

Interactive comment on “Continued increase in atmospheric CO₂ seasonal amplitude in the 21st century projected by the CMIP5 Earth System Models” by F. Zhao and N. Zeng

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The major issue raised by the reviewers is that, the original manuscript largely treats the models in aggregate, lacking in-depth analyses on individual models and change of environmental drivers. In response to this concern and other questions and comments raised in the constructive comments, we have performed additional analyses and closely examined the behavior of some individual models.

As a result, we have completely rewritten the discussion section, and added six Figures. We also included ten supplemental figures. Specifically, the following items have been changed.

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1. Abstract. The abstract has been modified for clarity.

2. Introduction. Amplitude figures for Mauna Loa and Point Barrow CO₂ are updated. Clarification on why the amplitude figures are different from Graven et al. (2013) is given. Several new references including Randerson et al. (1997) and Peylin et al. (2013) are added, including some descriptions. Minor textual changes are also made.

3. Results. Sect. 3.1. Compared our results, with Gurney and Eckels (2011). Merged some results from Sect. 3.2 into this section, added relative amplitude change for the Northern Hemisphere (25–90N).

Old Sect. 2.2 and Figure 3 are removed.

Sect. 3.2 (old Sect.3.3). Redesigned Figure 4 (now Figure 3) to include curves for individual models and detrended CO₂ growth rate. As a result, the text is lengthened, and the features of several models are discussed, and cited Anav et al. (2013).

Sect. 3.3 (old Sect.3.4). The description of Figure 4c (originally Figure 5c) is rewritten for better clarity. Add description for new Figure 5 showing zonal amplitude of all models, which includes different phase. Also discuss further on individual models and add Figure S1. Our new figures and analyses should answer some major questions raised by both reviewer, on the importance of tropical regions and interpretation of Figure 4c.

Sect. 3.4. New section. Moves in description for sensitivity experiments, and displays sensitivity experiment results for the GFDL and IPSL models (Figure 6 and 7). Also analyzes the major mechanisms, the caveat and reason for not including the IPSL model.

Sect. 3.5. Rewritten the first sentence. Changed some wording and added statement for uncertainty. Change caption of Figure 6 to Figure 8.

4. Discussion. In this new section motivated by helpful comments from the reviewers, we include the following:

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To address the concern that ensemble patterns may be dominated by only a few models, we show the spatial patterns of individual models in Figure S2, which display high consistency and support our original conclusion. Also added discussion on the choice of two time periods.

In response reviewer 2's interesting questions on the amplitude change of Mauna Loa and Point Barrow, we first compared the model simulated CO₂ at the locations of the two stations with observation. We present our new findings in Figure 9 and 10, and discuss the difference of our findings and the results in Graven et al. (2013).

We then stated the amplitude increase at Mauna Loa and Point Barrow by 2081-2090. Then we discussed the caveats of treating this result, commenting on over-represented and missing mechanisms in CMIP5 models and the uncertainty in CO₂ emission.

Next, we discussed on the difference of climate simulations by the CMIP5 models, showing changes of soil moisture and near-surface temperature for each individual model in response to reviewer 1's comment on the change of drivers (Figure S6-S9).

We followed this by presenting the change of ecosystem types in some models (adding Figure 11 and 12), and discussed the implication.

We wrap up our discussion with effect of land use/cover change, both showing crop cover change (which addresses reviewer 1's comment on the change of drivers) and stressing the missing representation of agricultural intensification.

5. Conclusions. The original "Discussions and Conclusions" are significantly shortened due to the separation. We also removed the last paragraph as suggested by both reviewers, and added our suggestions on future work.

Specific point-by-point responses to each reviewer have also been posted separately.

Interactive comment on Earth Syst. Dynam. Discuss., 5, 779, 2014.