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Ocean Science Discussions

Interactive comment on "Importance of El Niño reproducibility for reconstructing historical CO_2 flux variations in the equatorial Pacific" *by* Michio Watanabe et al.

Anonymous Referee #3

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This study is an important contribution for understanding ENSO and carbon fluxes variations in the equatorial Pacific. The authors have investigated the processes in regulating the relationship between ENSO and carbon fluxes in assimilations with nudging ocean temperature and salinity based on two MIROC models, i.e., OLD MIROC-ESM and NEW MIROC-ES2L. They demonstrated that the ability of model in producing correct amplitude of ENSO is crucial for reproduction of the air-sea CO2 flux variations in coherence with ENSO. Both the storyline and the writing are clear. However, there are still some unclear aspects listed as below, I would expect the authors further clarify them and improve the manuscript.

1. It is exciting to see the NEW model shows promising results of the anticorrelation between ENSO and air-sea CO2 flux, which the OLD model couldn't capture well especially the magnitude of ENSO. As revealed by Dong et al. (2016), most CMIP5 models could not capture the relationship right. It would be helpful to have some discussion on which key model developments do improve the representation of ENSO magnitude in the NEW model? A paragraph of discussion on this will provide advices for other modeling centers.

2. ENSO is an air-sea coupled system, it involves both ocean and atmosphere processes. In this study, both OLD-assim and NEW-assim only nudge ocean temperature and salinity, the atmosphere ran freely without any data nudging. I have couple of questions here: i) Does the IAU apply to every ocean level including the ocean surface? ii) How is the atmosphere part for instance winds treated? As the ocean part has strong nudging, the atmosphere should be adjusted accordingly, the mismatch of ocean and atmosphere would cause some spurious circulation. iii) Why is this spurious upwelling only found in the OLD-assim? iv) Is the spurious upwelling obvious in the climatological mean state in OLD-assim comparing with the OLD? A comparison of climatology in the nudged data and the model free runs will help understand this point. v) Would a different assimilation method, e.g., including atmospheric circulation nudging, end up with a different conclusion?

3. Line 32: "...warm by 1.5C within ∼20 years..." -> "...warm by 1.5C within ∼20 years relative to the preindustrial state"

4. Line 87: "This remainder.." -> "The remainder..."

5. Combining Fig. 5 and Fig. 7, Fig. 6 and Fig. 8 will help readers for the comparison of OLD and NEW.

6. Line 234-236: "In this research, the same simple data assimilation scheme is incorporated into two ESMs, OLD in which the ENSO amplitude is about half the observed value and NEW with improved reproducibility of ENSO." Is this statement of ENSO am-

plitude based on the free runs of the two models? It would be helpful to add panels of ENSO amplitude in the free runs with OLD and NEW models in Fig. 1.

7. Line 237: "...is consistently represented..." here needs to be rephrased to make it clearer, e.g., the anticorrelation relationship between SST and CO2F.

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