Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
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# Comment on gmd-2021-411

Anonymous Referee #2

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Referee comment on "Assessing the robustness and scalability of the accelerated pseudo-transient method" by Ludovic Räss et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-411-RC2, 2022

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Review of Rass et al.

This paper presents a pseudo-transient method for solving stationary PDEs. The work here is novel, but it needs to be improved before publication in GMD. Please see my major and minor comments below.

Title: "towards exascale computing" is not necessary. Remove.

Major Comments:

1. In the introduction, the authors contrast the pseudo-transient methods with Krylov iteration methods, such as conjugate gradient or GMRES methods. A benefit of pseudo-transient is that they are local and do not require global reductions unlike standard Krylov methods. First, there has been work on communication avoiding Krylov methods that reduces/avoids many of these global comms. See, for example, the widely cited Ph.D. thesis

Hoemmen, Mark. Communication-avoiding Krylov subspace methods. University of California, Berkeley, 2010.

or the more recent work the reduces the number global reductions for Gram-Schmidt and GMRES.

Å□wirydowicz, Katarzyna, et al. "Low synchronization Gram–Schmidt and generalized minimal residual algorithms." Numerical Linear Algebra with Applications 28.2 (2021): e2343.

In addition, preconditioning and "intelligent" guesses for the initial Krylov vector can vastly reduce the number of iterations required, thus making Krylov methods more competitive. A computational comparison and discussion of the proposed method with Krylov would be a welcome addition to the paper.

2. In Section 2, the authors assume the the computational domain is a cube with the same number of cells in each dimension. In geoscientifc models, such as the atmosphere and the ocean, there is are order of magnitude differences in scales between the horizontal and vertical, and hence large differences in the grid spacing. The PT methods requires choosing an optimal Reynolds number, which depends on the length scale. How would the authors adapt the PT method to handle these scale differences--they claim "the solution strategy is not restricted to cubic meshes with similar resolution..."

3. The English is sub-standard and needs to be improved. See the minor comments.

Minor Comments/questions:

1. Line 31: "see a regain in active development..." is awkward. Replace with "are in active development". Citations to back this assertion
would be nice.

2. Line 121: The notation [0;L] is not standard. [0,L] is standard.

3. Equation (1): Odd notation for the divergence operator on the right hand side. This is the continuity equation assuming constant density.

4. Equation (2): Why is "i" used instead of "k" ?

5. Line 138: Replace "to assemble" with "assembling"

6. Line 146: Replace Eq. (15) with Eq. (3).

7. Line 149: Replace the comma after tau with a semicolon.

8. Line 174: Remove "the" before "Eq. (7)".

9. Equation 7: This is the equation for Cattaneo diffusion. See, for example, "Methods of Theoretical Physics" by Morse and Feschbach. It is also called the Telegrapher's Equation in .

10. Line 181: What happens to C if the grid spacing is different in different dimensions? See major comment 2.

11. Line 335: Replace "it's" with "its".