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Earth Surface Dynamics Discussions

Interactive comment on "How does grid-resolution modulate the topographic expression of geomorphic processes?" *by* Stuart W. D. Grieve et al.

Anonymous Referee #1

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This manuscript seeks to quantify how well topographic information of varying resolution can be used to extract quantitative information for landscape evolution interpretation and simulation. The authors have crafted a clear goal in this respect and chosen three well-trod soil-mantled landscapes to explore how successive degradation of DEM resolution affects estimates of curvature, slope length, relief, and channel network extent. While the geomorphic community trumpets lidar's superior capabilities for these endeavors, the authors are correct in noting that the extent of lidar coverage is limiting (although we should still advocate for global coverage!). This manuscript succeeds because it nicely presents empirical findings and because it incorporates a nifty theoretical explanation for why we lose the ability to resolve features of a given wavelength

with changing grid spacing. Below, I describe a small handful of suggestions that should be easily incorporated if so chosen.

Major comments: 1) Are DEMs of the same grid spacing necessarily equal? The issue of varying DEM grid spacing is the fundamental message of this manuscript and the authors argue for the utility of the results obtained here for interpreting TanDEM-X and SRTM data, but these datasets are derived differently from lidar data and it's not clear to me that the exercise laid out here will always be relevant in this respect. In other words, can the authors show that degrading lidar data to 12meters is essentially the same as obtaining a TanDEM-X dataset? Or similarly for a 30-m SRTM dataset? Because we hold up lidar as the gold standard, it's appropriate as the reference but it seems that additional factors will likely affect how well radar-based techniques can resolve surface features. It would be highly convincing, for example, if the authors could show that a degraded lidar dataset is consistent with TanDEM-X or SRTM data in a simple way that closes the loop and truly opens the door for widespread use of the principles established in this very fine paper. Perhaps the answer is already known and a simple "yes, this works" can be garnered from the literature.

2) Language: the manuscript cycles through the terms "resolution" and "grid spacing" in various forms and there are a few places where the meaning can become confusing (e.g., line 497). The word "resolution" is sometimes traded for "spacing", inviting ambiguity and my suggestion is to simplify wherever possible.

3) Broadly convex hilltops can be resolved with coarse data. The authors nicely show that curvature at the Gabilan Mesa site is retained as grid spacing increases, which is a very nice result. After seeing more and more of the GM lidar data, it does appear that many sections of that study area exhibit remnant surfaces that are not yet adjusted to regional baselevel lowering, which is a potential bias that could merit mention. That said, I think the result here is nonetheless robust. perhaps more importantly, though, I wonder how this result would be useful for a researcher working in a far-flung field area without a priori knowledge of whether their study site exhibits broadly convex hilltops.

How would they be able to determine whether they're working with an Oregon Coast Range or Gabilan Mesa like study area? How will they know to trust their curvature values or not?

4) Theoretical explanation for grid spacing dependency on feature resolution. Section 5.1.1. does a very nice job of laying out a spectral analysis-based explanation for this problem. It nicely complements the empirical analysis here but it is terse and challenging to follow. My concern is that readers without a background in signal processing will not be able to follow it. The wonderful outcome in lines 640s to 660s merits much fanfare and is well-stated, but getting there could be much more straightforward. On line 629-634, exactly how does the gain equation show the associations stated, for example? There is no curvature value in this equation (strictly speaking), so the connection b/w gain and the traditional metrics could be more clear. In fact, my sense is that this section would be more effective as a substantial part of the manuscript methodology rather than a theoretical afterthought stuck in the discussion. This analysis is central to the message here and the authors might consider putting it upfront because it bears on all of the empirical results. That said, it would require some hand holding to be effective in that role. In particular, the goal needs to be clearly stated as well as simply stated explanations about wavenumber response function, continuous vs. discontinuous waveforms, and gain. The explanation for fidelity is nicely stated but I fear most readers will have to do substantial work to get there...which would be rewarded if they do so, however! A major rehaul is not the suggestion, but rather a more integrated role for this section. In particular, the very different curvature and slope fidelity curves are highly compelling (fig 12). Because the loss of slope fidelity explains previously published papers, this also strikes me as something that's more meaty than discussion subsection material.

Specifics: The text is very well written with excellent figures, too.

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