Author's response to referee's and editor's comments on "Blockworlds 0.1.0: A demonstration of anti-aliased geophysics for probabilistic inversions of implicit and kinematic geological models" (gmd-2021-187)

Response to Referee #3 (Anonymous)

We thank the referee for their comments. As instructed by the Topical Editor, we are responding to in-line comments on our paper as attached to the report.

> (lines 131-132) "...calculate a grid scan through the posterior for inversion of forward gravity from a uniform-density spherical intrusion." This is difficult to understand. Can you reword to be more precise? grid of what?

Since this sentence refers to the posterior density for the geological parameters, we mean a grid over possible values of the geological parameters. We have unpacked this in a bit more detail now.

> (line 201) action or observation? I think of a sensor as passively recording. Whereas a vibroseis truck to me is actively inducing a signal.

We understand and have reworded: "...such that the response of a sensor to the anti-aliased model..."

> (line 204-205) the geophysical property of mass has a nice relationship to volume... so volume of cell works. Is this true of other geophysical properties? Maybe for conductance/conductivity, but what about seismic impedance?

We address this in Section 5.3, since we work only with gravity in this paper and hence treatment of other sensors constitute future work. We expect that a simple volume average will work well in static problems solved with a finite-volume approach, including properties such as mass density, magnetic susceptibility, DC thermal and electric conductivity, and slowness for travel-time tomography. If a sensor responds to some other function of rock properties that is not a volume average, one may need to use an approach similar to that in Section 2.3 to train a different anti-aliasing function.

For time-dependent, nonlinear, or anisotropic problems such as diffusion and wave propagation (full-wave seismic, EM imaging, magnetotellurics etc), further investigation is needed depending on the forward problem. For example, our method is aligned with the "equivalent media" methods reviewed in Koene et al. (2021) for wave propagation, and thus would share their advantages and drawbacks.

> (Figure 3) Can you increase the size of this figure? I guess that's up to the typesetting, bubt it's conceptually important so it'd be nice to see it stand-alone. Not really sure [why] it is put with the two below.

We agree that the interface diagram comes in a bit small. We prefer to keep these panels grouped since they are conceptually related, but to make panel (a) more visible we have increased its size relative to the others and made the figure full-width on the page.

> (line 257) but then you say the "Blockworlds code covers four elementary event types..." in the next paragraph. So should you just say you are using Blockworlds that includes "how anti-aliasing interacts with..."

It may be better for us to say "inspired by Noddy" here, since Blockworlds is not a direct port of Noddy. Our text now reads: "To illustrate how anti-aliasing interacts with more realistic geological structures, Blockworlds implements a simplified kinematic model inspired by Noddy (Jessell 1981; Jessell & Valenti 1996)."

> (lines 267-268) can you make a figure showing this? Is this demonstrable in Figure 4?

We have added a few corresponding labels to Figure 4 in order to show how the symbols attach to the action of each kinematic event.

> (line 272) I've lost what g is. You need a table of symbols

We have now added a table of symbols. We have also reworded the opening text of section 3.1 to more clearly introduce the overall notation we use.

> (line 322) I would think a uniform distribution is a maximum entropy PDF.

It is, for probability distributions with support in an interval *[a,b]*. For distributions with support on the real line and specified mean and variance, the normal distribution has maximum entropy, and the vMF distribution is the maximum entropy distribution on a unit hypersphere. Since on reflection it's not clear that the words "maximum entropy" add much to the discussion, we now omit that terminology.

> (line 424) if you aren't actually showing these in figures, I would use a different sentence structure. Example: "There are more dramatic differences in the low and high resolution for Models 10 and 11..." If this is true: why not use these instead of what's in Fig 6 and 7 right now?
> (also line 426) No figure?

We have modified the sentence accordingly: "The differences between low and high resolution models are, predictably, more dramatic for folded models where the priors do not exclude fold wavelengths close to the Nyquist limit for the coarse mesh scale, such as Models 10 and 11. Other models, such as Model 9, show that anti-aliasing gives much better results for fold wavelengths greater than the mesh scale."

We picked the current figures as illustrative use cases where geological structures aren't Nyquist-undersampled with respect to the geophysical mesh (we never expected or in-

tended anti-aliasing to handle Nyquist-limited complex structures). All 15 of our models cover different edge cases and we prefer to limit the number of full-page figures in the main text. However, figures for all 15 models can be easily reproduced by running the code in our repository. We highlight this more fully now at the beginning of section 4.1.

> (line 456) so this is the reference posterior in the DKL?
> Model 1 DKL posteriors: fine mesh vs coarse mesh
> Model 1 AA DKL posteriors: fine mesh vs coarse mesh AA?

We now specify, as we mention in the text beneath equation 21, that the reference posterior for DKL is the high-resolution anti-aliased posterior.