

Geosci. Model Dev. Discuss., referee comment RC3  
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## Comment on gmd-2021-168

Anonymous Referee #3

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Referee comment on "Improved double Fourier series on a sphere and its application to a semi-implicit semi-Lagrangian shallow-water model" by Hiromasa Yoshimura, Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-168-RC3>, 2021

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Comments on "Improved double Fourier series on a sphere and its application to a semi-implicit semi-Lagrangian shallow water model" by Hiromasa Yoshimura.

### General comments

The author proposes an alternative formulation to alleviate the pole problem used in a shallow water model using double Fourier series. The paper presents specific forms for the gradient of a scalar, vectors, and Laplacian and Helmholtz operators. The comparison against spherical harmonics and the new double Fourier series provides insights into the properties of the former. I recommend the publication of the paper provided that the following concern is appropriately addressed.

### Major comments

- As the other reviewers noted, the tests seem to be randomly chosen. I recommend the author to investigate at least the convergence (error vs horizontal resolution) and conservation (energy, vorticity, etc.). Avoid visual comparison where possible and conduct quantitative evaluation. The errors should be given in standard error norms by numerical values.
- The presentation of the paper can be improved. For example, Subsection 5.2 and 5.4 are short and 5.3 is of two long paragraphs. Author's intention for the tests should be provided. The author discusses the pole problem, but Figures 4, 7 and 9 are shown in longitude–latitude; Figure 9 omits the polar region. It would be nice to add a diagram to show the differences of expansion visually.

## Minor comments

- Page 1, Line 21: more accurate rather than good
- Page 1, Line 25:  $O(N^3)$  memory usage, unless calculated on-the-fly
- Page 2, Line 4: Alternatively (avoid repeating the same word, another).