

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-321

Anonymous Referee #2

Referee comment on "Implementation of a Gaussian Markov random field sampler for forward uncertainty quantification in the Ice-sheet and Sea-level System Model v4.19" by Kevin Bulthuis and Eric Larour, Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-321-RC2>, 2021

The authors added support for Gaussian random fields with Matern-type covariance functions in ISSM (Ice-sheet and Sea-level System Model) and in this paper, they show the resulting new capabilities ISSM offers for forward UQ. The authors describe how to draw samples from a Gaussian distribution with Matern covariance and use these samples to run forward UQ for a few ice sheet flow models.

The topic of the paper is interesting. In terms of novelty as mentioned above, the mathematical techniques described in this paper are all well-known, hence there is not much one can comment on this aspect. The validation tests ("sanity checks") are nice and may be useful, especially to the users of ISSM. Below I list a few comments/concerns:

- The examples are interesting but lack sufficient details. For instance, there are several things explained in words but there is no concrete problem/mathematical description, only several references to previous work are provided. The authors spent significant effort to explain the sampling procedure, which is known, but unfortunately rushed through the numerical experiments.
- How are the parameters (mean, correlation, etc.) chosen for the Gaussian distributions one samples from for the forward UQ? Without a proper data assimilation or inversion process for these ice sheet problems, not sure how realistic these distributions are and certainly not sure how much these can be trusted for prediction and UQ.
- What was the dimension of the unknowns or quantity of interest? Are the sampling and forward UQ processes described scalable and computationally tractable for large-scale ice sheet problems?
- How exactly the convergence of the samples is assessed?
- It is unclear what the novelty in this paper is. Is the goal to present these new capabilities ISSM provides and compare the new results with previous forward UQ studies? If so, the abstract of the paper is a bit misleading. This suggests that the

authors propose a new sampling technique for UQ.

- Also, from the title (and the abstract), it is not clear that only forward UQ is being considered.