

Interactive comment on “Mid-Holocene thinning of David Glacier, Antarctica: Chronology and Controls” by Jamey Stutz et al.

Keir Nichols (Referee)

knichol3@tulane.edu

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Please find below my review comments, as well as attached as a pdf (just in case this is more helpful for the authors, particularly with formatting that may not show up below)

General comments

Using ^{10}Be and ^3He exposure ages at multiple sites, Stutz et al. constrain the minimum LGM thickness and post-LGM thinning history of the David Glacier, one of the largest glaciers draining ice from the East Antarctic Ice Sheet into the Ross Sea. The paper adds to our knowledge of the past behaviour of the EAIS, filling in a large spatial gap. Through flowline modelling, the authors then explore the potential dominant mechanisms/forcings that could help explain the retreat and thinning history of the

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glacier, informed by both their own constraints as well as marine evidence. The paper will be of great interest to both glacial geologists and numerical ice sheet modellers alike. I thoroughly enjoyed reading the paper and found it very informative and interesting. The paper is well written, logically structured, and the figures are of a high quality, making it easy to follow for the vast majority of it. I would not class any of my comments as “major”. Most of my comments are requesting a little bit more information in a few parts of the paper, or minor technical corrections/suggestions. I recommend publication after addressing some points, listed below:

Specific comments (intermediate)

Sect. 2.1 - I think a short paragraph (either at the end of this section or the beginning of the next section, 2.2) describing how exactly the exposure ages inform the modelling approach would be helpful. I think at present it is a little unclear as to how the two are linked.

Additionally, I think a little bit more info on which parameters were varied in the sensitivity experiments, and how they were chosen, would be beneficial.

Could the authors produce a figure for the D’Urville Wall and Mt. Neumayer area similar to Figures 2 and 4? At present, section 3.3 comes as somewhat of a surprise, and is difficult to place spatially (though it is helpful that the location is shown in Figure A2. I must say that I very much like the supplementary figures).

The authors refer the reader to the online antarctica.ice-d.org database for nuclide concentrations and other information required to calculate the exposure ages reported. I think it would be beneficial to add a table to the supplement of this paper including both information that is already included in the ICE-D database (sample IDs, nuclide concentrations, samples thickness, shielding factor, etc.) as well as some information that is not. The latter would include (for Be) quartz mass, Be carrier mass, and the $^{10}\text{Be}/^9\text{Be}$ ratio (+ for process blank(s)). This information would be necessary if a reader were to want to redo the data reduction before recalculating exposure ages

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independently.

Additionally, because the sample data is not included in a table in the paper, the only place to see which samples were analysed is in Figs 2 and 4. Because there is no figure showing the samples analysed for the D'Urville Wall and Mt. Neumayer, the reader cannot double check the exposure ages or recalculate them independently.

In the ICE-D database, there are no exposure ages or nuclide concentrations included for any of the samples from the D'Urville Wall site. Additionally, the D'Urville Wall site is named "Mt. Neumayer", whilst there is another separate section for the Mt. Neumayer samples.

Specific comments (minor/technical)

L 24 "Antarctic ice sheet" – this is the first mention of this phrase here, the authors could add "(AIS)" here rather than on line 28.

L 47 A space is needed after "Oscillation"

L 54 Are the references for the statements in this sentence the same as the next one (papers by Anderson and McKay)? If not, I think references may be needed here in line 54, otherwise please disregard.

L 59 "TAM" hasn't been defined yet. After defining it here in Line 59, you can remove "Transantarctic Mountains" in line 64 and replace with TAM.

L 76 "sampled" could be changed to "collected"

L 79 Should it be "using the structure from motion technique. . ."?

L 84 I think starting this sentence with the phrase "The aim of the sampling method is to track the upper ice surface. . ." would be more accurate.

L 90 I think some extra context would be useful at the end of this section. Why would bedrock be more useful for longer term exposure vs erratics?

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L 95 How many etchings were done with the samples? A range would be useful.

L 101 (and reference list) The reference to Balter et al. (2020) can be updated from the Cryosphere Discussion paper to the final paper (Possibly Balter-Kennedy et al., 2020 now instead?).

L 101-102 Which nuclides were measured in these additional samples?

L 106-108 I think links to the online calculators, both the ice-tea one and that which has evolved from the Balco et al. (2008) paper, would be useful additions here.

Sect. 2.2.2 When the authors use the phrase "consistent with all existing geological constraints" (L 187) and "consistent with geologic constraints" (L 190), does this refer to the exposure ages produced by this study, prior geologic constraints, or both?

L 108 (and reference list) Balco (2020) is referenced for the ICE-D database. In the reference list, the entry for Balco 2020 is for a study in the Annual Reviews journal, however, I think the paper the authors intend to reference is that in Geochronology (<https://gchron.copernicus.org/articles/2/169/2020/>).

L 206 Table number is missing here (also line 256).

L 246-247 "High elevation bedrock samples are much younger than exposure ages from nearby bedrock at similar height above the local ice surface" - Should the second part of the sentence read "from nearby erratics"? Otherwise, this sentence is a little confusing.

Sect. 4 L 252 I think one or two sentences briefly summarising the exposure age findings (timing and magnitude of thinning at the different sites) would make for a handy intro to this section. At present it feels like a jump to go from Sect. 3 to Sect.4, I think an additional sentence would help link them.

L 264 To help the reader follow, I would reiterate here that, as stated in L 144 – 146, "a reduction in lateral buttressing is expected as the expanded David Glacier and

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grounded ice in the Ross Sea decouple”

L 295 “The reconstructed palaeo-thinning along the David Glacier during the mid-Holocene is synchronous with rapid thinning reconstructed at a number of sites in Antarctica”

In addition to citing the study by Small et al. (2019), I think it would be helpful to the reader to list and cite the sites around Antarctica which the authors have in mind here. In the abstract, the authors mention that the timing and rate of thinning at David Glacier is similar to reconstructions in the Amundsen and Weddell embayments, so I think it would be helpful to know the exact sites and records in those two regions.

L 313 – 318 I think a sentence or two on the rationale/motivation for the data model comparison may be helpful to the reader. Something on what the data model provides in the grand scheme of things (like helping to inform future modelling studies) could be useful. This may also help to link this part of the paper to the rest of the study.

On the same point, the paragraph at lines 331 to 357 covers what I think would be better suited to the start of this sub-section. I think this paragraph would be better placed prior to the data model comparison (so prior to line 313).

Additionally, I think the paper would flow better if the Palaeo-thinning rates and data-model comparison were separated into two sub sections. So 5.1 with the thinning rates, then 5.2 with the data model comparison.

L 324 “15-13 345 ka” should this be 15-13 ka?

L 331 “. . .widespread interior in its interior. . .” should possibly be widespread “thinning”?

L 387 Should it be adjacent “to” Mt. Kring, rather than adjacent “at”?

L 424 Two question marks here within the brackets – I imagine this might be two references missing due to a reference manager error?

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Even though some of them may be obvious, I think some of the terms in equations 1-6 are not defined.

Coulman Island is mentioned a few times but is not included in any of the location figures (though the Coulman Island GZW is mentioned in Figure A2). If possible, labelling it in one of the earlier figures would be helpful – though I do not think this is a problem worth making an entirely new figure for. If it cannot be easily labelled in an existing figure, at the first mention in the text, the location could be described in a little more detail (e.g., XX km in XX direction from the DIT) to save from making a new figure just to add a label for one location.

Figures

Figure 1 caption – there is an “A)” at the start of the caption, but it appears to be the only part of the figure (i.e. no Figure 1B, C etc.).

I may have missed it in the text, but what is the source of the bathymetric features? The iceberg scour, grounding zone wedge etc. locations? If not mentioned in the text, I think this could be added to the caption (my apologies if I missed this in the text, though).

Figure 2 and 4: Changing the colour of the ^3He exposure ages from grey to something else may help them stand out – at present they blend in with the colour of the ice

Figure 2 – It is not clear which samples in ICE-D match those with the sample IDs MtKring01px4-5, MtKring02px, 03px, and 03ol in Figure 2. MK04 is in Figure 2, but there are no ages or nuclide concentrations for this sample in ICE-D. Additionally, MK14 is a ^{10}Be age but is grey, should it be red?

Figure 3 B “20” on the y axis, and “7.5” on the x axis are overlapping

Figure 9 My apologies if I have missed it, but SIS is defined in the figure caption, but I don’t see SIS labelled in the figure.

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I was a little confused by the appendix – is it meant to be split into two parts (the latter with the model setup and results)? At present there seems to be two Figs A1, 2, 3, and 4.

Figure A3 (first one) Orange circles – do the authors mean red circles? Also, the grey squares are not mentioned in the caption.

Figure A4 (first one) - The red squares are not mentioned in the caption.

Figure A1 (second one) This is not of huge importance, but I think Figure A1 would be more useful within the main text given the importance of the flowline model to the overall study. Also, location name abbreviations in the figure caption need to be defined (my apologies if they have been defined elsewhere and I missed them).

Please also note the supplement to this comment:

<https://tc.copernicus.org/preprints/tc-2020-284/tc-2020-284-RC1-supplement.pdf>

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-284>, 2020.