The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2021-23

Anonymous Referee #1

Referee comment on "Southern Ocean polynyas in CMIP6 models" by Martin Mohrmann et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-23-RC1, 2021

This manuscript examines the representation of polynyas in CMIP6 models as compared to observations. Some of these comparisons are not straightforward, due to lack of CMIP model variables, limited observations, and the different metrics that could be used to define polynyas, but the authors are transparent in these limitations and convey the information clearly. Modelled coastal polynyas are often too large, likely as a result of coarse horizontal resolution. Modelled open water polynyas are often too small compared to observations, and there is a large inter-model spread in the frequency of open water polynyas. The authors examine vertical ocean profiles in polynyas versus sea ice covered regions in a subset of the models and in float data. The Discussion contains a number of useful insights on the reasons behind the intermodel variation in polynya activity, relating to resolution, simulation of the ACC and overflow parametrizations.

I found this to be a very interesting and thorough paper. It is well within the scope of TC and presents novel results and conclusions. The methods are clearly explained and the analysis code has been made publicly available. It is generally well-written, apart from some of the latter sections, and the figures and tables are appropriate. I am selecting 'major revisions' only because of section 5.2, which I think would benefit from a second round of reviews.

Main comments

- Section 5.2 - I found the arguments here a bit hard to follow. I would like to see additional subplots for the other relationships discussed here added to Figure A6. As you mention the results from this section in the abstract and conclusions, the figure should also be brought into the main paper. It seems like the results here would be interesting to a wide audience, so I think it is worth spending some more time on presentation.
- Section 4.3 or Section 2.3 - Please give some more details on the domain of the SOCCOM float - e.g. time period, number of profiles etc. Please also describe how you extracted the profiles from the CMIP6 models - is this one profile per grid cell in the Weddell Sea region? Is there some time averaging?
- L329: 'To evaluate the effect of OWPs on vertical stratification' - 'To evaluate vertical stratification in OWPs' (also L371) - as there isn't a clear cause and effect relationship here.
- Conclusions - I would like to see more of the polynya statistics summarised here. This could work well as a bulleted list.

Minor comments

L8 'presence or absence of OWPs are' > 'presence or absence of OWPs is'

L12 'that require to be addressed' > 'that should/must be addressed'

L30 requires citation

L85 Suggest adding a sentence on uncertainty in SIC observations

Table 1 - please add units on R_o and R_a (otherwise a very nice table though!)

L101 ‘not good’ > ‘poor’

L134 Please describe what a ‘flood fill algorithm’ is

Fig. 3 ‘propability’ > ‘probability’ on colorbar. I would also make all of the ocean ocean the dark blue (not grey).

Fig. 4 - shouldn’t this be ‘equivalent ice thickness’ not ‘floe thickness’?

Fig. 6 ‘All data sets where’ > ‘All data sets were’; ‘its’ full length’ > ‘its full length’

Fig. 8 (and similar figures in the appendix). I like this visualisation, but I wonder if you can separate the coastal and open water polynya bars and make the whole figure taller so it is easier to see?

L163 - Why doesn’t the mean of daily data go from 1st May to the end of Nov?

L334 ‘is resulting in’ > ‘results in’

L340 ‘Compared to the float data, ACCESS and BCC underestimate…’

L353 ‘deeper reaching’ -> ‘deeper-reaching’ ?

L354: ‘There are some profiles’ - please be more quantitative

L366: Define N^2 in the text

Fig. 10 - Please add subplot labels (a, b, c, …) and refer to these in the main text. This will make the text easier to follow

L383 ‘This is consistent…’ Rephrase, it’s not clear here what you mean

L386 ‘can usually be run’; remove ‘in our case’

L438 ‘All these parameters are positively correlated with OWP activity **in observations**’