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Ocean Science
Discussions

Interactive comment on "The impact of melt water discharge from the Greenland ice sheet on the Atlantic nutrient supply to the Northwest European Shelf" *by* Moritz Mathis and Uwe Mikolajewicz

Anonymous Referee #2

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Review of "The impact of melt water discharge from the Greenland ice sheet on the Atlantic nutrient supply to the Northwest European Shelf" by Moritz Mathis and Uwe Mikolajewicz

Mathis and Mikolajewicz investigate the sensitivity of freshwater discharge from the Greenland Ice Sheet on conditions at the Northwest European Shelf in future model scenarios. They find that increased meltwater discharge results in larger variability at the shelf-break. Subpycnocline nutrient concentration increase and results in increased nutrient fluxes and variability at the shelf break. They find that a regime shift

occurs 1-2 decades earlier depending on the discharge rate.

I find the sensitivity experiments very interesting and the results can contribute to our understanding of the impact of climate change in the northern North Atlantic. However, some aspects of the design of the experiments need to be clarified, including the sources of freshwater discharge, and also I find that some of the interpretations of the results needs to be clarified or modified, as I describe below. Finally, I have some minor comments. When these issues have been clarified I can recommend publication in Ocean Science.

Comments

It is not clear where the increased freshwater discharge (FWD) in the experiments takes place. A reference is made to an unpublished manuscript (Martin et al., 2019) and it is described as following the observational climatology. However, relatively few studies have been made on this issue so more information about the locations of the increased discharge and the actual present day values are needed to fully understand the implications of the sensitivity study. It would be interesting to know how the discharge field scales in comparison with observations, for example related to the studies of Bamber et al., (2017) and Mouginot et al. (2019).

l. 150: The sensivitity study is designed as a linear increase of FWD where the final 0.1 Sv is obtained from an ice sheet model. It is not clear whether this simple linear transient increase is just a simple (ad hoc) model for the changing rate or if it is based on numerical experiments?

l. 161: As far as I know, a value of 1Sv is far above any present estimate of future runoff from GIS ($\sim$20 times the present day value). Has it any relations to estimates of future runoff rates?

l. 295: Time series in Fig. A5 should illustrate the earlier onset of the shallow ML-regime for increasing GIS melting rates. I can not see this. There is hardly any differ-

ence, as far as I can see, between the HIST and HIST/0.1Sv. Even the 0.25Sv (only a single realization) is quite similar to the HIST. So either this conclusion is reached based on the 0.25 and 1.0 Sv single-realization experiments or it has to be described more clearly where the difference occur. If the conclusion is based on the two large-discharge rate experiments it should be pointed out that these experiments (both single realizations) imply discharge rates between 5-20 times present day values, and also application of these high rates should be justified further, cf. my comment above.

l. 328-334: The decrease in inflow to the North Sea is in qualitative accordance with the study of Holt et al. (2018). This is a very interesting results. However, it is not clear whether the mechanism for the reduced inflow is the same in the two models. Did the authors calculate the change in stratification and the deformations radius and relate it to the curvature of their coarser bathymetry? If not, I would suggest to include it or, otherwise, it should be clarified that this was not analysed.

l. 333: It is stated that the results are similar to Holt et al. (2018). This may by so in a qualitative sense but it is not clear whether the mechanisms are the same, cf. my comment above. Also there is only a qualitative similarity in the sense that the inflow decrease.

Minor comments:

l. 135: The reason that CMIP5 could not be used because of they were made on another super-computer and hence inconsistent is not clear. What was the relevant problem with the super-computer?

l. 186: change -> changed

l. 232: ..the meridional "density gradient" -> density difference (the units are not gradients).

Table 2: the meridional "density gradient" -> density difference (the units are not gradients).

Table 2: ".. at 500-1000m ..." Is it averaged between 500-1000m?

l. 273: explain "..MLD in the NE Atlantic is lower ...". Do you mean more shallow?

l. 277 - 280: This sentence need to be clarified. It seems to imply a relation between SLP and MLD standard deviations (?) and this need to explained.

l. 315: detailled -> detailed

l. 366-370: The argument that meltwater or iceberg-transported substances can make a significant difference to subpycnocline nutrient-concentrations in the northern North Atlantic is not supported by the studies referred. This needs to be clarified or modified.

l. 384: The contribution to the "nutrient flux" is described. However, there are no calculations of the fluxes. (Do you mean a contribution to PP?)

Table 4: the definition of the area ("the northern North Sea") is not specified.

Fig. A5: in a) and b) only the blue color is described.

References

Bamber, J. L., Tedstone, A. J., King, M. D., Howat, I. M., Enderlin, E. M., van den Broeke, M. R., & Noel, B. (2018). Land ice freshwater budget of the Arctic and North Atlantic Oceans: 1. Data, methods, and results. Journal of Geophysical Research: Oceans, 123. https://doi.org/10.1002/2017JC013605 Mouginot, J., Rignot, E., Bjørk, A. A., Van den Broeke, M., Millan, R., Morlighem, M., et al. (2019). Forty six years of Greenland Ice Sheet mass balance from 1972 to 2018, Proceedings of the National Academy of Sciences, 116, 9239–9244. https://doi.org/10.1073/pnas.1904242116

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