Editor comments on "Mid-Holocene thinning of David Glacier, Antarctica: Chronology and Controls" by Stutz et al.

I would like to thank the reviewers for reviewing the re-submitted version of this article. The reviewers identify a number of minor outstanding issues but confirm that their previous comments have largely been addressed. However, on reading the revised version of the manuscript I feel that there are still a large number of points that require clarification. To this end, I have carried out my own review of the current version, my comments are below. I hope that you find my feedback constructive.

Pippa Whitehouse (Editor)

Major points

Model Setup: there appear to be two sets of sensitivity experiments carried out; in the first, the aim is to reproduce the modern behaviour of David Glacier (line 167), while the second investigates the controls on glacier retreat from an LGM state (more on this in the next main point).

With regard to the experiments that seek to replicate modern conditions: what climate forcing was used? What parameters were tuned and what values do these parameters take? I could not see any results documented for this set of experiments. With regard to the experiments that investigate controls on glacier retreat: lines 215-216 suggest that the deglacial experiments are initialised using parameters tuned to replicate modern conditions – state clearly what these parameters are, what values they take, and provide justification that they are relevant for initialising the model under glacial conditions. Separately, state what values are used for accumulation and temperature (ice? atmospheric? oceanic?) forcing in the deglacial experiments and whether they vary over the course of the experiments. I have tried to ascertain this information from the text but in places it is very confusing. E.g. text on lines 205-206 states that "transient changes in accumulation and internal ice temperature are tuned over the modelled period…" (what period?) "…to ensure a stable LGM configuration". How does this statement relate to the forcing applied in the deglacial experiments?

Deglacial sensitivity experiments: text on lines 112-114 clearly links the two main components of this study but justification for, and details of, the precise modelling experiments carried out is lacking or hard to track down within the text. Consideration of the following questions within the methods section would help clarify the study:

- Why did you decide to carry out your own modelling experiments?
- Are you seeking to address specific research questions?
- Specifically, why do you seek to investigate the role of basal melt and lateral buttressing? Why do you think they are the most important factors controlling ice stream dynamics in this setting?
- What experiments were carried out, what values were used for each parameter, what is your justification for using these parameter choices / combinations? (Include a table in the main text)
- You mention that grounding line retreat is initiated by progressively increasing sub-ice-shelf melt or decreasing lateral buttressing (lines 221, 331) – is the progressive change carried out within the course of a single numerical experiment or do you carry out many experiments with constant forcing to identify the threshold for triggering grounding line retreat?

Site information: Field sites are first mentioned in the results – consider introducing them in methods section 2.1: Field and laboratory methods. The location of some sites is not clear from the main text, e.g. Cape Phillipi, and it is not clear when fieldwork was carried out.

Interpretation: for readers whose expertise does not lie in cosmogenic exposure dating, some aspects of the interpretation of the field data (sections 3.2 and 3.3) warrant additional explanation or supporting references. Check statements/text on lines 241, 243, 249, 250, 251-252, 263.

Data-model comparisons: some comparisons made in the text are not supported by evidence in the figures. E.g., "the magnitude of modelled elevation change matches well with the surface exposure data" (line 315) – this statement is not supported by the information shown in figure 8. Similarly, "at the LGM, the expanded David glacier had… a grounding line that was pinned on the David Fjord bathymetric sill" (lines 405-407) – modelling profiles in figures 9-11 have the glacial grounding line location well offshore, not pinned on the David Fjord bathymetric sill (assuming I have correctly identified the location of the sill).

In addition, more care is needed to avoid making comparisons between the model predictions and the timing of ice sheet change recorded by the exposure data (see lines 348, 350, 364-365, 472-473, 487). The flowline sensitivity experiments simply apply a step change in forcing, they do not seek to replicate the evolution of forcing during the Holocene. A better approach may be to compare observed and modelled *rates* of thinning; the latter are not reported in the main text, but various statements claim 'good agreement' (lines 407-408, 473). You could also discuss what the modelling reveals about the *relative timing* of grounding line retreat and upstream thinning.

Combined forcing: several statements imply that interactions between enhanced sub-ice shelf melt and reduced lateral buttressing are required to initiate grounding line retreat and/or retreat is triggered at lower threshold values when forcings are combined (see lines 15, 347, 366, 486). These results are not rigorously demonstrated by the results shown in the current manuscript.

Section 5.1: I agree with reviewer 2 that the information in this section provides useful motivation for your study and hence, with the exception of the final paragraph, material should be moved to the opening section of the manuscript.

Writing style: there are several places where the text is implicit rather than explicit, leaving the reader to guess what you are talking about. E.g. Instead of saying "Given the inferred intimate link between the expanded David Glacier and grounded ice in the Ross Sea…" (lines 325-326), this could read, "Given that ice from David Glacier coalesced with grounded ice in the Ross Sea…". Look out for other instances.

Minor Comments

Comments on the text

Many statements in the first paragraph of the introduction require supporting references

Line 39: suggest "…require a correction for *the ongoing response to* millennial…"

Lines 38-43: it is not clear how "a geological perspective on ice sheet behaviour" (lines 31-32) addresses the issues raised in this point

Lines 44-49: your study does not address the role of short-term climate variability

Lines 85-87: additional explanation is needed to explain how samples with “subglacial origins” are used “to track the upper ice surface through time”

Line 100: “the PRIME lab” – what does PRIME stand for?

Lies 125-126: please justify your use of a flowline model to represent ice *sheet* flow and clarify the implications of the assumptions stated on line 126

Line 132: incorrect units for gravitational acceleration

Line 134: the exponent in equation 4 should be (1-n)/(2n)

Lines 153-154: when you talk about ‘lateral buttressing’ I think you are referring to buttressing by ice rather than buttressing by, e.g., fjord margins – make this clear

Line 164: clarify what you mean by an “ice stream-parallel width”

Line 172: indicate the location where tributary mass flux is injected on relevant figures

Line 196: W12 is not a GIA model, it is an ice sheet reconstruction (that was created with the purpose of using it to drive a GIA model). A similar comment applies to the “prescriptive post-glacial rebound model” mentioned on line 303

Lines 197-202: throughout this section you refer to ‘ice surface elevation’, but elevation is usually defined in terms of a height above sea level – you do not clarify what assumptions you make about sea level. I suggest referring to ‘ice thickness’ rather than ‘ice surface elevation’ throughout this paragraph. Ice thickness is defined relative to the bed (regardless of the absolute elevation of the ice surface or the bed) and ice thickness change is what is recorded by the exposure data.

Lines 202-204: text on the timing/processes responsible for retreat should be in the next paragraph

Line 222: is the 7.5 kyr spin-up prior to, or included within, the 15 kyr model run?

Line 224: what is the temporal frequency of the sub-ice-shelf melt rate perturbations?

Lines 266-267: text is unclear

Line 275: what does ‘320’ refer to?

Line 277: “at a number of sites in Antarctica” – summarise the geographic distribution

Line 293: specify that you are talking about the East Antarctic Ice Sheet

Line 302: “forward ice sheet models” – explain, or simplify the terminology

Line 308: “its neighbouring grid cell” – surely each cell has several neighbours?

Line 318: “which impact rate of retreat” – retreat of what? Suggest delete

Line 335: “modelled surface reconstructions place the upper ice surface ~300 metres above…” – what experiment does this text relate to, what time does it relate to?

Line 345: please clarify what is pinned to the sill

Line 352: what are you referring to by the phrase “meltwater parameterization”?

Lines 353-354: “a general fit to modern sub-ice shelf melt rates and basal stress” – are these known for David Glacier, if so, please report values and confirm the fit with your modelling

Lines 411-412: please provide evidence to support your statement that stability of the grounding line implies stability of the Drygalski Ice Tongue

Lines 415-416: text on the Terra Nova Bay polynya is not relevant to this study

Lines 445-446: is the “stable position” mentioned here related to the bathymetric sill mentioned on line 444? How does mention of these stable positions link to opening text in this paragraph, which is about unstable retreat?

Line 447-454: as suggested by one of the reviewers, link this paragraph more closely to the modelling that you have carried out

Line 464: “The modelled grounding line initially retreats to a location where a large GZW has been documented by Lee (2019)” – be more specific about when this happens and the location of the GZW; there is no reference to a GZW identified by Lee (2019) in fig. 12

Lines 488-489: “Data-model mismatches highlight enduring questions…” – be more specific/explicit about what questions you are referring to

Line 492: “Our data constrain…” – what aspect of the glacier do your data constrain?

Comments on Figures

Figures 3 and 5: why are some ages in bold, why are some italicised?

Figures 4, 6 and 7: please explain the y-axis caption ‘Relative Elevation’

Fig. 8: it is difficult to differentiate between some lines; the pale blue line in the lower plot does not appear to be represented in the legend; it is not clear how the 12 models listed in the legend are related to the six studies referenced on lines 303-304

Figures 9-11: three sites are mentioned in the caption, but I only see two on the figures in (A)

Figures 9-11: the top plots in (B) are very confusing. The two sets of y-axes labels imply that a particular melt rate translates into a specific % reduction in lateral buttressing – is this correct? In figure 9, the legend suggests that melt rates are kept constant, but the plotted lines suggest that both melt rate and % of lateral buttressing vary with time. Similar comments can be made for figures 10 and 11; it is not clear what is actually represented by the coloured lines plotted in these figures.

Figures 9-11: it is not appropriate to plot the exposure ages on the same figure as the output from the sensitivity experiments without careful caveat. The implication of plotting the exposure ages is that the x-axis represents some specific time in the past. However, the model output does not represent a specific time, it simply documents the response of a flowline to a step change in forcing.

Fig. 9: what does ‘0% reduction’ refer to – no reduction in buttressing or no reduction in melt rate?

Fig. 10: ice profiles in the top plot of Fig. 10A (‘0% reduction’) do not agree with plots of ice surface elevation change or grounding line migration in Fig. 10B. Fig. 10A also disagrees with text on line 342 which says that retreat occurs when buttressing is reduced by 4%

Fig. 11B: not clear how to interpret the six experiments shown by the six different lines; why are there only three lines in subsequent plots, and why are the two types of forcing seemingly applied at different times?

Fig. 12: the upper plot is not a map of "Holocene thinning". It would be useful to include the position of B' in plot (A) to help relate the two figures. The caption to (B) refers to retreat between 11 ka and 5.5 ka, but plotted ice profiles relate to 13 ka and 4.5-5.5 ka.

General Comments

Check that all acronyms are defined, especially those used in figures

In all cases check it is clear whether 'surface' refers to bedrock or ice

Check the grammar of all text and figure captions. There are several instances of singular/plural errors and in a number of places the text does not make sense or is ambiguous

Check the use of brackets in conjunction with references in the text and figure captions

Use a consistent number of significant figures throughout the text, figures, and tables

Comments on Supplementary Material

Fig. S3/S4: ensure that the orientation of the photo is stated in all cases

Figure S6: does the accumulation profile in the top plot relate to modern or palaeo conditions? Do the ice velocity and ice sheet profiles in the lowest two plots relate to modern or palaeo conditions? What is the implication of the different size yellow triangles?

Table S1: there are some inconsistencies in the text description of the modelling results. For example, why is the grounding line retreat rate for experiment MS1 described as 'rapid' when the value listed is less than half the value listed for experiments MS2 and MS3, where the retreat is described as 'moderate'?