Dear Editor and reviewers,

Thank you for all the constructive comments on our manuscript. We feel sure that addressing the comments will improve the quality of the paper. Below, we provide our responses to all three reviewer comments.

Best Wishes

Hansruedi Maurer (on behalf of the author team)

Reviewer 1 (Ben Pelto)

General comments

- ***Availability of code and data***
  We plan to make the GlaTE Matlab scripts publically available on GitHub. Likewise, we will upload the data sets employed in the paper on this platform. This will allow reproducing all our results, and we hope that the codes will be helpful for other data sets.
- ***Accuracy of H-GPR ice thickness estimates***
  Indeed, the accuracy of the H-GPR thickness estimates is critical for our algorithm. As noted correctly by the reviewer, the literature offers quite a range of thickness estimates. We have re-evaluated our data and concluded that a depth-dependent accuracy (i.e., percentage error) would be a better option. A reasonable choice for our data sets is 5%, that is, an accuracy of 5 m would correspond to a thickness of 100 m. When available, it would be straightforward to consider individual accuracy estimates for the individual data points. In the modified manuscript we include a more detailed discussion on this topic.

Specific comments

- ***Editiorial comments***
  We have addressed all editorial comments
- ***Sampling of DTM***
  Yes, the DTM is sampled on R, as it was indicated on line 105
- ***Mass balance estimates***
  Yes, the results are in broad agreement with typical values obtained in this region
- ***Table with glaciers***
  The revised paper includes a table with the important characteristics of the glaciers considered
- ***Merging of different campaigns***
  An earlier version of the manuscript included data sets of merged campaigns. However, we decided to show only data sets that were acquired in the framework of a single campaign, to avoid the problem of the ongoing melt. The statement about the merged data set was just a remnant from the earlier draft, and we have removed it in the revised version.
- ***Table with ice thickness estimates***
  Since we make the data sets publically available, we don't think that such a table is necessary
- ***SOED and crossing profiles***
  We added additional text in the revised manuscript to address this issue

- ***Adding data to GlaThiDa***
  Our measurements in Switzerland until 2015 are covered in the GlaThiDa 3.0 release, and we intend to provide an update with the next release

Reviewer 2 (Douglas Brinkerhoff)

General comments

- ***Novelty of approach***
  We do not claim that the ice thickness estimation approach within GlaTE is novel. As indicated on line 112ff, any of the algorithms described in the literature can be incorporated. The novelty lies rather in the consideration of the uncertainties of the H-GPR measurements, and in the formulation in form of a sparse system of linear equations, which allows incorporating any further constraints. In the revised manuscript, we make this more obvious in the abstract.
- ***Choice of weighting parameters λ_1 to λ_4***
  We agree with Reviewers 2 and 3 that the discussion on the choice of the weighting parameters may be confusing. Based on their comments, we re-thought the strategy for choosing λ_1 *to* λ_4. The revised manuscript includes a more detailed description. In brief, we fix λ_3 to a constant value. This parameter has very little effect on the inversion result. Next, we perform a series of inversions with different λ_1/λ_2 ratios (remain fixed during a single inversion run). During each inversion run, the smoothing parameter λ_4 is gradually lowered, until a prescribed percentage (e.g., 95%) of the GPR data is fitted with the prescribed accuracy. When the λ_1/λ_2 ratio is getting too small, the inversion algorithm fails to match the GPR data, even when $\lambda_4 = 0$. The lowest ratio, which allows to fit the GPR data, is finally chosen. This procedure (i) allows to fit the GPR data with a prescribed accuracy (no overfitting), (ii) maximizes the contribution of the glaciological constraints and (iii) minimizes the influence of the (unphysical) smoothing constraints.

  Reviewers 2 and 3 suggested cross validation methods for identifying optimal weighting parameters. This is potentially an interesting option, but we judge the procedure outlined above to be physically more meaningful and computationally cheaper.
- ***Choice of α parameter***
  Reviewer 2 is right. It makes conceptually much more sense to minimize the squared differences between observed and modelled thicknesses. We changed the manuscript accordingly and recomputed the three test cases. Interestingly, the α values, obtained with the new procedure, are very similar to the old values.
- ***Choice of lines during SOED procedure***
  The choice of the lines is influenced by a plethora of factors. However, the procedure does not consider (explicitly) the amount of crossing profiles, which could be advantageous for cross-checks. We have added a more detailed explanation on this topic.

Reviewer 3 (Fabien Maussion)

General comments

- ***Choice of regularization parameters***
  See response to Reviewer 2 on this topic.
- ***Objective assessment of GlaTE performance***
  We agree that our statement concerning the performance of GlaTE is somewhat weak. We have participated in the ITMIX2 initiative, where numerous approaches were compared in form of blind tests. Evaluation of ITMIX2 is still in progress, but we make a reference to this initiative, which is certainly a good measure for the performance of GlaTE.
- ***Code and data availability***
  See response to Reviewer 1 on this topic

Specific comments

- ***Flowsheds***
  We also expected discontinuities between flowsheds, but surprisingly this was not the case.
- ***Apparent mass balance computation and glacier cluster***
  More explanation were added to the text
- ***Lower boundary of Di***
  We followed the approach of Clarke et al. (2013)
- θ ***vs*** ϕ
  This is the same quantity. The typo was corrected
- α ***parameter***
  α accounts for the uncertainties of all multiplicative factors in Equation (5), also including *A*.
- ***mean(abs(diff())) issue***
  See corresponding response to Reviewer 2
- ***LSQR***
  The system of equations includes ~300,000 rows and ~90,000 columns. Due to the sparseness of the system matrix, the LSQR algorithm requires only about 2 seconds on a standard PC with a 3 GHz processor. However, due to the adjustments of the smoothing parameter λ_4, the system of equations needs to be solved several times during an inversion run.
- ***Figure 1***
  The figure caption (resp. the figure itself) was corrected
- ***Flight time to next profile***
  Yes, this is correct. We did not account for the transition time. This was already mentioned on line 590.
- ***Statistical analysis for determining*** α
  During the next few months, we will analyze a very large data set acquired over all significant glaciers in Switzerland. We hope that we can prove you to be wrong …..