Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
https://doi.org/10.5194/gmd-2021-293-RC2, 2021

Comment on gmd-2021-293

Anonymous Referee #2

Referee comment on "An evaluation of the E3SMv1 Arctic ocean and sea-ice regionally refined model" by Milena Veneziani et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-293-RC2, 2021

Review of:" **An evaluation of the E3SMv1-Arctic Ocean/Sea Ice Regionally Refined Model.**" by Milena Veneziani et al.

The manuscript compares the Arctic regionally refined E3SM configuration (E3SM-Artic-OSI) for the ocean and sea-ice in a stand alone mode using data-based atmosphere land and hydrology components.

The author carries out the comparison based on a variety of globally modeled but also Arctic ocean related quantities, such as AMOC strength, horizontal temperature and salinity biases but also vertical section of temperature and salinity of certain key features. Further the author focuses on the comparison of the exchanges through Arctic Gateways and the Arctic freshwater content between the higher and lower resolved Arctic E3SM configuration. Also the trends in the sea-ice components between both E3SM configurations have been thoroughly analyzed. A variety of observational derived data have been used to evaluate and classify the improvements in the E3SM-Artic-OSI configuration.

In summary it is shown that E3SM-Arctic-OSI significantly improves the simulated Arctic Ocean and sea-ice when compared to a less resolved Arctic model configuration (E3SM-LR-OSI). In particular the exchanges through the main Arctic gateways, Arctic Freshwater content variability and sea ice trends benefit from the refined resolution. Although other aspects like upper ocean stratification and sea ice thickness need further tuning as it is the case in other models as well.

To my knowledge, the here presented work is novel and of special interest to the broader E3SM modeling community. The author presents very well the shown results and improvements between the different model configurations. Therefore I would recommend that the paper is accepted after some minor revision.

Comments:

-line 4: ...cost of high – resolution (HR) ***regular gridded*** global configurations...

-line 6: "...while employing data-based atmosphere, land and hydrology components…." If I understand well you run MPAS+Sea-Ice more or less in a standalone mode with a prescribed atmosphere. What are in this case the land and hydrology components? Maybe some rephrasing is necessary.

-line 43: "…Wang et. al 2018…", Its fully OK here to cite Q. Wangs paper, but since you anyway run your configuration uncoupled it might be worth it to cite also the papers of C. Wekerle et. al 2013, 2017a and 2017b. Since they directly deal with mesh improvements in the Arctic realm (but in an uncoupled FESOM standalone configuration) and their consequences for the local ocean circulation down to an eddy resolving regime (C. Wekerle et. al 2017b).

-line 75: Why only 10km was chosen for the Arctic refinement, considering the rossby radius for high latitudes, at this resolution the Arctic ocean will be barely eddy permitting. For example the standard higher resolved Arctic FESOM configuration goes down to a resolution of 4.5km using around 650k surface vertices. There exists an intentional similar paper to yours within the FESOM community (C. Wekerle et. al 2017a), maybe it's worth to be cited

-line 88-89: Why is there no background diffusivity utilized?

-line 110: I would like to know but also the community might like to know at which time-step the high and low resolution configuration perform.

-line 111-118: I haven't fully got the point why or for which purpose you bring the RAMS configuration into the comparison since it's also just another model that is not directly related to E3SM. Maybe you can clarify in a couple of sentences, also in the introduction, what's the benefit of RAMS in this comparison.

-line 132-136: For my own curiosity (doesn't need to be in the paper), can you say something to the "...recent improvements in the MPAS-Ocean eddy parameterisation scheme…"

-line 145: Are there known causes why your AMOC in the high but especially in the low resolution are so weak?

-line 145-148: I would be interested to know what the maximum March (NH) and September (SH) mixed layer depth in both configurations looks like.

-line 211: …heat flux th***r***ough Davis Strait …

-line 320, Fig.14 and Fig.15: You compare the 3rd. cycle of your E3SM simulations with the 1st. cycle of the RAMS simulation. In my experience, there are usually considerable differences between the 1st. and the 3rd. forcing cycle. At least this is the case for the Atlantic and Southern Ocean. For the Arctic these differences might be not that large, but nevertheless it might be of benefit also to provide the temperature and salinity profiles of the 1st. forcing cycle of your E3SM simulation in Fig. 14 and Fig. 15 as a dashed line.

References:

Wekerle, C., Q. Wang, S. Danilov, T. Jung, and J. Schröter (2013), The Canadian Arctic Archipelago throughflow in a multiresolution global model: Model assessment and the driving mechanism of interannual variability, J. Geophys. Res. Oceans, 118, 4525–4541, doi:10.1002/jgrc.20330.

Wekerle, C., Q. Wang, S. Danilov, V. Schourup-Kristensen, W.-J. von Appen, and T. Jung (2017a), Atlantic Water in the Nordic Seas: Locally eddy-permitting ocean simulation in a global setup, J. Geophys. Res. Oceans, 122, 914–940, doi:10.1002/2016JC012121.

Wekerle, C., Wang, Q., von Appen, W.-J., Danilov, S., Schourup-Kristensen, V., & Jung, T. (2017b). Eddy-resolving simulation of the Atlantic Water circulation in the Fram Strait with focus on the seasonal cycle. Journal of Geophysical Research: Oceans, 122, 8385–8405. https://doi.org/10.1002/2017JC012974