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Discussions

Interactive comment on "Analytical solution for viscous incompressible Stokes flow in a spherical shell" *by* Cedric Thieulot

Anonymous Referee #2

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In this manuscript the author presents new analytical solutions for Stokes flow in a spherical shell, which could be used for benchmarking mantle convection codes. This is useful and as his derivation seems correct. I think it can be published with some minor changes to the introductory discussion.

The author writes "Also, the semi-analytical solutions present a major drawback: the solution is given as a function of spherical harmonic expansions which are based on infinite sums and which can be cumbersome to manipulate and/or implement ". This is missing the point somewhat. A great thing about using spherical harmonics is that for azimuthally-constant viscosity the Stokes equation can be solved independently for each spherical harmonic, which means if the driving density field consists of a single spherical harmonic then the flow solution can also be expressed using a single spher-

ical harmonic. No infinite expansion necessary. In fact, this is effectively what the author is doing in this manuscript – his driving density field and flow solution both consist azimuthally of spherical harmonic degree 1 and order 0. Presumably, the solutions the author has found are part of a family of solutions that could also be derived for other spherical harmonics, so if the author wanted to he could generalise this. Another example is that Zhong 2008 presented "analytical" flow solutions for single spherical harmonics (using the propagator matrix method instead of a mathematical equation).

Stylistically, the author has a habit of writing in single-sentence paragraphs, which is normally not considered to be good writing style. In particular, most paragraphs in the Introduction contain only a single sentence. I suggest he groups sentences together to make longer paragraphs. Additionally, it is best to avoid colloquial expressions such as "seen the light of day" in a formal scientific manuscript.

The references the author cites in the first two paragraphs are very recent examples that back up these points; it might be better to cite earlier ones.

The list of "last 30 years" 3D spherical convection codes in the 3rd paragraph is not complete, so he should either insert "e.g." to indicate that these are examples rather than an exhaustive list, or try to make it complete. Missing codes that I can think of right now include the yin-yang grid ones of Kameyama and of Yoshida, and any code that uses a spectral method (codes of Glatzmaier, Zhang+Christensen, Machetel, Monnereau)

One analytic solution the author should mention is Zhong (1996) – although this is not in spherical geometry. It would also be better to mention the Popov et al paper somewhere in the introduction.

Zhong, S. (1996). Analytic solutions for Stokes' flow with lateral variations in viscosity. Geophysical Journal International, 124(1), 18-28.

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