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Earth System Science Data Discussions

Interactive comment on "A consistent dataset of Antarctic ice sheet topography, cavity geometry, and global bathymetry" *by* R. Timmermann et al.

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First of all, we would like to thank both reviewers for their careful reading of the manuscript and their helpful and constructive comments. Your input and encouragement are really appreciated and helped a lot to improve the manuscript.

In the following, we quote the reviewers’ comments in *italic* typesetting, followed by our replies.

Anonymous Referee #1

General comments

For a data set like the RTopo, I would like to see some error or uncertainty estimates of the presented topography and elevation fields, beside the cited error of 25 m for the ice shelf thickness of Filchner-Ronne (P 238,L 17ff). Could you please provide

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additional information or state/declare that these are not available.

We agree that a good understanding of errors is important, however with several datasets of very different nature, errors are extremely hard to quantify. For the two sectors with newly gridded bathymetry data (southeastern Bellingshausen Sea and Larsen A/B area), the maps of ship tracks we provide in the original manuscript give some idea about where the resulting map can be trusted. A similar map has been provided for the BEDMAP dataset the in Lythe et al. (2001) paper; the same is true for many of the other source datasets (and the corresponding publications), so we would like to refer the reader/user to the original publications here. Please also note that error quantification becomes nearly impossible where values have been infered from consistency arguments. Still, we were able to collect a bit of information, and the revised manuscript (to be submitted after this response) will contain a section discussing plausible error estimates for the various regions.

Two times you talk about a minimal water depth of 10 am below floating ice shelfs (P 238, L 16 and P 240, L 2). Do you apply this threshold generally? Please clarify this point.

We do apply this threshold generally, but (except for the two regions we mentioned) it mainly kicks in where interpolation artefacts create inconsistencies between surface topographies and the surface type mask. We added a comment on the general procedure at the end of Section 2.2.2.

To determine the ice bottom surface height from surface elevations (ice draft), assumptions about the densities distribution in the ice and of the ocean are required. In the Filchner-Ronne Ice Shelf the sea water density is approximately 1028 kg m-3 and the ice shelf has density ranging from 917 kg m-3 for meteroric ice to 896 kg m-3 for marine ice (Lambrecht et al., 2007). In contrast the George VI Ice Shelf's ice density

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is 910 kg m-3 without any firn correction. Do have have done also these calculations and if so what have been you densities and have you used a firn correction?

As stated in the manuscript, we converted Lambrecht's ice thickness fields to upper and lower surface topography maps using their eq. (2) with the densities suggested by the authors. Conditions for George VI are different, so again we sticked to the ice properties suggested by the PI of that particular data contribution. For the other ice shelves, we received and retained separate fields for surface height and draft. The rationale behind all this is to be as close to reality as possible, on the scale of individual ice shelves, rather than being globally consistent.

Does you data set map a particular year?

Globally it does not. Regionally it reflects the situation at the time when the particular surveys were carried out, but even these have often stretched over a decade and more. Given that most of the ice thickness surveys were conducted after the mid-1990s, we might want to assume that the situation represented is a somewhat recent one.

On your web page you are asking for an e-mail address to keep the user about you data set updated. You might add this request also in our manuscript under section 4 (Data access).

Good idea, thanks. Done.

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Specific comments

P 233, L 17ff You might shift the ?consistent? to the beginning of the sentence to highlight that not only the masks are consistent: ?The resulting consistent global 1-min topography data set (Rtopo-1) contains maps : : :, and masks for : : : .?

We decided to put the “consistent” in front of “maps”.

P 233, L 17 Would you please be so kind to explain the meaning of the acronym RTopo.

You might want to assume that it stands for “Revised Topography”.

P 234, L 7 To make the point you should rephrase for example:“The rate of ice mass loss from the Antarctic ice sheet (might) contribute to the eustatic global sea level as stated in the IPCC?s Fifth Assessment Report.”

We take your point, but decided to keep our sentence and put the statement “Ice mass loss from any ice sheet is bound to contribute to changes of the global (mean) sea level.” in front.

P 234, L 11 Our final goal is to reduce errors and not bars and, hence, you should rephrase:?In order to reduce errors in high-resolution simulations ...?

Right. We replaced “error bars” by “uncertainties”.

P 234, L 11ff You should split the long sentence (line 11-15) in two parts, like “In order to reduce ... consistent maps for Antarctica ice sheet/shelf topography and global ocean bathymetry. Therefore we combine available ...”

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Done.

P 234, L 22f Does it sound better? "In contrast to the ongoing activities to compile the International Bathymetrie Chart of the Southern Ocean (IBCSO, eg. Schenke and Ott, 2009), our..."

We made it "In contrast to the activities towards an International Bathymetric Chart of the Southern Ocean (IBCSO)"

P 235, L 7 Since your surface elevation is the upper surface of bare ground, ice sheets/shelfs or caps, regardless if it's label "ice" or "ground" (for example Greenland), you should skip "Antarctic" and rephrase: "surface elevations (upper ice surface height for sheets/shelves; bedrock elevation for ice-free continents; zero for ocean)"

Done.

P 235, L 15ff What do you think about this formulation: Ice not connected to the Antarctic ice sheet, including glaciers on subantarctic islands and the Greenland ice sheet, is not covered in our data set; these areas are labeled as bare land surface under preservation of the surface elevation.?

Perfect!

P 236, L 11 Do you mean details?: " ... with an impressive amount of details."

Indeed that's what I mean, but "amount of detail" (without s) seems to be the more common phrasing.

P 236, L 15ff I find it misleading in the text to declare all disconnected ice caps

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from the ice sheet as bare land. Since in the below mentioned data set of Greenland (see below) disconnected caps exists in close neighborhood to ice sheet, for the main land of Antarctica it would be of great value to label these points as ice caps. In this case it would help ice sheet/shelf modelers to distinguish between glaciated and ice-free areas. If, as you figure caption 2 suggests, these caps are located only on the the island of Antarctica, then I am fine with it. However, you should clarify this point in the main text and not in the figure caption.

On the scale of our data set, there are no detached ice caps on the Antarctic main land. The comment in the caption to Fig.2 is only to keep the reader from searching for grey colors, because the grey patches are actually too small to be seen on this picture. We rephrased the caption though.

P 237, L 10 You might erase Antarctic:"... the transition line follows the ice shelf front or coast."

we rephrased it to "or the coast line"

P 237, L 10ff Since the sentence that begins with "In order to avoid" is long and conveys several information, you might skip the embedded brackets "(which is the latitude between the Larsen B and Larsen C Ice Shelf areas)" or split the sentence.

We removed the part in the brackets. That the line is between these two ice shelves is just coincidence anyway.

P 237, L 21 You might replace the word "use" by "incorporate" to obtain: "In order to incorporate topographic information..."

Much better! Done.

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P 238, L 4 Since inlets are not really filled with values you might rephrase: "Given their small scale..., the inlets downstream from Hennen Ice Rise are represented by interpolated values."

We now fill the data gaps in the inlets.

P 238, L 8 You probably mean floating condition and should rephrase: "In order to maintain floating condition in the..." At the end of the sentence I would rephrase: " ...grounding line positions of Rignot and Jacobs (2002) instead, which has also been suggested by Makinson and Nicholls (1999) and Lambrecht et al. (2007)."

We actually just mean "floating ice". Corrected. The last part of the sentence we rephrased to "which is consistent with the maps of Makinson and Nicholls (1999) and Lambrecht et al. (2007) at this location. "

P 238, L 19 Figure 3 suggests, that the width of the transition zone between data sets varies. Would you please provide some information about the width range like: The width of the transition corridor varies between X to Y and be seen in the left panel of Figure 3" In the view of the utilized tanh a per-se threshold defining the transition from one end to the other does not exists. Which threshold have you used in your left figure 3.

In this figure, we plotted the transition zones within the 25%-75% interval. In the new figure with revised color scale, we will use the interval 10%-90%. Data processing used cutoffs at 1% and 99% though.

P 238, L 21 Erase localized to obtain: "... and occur in a narrow band along the grounding line."

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We do not see what's wrong with "localized". It means something like "in a very limited area", which es exactly what we want to say. No change to manuscript here.

P 238, L 22 I prefer in the running text "Figure" instead of "Fig", as long as they're not part of a pair of parentheses.

Makes sense. Done.

P 238, L 26 You might rephrase by replacing "with" against "from" and by replacing "datasets" against "data set" : "...which is a combination of ship data from the "Airborne Geophysical Survey of the Amundsen Embayment" (AGASEA) and the BEDMAP data set."

As far as I understand, the data set in question (Nitsche et al., 2007) actually is a combination of (independent!) ship data with data from AGASEA and BEDMAP. No change done to manuscript.

P 239, L1 Do you mean "The former data set has already..." instead of "This dataset has already..."?

No, I don't. ALBMAP already includes the full Nitsche et al. dataset, but for bathymetry we did it again from the original data to avoid losing resolution. No change done to manuscript.

P 239, L 2 Erase "here" to obtain: "use the original Nitsche et al.(2007) data."

"Here" refers to Pine Island Bay. The Nitsche data set is a bit larger, but we only use it in the Bay (because that's where it mostly brings independent information).

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No change done to manuscript.

P 239, L 10 Please introduce the abbreviation PIG in the main text, for example in line 7: "An important exception is Pine Island Glacier (PIG), where..."

Done.

P 239, L 21 You might add "observations" to obtain: "obtained from ICESat altimetry observations"

We decided not to.

P 239, L 23 Delete "," (comma)

Not so sure about this, but it reads easier without comma. Deleted.

P 239, L 24 You might rephrase: "...in a sense that all areas denoted as ice shelf are characterized by floating ice in reality."

I agree that this phrase was a bit awkward. We decided to put it this way: "It is a rather conservative estimate in a sense that for all areas denoted as ice shelf we can be sure to find floating ice in reality."

P 240, L 2 Add a subject:"...based on ALBMAP, but it has been modified..."

Done.

P 240, L 5 You might erase "The existence of" to obtain "Such deep troughs..."

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Decided not to.

P240, L 9 You might delete "indeed": "...show that troughs of very similar depth and ...,"

We replaced "indeed" by "in fact".

P 240, L 14 You might rephrase "... February 2002, respectively, transformed the former cavities into open water embayments."

Done.

P 240, L 19 You might erase "as a basis": "... spherical triangulation is used to fill the gaps between cruise tracks."

Strictly speaking the triangulation only creates the grid for interpolation. We agree though that the sentence is clearer without the "as a basis" bit and removed it.

P 240, L 20 Of course we all do our job carefully and hence you should delete carefully: "... embayment has been corrected wherever the existance..."

Right you are. Done.

P 241,L 2 You might erase "in the area": "... cruise ANT-XI/3 (Rottmann et al., 1996) near the Ronne Entrance (Fig. 6)."

It is indeed an area near Ronne Entrance, so a bit larger than just near the entrance. Therefore we decided to keep the words.

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P 241, L 7 It is not completely clear to which data sets refer the "these" (from the sentence: "In contrast to the representation..., THESE data taken together .."). Please clarify this point.

"These" refers to all the data sets listed above. We replaced "these data taken together" by "our bathymetry data".

P 241, L 10 Please rephrase the sentence that begins with "Note that we .." to obtain for example: "The data gap in the bathymetry in the northern part of the George VI Sound is filled with an assumed profile that is fully consistent with the Potter and Paren (1985) plume line profile along the the northern ice shelf front."

The reason for putting it the way we did is that the assumptions in the northern part of George VI Sound are crucial for our suggestion that there is a coherent trough extending all the way from Marguerite Bay to Ronne Entrance. We mean to say that there is a bit of uncertainty, but we tried to keep it to a minumum. To keep this message, we decided not to modify the manuscript.

P 242, L 2 You might replace the second "Smedsrud et al. (2006)" against "they" to obtain: "They interpolated original seismic..."

We decided to combine the two sentences with ".., who interpolated..."

P 242, L 6 Do you meant plural data: "...no seismic data are available, ice shelf draft..."?

Yes. Changed.

P 242, L 8 Please erase one "at", like "... deepest grounding line at the Fimbul

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ice shelf..."

Done.

P 242, L 10 Do you really need for a single sentence a new paragraph, which isn't a perfect style?

Given that this is a different subject that in the first paragraph, we would like to keep it separate. We split the sentence into two though.

P 242, L 13 If you had discussed the mask already, you would not need to do it again. Hence replace "discussed" by "mentioned": "As mentioned, we provide a global mask that..."

Good point. Done.

P 242, L 15 You might also discard "as already mentioned" to obtain: "However, coast and grounding line locations..."

Done.

P 242, L 21 Since you have a enumeration of more than two items, you might add the missing "," (comma) to obtain:"... Amery Ice Shelf (ice front, grounding line, ice rumbles), and Fimbul Ice..."

Done.

P 242, L 23 Since you state that subglacial lakes are ignored, have you reduced the ice thickness by the water depth or have to add the water depth to the ice thickness?

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Please clarify this point.

The method of calculation in BEDMAP/ALBMAP was: surface elevation minus ice thickness = bedrock elevation. Given that airborne radar surveys map the ice bottom, not the bedrock, the lake will be within our bedrock model. We clarified this bit in the revised manuscript.

P 242, L 25 Since you haven't a mask value or type labeled "continent", you probably mean "bare ground".

Right. We changed this bit.

P 243, L 8 You might rephrase because your data set comprises a mask and data fields: "...that are consistent with the mask and all other (data) fields."

Done.

P 243, L 18 To be consistent with the tense of the first sentence in this paragraph you might rephrase to: "... the southeastern Bellingshausen Sea), we have presented data..."

Done.

P 243, L 18 You might replace "next to" against "beside": "Beside maps for bedrock topography and the upper and lower surface..."

Given that the maps and the masks stand side by side on an equal level of importance, we would like to keep the "Next to".

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P 243, L 20 You surely have "systems" in mind: "... heights of the Antarctic ice sheet/ice shelf systems.."

Actually, no. There is just one ice sheet/shelves system in the Antarctic.

P 243, L 22 Is it really of natural origin? You might rephrase "Of course, this kind of data set can..."

We just removed the word.

P 243, L 22 Since you summarize your manuscript, you have already mentioned all aspects that you discuss here. Therefore, delete all "mentioned" parts. You might rephrase: "The bathymetry under Larsen C Ice Shelf is, for example, not more than an educated guess. Therefore contributions to improve the data set are more than welcome." P 243, L 27ff I guess you would like to obtain new data right away. Therefore, you should change the tense of the last sentence to: "Any additional contribution regarding local ice shelf/cavity geometry are more than welcome and are used to update the data set as soon as possible."

We modified this paragraph in a way that follows both suggestions.

Figure 2: In the sub sections from 2.2.3 (Filchner-Ronne Ice Shelf) to 2.2.9 (Fimbul Ice Shelf) you describe certain aspects of the topography and refer therefore to the figures 4 to 6. However most of the named locations are not labeled in the corresponding figures. Please add the missing notations. In addition it might be informative in some cases if you would also refer to the given data set number of table 1 and/or figure 3 to guide the reader directly to the right location.

The revised manuscript has locations labeled in the pictures.

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Since the grounding line seems to be often congruent with the coast line on your plots and therefore barely detectable as gray line, please notice it for example in the caption of figure 2.

Where grounding line and coast line are congruent, there is no grounding line (not even in the data set!). The grounding line is not the limit of the ice sheet; it is the transition line between grounded and floating ice, which just does not exist wherever there is no ice shelf. We admit though that an 'ice front' line might be useful for many users, and we will happily provide assistance in its generation (if needed).

Figure 3: The colors of the data sources 3 and 4 as well as 6 to 8 are barely separably. In particular the spatially close located neighbors 6 to 8 should have distinctively different colors. Please spread the colors differently, use an other color map, or use additional characteristics like strips, points.

We will modify the color scheme.

Figures 4-6: Please add the notations to referred locations from the main text.

Same as above. Will do.

Data set: I suggest to add the attribute ?coordinates? to all fields, with the exception of lon and lat, in the NetCDF files, because it helps some visualization programs to draw proper figures. foreach FIELD (bathy draft : : :)
ncatted -O -a coordinate,$ {FIELD },c,c,"lon lat" FILENAME
end Further on I would like to see the coding of the mask values given as attributes or as part of the long_name attribute like "mask (ocean:0, ice sheet:1, ice shelf:2, rock:3)" In addition, I recommend to add global attributes explaining the origin of the

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data set and give proper citation hints (The nco ? netcdf climate operator ? suite helps to perform the task).

We will follow these suggestions for the next version of the data set.

Wish list ========= I understand the restriction on the ice sheet of Antarctica, which is enough for one data set. However, the global coverage of the presented data set calls for the integration of the Greenland ice sheet as the second largest ice sheet on earth for the next release. To restrict the effort in this case it might be possible to integrate another freely available data set into RTopo as for example the data set provided by the SeaRise project available under http://websrv.cs.umt.edu/isis/index.php/Present_Day_Greenland.

Sounds great. As soon as there are enough contributions to come up with a new version, we will seriously look into this.

I personally prefer the "data set" instead of "dataset", but I am also fine with the latter one. In my humble opinion is a data set a selection of fields and, hence, a data set like the BADMAP calls for the single form. Please consistently use either the single or plural form in your manuscript.

We consistently use "data set" now.

Thank you so much for your very careful reading of our maunscript!

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