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Interactive comment on "Second-order Scalar Wave Field Modeling with First-order Perfectly Matched Layer" *by* Xiaoyu Zhang et al.

Anonymous Referee #1

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General comments:

After a thorough review of the finite-difference method and the PML method, the paper proposed to combine the 1st-order PML system and the 2nd-order wave equation system with an explicit interface to exchange the pressure field between the two systems, numerically solved by the staggered-grid and conventional grid finite-difference methods, respectively. The idea is clearly delivered and the numerical examples are convincing. Overall, the paper has good technical content and it is well organized. I attach an annotated pdf in which I suggest several corrections for typos and so on. Besides, I have some specific comments as follows.

Specific comments:

Printer-friendly version

Discussion paper

1. In general, I feel it's a bit hard to follow the description of the algorithm (Page 7). Maybe it's helpful to zoom in Fig 1 and label more symbols in the figure that are used in the text, e.g. $p_x^n(i,j)$, $v_x^{(n+1/2)}(i_r+1/2, j_r)$, etc. Also, if I am right, please mention the updated $p_{i,j}^{(n+1)}$ in Step 2 is not used in Step 3, in which the old $p_{i,j}^n$ value is used to calculate $v_x^{(n+1/2)}(i+1/2,j)$ and $v_z^{(1/2)}(i,j+1/2)$ and therefore requires storing these old $p_{i,j}^n$ values on the red lines, the cost of which is however negligible.

2. Also for the algorithm, I think you just show the case when 2nd-order finite-difference is used for discretization in space. If higher orders are used, i.e., more adjacent grid points (or half grid points) are used to calculate the wavefields on the central point, how should we exchange the pressure field between the SG-PML region and the inner CG region? I think we have to leave more grid points between the red and blue lines, unlike in Fig. 1 that the red and blue lines are just one grid apart. Please give a clear description in the paper as your first numerical example has shown that a reasonably accurate modeling (i.e. no strong dispersion) requires at least the 4th-order finite-difference approximation.

3. In Section 4.2, the proposed method and the classical SG PML appear to have similar absorbing capabilities (e.g., Fig. 15b,c). I think this is reasonable because in essence, the two methods are same; the differences should be attributed only to the different wave equations employed for wave modeling in the computational domain, namely the 1st-order and the 2nd-order systems, respectively (and thus different discretization and finite-difference methods). On the other hand, the 2nd-order PML (e.g., third columns of Fig. 15) behaves quite poorer than the two methods mentioned before. Why does this occur? Although the realization is different, the 2nd-order PML borrows the same idea as the 1st-order PML and thus they should have similar behavior. In addition, why is the hybrid ABC method the worst of all?

4. I would suggest the authors also compare the proposed method with the C-PML method because it has been shown better absorbing capability than the classical PML

especially at grazing angles (Komatitsch and Martin, 2007).

Please also note the supplement to this comment:
https://www.solid-earth-discuss.net/se-2018-48/se-2018-48-RC1-supplement.pdf

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