Solid Earth Discuss., 5, C863–C864, 2014
www.solid-earth-discuss.net/5/C863/2014/


Solid Earth
Discussions
Open Access

# *Interactive comment on* "Practical analytical solutions for benchmarking of 2-D and 3-D geodynamic Stokes problems with variable viscosity" *by* I. Yu. Popov et al.

**Anonymous Referee #1**

Received and published: 13 January 2014

This is a nice piece of contribution for numerical studies in geodynamics. In geodynamic studies, the very first step is to validate the code results with analytical benchmark results. Previously, the analytical results are quite simple, i.e. typically with constant viscosity or 2D depth-dependent viscosity. With the implementation of new techniques in geodynamic codes, such as adaptive mesh refinement (AMR), new type of analytical benchmarks are required to validate the code results. For example, we need to test the accuracy for a small area with strong viscosity gradient (exponentially varying viscosity). This study develops a theoretical analysis to construct the analytical solutions for linearly and exponentially varying viscosity in both 2D and 3D. Therefore, it is quite useful for testing complex numerical models, including models with AMR or



with open boundary conditions. Therefore, I think it is suitable to be published. I have some relatively minor points which may help to improve the manuscript.

1. It may be redundant to use three kinds of norms to show the error. I think using one of them, e.g. L2-norm, may be good enough. For these norms shown in the tables, please clearly indicate that they are absolute value: ||vxn-vxa||, or they are relative value (||vxn-vxa||)/||vxa||. 2. For the three figures in each set, it is better to reverse the order of Fig.1 and Fig. 2. I like to first see the viscosity and density structure, then see the velocity and pressure field (similarly, reverse the order of Fig. 4 and Fig. 5, ..., etc.) 3. In all the figures showing vx, vy and pressure, the last subfigure is smaller than others, please correct. In addition, the magnitude for pressure error in Fig. 4 is probably wrong. 4. In all the figures showing viscosity and density structure, it is better to use one as the aspect ratio. 5. In Figure 3, are there two lines overlapping each other? I can only see eight lines in total. 6. In Fig10 – Fig 12, for figure caption, change "linearly varying viscosity" to "exponentially varying viscosity"? 7. For 3D geometry, it is not necessary to show the result of the two cases with low viscosity contrast. The four 3D cases can be reduced to two. 8. Is it possible to develop a similar generalized analytical solution with a viscosity jump? For example, with the classic propagate matrix method, we can set the lithosphere viscosity as 100, and the underlying mantle as 1 and still get the analytical solution.

Interactive comment on Solid Earth Discuss., 5, 2203, 2013.