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Discussions

# Interactive comment on "Tectonic and oceanographic controls on Abbot Ice Shelf thickness and stability" *by* J. R. Cochran et al.

**J. R. Cochran et al.**

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Summary This paper describes the use of the Operation IceBridge topographic mapper, radar and gravimetry data, plus some ancillary data sets, to describe the tectonic setting underlying and surrounding Abbot Ice Shelf (AbIS) and the oceanographic conditions which combine with the bathymetry to determine basal melting. The paper is well written and is a valuable contribution to the literature on Amundsen Sea ice shelves. While I have a large number of comments, I don't think it will take long to revise this paper. Comment IDs are page/line numbers.

– Laurie Padman MAJOR COMMENTS 1) Maybe for the journal, not the authors: Figure sizes on "printer friendly format" are inadequate. I needed to view the figures greatly expanded on the computer, especially Figs. 1-3.

The reason for this is that a number of figures were prepared in "landscape", rather than "portrait" mode. TCD did not rotate any of them on the page and, for some reason, TCD did not print them fully across the page. This is an issue for the editor to address.

5513/7-10: Can you tell us briefly here, why the base could not be imaged by radar in this region?

Based on the appearance of the echograms, it was originally assumed it to be an instrumental problem. However, we have queried John Paden at CRESIS, who said he did not think that was the case and suggested the presence of accretion ice

5513/16: A standard error of 12 m seems high when the full range is 1-26 m.

Yes, thank you. I checked and found an error in the script that I used to calculate it. The actual value is 5.79 m. The same script was used for the gravity crossover, where the correct value is 0.75 mGal, rather than 1.44 mGal.

5519/25: As a non-geologist, I was a bit confused by what was meant by "an en echelon set of faults". Also 5520/3, "half graben". You don't need to teach us geology, but a quick and simple explanation of these terms might be useful. OK. We have reworded the sentence to explain the pattern. It is fairly common, particularly in the early development of a tectonically active area.

A half-graben is a basin bounded on one side by a fault. We have reworded the sentence where the term is first used, to make this clearer.

5520/8: I don't really know what I'm meant to see in Fig. 1 and Fig. 3b to confirm the existence of "ice rises and rumples on the ice shelf surface". For Fig. 1, it may just be that the figure is too unclear, even magnified on the screen.

We have replaced Figure 1with a MODIS MOA image which more clearly shows the two linear chains of topographic rises/rumples extending east from the King Peninsula into the ice shelf. We have also added a label with an arrow to them to guide the eye. and the text indicates where they are located on the profiles in Figure 3.

5521/19: See extensive comments below re Figure 4. In particular, given that your thesis is about circulation of CDW through poorly defined troughs, you need the IBSCO data points marked, and the RSS Shackleton 2012 cruise near the western ice front marked.

We have added the location of the Shackleton line along the western ice front to a revised Figure 4., but do not have all of the IBCSO track line data. There are, however, very few tracks on the continental shelf north of the Abbot (Figure 1 of Arndt et al (2013) suggests only three lines). We do have data from a 1999 Palmer line in that region and will show its location on a revised Figure 4 discuss it in the revised paper.

5522/3: Give actual "x" coordinates for the locations of "footwall rims" in Fig. 3 for us to focus on. I think one of these is near x=37 km, yes? Others?

Yes, and they are now listed in the text.

5522/6-8: Comparison of mean depth of AbIS needs to specify here (in main text) that the means are evaluated from Bedmap2 points at the same locations (along the OIB lines). This is clear in Figure 8 caption but the impression, at this point in the text, is that you're comparing an "OIB mean ice shelf elevation" with the Bedmap2 total ice shelf mean value, so that sampling might explain the difference.

OK, sentence changed to make that clear.

5522/13-16: I was surprised that any marine ice is expected on Abbot. Usually requires strong basal slopes and sources of supercooled water (so, a fairly strong vertical velocity of meltwater).

Such source regions may exist both near deep glacier grounding lines and where near-freezing surface water melts basal ice and upwells. We have reworded the sentence addressing this and your comment.

5522/19-23: This long sentence is very difficult for me to parse. Break in two, or otherwise rewrite?

It is broken up.

MINOR COMMENTS In general, I'd use "Abbot Ice Shelf" instead of "the Abbot Ice Shelf". Also, consider whether it is reasonable to abbreviate it to, e.g., "AbIS" (not "AIS", which is ambiguous).

OK, re. your first comment. However, we are not fond of creating acronyms and would rather not.

5510/6: comma after "balance" OK- changed

5510/10: capitalize "Shelf" OK- changed

5511/4: comma after "Embayment" OK- changed

5513/3-6: don't need quotation marked around instrument names. OK- changed

5513/9: space after "axis" OK- changed

5514/4: comma after "island" OK- changed

5517/29-30: Where do I see "Peter I Island" and "De Gerlache seamounts" on a figure? They are well off the shelf to the north. The island and seamounts are only mentioned in passing and to extend Figure 4 that far north would shrink things that it is meant to show to the extent that it would not be useful. We do give their latitudes and longitudes.

5520/17: Explicitly mark and identify the BGA on Figure 2. It is off of the map to the west. We will extend Figure 2 west to 110°W although it will make everything on the map smaller.

5520/18: Not sure what is meant by "which LATER marked the ..." The paragraph has been reworded.

5521/3: Clearer, I think, if you say "extends NORTHWARD along ..." OK- changed

5522/28: "Wilkens" => "Wilkins" Thank you – fixed

5523/1-2: I think it is not just that the "winter water" layer cools and deepens seasonally that matters, but that the upper ocean responds dynamically much more easily (and quickly?) than CDW inflows forced by larger-scale atmospherics. E.g., at Wilkins we see frontal upwelling and downwelling responses to *local* winds. You get to some of this in the next para, but I'd bring this up here.

We have reworded both this sentence and the next paragraph to address your comment.

5523/5: I don't recall anything about "the August 2007-2008" period as being special. This is not your survey period, so it has something to do with Rignot et al. (2013)? However, I also don't recall seeing a statement of *when* the AbIS OIB data set was acquired.

2007-2008 is the time frame of the Rignot et al (2013) snapshot of melt rate. We removed the reference to the years in the revised version. The OIB data is from October and November 2009. The year is given at the beginning of section 2.1.

5523/10: I don't know why you say that AbIS "is NOW sensitive to". The studies you quote suggest it isn't thinning so, unlike Wilkins, it hasn't become more exposed to surface processes with time. It IS reasonable to assume that its thinness makes it sensitive to fracture processes by surface meltwater, but the "NOW" really requires you to tell us how its exposure to upper-ocean processes has changed. Since it isn't by ice draft, the only other option is a trend in Amundsen Sea surface properties. If that's what you're implying, you'll need a citation.

OK -See your point. The "now" is now dropped.

FIGURES Figure 1: Unclear, even when greatly expanded on-screen. There are a lot of things, and some *very* small text labels, that don't help the story. A better approach (IMO), is to build your own map, e.g., using the MOA or Landsat backgrounds, contouring a recent DEM and, maybe, adding IBSCO depth, then only labeling the features

that matter.

We have redone Figure 1 using a MODIS MOA image and the Bedmap2 surface DEM, as discussed above.

Figure 2: Identify and label the BGA. That requires extending the map westward to 110°W, but we will do that.

Figure 3: Axis numerical labels are too small. We will increase the font size

Figure 4: (a) Limit of rifting is shown as a red line on the map itself, but purple in the legend panel. Fixed

(b) Extend map so it gets to the shelf break along all or most of the northern boundary, so you can see where a trough leading out from between Dustin and McNamara islands might go.

We will extend at least far enough to show the Palmer track mentioned above.

(c) Add IBSCO track lines. I really don't like this figure as-is: it leaves the impression that there *is* a sill between the CTD stations and the western ice front, which you tell us really isn't there based on new data. And it doesn't show the trough that you postulate might lead north between D and M islands but I can't tell, from the present Fig.4, whether that is a reasonable hypothesis.

There are two different comments here. We have added the Shackleton track line along the western ice front and will mask out the erroneous sill in the IBCSO map. IBCSO does not use this track. There may or may not be a trough leading across the continental shelf and between Dustin and McNamera Island. We note that it is a possibility given deep water between the two islands under the ice shelf. See an earlier comment regarding IBCSO track lines north of Abbot

Figure 6: Minor comment: using solid line for Bedmap2 mean and dashed for your own mean draft suggests that Bedmap2 is the "preferred" value. Since the histogram in B

is Bedmap2, this is probably okay.

Figure 7: Would like to see a second panel showing proposed *map* of seafloor depth, and maybe a third showing "water column height".

We tend to disagree, as does referee Brisbourne, although for a different reason. As noted above, the wide track spacing precludes effective gridding

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