Geoscientific
Model Development
Discussions

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comment

Interactive comment on "Efficient ensemble data assimilation for coupled models with the Parallel Data Assimilation Framework: Example of AWI-CM" *by* Lars Nerger et al.

Lars Nerger et al.

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We like to thank for reviewer for the careful review. Please see our response below.

The manuscript describes the application of the Parallel Data Assimilation Framework (PDAF) for coupled data assimilation, with a strong focus on strongly-coupled data assimilation (DA). An example implementation with a coupled atmosphere-ocean model is described in detail and the differences to a previous similar application of PDAF as well as to a similar application of the Data Assimilation Research Testbed

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are explained and discussed.

While the presented MPI-based implementation for strongly-coupled data assimilation with PDAF is a logical extension of PDAF's approach for single-component models, it merits publication as a novel and highly relevant approach in the coupled case. This is well demonstrated by the comparison to and discussion of the implementations in Kurtz et al. 2016 and Karspeck et al. 2018.

However, the presented example of data assimilation for the coupled atmosphere-ocean model AWI-CM seems to fall short of demonstrating strongly-coupled data assimilation. Lines 322 to 330 describe a weakly-coupled assimilation system with coupled forecasts but observations of and assimilation in the ocean component only. The text explicitly states that "the assimilation update is only performed in the ocean compartment" which is confusing after sections 2.2 and 3.3 describe how the model states of ocean and atmosphere components are joined into a single state vector and how the model codes are extended to realize this technically. Presumably this experiment could have been realized with less code modifications than mentioned in the text. While even this setup with ocean-only assimilation into a coupled model demonstrates progress over data assimilation into a single-component model, the current presentation is unfortunate.

Response: Actually, the model coupling is intended to support both weakly-coupled and strongly-coupled data assimilation. For the version 1.0 of the model binding AWI-CM-PDAF, we have focused on the realization of the weakly-coupled data assimilation. This is the case discussed in Section 4. The code modifications are actually the same for weakly- and strongly-coupled DA because in either case one needs to modify the model parallelization to enable the ensemble integration and the initialization of the ensemble. As we don't assimilate in the

atmosphere, one could have omitted the call to Assimilate_PDAF in ECHAM, but this is a minor difference.

We have now revised the manuscript to make the support for weakly- and strongly-coupled assimilation more explicit.

I suggest that either the use of the presented example is well justified in the text and its relation to the previous sections and strongly-coupled DA is explained or that the example is extended to a strongly-coupled DA experiment. As it appears that large parts of the discussion and conclusion would still apply to a truly strongly-coupled data assimilation experiment, I would encourage the authors to aim for this way forward.

Response: We have extended the Introduction to include a discussion on the status and challenges of weakly and strongly coupled DA. Given that strongly-coupled DA is a very young approach that is not yet fully established and weakly-coupled DA by itself has differences to DA in uncoupled models, we think that the focus on the weakly-coupled DA for the scalability experiment is sufficiently justified. In any case we expect that the scalability of the strongly coupled DA is very similar ot the case we have examined. We have extended the discussion to better point this out.

Other minor points/typos:

line 46: transfers instead of tranDAsfers
line 71: introduce EnDA as abbreviation here
line 267: indicated instead of indicted
line 293: called instead of "are called"
line 355: "DA coupling" instead of "DA coupled"
line 386: FESOM-ECHAM instead of FEMOS-ECHAM

Figure 1 caption: "user-provided" instead of "used-provided"
Figure 6: relative time should not have units of [s]

Response: We corrected all these minor points and typos.

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