Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-170-RC1, 2020

Biogeosciences Discussions

Interactive comment on "Spatially resolved evaluation of Earth system models with satellite column averaged CO_2" *by* Bettina K. Gier et al.

Anonymous Referee #1

Received and published: 14 July 2020

This is a concise analysis of the current CMIP6-generation emission-driven Earth System Models' ability to reproduce satellite-observed variability characteristics of column-average atmospheric carbon dioxide concentrations (XCO2). The manuscript provides a comparison with the previous generation of models and demonstrates improvement over time as a modeling community. The manuscript also demonstrates that geographic and temporal sampling biases in the satellite observations contribute to an observed negative trend in the amplitude of the seasonal cycle of XCO2. This manuscript is an important documentation of the models' ability to simulate atmospheric CO2 and could be suitable for publication after addressing some of the concerns outlined below.

Major Comments:

1. The spatial sampling issues comparing models to satellite obs are addressed in

this manuscript, but the temporal issues are only partially addressed. It is not clear what role the presence of cloud cover plays in the results. Satellite observations of column-average CO2 occur over locations with low cloud cover (line 120). One could imagine that some processes – such as stomatal conductance – could vary significantly on cloudy vs. cloud-free days. The model monthly averages however include all model timesteps and are not impacted by the presence of clouds. Some quantitative assessment of this effect is needed to interpret the results of this study. Perhaps reconstructing some monthly averages using a daily or sub-daily cloud mask could help understand whether or not this has a large influence on the comparison between models and satellite observations.

2. What are the baseline trends in the control simulations for the physical climate and carbon cycle processes that influence atmospheric CO2? Was there an attempt to detrend the models? Why or why not?

3. Were multiple model ensemble members from each model considered? The manuscript seems to suggest that only one ensemble member from each model was considered. This point should be clarified and all available ensemble members should be analyzed to get as comprehensive a picture as possible regarding the models' intrinsic variability given the nature of this study and the relatively short time period of analysis.

4. The conclusions section would benefit from a longer discussion regarding the limitations of the study and future directions. Can the authors make any further recommendations regarding improvements that are needed on either the observational or modeling side to make this comparison better?

Minor Comments: * Line 21: Replace "slightly" with a more quantitative value * Line 40: Unequivocal warming of what? Troposphere? * Lines 46-48: This sentence has some grammatical issues * Line 57: What is meant by "seems to be" * Line 119: The observational record is already relatively short from a climate perspective. Discarding

2 years seems like a lot. Consider adding in the years if simulations are now available * Lines 131-133: Consider expanding the discussions as to why these sites were selected * Line 205-206: Consider mentioning these offsets sooner in the paragraph to improve readability.

References: * Please add data DOIs for all CMIP6 datasets downloaded and analyzed from the ESGF archive.

Figure Comments: * Figure 3: Is there a way to incorporate linear trend information into this figure? * Figures 6a & 6b: Consistent color scale ranges are needed for comparison * Figures 7a and 8a: A non-diverging color scale for the top panels could make it easier to contrast against the information contained in the bottom panels

---

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-170, 2020.