1 Topic editor by Ludovic Räss, 17 Feb 2025

Dear authors,

Thank you for providing a revised version of your manuscript draft. As supported by the external reviewer, your current manuscript version significantly improved. As remaining step, I would like you to address the following item, as both the external reviewer and myself would like you to include further details about this in the text. Namely, it would be valuable to better describe how dependent your results are on processed data from other models (e.g. mass balance, MB and mb). As the external reviewer suggests, "these derived data have uncertainties and limitations, and it would be interesting to hear how dependent the model are on these data. The Shap analysis provides some input to this, but some remarks on this would be interesting."

Thank you for your work, best regards Ludovic Räss

2 Report by Anonymous referee #2, 16 Feb 2025

Overall, I find that the revised manuscript is significantly improved. It contains now a more detailed motivation and perspectives to previous work, the methods and selection of datasets are better described and well-argued, and the presentation of the model appears now self-contained. The revised structure and including more explanation in the main manuscript has contributed to this, as well as more elaborated explanations. The description of datasets and why these are chosen are now sufficiently explained, and the assessment of the results in relation to these datasets is improved. Further, I find that the revised paper presents the method and results sufficiently clear. The examples presented in figures 3 and 4 are impressive and promising. My remaining considerations are now related to how dependent the results are on processed data from other models, like the mass balance, MB and mb. These derived data have uncertainties and limitations, and it would be interesting to hear how dependent the model are on these data. The Shap analysis provides some input to this, but some remarks on this would be interesting. Minor edits:

- Figure 1 caption: region 18 has also no training data. Thanks for spotting this.
- Line 388: ex-novo is not commonly used, please clarify. Changed to: "Ice velocity maps (or mass balance) can be generated from scratch or used to fill gaps in existing products."

We thank the Anonymous referee #2 for the time to review again the manuscript. We are glad that we could improve the quality of the work by making use of their comments and insights. With respect to the last comment, we here provide an answer to the Editor as well, who shared the same concern.

We agree with the Referee #2 - the Shapely analysis provides an indication on variable ranking but does not provide information on why that variable is important or not. If a variable is ranked low, it may indicate either that the variable is not as informative as the others (in the tree structure), or that the variable is extracted from a product of low(er) quality.

The DEM is by far the most important input product for the model. It generates 24 out of 39 features, some of which are very important (namely, slopes). IceBoost was originally developed on the Aster GDEM (same horizontal resolution), and the model accuracy was found significantly lower as to Tandem-X EDEM, confirming that the quality of the DEM is crucial.

The velocity product drives 6 features. The Shapely analysis shows some importance for ice velocity, but probably not as high as expected. One of the reason could be that the dataset is imperfect. The geodetic mass balance dataset is itself of 'lower quality' because it contains glacier-averaged data. The downscaled variable, mb, is found slightly more informative. We

note that the downscaling method introduced for this feature is only applied outside polar regions. In the polar regions, RACMO is used.

We have now added two appendix sections, C and D, where we investigatge the effect of the MB and mb features on the model output.

- In Appendix C, we assess the volume of the Unteraargletscher by varying the mass balance (MB) from -4 to 4 $m\ w.e\ yr^{-1}$ including the reference value of -1.59 $m\ w.e\ yr^{-1}$. The modeled volume show little overall variations, even with an unrealistically wide range of MB values. This aligns with the Shapley analysis, confirming that MB is a weak predictor, and that the results are rather insensitive to this variable.

- In Appendix D, we perform a sensitivity test on the two regional parameters used to calculate mass balance maps: $\bar{s}$ and $\bar{q}$. Using a Monte Carlo approach with 1,500 model runs and Gaussian noise added, we monitor the modeled volumes of the Unteraargletscher and Aletsch glaciers (Central Europe). We find that a 50% uncertainty in both parameters leads to an upper-limit error of approximately 15% in the modeled volumes.