Author comment for Anonymous Referee #2

Vijay S. Mahadevan and Jorge E. Guerra on behalf of all authors

February 20, 2022

Dear Reviewer,

We are grateful for the suggestions and technical comments provided to improve the manuscript. We will address all the technical and non-technical comments when revising the manuscript. Additionally, we have provided a discussion on some of the general comments in the reviewer notes, which should provide better context to the work presented in the paper.

1. I suggest a brief review of and possible reference at "https://cerfacs.fr/wp-content/uploads/2021/11/Globc_TR_Valcke_21_145_regridding_analysis_final.pdf"

   Yes, we will include a reference to the technical report, which certainly looks more indepth at the performance aspects of some of the remapper implementations.

2. Please define convergence and convergence rate somewhere.

   We will include these definitions in the consistency Section 3.2 of the manuscript.

3. Please explain the numerical results in Section 5 in slightly greater detail. I understand you have defined the metrics, but I believe there needs to be some more detailed description of what the values represent qualitatively to help the reader fully understand the tables and figures, especially tables associated with convergence rates when first shown in Section 5.1.1.

   Understood. Reviewer #1 had a related comment as well. We will address both of these comments by adding more details about the theoretically expected and the numerically observed convergence rates behaviors. The additional details should add more context quantitatively understand the results showcased in the tables.

4. You alude to multiple resolutions on page 24 and you show results for varied resolution in the paper including coarse to fine and reverse. But I don't think you ever define the resolutions. Could you provide some insight into the actual resolutions associated with each grid and refinement. Maybe a table? Number of gridpoints would be fine.

We can certainly add a table with some statistics about each of the meshes including the resolution (number of elements), average/min/max element sizes to provide better context for both uniform and regionally refined meshes. Just a note that the meshes are available openly in our data repository[1] as well.

5. As I understand it, the methods assessed are all linear and are implemented as a sparse matrix multiply applied to the source data, except for the special extra methods (ie. CAAS) that are implemented as run-time adjustments the require analysis of the actual data fields.

This is true. The methods that we have currently explored are either linear (ESMF, TempestRemap) or quasi-linear (GMLS-CAAS, WLS-ENOR), where the bulk of the work can still be performed once with a bounded cost at runtime to apply the projection for field transfer.

6. Is there anything to be said about non-linear methods? Could ESMs benefit? Could they be easily implemented? I don't think this paper needs to address this question.

Nonlinear remap methods in general have a much higher computational complexity in comparison to linear or quasi-linear remapping schemes. However, such methods can offer tremendous flexibility in terms of imposing conservation requirements, preserving inherent properties of the field with additional constraints in the system (e.g., divergence-free conditions), maintaining valid bounds of the transferred field data (monotonicity), producing optimally accurate approximations (discontinuity detecting, feature tracking, adaptive-order reconstructions) to provide coupled data with minimal spatial error propagation. Additionally, since the nonlinear methods do not need to rely on explicit mesh connectivity through creation of a linear map, the application of such schemes to adaptive or moving meshes are a trivial extension. So there is certainly a lot of value in having a nonlinear remap method tuned for ESMs, if there are specific components like sea-ice that require high-order accurate field data

[1] MIRA Datasets: https://github.com/CANGA/MIRA-Datasets

satisfying auxiliary conditions.

We have provided some references related to these schemes in Section 2.1 and Section 6.3 in the manuscript, which also provide significantly more information for interested readers.