Dear Reviewers, dear Editor,

We are grateful for the positive evaluation of our manuscript and the further reviews. Please find a detailed point-by-point response to the remaining comments of the reviewers below. In addition to this response document we have attached the revised manuscript version, and marked the changes in blue. We thank reviewers for their constructive feedback which has helped in improving this manuscript further.

On behalf of all coauthors,
Nico Wunderling, Anna von der Heydt

Reviewer #1:
accept as is
We thank the reviewer for this positive evaluation of our work and previous suggestions.

Reviewer #2:
The authors have done an excellent job at responding to my comments. I only have two remaining concerns:
We thank the reviewer for this positive assessment and agree with the two remaining points made. Please find our response below.

1. The new definition of tipping points (paragraph beginning line 26 in the manuscript with tracked changes) remains poor. The definition does not align with Levermann et al.'s, despite the authors' claim. Levermann et al. write: "Tipping elements are regional-scale features of the climate that could exhibit a threshold behaviour in response to climate change—that is, a small shift in background climate can trigger a large-scale shift towards a qualitatively different state of the system." But the definition in the present manuscript does not include any notion of 'small shift causing a large change'. I suggest the authors update their definition. I also recommend to exclude the term "nonlinear" from the definition (it is certainly not synonymous with "self-amplifying feedback" as the current manuscript implies).
We thank the reviewer for this important point and regret our definition was not entirely clear yet. We have accordingly adapted our definition so that it now suits the Levermann et al. (2012) definition. We have also removed the term nonlinear to not imply that this would mean the same as *self-amplifying feedback*, see ll 28-32.

2. The new result that centennial-scale cascades are possible if warming exceeds 2C is important but buried in a very long paragraph in the Discussion. I suggest:
- splitting the paragraph into smaller ones to make the main conclusions more clear -- or, explaining the new result first in Results
We agree and have restructured the respective discussion paragraph into three main enumerated findings that can be found easily, see ll 646-660.

- briefly including the new result in the abstract
We have sharpened our abstract in line with our three main findings from the discussion, see ll 10-15.

- explaining why this result does not contradict Wang et al. (is it because these cascades may lead to impacts but not large temperature feedbacks?)
Our results are in line with Wang et al. (2023, Reviews of Geophysics) and their summary in Table 13 because of the following reason: (i) First, tipping cascades cannot be expected within years as is stated in Wang et al.. They can rather not be ruled out on timescales of centuries to millennia for warming levels of 1.5-2.0°C. Only for very high levels of sustained warming (significantly beyond 2.0°C), timescales of tipping cascades

on the order of many decades to a few centuries cannot be ruled out. (ii) Second, some Earth system elements may not exhibit tipping behavior but can still be responsible for important Earth system interactions involving tipping elements (such as ENSO→Coral reef/Amazon rainforest interaction or Arctic sea ice→AMOC). In this respect, interactions between (debated tipping) elements can destabilize subsequent climate components. (iii) Third, there are temperature feedbacks that can be expected if tipping events occur (Wunderling et al., 2020; Steffen et al 2018) but they are either limited, taken already into account in complex IPCC-type Earth system models, or act on long timescales (centuries to millennia).
Therefore, we believe that our assessment in this review is in line with Wang et al..

Lastly, Wang et al. state in Table 13 that the *level of understanding* for tipping cascades is low, which warrants the updated knowledge on tipping element interactions performed in this review.

We have added this in a brief statement to our manuscript, see ll 661-662.

Reviewer #3:
accept as is
We thank the reviewer for this positive evaluation of our work and previous suggestions.

Reviewer #4:
Re-Review: The authors have revised their paper substantially which has led to significant improvements. My final comments primarily concern missing citations that are suggested in order to make this review more comprehensive.
We thank the reviewer for this positive evaluation of our work and are happy to include the remaining comments by the reviewer into our revised manuscript. In particular, the additional references help to sharpen our manuscript further.

1. line 19: cite Stocker & Schmittner 1997. This study is relevant as it showed thresholds associated with both warming levels and speed.
This is a very relevant study but related to the AMOC specifically.

2. line 35: suggest to add the following to the sentence: …. but also due to their potentially dramatic consequences on regional and local scales.
We have added this sentence including "...including impacts on biosphere and human societies.", see ll 38-39.

3. line 42: cite Stocker & Johnsen 2003 that showed the global nature of abrupt changes in the North Atlantic region due to the thermal bipolar seesaw.

We have added this reference in l 47.

4. line 70: suggest to specify this statement by ending the sentence with: … leading to a rapid local response to the slow large-scale changes
We have added this sentence, see l 75.

5. line 91: future projects: specify, e.g. TipMIP, and WhatifMIP
We agree and have added the respective references in l 97.

6. line 114: *group of long-standing experts": are these co-authors of this paper? If so, mention this explicitly. If not, who were they? As it stands this statement lacks transparency
By this we mean the co-authors of this study. We have rephrased the according sentence, see ll 118-120.

7. line 141: Stommel 1961 should be cited as it was the frist to describe the salt advection feedback
We have added this reference in l 146.

8. line 158: the important role of the sub-polar gyre should be mentioned here. cite Born & Stocker 2014 J. Phys Oceanography, Liu & Fedorov 2022
We have added the role of the Atlantic subpolar gyre and the according references in ll 163-164.

9. line 160: …. underestimated, as even moderate warming may push the AMOC across a threshold (Romanou et al., 2023, J. Climate)
This is indeed an interesting result that even such moderate warming may push the AMOC outside its Holocene state, and possibly towards a tipped state. However, the paper does not discuss the GIS melt effects on the AMOC.

10. line 164; 176: cite Stocker & Johnsen, 2003, Pedro et al., 2018
We have added these references in l 170 and l 181.

11. line 180: cite Sutter et al, 2023, Nature Climate Change
We have added these references in l 185.

12. line 249: … with consequences on the carbon inventory (Bozbiyik et al., 2011, Clim. Past)
We have added the sentence and reference in l 254.

13. line 509: what is the measure of "smaller"? The best temperature reconstruction for Greenland during the SDO events is Kindler et al. (2014, Clim. Past) shows several DO equal of larger warming than B/A
We agree that the measure *smaller* does not account for all B/A events. We therefore omitted it from the sentence, see l 515.

14. line 510: reference wrong as these are model simulations. Suggest that the appropriate reference is Barker et al., 2011, Science

We thank the reviewer for catching this and replaced the reference by Barker et al., 2011, Science, see l 516.

15. line 525: should mention that DO could also be self-sustained oscillations, see Vettorietti 2022, Nature Geoscience

We have added the sentence and reference in ll 531-532.

16. line 607: you may cite a recent EMIC development: Pöppelmeier et al., 2023, J. Climate

Indeed! We have added this reference in l 614.

17. line 689: this statement ignores eg RAPID and OSNAP for AMOC monitoring, as well as satellite laser altimetry of ice stream velocities over Greenland and Antarctic ice sheets.

This is a very valid point that the reviewer raises here. We therefore altered our statement but are convinced of the necessity for further observational efforts in the future to be able to cover all relevant scales in time and space as well as additional observational records for tipping elements. We now write (see ll 703-706):

First, data from recent Earth observation efforts (e.g. for AMOC by the RAPID and OSNAP programs (Srokosz et al., 2015), or for ice stream velocities by satellite laser altimetry from ICESat/ICESat-2 (Adbalati et al., 2010; Schutz et al., 2005)) may need to be extended to cover more variables relevant to Earth system tipping elements as well as better covering the relevant temporal and spatial scales.

18. line 692-694: here efforts to develop km-scale models need to be mentioned. While not feasible today, with growing computing resources, TP simulations will become feasible within the next decade. Cite Slingo et al, 2023 and Hewitt et al, 2023, both in Nature Climate Change

We agree and have added the according references together with a statement of these indeed very exciting developments in Earth system science, see ll 710-712.