Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., author comment AC1
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Reply on RC1

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Author comment on "Strategies for conservative and non-conservative monotone remapping on the sphere" by David H. Marsico and Paul A. Ullrich, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-248-AC1, 2022

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1. “The largest errors occur when interpolating to the lat-long grid. Do we see particularly large errors at any point on the grid (e.g. poles or equator).”

In general, the errors are not the largest at the equator or poles for latitude-longitude meshes. They are largest in regions of high curvature, where we would expect there to be overshoots or undershoots. See the attached plot for the errors on a lat/lon grid for two of the test cases.

2. “I think that it might also be relevant to mention conservative mass fixers developed for semi-Lagrangian schemes, such as the variants of Zerroukat, which make local corrections to fix both conservation and bounds.”

The CAAS algorithm is similar to the one described in the paper “A simple mass conserving semi-Lagrangian scheme for transport problems” and we will include a mention of it in our revised manuscript.

3. “Please provide some more information about how R is constructed for each combination of grids.”

For the conservative remapping, R is constructed according to a two stage procedure for finite-volume meshes. First, a fitting procedure is used to construct a local nth degree polynomial. This polynomial is then integrated over each overlap face that intersects a given target face (details can be found in the papers Arbitrary-Order Conservative and Consistent Remapping and a Theory of Linear Maps: Part I/II). CAAS is then applied as a post-processing operation once R has been applied to the source field.

For the non-conservative remapping, the entries of each row of R are determined by approximating each value on the target mesh as a weighted sum of values on the source mesh, as in equation (19). We consider both the non-integrated and integrated versions.

For the non-conservative non-integrated remapping, the non-zero entries of each row of R correspond to the faces on the source mesh whose centers form the nodes of a polygon that contains a given point on the target mesh. The values are then determined by whatever weights we’re using, i.e. bilinear, generalized barycentric, or Delaunay triangulation interpolation.

For the non-conservative integrated remapping, R is constructed by way of the overlap mesh. By using the overlap mesh, we ensure that every face on the source mesh is sampled. Specifically, we approximate the value of the field on each target mesh face by integrating the source field over that target face by applying numerical quadrature to each intersecting overlap face (see equations (27) and (28) for this written out fully).

4. “I'm confused by the reference of supermeshing in the nonconservative section - this technique is introduced usually to ensure conservation.”

While the overlap mesh is generally used to ensure conservation, we have adapted it to be used in a non-conservative context. For non-conservative remapping, the overlap mesh provides a systematic way of ensuring that every point on the source mesh is sampled, because the overlap mesh consists of all faces common to both the source and target meshes. The sample points used are obtained by triangulating the supermesh faces.

Please also note the supplement to this comment:
https://gmd.copernicus.org/preprints/gmd-2022-248/gmd-2022-248-AC1-supplement.pdf