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Comment on acp-2021-877

Anonymous Referee #2

Referee comment on "Impacts of three types of solar geoengineering on the Atlantic Meridional Overturning Circulation" by Mengdie Xie et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-877-RC2>, 2021

Review of "Impacts of three types of solar geoengineering on the North Atlantic Meridional Overturning circulation"

General comments:

The study examined the relationship between the AMOC responses under radiatively forced experiments and the geoengineering experiments used to mitigate the warm. The paper is overall well written and clearly presented, and the conclusion of the efficacy of the mitigation geoengineering method logical.

However, my major comment is about the mechanism proposed to explain the AMOC response differences in the experiments, that is the sea ice-driven response. The main evidence used to support this inference is the mainly correlation between AMOC strength and Sea ice extent. They argue that the correlation should be negative if the sea ice extent is caused by the AMOC, but the correlation found here is positive. The expected negative AMOC-sea ice extent correlation is based on the assumption that an increase in the AMOC should transport more heat into the Arctic and thus reduce sea ice extent. However, several studies have shown that that heat transport into the Arctic increases with AMOC weakening under global warming. Infact, this heat transport increase into the Artic is also seen in Figure 3, poleward of 60N and agrees with sea ice extent differences between the experiments. Under this scenario, it could also be argued that a positive correlation AMOC - sea ice extent is caused by the AMOC. The earlier paper also cited to support this mechanism (Li and Fedorov 2021) is also primary forced by sea ice changes rather than the radiative forcing in the experiments in this study, so the conclusions from this study do not necessarily carry over. The authors should provide more evidence support the causality they're inferring from this study.

Specific comments:

Title: Not sure "North" is appropriate before Atlantic Meridional overturning circulation"

Line 165: Last sentence is not clear "and RCP4.5" probably should be removed

References

Årthun, M., Eldevik, T., & Smedsrud, L. H. (2019). The role of Atlantic heat transport in future Arctic winter sea ice loss. *Journal of Climate*, **32**(11), 3327– 3341.

Oldenburg, D., Armour, K. C., Thompson, L., & Bitz, C. M. (2018). Distinct mechanisms of ocean heat transport into the Arctic under internal variability and climate change. *Geophysical Research Letters*, **45**, 7692– 7700. <https://doi.org/10.1029/2018GL078719>