Author answers to the comments of the manuscript “Compensatory effects conceal large uncertainties in the modelled processes behind the ENSO-CO_2 relationship”

RC2:

Comments on “Compensatory effects conceal large uncertainties in the modelled processes behind the ENSO-CO2 relationship”

This manuscript investigates ENSO-CO2 relationship in 22 CMIP6 ESMs by describing their characteristics ENSO-NBP pathways, and explain processes which contribute most to the overall uncertainties in ENSO-CO2 relationships among ESM. And authors find that the largest source of uncertainty is the differences in the sensitivity of NBP to climate. Overall, the manuscript is concise and clear. Here are some minor suggestions.

> We thank the reviewer for the careful reading of the manuscript and their constructive comments.

(1) In abstract: “look beyond the top-down ENSO-CO2 relationship in 22 CMIP6 ESMs”, how to understand the “top-down”

> We will rephrase this to provide a better description of our approach to disentangle the ENSO-CO2 relationship.

(2) Page2Line30: “Tropical carbon flux anomalies lag behind ENSO by three to six months (Zhu et al., 2017)”, this another paper may be a good reference here which calculate the lead-lag between ENSO and CGR/NBP. “Wang, J., Zeng, N., & Wang, M. (2016). Interannual variability of the atmospheric CO2 growth rate: roles of precipitation and temperature. Biogeosciences, 13(8), 2339-2352.”

> The two publications provide comparable results in terms if lag time. We decided to cite Zhu et al because it provides the spatial patterns of the lag. However, we see the benefit of adding another citation that calculates the lag to NBP instead of GPP.

(3) Page 4, which periods do you use for reanalysis products?

> We used the whole period of available data for each source at the time of the analysis. We will add the specific range of years to the methods section on page 4.

(4) Page 9, Line 170-171, you may calculate and show the spreads in ENSO-induced temperature and precipitation for each region in the plot.

> We will add a top row to these plots similar to Figure 2.

(5) Page11Line 197-198, “the high NBP anomalies in GFDL-ESM4 are resulting from increased Rh”, increased Rh => reduced Rh? In Figure 6, NBP anomalies in MIROC-ESMs are nearly totally caused by Rh. Maybe need to mention it in the text.

> In the global panel of Figure 6 we see that the diamond representing the NBP anomaly aligns with the sum of NPP, Rh and Fire. The NBP anomaly is larger than all of the single fluxes. This means that a low NPP anomaly (plants take up less carbon) meets a high Rh anomaly (ecosystems respire more carbon). We use this alternative sign of carbon flux anomalies to visualize the composition of NBP anomalies, and describe the direction of the fluxes in the figure caption.

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