

## ***Interactive comment on “Symmetric Equations on the Surface of a Sphere as Used by Model GISS:IB” by Gary L. Russell et al.***

**Anonymous Referee #1**

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The idea of presenting symmetrical equations of motion with dependent dynamical variables (more velocity fields than spatial dimensions) is an interesting one insofar as it permits to avoid singularities of the coordinate system.

After reading this manuscript, I was however left with mixed feelings about the approach. It does not seem that the authors found strikingly interesting or advantageous behaviours associated with their approach. In particular, I would have liked to see explained specific features of the numerical solutions that are especially attractive and specific to their approach. Getting rid of singularities may be achieved in different ways. What is particularly attractive in the authors' approach?

I appreciated the thoroughness of the mathematical description that the authors presented (there is one exception, see below). I am confident the mathematical description

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presented will allow other scientists to reproduce their approach.

I believe the manuscript would benefit from adding a sub-section on the particularities of the numerical solutions obtained from the symmetrical approach compared to other means of mapping the sphere without singularities (but with discontinuities of the coordinates). In other words, the authors should help the reader understand why it may be beneficial to learn the symmetrical approach. Does the increased mathematical complexity worth the effort?

My recommendation is therefore: acceptable with minor revisions.

I also provide this list of minor comments:

p.2 l.1: At this point, please define what is precisely meant by symmetric formulas and isodirectional flow;

p.2, l.5-10: Another possibility, keeping the lat-lon paradigm, is to use the Yin-Yang grid (see Qaddouri et al.). This is operational in Canada and this approach should be mentioned here as well as the other approaches;

p.2, l.9: How are the eight corners of the cubed-sphere singularities? At these points, the determinant of the metric tensors corresponding to each connected domain do not vanish.

p.2, l.25: Isn't the symmetry broken when rotation is introduced? Are the three Cartesian coordinates inertial?

General comments on the introduction: The Introduction should perhaps be shorter and more focused. It is somewhat dry.

p.4, l.26-27: "Three horizontal velocity components ... rotate around each respective axis." Please rephrase. It is unclear how a velocity component can rotate around an axis.

p.5, l.8: Eq. 2.5 should be better justified.

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p.25, l.32: Change "years" for "days".

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2018-126>, 2018.