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Interactive comment on "NCAR global model topography generation software for unstructured grids" *by* P. H. Lauritzen et al.

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We thank the reviewer for his/her review of the manuscript. Below the reviewer comments are repeated (or partially repeated) in red font and our reply is in blue font. Changes to the original paper is shown in red font in the revised manuscript (attached).

We would like to inform the reviewer that we have added a newer raw topography data (GMTED2010) to the manuscript even though none of the reviewers have asked for it. Users of the software have requested this newer dataset. In the results section (Section 3) the differences between GTOPO30 and GMTED2010 are highlighted.

General comments:

1. This paper describes a method for generating topography and computing sub grid variances of topography for use in parameterizations that need it (e.g. gravity-wave drag). It is clearly written and reproducible. The method is fine as far as it goes and my main complaint is that the approach is mostly an application of previously developed tools for a new use, rather rather than a taking a more novel approach to topography generation. So, for example, the authors make use of an intermediate cubed-sphere grid to do the scale separation, primarily so they can re-use their work developed for CSLAM and previous regridding related to cubed sphere approaches. The discontinuous/fractal nature of topography and more rigorous scale separation would seem to make this an ideal application for, say, wavelets or other techniques rather than the cubed sphere approach they describe. This doesn't detract much from the utility of their method and this paper serves as useful documentation of the methods currently employed.

1. The purpose of the paper is not to introduce a novel method for the generation of topographic variables (although that would be an interesting research subject!) but it is the intention to make the generation of the forcing data sets for global models traceable and transparent, and easily accessible for modeling groups. The separation of scales is discussed in item 4 below

2. The results section is focused on topographic smoothing which is largely unrelated to the method they describe. It would have been better to have an application or test that demonstrates to what extent they have achieved the scale separation desired or, for example, that the GWD parameterization is affected by their (presumably improved?) estimate of sub grid variance. Smoothing is done after topography generation using known techniques, with the fairly obvious statement that 'It can

GMDD

8, C2302–C2307, 2015

clearly be seen that there are large differences between the height of the mountains with different smoothing operators and smoothing strength.' I don't think this section adds much to the paper and is not that relevant to what I thought was the point of the paper.

Reply: The results section has been largely rewritten with less focus on smoothing. See Section 4 regarding scale separation.

Changes to the manuscript:

- Climate model simulation results with different levels of smoothing has been removed from the manuscript.
- A discussion on sub-grid-scale variance and smoothing has been added to the manuscript (new addition to the results section).
- Differences in elevation, SGH and SGH30 between the newer GMTED2010 and older GTOPO30 raw elevation datasets is discussed (new addition to the results section).

See Results section in revised manuscript for details.

Specific comments:

3. At one point the authors state that the target grid must have great circle arcs (p4633, line 20), but figure 3 shows the target as 'any structured or unstructured grid.' It should be noted that lat/lon grids (namely, latitude circles) are not great circle arcs and in fact near the poles are very different from great circle arcs, so this would appear to

GMDD
8, C2302–C2307, 2015

eliminate a large class of grids?

Reply: The software supports any structured and unstructured grid, and assumes great-circle arc control volume cell edges during the remapping. As the reviewer notes, that will introduce a truncation error for grids that are not using great-circle arcs for the edges of the control volumes, however, the software is still valid/usable. For comparison, the widely used SCRIP software package approximates all control volume edges as straight lines in longitude-latitude space.

Changes to the manuscript: Text has been added to section 2.2.2 to address the reviewers concern:

'As for Step 1 of the algorithm, several methods could be used such as SCRIP and Kritsikis et al. (2015). The latter has the advantage of more accurately representing both small and great circle arc sides of the control volumes whereas SCRIP approximates cells sides in latitude-longitude space. Here the remapping is performed using CSLAM (Conservative Semi-LAgrangian Multi-tracer transport scheme) technology (Lauritzen et al., 2010) that approximates the cell sides with great-circle arcs. That said, the algorithm can still operate on grids where the control volumes do not consist of great-circle arcs, such as regular latitude-longitude grids where the control volume sides parallel with latitudes are small circle arcs, but there will be an additional truncation error in the geometric approximation to the control volumes

4. It is unclear how the authors estimate which scales are represented in the cubed sphere, stating in 2.2 (p4629 around line 20) that 'A quasi-uniform approx. 3000m resolution results in a scale separation of 6000m'. Is this just a 2-dx assumption? Or how is this estimated? This partly illustrates my earlier point that using the intermediate

GMDD

8, C2302–C2307, 2015

cubed sphere is not a particularly rigorous form of scale separation.

Reply: Yes this is just a 2dx assumption and we agree that is not particularly rigorous but likely good enough given the uncertainties in the topography scale for which gravity waves propagate in the vertical or not (see discussion in paragraph 4 in the Introduction).

Changes to the manuscript:

- The following text has been added to section 2.2.: 'Any quasi-uniform spherical grid could, in theory, be used for the separation of scales or, given the discontinuous/fractal nature of topography, a more rigorous scale separation method such as wavelets or other techniques could have been used. It is noted that the separation of scales through an intermediate grid does not correspond exactly to a spectral transform truncation (used in the previous section). The intent is to approximately eliminate scales below what can be resolved on the intermediate grid.
- Right before Section 2.2.1 the following has been added: '(based on a simple '$2\Delta x$ assumption')'

5.The section on continuous scale separation is really just a description of spherical harmonic decomposition and is maybe only useful for the first couple of figures showing spectra. Spectral transforms are not used as part of the method so later discussions of scale separation in wavenumber space are a bit misleading since there is no guarantee, and indeed there should be no expectation, that the method really

GMDD
8, C2302–C2307, 2015

does correspond to a particular truncation in spectral space.

Reply: For the discussion in continuous space spherical harmonics are a natural choice for separating spatial scales although the method used in discrete space does not represent a spherical truncation but only approximately so. The reader is 'warned' about this in the revised manuscript.

Changes to the manuscript: See item 4.

Technical corrections:
4625 line 2 - eliminate foot note and include in text? (personal preference)
4626 line 3 - should be 'drag to be produced'
4626 line 14 - reduce triple quotes to double quotes
4627 equation 3 - first sum should be bounded by M at the top, not infinite
4633 line 22 - where $-$ > were
4634 line 3 - variable-resolution, not variables resolution
4638 line 2 - is not significantly ? by the roughness

Reply: Thank you

Changes to the manuscript: All technical corrections have been performed.

Please also note the supplement to this comment:
http://www.geosci-model-dev-discuss.net/8/C2302/2015/gmdd-8-C2302-2015-supplement.pdf

Interactive comment on Geosci. Model Dev. Discuss., 8, 4623, 2015.