Review of "Proglacial lakes substantially modulate the surface mass balance of deglacial ice sheets" by Sijbrandij et al.

Signed: Niall Gandy

This paper investigates how large proglacial lakes influence the climate and surface mass balance of the Laurentide and Fennoscandian ice sheets during the Allerod. The authors use ECHAM6 together with a surface mass balance model to compare simulations with proglacial lakes, with freely evolving lakes, and with lakes capped a 4C to represent colling by meltwater inflow and iceberg calving.

The simulations show that proglacial lakes generate substantial summer colling over adjacent ice sheets, reduced precipitation, and increase the snow-to-rain ratio, produce a marked reduction in surface melt. The authors argue that this representants an important negative climatic feedback that may partially offset the dynamic ice loss associated with proglacial lake formation.

I have suggested a number of major and minor comments below. The study addresses an interesting and underexplored aspect of deglaciation, and the experiments design is generally clear and well executed. The manuscript is well written, and the results are potentially important. However, the discussion currently focusses more on demonstrating the simulated response than explaining the physical mechanisms responsible for it. I believe the manuscript will make a useful contribution to understanding ice-lake interactions following minor revisions.

Main points

Further develop the discussion of the precipitation changes

The manuscript places considerable emphasis on reduced melt, but precipitation changes received only a brief description (alongside figure 2). I found these results some of the more surprising in the paper, and wanted to read more about it! The paper would be strengthened by adding some discussion of the potential physical mechanisms for these changes.

Justify the set up of the cold proglacial lakes

The PL13ka_cold experiment is central to the paper because it enhances all reported effects. The authors acknowledge that the imposed 4C cap is idealised, but the discussion remains qualitative. I'm happy with an idealised approach like this, and you can learn a lot from these experiments, but it would still be useful to consider why 4C is the most appropriate threshold. Can we test how sensitive the results are to that value? Would a seasonally varying cap produce a similar result?

A limited analysis of the physical drivers of the cooling response

The manuscript reports cooling cover and around the lakes, but it would benefit from more diagnosis of the atmospheric processes producing that cooling. Is it coming from sensible and latent heat flux changes, clouds, something else? For me this is the most significant weakness

of the manuscript in its current form; there are really interesting results here but I want to understand “why” more than I do at the moment.

Specific points

5: “in combination *with* an ice sheet surface”?

17: Comparable in size or comparable in some other way?

35: “Even though…” onwards, this sentence is a little long, and I needed a second read to follow it properly.

74: “during *a* fundamental climate transition”?

73: “somewhat hybrid setup appears to be appropriate”. I agree, but it would better to briefly justify why here.

105: Should “overall” be in bold?

144: “5 % (2 %) in PL13kacold (PL13ka)” would be clearer as “5% in PL13kacold and 2% in PL13ka”

179: “There empirical method(s) are grounded”

228: Quiquet reference should be in brackets?

Figure 1: Something to give a more accurate sense of the geography of these plots would be helpful. Something like a graticule, scale bar, or contemporary coastline? This is true for other plots.

Figure 4: Please change the colour map on figure 1 to a colourblind friendly choice. I wouldn’t be sure until the paper is properly typeset, but fonts etc look a bit small at the moment.