

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2021-50

Céline Heuzé (Referee)

Referee comment on "Lasting impact of winds on Arctic sea ice through the ocean's memory" by Qiang Wang et al., The Cryosphere Discuss.,
<https://doi.org/10.5194/tc-2021-50-RC1>, 2021

I'll be brief: Interesting paper that would fit very well within this journal, but some crucial methodological points are currently missing.

Major comments, by order of appearance in the text:

- The temporal resolution of the forcings and of the model itself are never discussed. Monthly and annual results are shown, so I assume "monthly" was the highest frequency analysed. If so, the authors should at least discuss how different the results would be with daily/5-daily output (thinking of sea ice drift in particular).
- Likewise, I am missing a discussion on whether the run lengths are sufficient. Is a 6-year perturbation enough? Is a 4-year period without forcing enough? Or are we, throughout the paper, looking at transient responses?
- [my biggest issue] The relevance of liquid freshwater, instead of e.g. integrated salt content, is more and more debated within the physical oceanography community. This is particularly problematic for a Pan-Arctic study, to investigate a change that will impact the salinity, using a model. So first, please quantify your model's (potential) biases in upper-ocean salinity. Furthermore, you're not integrating over a fixed depth but only until the depth of the reference salinity. Again, show how well that depth is represented in your model AND how the depth changes throughout the basin and throughout your runs. Now, taking both comments into account, I'd also like to see an evaluation of the robustness of your results by comparing isohaline vs fixed depth, and reference salinity vs integrated salt content. It can be as simple as showing maps of the mean FWC in the control run for all four options.
- You never explain how sea surface height is computed. In particular, is it produced by the model, or did you have to compute it afterwards e.g. from the temperature and salinity fields?
- [my second biggest issue] As per point 3, I would like to see an assessment of the model's sea ice concentration, thickness, drift speed and seasonal cycle in the control run before you move to investigating the potential differences coming from the different forcings.
- Overall, there are many instances of inconsistencies or lack of precision that force the reader to guess what you really are showing. I am giving examples in the next part of this review, but throughout the manuscript verify that your text, captions and colorbars

are not showing different things (velocities vs direction, anomalies vs actual values).

Specific comments:

- line 74: liquid freshwater content is only defined line 98. At least say here that the definition comes below.
- line 86 – 97: this paragraph falls out of nowhere. Start line 86 with e.g. "to design the perturbations, we look at..."
- Figs 3 and 4: show the control as well – as you did for Fig 6.
- Fig 5: I suspect that the lack of seasonality of SSH is either the result of inadapted axis limits (giving the values in the text would help) or potentially too high a sea ice cover year-round (see major point 5).
- Fig 6: what is meant by "anomaly in drift or current", as in, what is subtracted from what? It would be clearer to show the arrows of each experiment, and let the reader compare to the control panel. And shading that has only positive values suggests that all experiments have a faster drift than control (shading described as an anomaly, see also major point 6)
- It is confusing that Fig 7 shows thickness but Fig 8 shows concentration, when Fig 8 is presented as the seasonal version of the Fig 7 discussion. Potentially show thickness only, or combine both diagnostics into sea ice volume.
- Fig 9: RMS of drift = specify that it is of the drift speed I
- line 257: show this SSH saved from the control run, including its seasonal cycle.
- line 295: show this result (that the sea ice volume export through Fram Strait is not impacted by sensitivity experiments), that's an important one.