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Geoscientific Model Development Discussions

Interactive comment on "'Climate Response Functions' for the Arctic Ocean: a proposed coordinated modeling experiment" *by* John Marshall et al.

Anonymous Referee #2

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This paper proposes a coordinated set of Arctic modelling experiments to look at how the Arctic might respond to various forms of external climate forcing. The different forms of climate forcing considered is wind anomalies (over the Beaufort as well as the Greenland seas), runoff and gateway inflow (Bering, Fram Strait). The authors explore an approach to get at the linear response to step changes in forcing through a convolution approach – the climate response functions in the title. The authors include some preliminary analysis of the idea using experiments with the MIT model.

This is an interesting topic and the community can use more well planned and coordinated experiments. Understanding Arctic climate variability is important and thus the approach suggested in this study is worth considering. Therefore the manuscript is an

appropriate subject for publication in GMD. It is generally well written and easy to follow. That said, some small changes could be made to improve the manuscript before publication.

To start with, a very minor point, but given this is a European journal, I'm surprised by the American spelling of modelling. Would much prefer to see the proper English spelling with 2 l's in the title, and through the text.

Figure 1 caption: The background colour shading is bathymetry (and elevation over land), but this is not mentioned in the caption.

Pressure units: Doesn't GMD request the use of metric units? If so, please change mbar to HPa everywhere.

Page 4, lines 26-28: The sentence, with the multiple dashes, is a bit too broken up to easily follow. Given the importance of the linearity of the response, this point can be expanded upon.

Section 2.2.1 – It lists the key switches. But it would be good to add a bit more motivation on why they were chosen.

Page 5, line 14 – Please add a reference related to the lack of near surface observations.

Section 2.2.2 – Would like to see a bit more detail in the discussion of metrics. Strength of boundary currents – which ones, where should they be measured, etc. For the ice fields, what domain should they be averaged over? Same for the mixed layer. And isn't the flux through various straits the same as the export of heat and freshwater, since that export only occurs through the gateway straits. Some of this can be answered by linking the text better figure 2a, which may have the necessary answers in a graphical form.

Figure 2b – Why the given box? Doesn't seem tightly tied to the inflow or the warmest temperatures. Figure 3 caption – define the negative sign for the fluxes.

Page 10, line 3 – Ilicak, not Iliac for the reference.

Section 3.2.4 – Given that temperature and salinity vary by section and season, won't fixed T and S changes always lead to some density compensation?

Section 3.3 – Are the CRFs applied all together, or individually? I think the latter, but the text isn't 100% clear on this.

Page 13, line 11 – I don't necessarily see a new equilibrium in the figure. But is an equilibrium necessary?

Section 3.3, summary point 3 – The CRFs are symmetric with respect to some metrics, but not all. Maybe make that clear in the text here.

Section 3.4 – Why does the heat flux through Fram Strait have a much larger envelope?

Page 14, line 23 – Do you mean not many ensembles, or not many members?

Figure 8 – The two changes shown here are not really opposite, so showing them together is not consistent with the previous figures. Even though it adds a figure, it might be good to separate the results from these two switches into two separate figures.

Page 21, line 22 – But might freshwater processes from river runoff depend on resolution and the processes involved in shelf basin exchange? Such a question may prompt the idea that it might be good to have these CRF experiments done with different resolutions as well as different models to get at this question. Maybe add some discussion of that point?

Page 22, line 1 – Give the FAMOS web link here too.

Section 5 – Not sure I like a conclusion that is just a numbered listed. Some more explanation, especially of the hoped significance of this coordinated experiment, would be good.

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