

Review of revised manuscript, “Quantifying and attributing the role of anthropogenic climate change in industrial-era retreat of Pine Island Glacier” by Alexander Bradley et al.

I have reviewed the authors revised manuscript on their study on the historical forcings and dynamics of Pine Island Glacier retreat. The authors have made thorough revisions and offer thoughtful replies to my earlier comments.

My more substantive comments were around the framing of the attribution assessment and the role of the model initialization. I think the authors have adequately addressed these points. They highlight at several points how their initialization strategy may affect model behavior and thus attribution assessments and are careful to frame the conclusions in light of this. I think this helps not only to clarify the study itself, but also provides some new discussion that will be useful for informing future work (e.g., noting that a range of initial states could be an additional “parameter” to incorporate into the calibrate-emulate-simulate procedure).

Although the authors conclude there is still significant uncertainty around the anthropogenic role in the retreat of Pine Island Glacier, they have still made progress on this challenging problem as the first study to tackle the ice-dynamics side of attribution in this region. There are numerous insights that the field can gain from this work.

I have a few very minor comments suggested below, but overall I support the manuscript moving towards publication in The Cryosphere.

We’d like to again say thank you very much for your detailed comments on the paper. As you say, they have helped to clarify the work and better position it in the literature. Below we respond to the final comments.

Minor comments by line

198 – errant characters: (an .

Thanks for spotting this – we have removed in the updated manuscript.

201 – perhaps provide a rough sense of what you mean by “small” here. Decades? Years?

We’ve added an estimate of this (years) in the updated manuscript.

233 – would it be more relevant to cite one of the observational studies that has shown decadal variability in this region (e.g., Jenkins et al., 2018 Nat. Geo.), since the autoregressive noise models are already cited above?

That’s a good point – we’ve added the Jenkins reference suggested.

290 – “first partially grounded cell and the last full floating cell” – this could be somewhat ambiguous wording, as “first” and “last” depend on whether one is counting in a seaward or landward direction. I see what you mean, but my intuition was initially to count in the direction of ice flow so “last floating” threw me off. Perhaps this can be clarified.

We’ve clarified this in the updated manuscript.

299 – observations themselves are uncorrelated? Or observational errors?

Thanks for spotting this – we’ve corrected this in the updated manuscript.

448 – “internal variability in the chaotic climate system is random and unpredictable”.

Perhaps better to say just unpredictable, since it is technically deterministic but chaotic?

That’s a good point. We’ve corrected this in the updated manuscript.

459 – “opinionated” seems an odd word choice here – consider revising?

Have changed this wording in the updated manuscript.

480 – highly likely or unlikely?

Thanks for spotting this!

576 – if the pycnocline continues to rise in the future forcing scenarios, does it eventually reach the surface within the timeframe here? (implying no additional effective forcing once all the water is at the temp of the deep water? If so, perhaps clarify.

We have added a clarification in the updated manuscript.

579 – should the ensemble descriptors be hyphenated? “all-forcings and no-1940s event ensembles...”?

Fixed, thanks for spotting.

626-29 – discussion on refocusing on the initial state – this is helpful and I think helps to show the benefits of this work despite remaining uncertainties.

Thank-you!

644 – check parentheses for reference

Fixed, thanks for spotting.

653 - “will” -> “could”, since the next sentence clarifies that this is conditioned on constant forcing rate? Or reorder the sentences, “if anthropogenic trends persist... then it will remain grounded for ~100 years before...” etc.

We have changed this to ‘could’ in the updated manuscript