Reviewer 3:

In the revision the authors have done a thorough job in responding to the points raised in the previous reviews and have taken new approaches to strengthen their arguments. I truly enjoyed going through the substantially revised manuscript, very straightforward and informative.

We thank the reviewer for the comments on our manuscript, which we have carefully adjusted and improved thanks to the suggestions and the feedbacks from the previous round of revision. We provide here a point-by-point reply to the reviewer's questions and doubts and an updated manuscript with supplementary information.

I was not totally satisfied with the clarity of the method section (Section 2). First, the descriptions of the 1pctCO2-bgc and 1pctCO2-rad experiments could be more clearly presented. These terms first appear in Section 2.1 Table 1, but their explanations are only provided later in Section 2.2 (Lines 135–145), which may confuse readers. I suggest including brief and clear explanations at the point where the terms are first introduced. Meanwhile, the explanations of these terms in Section 2.2 remain unclear. For instance, phrases like "biogeochemically only coupled simulations" (1pct-bgc and ssp585-bgc) and "radiative only coupled simulations" (1pct-rad and ssp585-rad) do not adequately clarify what "1pct," "bgc," and "rad" refer to. I found it necessary to refer back to the original paper (Jones et al., 2016) to fully grasp their meanings.

We thank the reviewer for this comment. We have implemented the following changes in Section 2.1, where the used data are first presented, so that the terminology is now clearer and consistent to what is shown in Table 1, thus making the methodology Section 2.2 more comprehensible without the need to refer to the original paper by Jones et al., 2016:

Lines 89-104:

"[…] .ScenarioMIP simulations (historical and ssp585) aim to reproduce the climatic response to realistic forcing of the historical period and to a prescribed 8.5 W/m^2 radiative forcing increase by the end of the 21st century. C4MIP experiments (1pctCO2-bgc, 1pctCO2-rad, ssp585-bgc, ssp585-rad) are idealized concentration-driven carbon-climate simulations generated to better understand and quantify changes in the ocean and land carbon storage and fluxes under different climatic conditions. Specifically, the experiments aim to test the carbon cycle response to the effect of increased CO_2 concentrations in the atmosphere (-bgc simulations) and increased radiative forcing resulting from higher atmospheric CO_2 concentrations affecting the climate system (-rad simulations). These two categories of simulations differ in their model set-up, so that in the former (-bgc), only the model land and ocean carbon cycle respond to a CO_2 increase while the radiation scheme uses a preindustrial CO_2 concentration, therefore allowing to test the biogeochemical effect of atmospheric carbon dioxide increase without the associated radiative forcing. Reversely, in -rad simulations the biogeochemical effect is factored out, hence the climate responds to the radiative forcing by increased CO_2 concentration, whereas the carbon cycle remains constrained by a preindustrial atmospheric CO_2 level. In our analysis, we adopt C4MIP simulations forced either with a 1 % per year increase in atmospheric CO_2 concentrations up to four times the preindustrial level of 280 ppm, with no confounding effect of changes in land use, non-CO_2 greenhouse gases, and aerosols, or with a standard CO_2 pathway from the ssp585 scenario. For the sake of our goal, we count these differences negligible, as considering both 1pctCO_2 and ssp585 experiments allows us to have a higher ensemble of data available. […]"

Second, it seems that the terms used in the Methods section and figure captions are inconsistent. For example, long-term sensitivity to climate (γ) include δNBP/δT (γT), δNBP/δmrso (γmrso) and δNBP/δSWin (γSWin) were shown in Section 2.2, 2.3 and 2.4. Confusingly, they seem to become γtas, γmrso and γrsds in Results Section 3.2 (Line 246) without explaining what tas and rsds mean there. In this case, I assume that γtas means γT. However, the caption of Figure 2 refers to γtas as carbon-climate feedbacks to net carbon sink projections, alongside β. This phrasing suggests that γ_{tas} may represent the overall carbon–climate feedback. More confusingly, Figure 6 presents $ENSO_{tas}$ and $ENSO_{mrso}$ as parallel variables once again. Please clarify what "tas" exactly means here. If γtas is the overall γ to all climates, please explain how it was derived from the three γT, γmrso and γSWin?

We acknowledge that the terminology may appear confusing to the reviewer, as we did not explicitly describe some acronyms. To be consistent across the different sections of the manuscript, in the revised manuscript we have replaced all the "*tas*" pedix with "*T*" (surface air temperature), as well as "*rsds*" with "*SWin*" (shortwave incoming radiation). We have also clarified that γT represents the overall carbon-climate feedback and is therefore not a derivation of γmrso and γSWin, which have been computed uniquely with the purpose of comparison, providing an equivalent indication of the long-term climate impact on the cumulative carbon sink, as reported in Figure S8:

Lines 266-271:

"The carbon cycle feedback framework aims to describe the positive carbon-climate feedback considering uniquely surface air temperature (γ_T), which is therefore considered as an overall representation of long-term climate impacts, as shown in Figure 2. We additionally focus on different explainable variables as equivalent terms representing long-term climate impacts (γ_{mrso} and γ_{SWin}). Thus, despite γ_T, γ_{mrso} and γ_{SWin} are not to be intended as cumulative long-term impact coefficients, the values of their standardized coefficients are reported in Figure S8 with the purpose of providing a quantitative comparison of the ESMs sensitivity to diverse climatic factors."

On another note, we have rephrased and reviewed the terminology regarding the carbon fluxes variability at interannual timescales associated to ENSO as a function of T and mrso, now reported as $\boldsymbol{\delta NBP^{T}_{n34}}$ and $\boldsymbol{\delta NBP^{mrso}_{n34}}$. Figure 6, Figure 7 and the whole manuscript now represents these terms in a coherent and clear manner.

While I raise this point for clarity, I don't see it as a major concern, since the main results and conclusions remain compelling and valuable.

Specific comments: In the code availability section, I noticed that the README.md file seemed lack content, and it was a bit challenging to locate the specific code corresponding to each figure. If feasible, it would be appreciated if the authors could consider adding brief guidance or reorganizing the code to enhance clarity for readers.

Thank you for making us notice this. We have restructured the code repository providing guidance in the README.md file and a reorganization of the code expliciting the .ipynb files associated to the generation of the manuscript figures.