Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2021-220

Anonymous Referee #1

Referee comment on "An improved regional coupled modeling system for Arctic sea ice simulation and prediction: a case study for 2018" by Chao-Yuan Yang et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-220-RC1, 2021

General comments:

The authors evaluate the updated version of Arctic prediction system in predicting summer Arctic sea ice in 2018. The prediction system CAPSv1.0 consists of model components for atmosphere, ocean and sea ice, and the sea ice parameters are initialized by assimilating observational information. The prediction system CAPS has proven some skill in predicting summer Arctic sea ice in earlier works, such as Yang et al (2020). Changing only one set of parameterizations (or configurations) in one model component allows to study the origin of improved prediction skill in different Arctic regions. However, there is lack of novelty in the analysis by repeating the results from a number of experiments and calculating the differences between them and a reference experiment (Yang et al, 2020), with key parameters of sea ice extent and sea ice concentration. Due to the number of performed experiments and the material to be discussed, highlight of the main findings is unclear and the major benefit from improved physics is not addressed. The model evaluation is mainly based on a case study of Arctic sea ice in summer 2018, the year with sixth lowest summertime minimum extent in the satellite record. The authors attempt to predict the slow recovery of sea ice cover in the Chukchi and Barents Sea, by extending the seasonal forecast over autumn. Although there is mismatch of the timing of reforming sea ice in the concerned regions, potential modelling solution or missing physics is not discussed.

My primary concern is that the paper has not yet met the GMD publication standards for model description papers for the following reasons:
1) authors should provide more technical details about the improved physical features than referring to several publications
2) authors should provide more materials and highlight the major benefit of physical changes in reducing prediction errors in seasal forecast of Arctic sea ice.
3) Regarding the evaluation of the Arctic prediction system, the present analysis based on only one year case study is insufficient to perform skill assessment. The authors should introduce novel ways of comparing model results with observational data.
4) As the authors primarily discuss on the melting season of Arctic sea ice in 2018 and most experimental runs are no more than three months long, a little adjustment of the

title may be helpful, such as by replacing “and climate simulation and prediction” by “in summer 2018”.

Concerning the amount of work to be done to reach the standard of publication with GMD, I suggest the authors consider resubmission after substantial improvement.

Specific major comments:

1. Better visualization for experiment design
F.ex. Table 3, please consider to put repeated parameterization (or configuration) to identical color. Figures of Arctic sea ice extent time series, e.g. Fig2, 3, 8, 11, 13. The line color could be consistent with the color used in Table 3 to distinguish from different model components. For the spatial maps of sea ice parameters, you should add some text in big front in figure or figure caption to highlight the improved model components.
2. Assessment of the results
I think the existing figures of the results contain very basic information and could be moved to supplementary. Main results should invovle more comprehensive statistical analysis and present more concrete evidence of improvements.
3. Identification of improved key process in sea ice seasonal prediction
- Wind-driven ocean currents and sea ice export has been identified as key factors in the retreat of Arctic sea ice during summer in the Beaufort Gyre (Armitage et al, 2020) and Barents Sea (Dai et al, 2020). The authors may have a close look at the wind anomalies from the changed atmopheric model.
- With regard to improved configuration in the ocean model, it would be scientifically interesting to investigate which factor plays a dominant role in sea ice melting, e.g. changes in sea surface temperature, salinity or eddy activity? SST can be the driver, but also the effect in the coupled system with changed physics. It would be more convencing by showing vertical profiles of ocean temperature and salinity in the concerned region.
- Little differences between sea ice model experiments. It is worth to document the effect but it can be moved to supplementary.

Specific minor comments:
4. The terms of ”Anomaly” and ”bias” in Section 3 are used inappropriately with respect to the reference (observation/reanalysis) field in such a short time scale (i.e. monthly mean in 2018). ”Prediction error” fits better in this context.
5. Figure 7 d-i REF was not introduced.
6. Line 325 (Figure 8) "Y21_RP also shows much better predictive skill after late August ...". I disagree with it when I look at the regional plots. The differences between Y21_RP and other two experiments are very small in three regions with the exception of larger positive errors in Y21_RP in BEA-CHU than the other two. The better match with observation in the total Arctic sea ice extent results from the dominant negative errors in all experiments compensated by the positive errors in the BEA-CHU.
For the same reason, " the good fit" of recovery of the total sea ice extent in autumn is mis-interpretated in Fig 13 in contrast to mismatch in each subregion.
7. Line 400 ”significant influences” is weak without sufficient sampling.

Reference:
Armitage, T. W., Manucharyan, G. E., Petty, A. A., Kwok, R., and Thompson, A. F.:

Enhanced eddy activity in the Beaufort Gyre in response to sea ice loss, Nat. Commun., 11, 1–8, 2020.

Dai, P., Gao, Y., Counillon, F., Wang, Y., Kimmritz, M., and Langehaug, H. R.: Seasonal to decadal predictions of regional Arctic sea ice by assimilating sea surface temperature in the Norwegian Climate Prediction Model, Clim. Dynam., 54, 3863–3878,https://doi.org/10.1007/s00382-020-05196-4, 2020.