbolic reflections from englacial conduits etc.). Perhaps also worth annotating surface multiples?
- Figure 4a: Can the authors explain why if the data have been migrated (as stated in the methods section) there are still hyperbolic reflections within the ice column? Is this evidence for warm ice with a different velocity to that used in the migration? It looks like there might be hyperbola at the bed too (i.e. between 0-2 km).

Figure 5

- No units are given? I assume metres?

Figure 6

- Needs a box showing its location on figure 1 (the extent of figure 1 is greater than that of figure 6).
- Edit the colour scales so that they are in discrete intervals of equal spacing (e.g. 100 m intervals), so that the boundaries between the colours match the contours. At present, with a continuous colour scale it is very difficult for the reader to match the colours with actual elevations. The inclusion of some topographic/bathymetric profiles (see earlier comments) may help with this.
- The authors report a surface DEM in the manuscript. This should be displayed in this figure. They may also wish to include an ice velocity map if one exists for this region.
- 6a – it needs to be made clearer that this is the subglacial/bathymetric map.
- 6b – what is grey backdrop? Presumably topography? Needs stated though.
- Caption: “Glacier surface elevation catchments.....”?
- Caption: “...elevation contours (grey).”
- 6a – what is the black line? The 0 m contour? Make this clear in caption.

Figure 7

- Needs a box showing its location on figure 6 (the extent of figure 6 is greater than that of figure 7).
- See colour scale comments for figure 6.

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