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Interactive comment on "Past and future response of Greenland's tidewater glaciers to submarine melting" *by* Donald Slater et al.

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Summary: This paper pairs observations of terminus position change from 191 glaciers around Greenland with runoff and ocean temperature model outputs to devise a simple parameterization that relates terminus position change and submarine melting. Through this analysis, they find that 23% of terminus position change can be explained by variations in submarine melting (at the ice sheet scale). The authors then use the distribution of submarine melt coefficients and projected runoff and ocean temperature change to construct terminus change distributions for the ice sheet through the 21st century. Using this approach, the median terminus retreat driven by submarine melting is near zero under RCP2.6 forcing but the median retreat jumps to 5.8km, with >20km of retreat for 19% of glaciers, under RCP8.5. The paper is very well written and well

motivated, with fairly minor changes recommended to ensure that the methods and interpretation of results are clear. Major Comments: 1. The description of the runoff estimates from RACMO would benefit from a little bit more detail. When you state that you "consider the mean summer runoff over June, July and August", do you mean that you calculate that mean and apply it uniformly throughout the summer (those same three months) when calibrating the submarine melt parameterization? Or do you calculate the mean and apply a normal distribution to spread it across the summer when calibrating the submarine melt parameterization? Essentially it's unclear what you mean when you say that you "consider" these data and I think the addition of a few more sentences explaining the method would be helpful. As a follow-up, if you use summer data here with the argument that most terminus retreat occurs in summer, then why use annual data to characterize ocean thermal forcing? 2. At the top of P16 you describe how you come up with your projections using the K values constructed from observations. Since your projections are very strongly dependent on the K values, this explanation needs to be expanded so that the reader can follow precisely what you have done to devise the projections. It's not clear why you sample the K coefficient 10ˆ4 times from the distribution. Are you extracting K values at random from the distribution for each year for each glacier? Do you extract the K values at random for each year but apply those same values to all glaciers? Are the values extracted over even shorter time periods (say every month) since the magnitude of retreat can vary within a melt season? These are important details that need to be included in the text.

3. I agree with the first reviewer that great care must be taken when presenting the results. The authors note that only a small percentage of terminus retreat can be explained by submarine melt change at the ice sheet scale and reiterate that submarine melting is only one control on terminus position in the discussion, but I agree with the first reviewer that the presentation of a handful of glaciers for demonstration purposes (focusing on Figure 10) may be misleading to someone who does not read the paper thoroughly. Minor Comments: P1,L8: "terminus position change" P1,L10: Insert comma after "considered" P2,L1: I don't think you really describe the chain of

events that lead to submarine melting and/or calving and the associated ice dynamics response. Replace "the described chain of" with something more like "the critical" or "the fundamental". P2,L4-6: I don't think you need anything about floating tongues here because then the rest of the paragraph reads like you are talking about processes occurring just where there is floating ice. If you want to call out that only a handful of glaciers outside of the far north have floating termini in regard to the modeling requirements/complexities, that can be done later on where appropriate. P2,L21-22 and P3,L1-4: Just a personal preference and you can leave it as is, but I think it would be beneficial to take these sentences (summarizing that it's challenging to model ocean and glacier processing right at the termini) to the beginning of the paragraph starting P3,L5 or even remove them altogether. P4,L29: Why 5 years? What if you looked at decadal data instead? Are the results influenced by this time scale? P5: I like the schematic in Figure 1. I think it's a good simple visualization of the approach and datasets. P5,L8: How are they significant? The biggest contributors to discharge? Fastest flowing? I recommend replacing with "fastest flowing" since you mention that 191/211 of the fastest flowing glaciers are included later in the paragraph. P9,L3: You presumably mean bias between the runoff and thermal forcing estimates from 1960-present and the respective MIROC5 data for overlaps in space and time, correct? Instead of "bias corrected", it would be clearer to say that the MIROC5 datasets were adjusted to eliminate systematic offsets with runoff from RACMO and thermal forcing from EN4. Right now this is relegated to an appendix (Appendix A) but I think the contents of this short appendix could easily be merged into the main text without bogging-down the reader. P9,L10: Like my previous comment, it would be helpful to include slightly more detail here. You remove linear trends over time from the data then fit a linear trendline to the detrended submarine melt rate (independent variable) and detrended terminus position (dependent variable) data, correct? It gets a little confusing in here with the multiple mentions of linear trend fitting. A supplemental figure showing the example time series with their linear trends and a scatterplot showing the detrended data and the linear regression applied to assess correlation would be help-

ful. Figure 7 caption: There are two sentences in here that I feel should be moved to the text since they contain information relevant to the analysis. "Anomalies are calculated per glacier as the difference from the mean over the full timeseries available for each glacier." should be moved to the text on P11 where anomalies are mentioned but there is no description of how the anomalies are calculated in the text. The last sentence of the caption should also be moved to the text so that the definition of significance (described on P13) is clear. Figure 10 caption: You can really trim this down. Right now it reads like another paragraph in the text when I think you only need to explain (1) what scenario these are for, (2) what the lines and shading mean, and (3) that the projections are smoothed. Additional discussion point: It is worth mentioning somewhere that although you deliberately excluded some glaciers with perennial floating tongues, there were many glaciers that historically terminating as floating ice that have become grounded in recent years. Jakobshavn is the most well documented example. The break-up of floating tongues may result in an apparent decrease in the relationship between terminus position change and submarine melting since the grounded ice may retreat more slowly than the tongue collapse due to differences in ice dynamics and submarine melting with the evolution of the glacier geometry.

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