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Comment on gmd-2021-187

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Referee comment on "Blockworlds 0.1.0: a demonstration of anti-aliased geophysics for probabilistic inversions of implicit and kinematic geological models" by Richard Scalzo et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-187-RC2, 2021

In the manuscript with the title "Blockworlds 0.1.0: A demonstration of anti-aliased geophysics for probabilistic inversions of implicit and kinematic geological models", the authors present an approach to overcome the aliasing effect of forward-calculated geophysical fields from non-ideal subsurface mesh discretizations. The approach and the provided implementation in a geological and geophysical modeling framework is relevant, as it enables an efficient treatment of such aliasing effects, and also timely, as these types of subsurface parameterisations are widely used in geophysical inverse schemes, especially in cases where regular and rectilinear meshes are used. The approach will therefore be of use in many similar modeling cases.

The manuscript is very well written and follows the logical structure of a scientific document. The introduction is quite detailed, but provides a comprehensive overview over the current approaches at the link between geological modeling and geophysical inversions and, in my point of view, this detail is also important to place the developments into the frame of current developments. The authors provide detailed descriptions and references to similar approaches. The methods section provides a very instructive motivating example, before delving into the detail of the implementation. Even if this order may seem a bit odd, it is common practice in computer science publications and here a good choice to quickly show what the problem is and how it can be mitigated, before describing the approach in detail.

The antialiasing method is presented with kinematic modeling examples, where the interaction of multiple geological events quickly leads to complex structural settings. Even if this is suitable to evaluate the use of the method, it is not directly evident that it will also work in other cases where the block model is obtained through different interpolation approaches, for example. The authors explain the current state of modeling very well in the introduction - but especially implicit methods, mentioned even in the title, are not evaluated in detail. I would suggest to clarify this point and also to remove implicit models from the title.

More minor aspects that could also be clarified or commented on:

- What is the influence of data error? Would the aliasing effect be similarly relevant or would it decrease?
- The problem of block representations is also that small changes in the parameters lead to no change in the likelihood function, and therefore to problems in specific inverse algorithms (not only in MCMC). It would be interesting to explain this aspect in more detail.
- There are several geophysical inversion schemes that are not based on "blocky" mesh structure, but on pillar grids that conform better to the exact interface location (e.g. IGMAS+ https://igmas.git-pages.gfz-potsdam.de/igmas-pages/)- but are then limited in terms of there possibility to represent geologically complex models. But it should be mentioned that the (vertical) aliasing-effect would be very limited for these methods.
- The anti-alaising approach works when the exact location of the interface inside a cell can be determined. Many geophysical inversion schemes first perform the mapping to a fixed grid, and then perform the inversion (I believe this is the case for the cited approaches by Giraud,etc.). In this case, the anti-aliasing approach would not work, correct? It would be good to mention this aspect (maybe also in the limitations section in the discussion).

References: the manuscript contains extensive references to important and relevant work in the field. Minor addition (to the description in line 85): GemPy also has magnetic forward modeling included in the inversion (published in Güdük, N., De La Varga, M., Kaukolinna, J., & Wellmann, F. (2021). Model-Based Probabilistic Inversion Using Magnetic Data: A Case Study on the Kevitsa Deposit. *Geosciences*, *11*(4), 150.) and the link to topology has also been evaluated in a case study (Schaaf, A., de la Varga, M., Wellmann, F., & Bond, C. E. (2021). Constraining stochastic 3-D structural geological models with topology information using approximate Bayesian computation in GemPy 2.1. *Geoscientific Model Development*, *14*(6), 3899-3913.).

Figures: informative and well composed. The examples in Figs. 3 and 4 are quite extensive and could potentially be reduced or partly moved into the appendix.