Summary and comments on the manuscript
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# Ice thickness and bed topography of Jostedalsbreen ice cap, Norway

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by

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## SUMMARY

The authors present an extensive record of ground penetrating radar (GPR) measurements to map the glacier ice thickness of Jostedalsbreen collected during multiple ground and airborne field campaigns between 2018 and 2023. Data was collected with various radar systems involving operation frequencies between 2.5 and 500 MHz. The acquired record is impressive with more than 350'000 point measurements and more than 1'000 line kilometers surveyed. These measurements are ingested into an inverse procedure to infer a high-resolution map of glacier ice thickness for the entire glacierised area. This map is truly valuable, as previous reconstructions of glacier ice thickness had no measurements at their disposal. Moreover, the authors provide an uncertainty map of their glacier ice-thickness field. A brief analysis of the basal topography for sub-glacial over-deepenings - i.e., possible sites for future lake formation - completes the manuscript.

I was very excited about this article and I want to admit that I was at no point disappointed. I want to congratulate the authors to this piece of work. The manuscript is very well written and strikes with clearness and high-quality illustrations. Below you find some major comments on several aspects of the methods and analysis. None of them are fundamental but will help to improve or to better assess your results. Overall, I am very positive about this manuscript because it combines '*impressively extensive*' field observations with modelling techniques. I therefore recommend that the editor should continue to considered this manuscript for publication in *Earth System Science Data* after minor revisions.

## MAJOR COMMENTS

**OPTIMAL RECONSTRUCTION**
You use an approach by Huss and Farinotti (2012) (HF apporach) to infer the glacier ice thickness of Jostedahlsbreen. Several parameters in this approach are not well constrained. How did you select the optimal parameters with regard to ice-dynamics as well as mass overturning/surface mass balance. Couldn't you use your abundant measurement record for a dedicated calibration.

**THICKNESS HOMOGENISATION**
As you have a second DEM from 2017 (aside the 2020 DEM) you could infer an elevation change map (possible a co-registration is necessary). So you could refrain from using individual elevation differences from DGNSS measurements to homogenise your thickness data. In this way, you account for spatial difference in elevation change. An elevation change map would further be useful for my comment on the 'future assessment' (below).

**FUTURE ASSESSMENT**
I think for the potential disconnection of Jostedalsbreen (L574-587), you have to combine your thickness observations with actual elevation changes observed by satellite remote sensing. I say that because even thin ice can prevail for a long time at high elevation. Moreover, I would rather use the thickness map to analyse future disconnection possibilities - instead of the point measurements.

**UNCERTAINTY MAP** I remain confused about how you built up this final map of thickness uncertainty (Sect. 3.8). You first produce additional thickness fields by feeding the minimum and maximum thickness estimates from your observations (relying on the measurements error) into the HF approach. For the extrapolation uncertainty, you vary certain model parameters. Yet it is unclear how many parameter combinations you tried and how you sample. You stay rather vague here. Moreover, I did not find which measure you used to quantify the variability (min/max, sigma, ...). Lastly, it is not clear to me how you combined the measurement error maps with these extrapolation uncertainty maps to produce a final uncertainty map. Please be more specific.

**DISCUSSION**
You state that the volume is very similar to previous estimates. I strongly doubt that these previous estimates did rely on as many thickness measurements as you had. So why are these estimates so similar. Do we no longer need to conduct measurements? I strongly

doubt that. I think there must be quite some differences in the thickness distribution - worth to discuss. Did these approaches use thickness observations in this region? GlaThiDa 3.1.0 holds no data on Jostedalsbreen. What about a comparison with the global products from Farinott et al. (2019) and Millan et al. (2022), that many people do use. I think that a map comparison of ice thickness is a worthwhile effort here.

**STRUCTURE**
In the uncertainty subsection of the extrapolated map product (3.8), you present already quite some results. Please transfer these to Section 4.

## MINOR COMMENTS

**L757 :** I do not see how measurements in Norway can help us constrain the ice thickness in Greenland or in Antarctica. I mean the setup is very different. Moreover, there exist a lot of thickness measurements for both ice sheets. Or do you think of the glaciers outside the ice sheets?
**L170 :** [...] in [...] $\longrightarrow$ [...] for [...]
**L686-690 :** Please confirm if the Data Availability Section is part of the main manuscript at ESSD. If not, present this section together with the acknowledgements, author contributions, etc.
**L692 :** Add a comma after 'In this paper'

FIGURES
**Fig. 1 :** What do the red dots indicate. I did neither find them in the legend nor in the caption.
**Fig. 1 & Fig 6 :** Consider moving them to the Appendix or a Supplement. You could directly use Fig. 9 as an overview showing the thickness measurements. All the other information on radar frequency and survey type (helicopter, snowmobile, foot) seem less relevant.
**Fig. 3 - Fig. 5 :** Think about only keeping Fig. 3 in the main manuscript. As much as I appreciate these additional figures, they could well be suited for an appendix/supplement - possibly by also transferring associated text blocks/paragraphs.
**Fig. 8 :** I would first present the thickness map (Fig. 10) and afterwards the uncertainty maps.
**Fig. A1 :** If possible, please add the locations of the 1986/1987 borehole measurements as well as the 1988 GPR surveys.

TABLES

**Table 2** I could not find that the asterisk $*$ information was referred to in the table. I suspect the last row.