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Biogeosciences Discussions

Interactive comment on "Simulation of anthropogenic CO_2 uptake in the CCSM3.1 ocean circulation-biogeochemical model: comparison with data-based estimates" *by* S. Wang et al.

Anonymous Referee #4

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General comments

This paper describes the estimated anthropogenic CO2 uptake by the global ocean using the Community Climate System Model (CCSM), and compares the estimated uptake to observation-based estimates from the literature. Results from CCSM sensitivity studies are then used to assess the validity of assumptions made in one of these observation-based estimates. Carbon-climate models should correctly represent anthropogenic CO2 uptake, so that they can be used to make accurate predictions of the future climate system. It is equally important that the assumptions of data-based methods for anthropogenic CO2 uptake be rigorously tested. As such, this paper rep-

resents a critical need for the carbon cycle community on two fronts. The manuscript is well-written and should be of interest to a subset of Biogeosciences readers. I support its publication in Biogeosciences, pending the revisions described below.

Specific comments

1) While the authors do a nice job of comparing the CCSM-based anthropogenic CO2 uptake to data-based methods, they simply leave out a section on how CCSM's uptake compares to estimates derived from similar oceanographic models (e.g. the models used in OCMIP). Do all ocean-based models suffer from anthropogenic CO2 uptake biases in these regions? Do the estimates of regional uptake look similar to those derived from the ocean inversion project (e.g. Mikaloff-Fletcher et al.), which uses the circulation fields from OCMIP?

2) The authors make an important point: that the uptake of anthropogenic CO2 is underestimated by CCSM in the Southern Ocean and, to a lesser extent, in the North Atlantic Ocean. They briefly mention that this model-observation inconsistency is driven by the weak mixing and ventilation in the CCSM. As this seems a key result, the authors would do well to further explore it. After all, the goal here is to identify the cause of the CO2 uptake bias, so that improvements can be made in future versions of the model. What does the mixing and ventilation look like in CCSM? How does it compare to observations? Other models? What is the best way to correct the mixing and ventilation "problem" in this model – to go to a higher horizontal resolution? To improve the mixing parametrisations?

3) The manuscript is missing a paragraph describing the regional biases in the assumption of constant circulation for KPH. To this end, please add a column to Table 2 for Cant_var, and comment on the regional differences between this and Cant_const. Whilst Figure 4 demonstrates that globally integrated estimates are not biased by the constant circulation assumption, this may also be a case where large regional biases cancel each other out. Regional modelers in particular will be interested in how climate-

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8, C5367–C5369, 2012

driven circulation changes can impact anthropogenic CO2 uptake.

4) Please clean-up the writing a bit in the manuscript. In particular, section 3.1 is quite challenging to read - ensure that each paragraph is anchored by a clear and concise topic sentence, and reduce the use of variable names in the writing if possible. Occasionally whilst reading, I encountered a few fairly meaningless sentences. For example, 10915, line 12 “It indicates that the bias . . . is considered.” And, 10916, line 20 “The differences in these regions are mainly due to the different assumptions made in each method.”

Technical corrections

10907, line 10, should read S. Ind. Ocean (>35oS) (disregard “-“ sign)

10907, line 19, “Southern” is misspelled

10909, line 3, missing “the” before Southern Ocean

10909, line 9, “fall in a wide range” should read “are wide-ranging”

10910, line 7, “need” should read “needs”

Interactive comment on Biogeosciences Discuss., 8, 10895, 2011.