Review of Rückamp et al. (2025) 'Future Retreat of Great Aletsch Glacier and Hintereisferner – application of a full-Stokes model to two valley glaciers in the European Alps'

Summary

This paper presents a full-Stokes modelling study of Hintereisferner and Great Aletsch Glacier over the course of the 21st century. Hintereisferner is initialised in 1997, Aletsch in 2011. The authors calibrate their model against observations up to the point these are available and additionally perform inversions for unknown parameters (basal sliding coefficient, ice hardness). The paper finds that Hintereisferner, even under a low-warming scenario compatible with the Paris Agreement, will likely disappear by mid-century, while Aletsch will likely survive in a dramatically reduced state. Under a high warming scenario, however, both glaciers will be (almost) entirely gone by 2100.

I think this paper is well-executed: the method is solid and the results convincing and thoroughly discussed. I have a few minor comments detailed below, the most substantial of which bears on re-writing some of the discussion to make it more impactful, but this is purely a question of emphasis and presentation rather than any sort of fundamental flaw in the paper. Therefore, I recommend that the paper be returned to the authors for minor revisions.

Page and line numbers refer to those in the clean version of the revised manuscript.

Major Comments
- Discussion: see the detail in the individual minor comments below, but I think the discussion could be reworked a bit to make it snappier and so that it focuses on the more interesting points the authors raise. At the moment, a lot of it feels either very obvious or doesn't really lead anywhere.

Minor Comments
- p.2, l. 28-43: To bring this completely up to date, might it be worth including IGM in the list here? It's not been applied globally yet, but there are some regional studies and it seems to be aiming for the same sort of applications as this paragraph is concerned with
- p.3, l.81: It may well be correct that this is the first time the specific form of data assimilation used here has been applied to mountain glaciers, but it's certainly not true in a more general sense, which is how this sentence reads. I might suggest toning this down slightly.
- p.6, l.125: Delete 'a'
- p.6, l.132: 'regional'
- p.6, l.139: The plural of 'RCM' is 'RCMs'. Same with 'GCMs' on the next line. No need to put an apostrophe in. Make sure there aren't other instances – I won't bother flagging them all up.
- p.7, l.164: 'As expected'
- Section 5.1: I think there are two points here. First, what happens if the inversions are done the other way round, i.e. an initial guess for beta is provided to do an inversion for B and then beta is inverted based on that B profile? Ideally, the model would end up in the same place, but it might not, and I think it would be worth checking this. Otherwise, it all feels a bit circular and arbitrary. Second, I'm not sure I agree about the L-curves. The one in panel d does have a clear corner and therefore optimal value, but the other three, especially a and c, really don't. Now, I don't think it would make much difference whether the next value up or down were picked on any of the curves, but I might walk back the statement about lambda being easily pickable at l.302-3.
- p.12, l.279: Is 'thermochemical' a typo for 'thermomechanical'?
- p.14, l.315: There's a missing closing bracket for the one opened before 'corresponding' on the previous line
- Figure 9 caption: Here, an apostrophe is needed for 'scenarios''
- p.17, l.362: …and here one isn't – it's just 'SSPs' for the plural
- p.17, l.363: 'diverges'
- p.17, l.368: 'projects'
- Figure 10 caption: 'present'
- Figure 11 caption: same as for Figure 9

- p.19, l.388: 'lead'
- p.19, l.389: 'projects'
- Figure 12 caption: same as for Figure 10
- p.20, l.409: 'some'
- p.21, l.416: There's a word missing – 'The basal friction parameter and thus the...what...associated…'
- p.21, l.417: OK, yes, fair enough, but are basal erosion rates really that high that one would expect them to lead to any sort of noticeable impact on the glacier's behaviour in the next 80 years? This feels a bit of a reach rather than a worthwhile point to include in the discussion. I'd replace it with changes in the glacier's stress regime, which would alter the distribution of sticky and slippery spots on the bed (and therefore beta) in a noticeable manner on the timescales relevant to this study.
- Section 7.2: I get that the authors are not attempting an exhaustive comparison with all previous studies, but this entire section pretty much just says 'different models with different set-ups give different results and we're not going to dig any further', which is maybe not the best use of a page-and-a-half of the discussion. That could be asserted in one line and no one would bat an eyelid. I feel it would be more valuable if the authors focused on the comparison with the Jouvet and Huss (2019) study, which should be most comparable, and tease out why they think the results are different, which then tells us something useful about the impact of different parts of the model setup. I would probably then just reduce the comparison with OGGM and GloGEM to a couple of lines, noting the difference, because there I agree with the authors that the models are so fundamentally different that it's very difficult to establish exactly where the differences in the results are coming from.
- Section 7.3: Similarly, this feels like quite a lot of effort to go to to point out that Hintereisferner is going to do worse than Aletsch because it's smaller, at a lower elevation, and in a drier part of the Alps. It's again something that would be an uncontroversial one-line assertion, particularly if the authors reference it to Figure 14, which summarises all the relevant information. The other material in this section about what this tells us about Alpine glaciers more generally is, I think, the interesting bit, so I'd suggest cutting down the first few paragraphs at the bottom of p. 23 and the last paragraph on p. 24 and condensing it into one paragraph that points out the obvious reasons for the different behaviour of the two glaciers.