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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.

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Dear Referee, Thank you for useful remarks and suggestions. We rewrite the manuscript in accordance with your review. Namely, the following changes were made. We improve language throughout the paper.

I understand that the list on page 2205 isn't exhaustive, but a few articles could (should?) be added to it: - 2D & 3D shear band formation & plasticity implementation (Lemiale et al, PEPI 2008 ; Kaus, Tectonophysics 2010; Thieulot et al, JGR 2008) - Busse et al, 3D convection at infinite Prandtl numbers in cartesian geometry, Geophys. astr. Fluid Dyn., 1993 - Kronbichler et al, GJI 2012 contains examples of SolCx,

2D circular inclusion, Blankenbach et al, and Busse et al. - (Gerya and Yuen, PEPI 2007), (Thieulot , PEPI 2011), and (Gerya 2010) should be added to the numerical sandbox experiment item - Duretz et al, Gcubed 2011, showcase SolCx, SolKz, and R-T instability. - falling block (Gerya and Yuen, PEPI 2003, Gerya, 2010, Thieulot PEPI 2011)

We add the suggested articles to the list in Introduction and, correspondingly, add references to the bibliography.

. . .explain how their solutions were arrived at. Also, may be the authors could comment on whether similar derivations could be done for compressible fluids for instance.

We use general mathematical method of characteristics to derive our solutions. This method can give one exact solutions in other cases (e.g., compressible fluids, etc.), but, unfortunately, it cannot guarantee the obtaining of the solution in an analytic form. Up to the moment, we did not yet get such solutions for other cases.

-the authors do not provide the reader with enough background theory nor literature examples regarding the expected error convergence. Given this particular type of Finite Difference stencil, is there an analytical prediction of the expected error convergence ? Given that the code they have used is most likely similar to the one in Duretz et al, GËĘ3 2011, they should mention beforehand what these authors reported so that the sentence "The calculations show that one has good convergence of the numerical scheme for small viscosity contrast, but it is not so for high viscosity contrast " makes actual sense. Also, "good convergence" without a reference point is meaningless. Discussion on the error convergence has been improved - 18 tables are shown but never discussed (the tables are barely mentioned in the text: line 15 page 2227 and line 16 page 2228). Are they all necessary ? Does the use of three norms bring something more than using only one ?

- 28 figures are shown and barely discussed. Are they all necessary ?

We reduced number of figures and tables in the paper and moved some of them to the supplement. The text is modified. Different norms of errors shows slightly different features of the convergence. That is why we present three norms. It does not lead to increase of number of figures.

- The convergence plots (figs. 3, 6, 9, ...) do not have axis labels.

We insert labels.

- Why do the authors restrain the (2D) grid size to such low values and to such a low ratio of variation (typically testing 12x12 up to 48x48, i.e. log10(h) ranging from -1.08 to -1.68) ? Duretz et al show results with grids ranging from 41x41 up to 1001x1001, for instance.

This is done to have similar resolutions in both 2D and 3D solutions. Duretz et al. only explored 2D solutions, where much higher resolution is possible.

- All the figures pertaining to 2D simulations show a caption referring to the x and y axis, and the velocity components are accordingly referred to as vx, vy. What is the z coordinate mentioned above every colour plot ? - It is a very positive point that the authors provide the matlab scripts that they have used, but the labelling of the files is misleading (they all have a name containing '3D' while half the simulations are carried out in 2D). A short text in the appendix should explain the content of these files and which one was used in which section.

We add (to the supplement) the corresponding text with explanation of the files contents

I would suggest the authors to either greatly reduce the numerical part while giving more context, or split the article in two distinct articles. In the latter case, the first article would be about the derivation of the family of solutions, and could propose/label a few carefully chosen ones. The second one would require additional work, such as running these experiments on a variety of codes (either through collaboration or by acquiring freely available downloadable codes, such as MILAMIN or ASPECT and make

a thorough analysis of their performance when the viscosity ratios are progressively increased.

We reduced the number of figures and tables in the paper. Part of them is given in supplementary materials . Comparing error convergence with other available codes goes beyond the scope of this paper aiming at presenting new particular analytical solutions.

Thank you for your useful remarks and suggestions.

Sincerely yours,

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