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Version: Revision

Title: Dynamic and Steric Sea-level Changes due to a Collapsing AMOC in the Community Earth System Model

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Point-by-point reply to reviewer

January 16, 2026

We thank the reviewer for their careful reading and for the useful comments on the manuscript.

The study by van Westen et al. investigates dynamic and steric sea-level responses to an AMOC collapse using hosing experiments conducted with a fully coupled model and two ocean-only models with different horizontal resolutions. The authors find that an AMOC collapse induces dynamic sea-level rise across the Atlantic and Arctic Oceans, with the largest signals in the North Atlantic. Meanwhile, the collapse produces global-mean thermosteric sea-level rise due to enhanced net downward top-of-atmosphere (TOA) energy flux, most of which is absorbed by the ocean through increased ocean heat uptake. Overall, the results are robust and clearly presented. I recommend minor revision with the following comments.

1. *Line 22: The term 'regional' needs clarification. Does this refer specifically to the Atlantic sector? Similarly, does 'background ocean circulation' correspond to the AMOC, or does it include gyre circulations or other components? Please specify to avoid ambiguity.*

   Author's reply:

   We agree that both 'regional' and 'background' are confusing here. This needs to be clarified or removed.

   Changes in manuscript:

   We will check the entire manuscript on this and change the text accordingly.

2. *Line 91: The details of the prescribed surface forcing in the ocean-only simulations should be clarified. My interpretation is that momentum fluxes are prescribed, while heat fluxes are interactive.*

   Author's reply:

   We agree that this needs to be clarified. In the POP simulations, the momentum fluxes (i.e., wind stress) are prescribed, while heat and evaporative fluxes are interactive through sea surface temperatures.

   Changes in manuscript:

   We will clarify the POP set-up and rewrite the Methods.

3. *Line 277-290: Related to the previous comment: Are surface heat fluxes prescribed in the POP simulations? If they are interactive, then surface-flux feedbacks may also contribute to the large ocean heat-uptake anomalies in the North Atlantic and Southern Ocean. This could partially explain the spatial heterogeneity of heat-uptake responses across the models.*

   Author's reply:

   The surface heat fluxes are interactive, only the near-surface atmospheric temperatures are prescribed. We agree with the reviewer that we need to clarify the POP set-up in greater detail, which helps to understand the heat-uptake responses.

   Changes in manuscript:

   We will clarify this in the Methods (see also point 2 by the reviewer).

4. *Figure 4b: The dynamic sea-level (DSL) response shows a positive trend in the time series but exhibits negative anomalies north of 30°N in the spatial difference map. How these two diagnostics relate?*

   Author's reply:

   Note that DSL trends use the left vertical axis, while DSL differences the right vertical axis. To avoid confusion, we will add this in the caption and make this more explicit in the main text.

Changes in manuscript:

We will rewrite parts of the caption and main text.

5. *Figure 8: The Southern Ocean heat-uptake response differs markedly between HR-POP and LR-POP, consistent with the role of mesoscale eddies highlighted in the manuscript. However, the physical teleconnection between AMOC collapse (or hosing) and Southern Ocean eddy activity is not discussed. A brief explanation of the mechanism, e.g., changes in wind stress, ACC baroclinicity, or remote propagation of density anomalies would strengthen the interpretation.*

   Author's reply:

   The eddy activity is modified under a different Southern Ocean stratification following the AMOC collapse, which is being addressed in a follow-up study (manuscript submitted to OS, Smolders et al.). We can expand the discussion in lines 258 – 267.

   Changes in manuscript:

   We will expand the discussion here and add a reference to the preprint.

6. *How many ensemble members are conducted in each experiment? Will the internal variability affect the results such as AMOC tipping time?*

   Author's reply:

   One realisation is available for each experiment due to computational constraints. We agree with the reviewer that this need to be explicitly mentioned in the manuscript. Internal variability may influence the AMOC tipping time (e.g., Romanou et al., 2023; https://doi.org/10.1175/JCLI-D-22-0536.1), but the destabilising feedback operates independently of internal variability once the saddle-node bifurcation is crossed. Comparable AMOC collapse trajectories have been found in the LR-CESM (https://doi.org/10.5194/esd-16-2063-2025, their Figure 2). It is good to briefly mention this in the paper.

   Changes in manuscript:

   In the Methods, we will include that one realisation is available for each experiment and discuss the role of internal variability.

Others:

1. *Line 129: how are the basin boundaries are defined?*

   Author's reply:

   It is good to elaborate on the choices of the basin boundaries. The boundaries are primarily based on the meridional extent of the AMOC, the AMOC is dominant from 34°S to 65°N. The ocean surfaces south of 34°S define the Southern Ocean region and north of 65°N (up to the Bering Strait) define the Arctic Ocean region. The remaining ocean surfaces are attributed to the Indo-Pacific Ocean region.

   Changes in manuscript:

   We will add a description of the basin boundaries in the revision.

2. *Line 129: determined - determine*

   Author's reply:

   Agreed.

   Changes in manuscript:

   Will be corrected.