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

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Throughout this document the reviewer's comments are in **bold type** and our responses are in standard type.

Grieve et al.'s study investigates how different spatial resolutions of digital elevation models (DEMs) affect topographic derivatives that are particularly relevant for characterizing geomorphological processes. They place emphasis on the second derivative curvature that is the basis for channel network identification, estimating hillslope diffusivity, and measuring hillslope length and relief. I have rarely received a request for reviewing a paper that is in such

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Discussion paper

good shape. The manuscript is very well written, concise, and the methodology sound. Overall, the conclusions drawn by the authors are well supported by their analysis. Notwithstanding, I have two comments that should be addressed before the manuscript is ready to be published.

We thank the reviewer for such a positive appraisal of our work and we are delighted that the reviewer considers our work to be of a high standard. In addressing the two comments made below we believe that the manuscript has been enhanced, and hope that following the changes outlined below this research will be of greater value to a wider audience.

1. The problem of coarsening resolutions is addressed by downsampling high resolution LiDAR data. However, this approach neglects that DEMs are acquired by different sensors that may generate artefacts due to vegetation, shadowing, foreshortening, etc. These systematic data errors are likely not captured by the local binning algorithm that the authors used to downsample the dense point clouds. My concern is that, now that a globally available DEM with 12 m resolution is available (WorldDEM), researchers may place a possibly to high confidence into the fidelity of that product. The incorporation of this data (or other data sources) into the analysis would provide guidance here.

A similar observation was made by reviewer 1, regarding our ability to compare datasets derived using differing data collection and processing methods. We had initially considered performing such an analysis between differing data products, however, we elected to use downsampled LiDAR data as we wanted to the impact of changes solely in data resolution, isolating potential sources of error identified above, and allowing us to tie our results with the theoretical observations presented in Section 5.1.1. We have added further discussion of these issues and our motivation for the

use of LiDAR data to section 2.1, with the aim of ensuring that our work is considered within the proper context.

2. The mathematical treatment of the observed loss of fidelity with increasing spatial resolution appears somewhat misplaced in the discussion. Instead, this part could well serve as a motivation of the study that should be placed at the beginning of section 2.

A similar comment was made by reviewer 1 and our response is copied below:

Prior to submission, we debated placing this section in the methods section rather than within the results section. We felt that this led to a more disjointed narrative than is present in the current structure of the manuscript. In other words, we tried what the reviewer suggests and didn't really like the result: the manuscript flows better if the numerical problem is highlighted and then we use the analytical solutions to show why this problem exists. This ensures that the paper's focus is on the practical problem of determining what one can actually say about a low resolution DEM rather than throwing the reader into a cold bath of spectral analysis before any results are reported.

Moreover, I think that this part is not intelligible for many who are infamiliar with wavenumber response functions. Adding more detail here will certainly be thanked by the general readership of ESURF.

We will expand this section to better clarify our use of wavenumber response functions and tie the analysis more closely to the real-world results, with the aim of making this section more accessible to the general readership of ESURF.

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