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Interactive comment on "A hierarchical mesh refinement technique for global 3-D spherical mantle convection modelling" *by* D. R. Davies et al.

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The paper presents a mesh refinement technique based on geometric multigrid refinement, that is fairly straight-forward to implement. The results show that this a useful technique and the specific example geometry shown, with decreasing resolution with depth is a sensible illustration of the potential power of this method. Overall, the results appear to be quite good, although it is not clear to me based on the results of Table 1 or Table 2 that the authors see a significant improvement in the global solution parameters with the non-uniform grid for a similar number of nodes, which is disappointing. For example, it is not clear to me that D13(5) is any better than D13(2). I found one other thing

quite puzzling. In Figure 4, the error for the l=16 case is enormous and I am not sure why. If I compare with Zhong et al. 2008, while they do not show relative error, their results appear to track the analytic solution regardless of harmonic degree. My only other comment is that the level of detail in this paper could be improved, specifically with regard to exactly how the diagnostics are measured (i.e., equations and formulas). In comparison, Zhong et al., 2008 show equations for the quantities that they measure. Oft times, in benchmark comparisons we have found that the devil can be in the details. How something is averaged can make as much difference in the reported result as the difference between the methods. While I recognize that the authors specifically point out that this is not a benchmark paper, it would make their results more useful to others coming along after them if an additional level of detail were provided. The resolution study on the convective flow results is very interesting and I would hope this might generate some additional 3D spherical benchmark discussion.

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