

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-323

Anonymous Referee #2

Referee comment on "Metrics for Intercomparison of Remapping Algorithms (MIRA) protocol applied to Earth system models" by Vijay S. Mahadevan et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-323-RC2>, 2022

This is a well organized and well written paper that will benefit the community. It provides a significant level of background information and introduces readers to typical results for a subset of remapping algorithms. The most important point may be the ability to leverage, share, and improve the analysis tools within the community for further assessments.

General Comments:

I appreciate the inclusion of Section 6.4 related to cost. While some addition information about performance would be interesting in this paper, I look forward to more detailed performance results in the future. It's clearly important to access the cost and memory use of all aspects including the "offline", "online" (sparse matrix flops and communication), and specialized "online" methods (i.e. CAAS).

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"

Please define convergence and convergence rate somewhere.

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.

You allude 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.

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 that require analysis of the actual data fields. 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.

Technical comments:

Page 18, section 4, line 10-19. Remap iterations are interesting as a stand-alone test, but that's not how climate models are implemented. Mapping introduces dissipation but the models then produce solutions independently at their own resolution at each coupling period. Certainly, the amount of dissipation is important in the forcing/coupling and remap iterations provides a relative and interesting measure of the dissipation and metrics associated with each method as part of this discussion. But I don't think the last two sentences of the paragraph on page 18, line 15-19 accurately reflect the situation in practice in ESMs.

Page 25, Table 1. Please describe what the numbers mean qualitatively, at least a bit. Is 1 good? Is 0 good? What does >1 or <1 mean? What does >0 or <0 mean? Are 1.031, 1.034, 1.025, 0.986, 1.057, and 0.999 meaningfully different? ...

Page 26, Figure 6. Again, please describe the numerical results a bit more qualitatively.

Page 31, line 3. "Notably, the slow accumulation of roundoff error in the global field integral as a function of remap iterations has a detrimental effect to global conservation." Are you suggesting that a fast accumulation would be better? Maybe rewrite to make it clear that the accumulation (even though it's slow) is detrimental. I think that's what you mean. At line 5, what does "and is distinctly subdued in the low-order ESMF map projection" mean and what are the implications?

Page 32, line 14. Could you explain the ESMF behavior more for figure 8 (and 9a to a lesser degree). How/why does the L_{max} term improve with more iterations? That makes no sense to me, and I am curious to understand this better.

Non-technical Comments

Page 3, line 4, suggest defining ESM here, "Earth System Models (ESMs)"

Page 3, line 10. confused. Drop the comma? or "Support for generation of mapping weights at runtime is growing"

Page 5, line 19. Is "high-order remap" or "higher-order remap" or "higher-order remapping" or "high-order remapping" or "higher-order mapping" or some other combination of those words best?

Page 8, line 17, Should "ESM's" to "ESMs", check consistency in document

Page 16, section 3.2. Can you better explain "exact sampling"? Seems to be explained further in 4.1, point 3 and Section 4.2. Maybe just indicate this will be discussed in greater detail in Section 4 here.

Page 18, line 21. Check use of "of" in the sentence.

Page 38, table 6. Maybe it's better to keep the method order the same for each variable?