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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 #1

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The objectives of this study are to evaluate a coupled climate model's ability to simulate oceanic uptake of anthropogenic carbon and to compare three data-based methods to estimate the anthropogenic carbon inventory. Generally speaking, accurate estimation of anthropogenic carbon uptake and understanding the mechanisms of carbon uptake are of interest to the carbon cycle community, and the topics of this submission are relevant to the journal.

I should mention first that I greatly admire published works of Moore in developing the NCAR biogeochemistry model with Doney and of Primeau and Khatiwala in their respective inverse modeling efforts. Khaiwala's work on KPH was excellent. So with

those three listed as authors, I am naturally inclined to view this work favorably. However, I do not feel positive about this work, mainly because it has very little to offer in terms of actually advancing the field or producing new and useful knowledge. This work has figures and tables to show and discuss, but at the end it neither increases the accuracy of anthropogenic carbon uptake estimate nor elucidates any new mechanism of carbon uptake.

As noted, the three data-based methods of estimating the anthropogenic carbon are the DC*, TTD, and KPH. The estimates for 1994 are respectively 106, 94-121, and 114+/-22. Given their uncertainty, they overlap. Also, there are a number of model-based estimates, for example by the ocean carbon cycle model intercomparison project (OCMIP) and the coupled carbon cycle climate model intercomparison project (C4MIP). The former MIP is composed of ocean-only models and the latter of coupled models, including CCSM used in this submission. From all these and other studies and to first order, we now know how much carbon inventory has increased in the ocean. A new publication on this now rather old topic has to tell us something new and meaningful or go beyond first order by greatly improving accuracy. In my mind, this submission does not do that.

In terms of the numerical experiments carried out with a version CCSM in this work, similar experiments have been done already by OCMIP and C4MIP. Those sets of models have shown a range of uptake globally and regionally. That CCSM in this paper is in the low part of the range and that "priority should be given to improving the ocean circulation" are nothing to write home about.

In terms of comparing the data-based methods, there is not a lot of motivation to start with because the three methods are in agreement to first order. Yes, the methods have different strength and weaknesses, and yes, there are potentially problematic assumptions like constant disequilibrium or constant circulation. But they do not matter much. A case in point is their Figure 4: Cant-const, Cant-var, and Cant-all are nearly identical. This simply means, as had been pointed our numerous times before, that

anthropogenic carbon uptake until recently is driven primarily by the air-sea pCO2 gradient (i.e., atmospheric pCO2).

I would like to note also that the utility of the data-based methods in estimating future carbon uptake is very low. The reason is simply that there will be repeat hydrographic cruises. Ocean uptake will be given unambiguously by the change in carbon concentration between repeat cruises. The number of cruise lines will not be as large as during the 1990s during the era of WOCE or JGOFS but considerations have gone into selecting the lines. In addition and very importantly, using atmospheric O2 data together with CO2 data will be a dominant way to estimate ocean uptake of carbon in the future. So, the statement that KPH could be used to predict future carbon inventory is not convincing. The DC*, TTD, and KPH methods had very important roles to play, but their time at the forefront is now largely passed in my mind.

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