

Response to the editor and reviewer 3

We thank the editor and the reviewer for their careful assessment and constructive comments. Below we respond point by point and describe the changes made for the manuscript.

This manuscript describes simulations with the GFDL model of impacts of an AMOC collapse on climate and carbon cycle. The paper is very well written and illustrated and contributes new information on an important topic. I think it could be published with minor revisions.

We thank the reviewer for the positive assessment and helpful comments.

Line 100: I'd like more information on the terrestrial carbon model, specifically if vegetation is dynamic such that plant functional types can change, or if it is static. Also, can vegetation adapt to climatic changes or not?

We have added to the method section: *"LM3.0 (Schevliakova et al. 2009) simulates water, energy, and carbon cycles, multi-layer soil and snow dynamics, and vegetation processes. Vegetation is dynamic and represented by five plant functional types (C3 and C4 grasses, temperate deciduous trees, tropical trees, and cold evergreen trees). Vegetation type is reevaluated annually based on simulated biomass and climatic conditions, allowing vegetation distribution and biomass to respond to changes in climate. However, the model does not represent evolutionary adaptation of plant functional traits."*

Line 358: how is land-use affected by AMOC changes?

We have clarified in the method section: *"Although land-use and land-cover changes are prescribed identically across simulations, carbon losses associated with a given land-use transition can vary because vegetation and soil carbon stocks differ across simulations."*

Line 363: what temperature dependency of NPP is used in the model? Could this result depend on model parameters or structure? Is vegetation able to change and/or adapt?

We have clarified in the manuscript that the changes in NPP are associated with the colder and drier conditions, rather than implying a direct causal attribution, as we did not perform a formal attribution analysis: *"Across northern Africa, Europe, and Asia, colder and drier conditions are associated with a stronger reduction in NPP than in soil respiration, resulting in net carbon losses."*

We have also added information to the Methods section on how NPP is represented in the model: *"NPP does not have a prescribed temperature dependence but emerges from temperature- and moisture-dependent physiological processes, including photosynthesis and plant respiration."*

In addition, we have clarified in the Methods section that vegetation can respond dynamically to climatic changes through changes in biomass, leaf area, phenology, and vegetation type, but that the model does not represent neither evolutionary adaptation of plant functional traits nor physiological acclimation (see response to the comment above).

Line 367: why is northward carbon transport reduced? Is this dominated by anthropogenic carbon? Is there northward carbon transport in the preindustrial? I'd expect that the AMOC transports DIC southward since NADW is colder and thus more carbon rich than warm upper ocean waters.

Thank you for raising this point. The transport of carbon is southward at 20°N in the preindustrial. We have changed the sentence to: “Enhanced southward transport of carbon (–31 GtC) at 20°N leads to a widespread decline of –41 GtC in ocean carbon inventory north of 20°N relative to the 2°C-ref simulation ..”.

Lines 409-410: why is this not quantified and reported? The results should be available.

Thank you for pointing this out. We have quantified the land and ocean carbon anomalies to understand why there is a smaller atmospheric CO₂ signal under hosing in preindustrial climates. We have clarified this in the manuscript: *“A notable exception is atmospheric CO₂, which exhibits a 40% (15 to 90) larger decrease under 2°C warming than under preindustrial conditions. In both climate states, the atmospheric CO₂ response reflects enhanced terrestrial carbon uptake, partly offset by oceanic carbon outgassing. However, the relative magnitudes of these opposing fluxes differ between the two background states, resulting in a weaker net atmospheric CO₂ decrease under preindustrial conditions. Specifically, terrestrial carbon uptake is weaker under preindustrial conditions (21.2 [18.8–24.0] Pg C), but is also offset by a smaller oceanic carbon release (–1.7 [–3.3 to –0.4] Pg C). The stronger atmospheric CO₂ decrease under warmer conditions therefore reflects a different balance between terrestrial carbon uptake and oceanic carbon release. Our experiments, however, do not allow us to determine whether these differences arise from state-dependent carbon-cycle sensitivities, differences in adjustment timescales, or a combination of both.”*

Line 495: Intermediate complexity models confirm long (multi-millennial) timescales of ocean carbon equilibration affecting CO₂ after AMOC collapse, e.g. Schmittner and Boling (2025).

Thank you for making this important point. We have added: *“Moreover, ocean carbon equilibration following AMOC collapse can occur on multi-millennial timescales, potentially leading to continued changes in atmospheric CO₂ well beyond the here simulated period (Schmittner and Boling 2025, Nian et al. (2026).”*