Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-325-RC1, 2021

Geoscientific Model Development Discussions
Open Access

Interactive comment on "Lossy Checkpoint Compression in Full Waveform Inversion" *by* Navjot Kukreja et al.

Anonymous Referee #1

Received and published: 17 January 2021

Review of manuscript: GMD-2020-325 Title: Lossy Checkpoint Compression in Full Waveform Inversion Authors: Navjot Kukreja, Jan HuÌĹckelheim, Mathias Louboutin, John Washbourne, Paul H.J. Kelly, and Gerard J. Gorman

This paper is a report on using compression for the forward and gradient solutions in full waveform inversion (FWI). They discuss an algorithm that uses compressed storage, as opposed to raw storage, in a checkpoint algorithm in the style of Griewank. A review of some of the existing literature is presented. Then the experimental methodology is discussed. The approach taken is to compare the reference solution (measured in terms of the gradient and forward solution) to the result when the forward solution is compressed. The study is reasonably complete and demonstrates for FWI that compression can be used.

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Discussion paper

Overall, while the paper has reasonable conclusions I don't think its sufficiently novel to warrant publication. At times it reads like a lab report on using compression technology and I would except any group that would pursue such an approach would have to do a similar exploration. The authors suggest that the idea of using compressed checkpoints is novel, and allows a tradeoff of time and disk space. However, I don't see evidence of exploration of the runtime speeds that could be achieved, and understanding of the accuracy/performance tradeoff beyond the schematic image in Figure 3. Further, the I would expect that this type of approach to be explored elsewhere and be a more minor contribution, particularly since in industry full storage of the forward solution appears to be the norm in FWI. I was hoping that the work would be more generally applicable to PDE-constrained optimization, but due to the use of a linear PDE constraint (which is consistent with FWI) I have my doubts about the extensibility of the results to cases involving turbulent flow, for instance. This is due to the need to linearize the PDE around a state to compute the gradient. Finally, a few oversights for the literature review have been made. The work Weiser and Götschel (See State trajectory compression for optimal control with parabolic PDEs, SISC, 2012) appears to be as complete an empirical study for parabolic systems, with an additional error analysis. I'm not sure how to reconcile this with the statement in the present work that the analysis of compression errors is "beyond known numerical analysis". Overall, I find the present work at best modestly useful, though it reads like a lab report and would be what I would expect every group pursuing such a technology to do. Thus the novelty of the paper, does not warrant publication at this time.

Minor points: 1) In the review, you could cite the growing work in parallel-in-time optimization by for instance S. Gunther or S. Gotschel (going back to the early 2000's Mayday and later Ulbrich and Heinkenschloss). This would likely be in the context of PDE constrained optimization. 2) How is the signal to noise ratio measured? 3) Could there be some more discussion about the wave energy included? It seems that compression would be a dissipative mechanism in general (removing hopefully high frequency modes). How does this impact the objective? Is it systematically less if so why or why not? 4) The structure of the figures, with one caption per image as opposed to multiple (and some error plots relegated to the appendix) is frustrating to read. This lends itself to the overall feeling that this is a lab report on this material.

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