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The Cryosphere Discussions

Interactive comment on "An improved bathymetry compilation for the Bellingshausen Sea, Antarctica, to inform ice-sheet and ocean models" *by* A. G. C. Graham et al.

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We welcome the comments and question by Dr. Jamieson about quality control of topographic features in our new dataset. We are encouraged to see that the dataset is already in use by ice-sheet modellers, and hope the compilation will continue to be a valuable resource to the modelling community.

Having assembled the bathymetry compilation specifically with higher-order ice-sheet models in mind, we are aware that models with finer grid sizes, such as those Dr. Jamieson is working with, will be sensitive to smaller geomorphic features which, previously, may have been insignificant in simulations using lower grid resolutions. As

a result, during grid production, we went to considerable effort to omit any artefacts that were deemed to result from 'poor quality' input data (e.g. from poorly processed multibeam tracks, anomalous or spurious depth soundings). Several iterations of point removal and subsequent regridding ensured major artefacts were removed or subdued. In addition, whilst we recognised the need to create a 'realistic' topography for models, we also wished the dataset to honour the input data as much as possible.

In his comment, Jamieson makes a strong argument for extra investigation of an apparent 'ridge' at the northern front of the George VI Ice Shelf, which is suggested to be erroneous (see profile through the bathymetric grid in the attached Fig. 1a, rendered as a black line, and the feature labelled 'ridge'). This 'ridge' was noted during the initial QC of the gridding outputs, but we decided against altering the interpolation any further by introducing artificial data points, because this would have guided the gridding process towards a 'preferred' result. Our aim was to produce an unbiased representation of the existing data, and we maintain that this was delivered in our submitted dataset.

Dr. Jamieson now describes flowline modelling experiments on the Marguerite Bay Ice Stream in which there are clear issues with the grounding line stabilising on the 'ridge'. This has a profound impact on ice dynamics and, consequently, requires that we establish whether the feature is real or not. Considering the impact the so-called 'ridge' might also have on sub-ice shelf through-flow in ocean models, we agree that further consideration of the feature is warranted.

With regard to the main question, to confirm whether the feature is real or otherwise, we did not find evidence in any published literature for the existence of a ridge at the ice front. The ridge was neither present in track maps, nor in bathymetric soundings, past descriptions of sub-ice bathymetry, or descriptions of oceanographic work.

We have also queried the two data points at the southern slope of the 'ridge' and can confirm that they are digitised from Maslanyj's (1987) contoured bathymetry map, derived from bedrock depth measurements. At -700 m depth, we can deduce that

neither measurement contributes to the form of the ridge, and thus, cannot explain the presence of the feature (see depth of blue dot, Fig. 1a). Therefore, it seems certain that the ridge is an artefact of our compilation.

Having ruled out the ridge being (a) generated from any actual soundings, or (b) the result of the two input points from Maslanyj's map, we address two further possible options suggested by Jamieson to explain the presence of the ridge. One is that the ridge results from an interpolation error at the seam between input datasets, the other stems from depths in the GLOBEC grid of Bolmer (2008) that themselves result from an interpolation procedure. In Fig. 1, we show that it is actually a combination of these two factors that results in the artificial ridge in the dataset.

In our original study, we already eliminated extensive problems of aliasing in the GVIIS region by gridding the ice shelf soundings separately from the ice bed on either side (see green line in Fig. 1a and 1b). This sub-grid (GVIIS spline, Fig. 1) only covered the portion of topography covered by floating ice, and did not extend to areas outside of it. In contrast, the sub-ice bathymetry in the GLOBEC compilation is significantly shallower than the soundings of Maslanyj (1987) and our sub-grid (compare the two profiles in Fig. 1b). The GLOBEC grid interpolates between deep offshore bathymetry at $\sim$-1000 m depth immediately north of the ice shelf front, to shallow depths of -300 metres beneath the floating portion of the GVIIS (Fig. 1b). The red line in Fig. 1a illustrates that a part of the GLOBEC dataset where bathymetry is artificially 'pulled up' was included in our compilation. This anomalously shallow topography produces the northern flank of the so-called 'ridge'. Subsequent interpolation between the shallow portion of the GLOBEC dataset and the deeper GVIIS spline grid, coupled with high elevation rift walls, leads to the creation of the cross-trough feature (Fig. 1a).

As a solution, we propose to remove the artefact in a revised version of the compilation grid, in order to achieve a bathymetry that is both glaciologically and geologically more plausible, as well as a profile that honours existing datasets (e.g. pink dashed line, Fig. 1a). Jamieson suggests a kriging technique as a unifying method for removing such

artefacts. We like this approach, but recognise that, in this instance, aliasing from the flanks of the trough will probably still result in 'pulling up' inner shelf topography. The simplest method for producing a 'realistic' topography is to remove a small portion of the offending GLOBEC dataset, and to add 3 or 4 artificial depth points, in order to guide interpolation away from shallower depths.

Although we recognise this is a subjective adjustment, the revision is essential for a more accurate and useful product. In an updated version of the dataset we will ensure this change is carried out. The digital dataset will be made available with a revised version of the manuscript, in which we will also summarise the justification for the grid adjustments discussed in this interactive comment.

References:

Bolmer, S. T.: A note on the development of the bathymetry of the continental margin west of the Antarctic Peninsula from 65 to 71 S and 65 to 78 W, Deep Sea Re. Part II., 271–276, 2008.

Maslanyj, M. P.: Seismic bedrock depth measurements and the origin of George VI Sound, Antarctic Peninsula, Br. Antarct. Surv. Bull., 75, 51–65, 1987.

Fig. 1: (A) topographic profiles at the northern edge of GVIIS, illustrating our new grid (black) and selected input data that made up the compilation. Data include a portion of the GLOBEC dataset (red), a sub-grid of sub-ice shelf bathymetry (green; GVIIS spline) and contour picks from bedrock depth measurements (blue). A 'ridge' is present at the seam between the GLOBEC and GVIIS spline datasets. (B) comparison of GLOBEC topography (red) and our new grid (green/black) for depths along the main axis of GVIIS. Note the mismatch and anomalously shallow depths in the GLOBEC grid.

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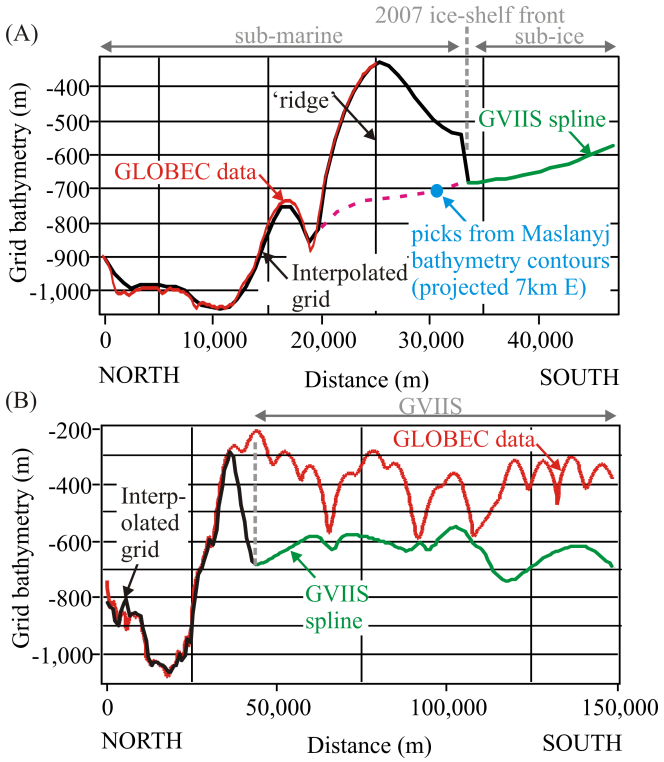
(A)
2007 ice-shelf front
sub-marine
sub-ice
'ridge'
GVIIS spline
GLOBEC data
picks from Maslanyj
bathymetry contours
(projected 7km E)
Interpolated
grid
Grid bathymetry (m)
-400
-500
-600
-700
-800
-900
-1,000
0
10,000
20,000
30,000
40,000
NORTH
Distance (m)
SOUTH
(B)
GVIIS
GLOBEC data
Interp-
olated
grid
GVIIS
spline
Grid bathymetry (m)
-200
-400
-600
-800
-1,000
0
50,000
100,000
150,000
NORTH
Distance (m)
SOUTH

Fig. 1.