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Interactive comment on "Characterisation of subglacial water using a constrained transdimensional Bayesian Time Domain Electromagnetic Inversion" *by* Siobhan F. Killingbeck et al.

Anonymous Referee #1

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General comments: This manuscript presents a good example of TEM survey to investigate the subglacial water. The trans-D Bayesian inversion is used to extract the resistivity information from the TEM data using the structural constraints to improve the accuracy. The seismic velocity is used to jointly delineate the material lithology. However, the manuscript is more likely to be a case history than a technical paper, as the trans-D Bayesian inversions is performed using the 1D forward operator from Leroi and the 1D trans-D Bayesian inversion has been reported in several literatures. On the contrary, the manuscript presents solid results in characterizing the subglacial water

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jointly using the TEM, GPR and seismic data. Hence, I recommend the manuscript to be organized as a case history. Furthermore, the trans-D Bayesian inversion can be used to quantify the uncertainty of the inversion, which is its major benefit. However, the manuscript gives litter discussion about where the uncertainty comes from. Especially, the possible distribution that that the errors in the data obeys and how it is related to the chosen of the form of likelihood function. It would be good if this contains can be added.

Specific comments: 1. P2L13-14: "TEM methods . . . . . by an offset transmitting coil". The grounded-wire or coincided loop are also commonly used to transmit the source signal of a TEM survey. 2. Compared with the methods mentioned in the INTRODUTION, Equation 1 only provides a poor estimates of DOI, without considering the current/noise level. Maybe the authors want to illustrate the role of transmitter loop size in controlling DOI, but it is well known that a larger loop will achieve a deeper earth. 3. Equation 2, 3,4. . . The vector and matrix should be bold. 4. P4L24-25: "since the accuracy of GPR depth estimation is $\sim$100-times smaller than the thinnest resolvable layer in TEM". Please add references for this statement. Another question: if the accuracy of the depth constraints from GPR results is higher, then what is the purpose of the variation of the dimensionality? 5. The elements of RJ-MCMC are outlined in the manuscript. It would be good if details of some key techniques are introduced, such as the principle to judge the convergence of the chain, how the accepted samples are resampled to suppress the correlations of the sample. 6. P11L4-5: "One million iterations were sufficient for the posterior distribution to converge (a test of 2 million iterations produced the same posterior)". Add the results of the test would be good. 7. P13L9-10: "data fit with the ensemble models are shown in Fig. 7(ii)". The model ensemble contains multiple models. Whose data fit is shown here, is it the average datafit? If it is, adding the error bar would be good. 8. P14 "5.2 2D Resistivity profiles". The 2D profiles is obtained by the stitching together the 1D inversion results or sampling the 2D model space as a whole. If the later one is chosen, how the 2D grids are updated? 9. Why the synthetic inversion of the 2D case is not given? 10.

Figure 10: As the presentation of the data is interpolated, please add the indicator of the recording station at the top of the figure so that the actual spacing of the stations can be illustrated.

Technical corrections: The manuscript is well written and I do not have technical corrections.

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