



EGUsphere, referee comment RC1
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Comment on egusphere-2022-397

Fredrik Jansson (Referee)

Referee comment on "A method for transporting cloud-resolving model variance in a multiscale modeling framework" by Walter Hannah and Kyle Pressel, EGU sphere, <https://doi.org/10.5194/egusphere-2022-397-RC1>, 2022

Review of "Transporting CRM Variance in a Multiscale Modelling Framework" by Walter Hannah and Kyle Pressel, egusphere-2022-397
Fredrik Jansson

General comments

The article considers the E3SM-MMF climate model, where every grid column of the global model (GCM) is coupled to a local cloud-resolving model (CRM), in order to resolve cloud and convection processes. These processes are important for the evolution of the model state but too small to be resolved directly on the GCM grid. This method of coupling coupling atmospheric models is known as a Multiscale Modelling Framework (MMF) or superparameterization (SP) .

The article points out an important issue with MMF/SP in general, namely that only the CRM mean state is communicated back to the GCM and then to the neighboring CRMs. For this reason, structures like clouds and convection may get stuck in a particular CRM, instead of being advected to the neighbor CRM. In the E3SM-MMF considered here, this shows up as a persistent checkerboard pattern of convection. The authors then suggest a remedy in the form of transporting not just the CRM mean state through the global model, but also the variance of CRM quantities as new passive scalars in the global model. They have implemented this scheme in E3SM-MMF and shown that the checkerboard problem is reduced. The article is well written and both the issue in MMF models as well as the remedy proposed are important. I recommend the article is accepted once the following remarks have been addressed.

Specific comments

In this article, <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021MS002892> , we have addressed a similar issue in superparameterized climate models, specifically for the transport of cumulus clouds in a high-resolution regionally super-parameterized model. We see the same issue of small-scale structures, in particular clouds, getting stuck in the CRMs where they are formed. We proposed a somewhat different solution to the one presented here, namely adjusting the total humidity variance (keeping the mean constant), in order to match the GCM liquid water content. Please consider referring to this article. I believe the similarities and differences in approach are interesting.

In our SP model with humidity variance adjustment, we saw that clouds and variability added through the coupling mechanism doesn't always persist in the CRM but can dissipate rapidly, if the receiving CRM is in a different state for example lacking the convection to support the clouds. It would be interesting to see if or how much this happens in the E3SM-MMF.

Section 3.2 E3SM-MMF Description:

Please mention whether the CRM uses the same vertical grid as the global model or something different.

3.4 Satellite Observation Data

When re-gridding 1x1 degree satellite data to ne30pg2 of comparable grid size, isn't there a risk that the re-gridding operation may affect the presence of checker-board features? Re-gridding the much finer IMERG data to ne30pg seems safer.

Technical corrections

Line 9: The first sentence is hard to parse because one can read it as "... cannot otherwise resolve convective scale circulations by coupling ..."

Eq. (2) B_g should be B_G , or is not defined

line 65: $\langle q_C^n \rangle^n$ one n too much

Eq. (4) Left-hand term has a q without index, should be q_G ?

Eq. (11) What is F ?

line 93: "Since the CRM columns do have any specific location within the parent GCM column,"
do -> do not

Line 180: Unclear "gains performance by limiting radiation to operate of even subsets of the CRM domain"

Figure 4. Is the data averaged in time before or after checkerboard detection?

Figure 9. Axis labels would be helpful, and a mention in the caption of what wave numbers are considered (e.g. which direction).

Line 132: "However, experiments with this approach exhibited some odd behavior that we could not fully explain" and Line 140: "with some subtle, but unique, changes to certain climatological features." I'd recommend either saying more or less about these. Now I wonder what exactly happened in these two cases, while also suspecting that it may not be particularly relevant.