Review of ***Recent observations and glacier modeling point towards near complete glacier loss in western Austria (Ötztal and Stubai mountain range) if 1.5 °C is not met*** by Hartl and Schmitt et al.

By Michael McCarthy

General comments

This study presents an improved observational dataset of recent glacier change in the Ötztal and Stubai mountain range and uses it with the large-scale glacier model OGGM to make projections of future glacier change in the region to the end of the century. OGGM is run in two different configurations: OGGM default and OGGM regional, where OGGM default uses globally available datasets for initialisation and calibration, and OGGM regional uses more accurate, local datasets in combination with an updated initialisation and calibration workflow. The OGGM projections are compared with each other and with projections from other large- and local-scale glacier models. The observational dataset consists of homogenised multi-temporal glacier outlines and volume estimates.

OGGM regional projects faster glacier decline in the Ötztal and Stubai mountain range than other large-scale glacier models, and suggests around 2.7% of glacier volume will remain by 2100 if climate warming is limited to 1.5 C. Under higher warming levels, it suggests glacier decline will occur faster, and remaining glacier volumes will be smaller by 2100. The observational dataset points to extensive glacier decline in the region in the last two decades.

The study is very clearly presented, appears to have been carefully implemented, and, in my view, makes at least three valuable contributions to the field:

1) By using more and higher quality data for initialisation and calibration and developing an updated initialisation and calibration workflow in OGGM regional, it addresses one of the key challenges of large-scale glacier models, which is that they tend to be over-parameterised due to a lack of observational data (e.g., Rounce et al., 2020). As such, it provides a framework for better regional-scale glacier modelling in the future.
2) By presenting new projections of glacier change in the Ötztal and Stubai mountain range, it adds to the evidence base around future glacier change in this region. It provides new and useful information about the impacts of different warming levels on regional-scale glacier evolution.
3) Via the improved observational dataset, it provides a more detailed understanding of recent glacier change in the region.

I have no major comments but think some minor modifications, listed below, could improve what is already a very good manuscript.

Specific and technical comments

Title and elsewhere in text: I don't suggest you change it, but is only 2.7% of 2017 glacier volume remaining by 2100 under 1.5 C not already 'near complete' glacier loss?

L45: Suggest remove 'between'.

L240 and throughout the text: Suggest 'evaluation' is preferable to 'validation', e.g., Oreskes et al (1994).

L303: What happens to the remaining 18 glaciers?

L311: I agree the model seems to reproduce the WGMS mass balance observations relatively well from 2000 onwards, over the calibration period. But it seems to produce more positive mass balances than the observations before 2000, which makes me wonder if it will produce too negative mass

balances in the future. I think this offset should be mentioned explicitly in the text, for transparency. Do you have any idea what might be causing it? Could it be the observations themselves, or are potentially more data still required for calibration? It could also be helpful to provide some performance metrics for the period before 2000 in a second table in the Appendix.

Section 3.3: My understanding is that all the results presented in this section are from OGGM regional. If so, it would be helpful to say this, e.g., on L314, 'The aggregated OGGM regional outcomes …'.

L327: The point about mitigation measures might be better in the Discussion than the Results?

L328: Does this increase in the number of individual glaciers account for fragmentation?

L338: On the topic of 'the full range of possible outcomes', it would be interesting to see the sensitivity of future volume change to the mean annual precipitation of the difference scenarios. Is this the major control on inter-scenario variability within warming levels?

L426: 'This is primarily due to their initialization strategy' seems like an assertion? 'This may be due to …' might be a better formulation.

Section 4.4.2: Earlier in the text, debris and avalanching are mentioned. These could be added explicitly here in relation to 'unresolved processes', as both are potential sources of error compensation and therefore calibration difficulties, and as both are starting to be considered in large-scale glacier models (e.g., Compagno et al. 2022).

Figure S4 caption: 'see Table ??' needs to be updated.

Figure S10 caption: Suggest 'For future projections except 1.5 C'.

Table S4 caption: Instead of 'supp. Figures S3 and S4' just 'Figures S3 and S4'.

References

Rounce, D. R., Khurana, T., Short, M. B., Hock, R., Shean, D. E., & Brinkerhoff, D. J. (2020). Quantifying parameter uncertainty in a large-scale glacier evolution model using Bayesian inference: application to High Mountain Asia. Journal of Glaciology, 66(256), 175-187.

Oreskes, N., Shrader-Frechette, K., & Belitz, K. (1994). Verification, validation, and confirmation of numerical models in the earth sciences. *Science*, *263*(5147), 641-646.

Compagno, L., Huss, M., Miles, E. S., McCarthy, M. J., Zekollari, H., Dehecq, A., ... & Farinotti, D. (2022). Modelling supraglacial debris-cover evolution from the single-glacier to the regional scale: an application to High Mountain Asia. The Cryosphere, 16(5), 1697-1718.