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Interactive comment on "Impact of atmospheric and terrestrial CO_2 feedbacks on fertilization-induced marine carbon uptake" *by* A. Oschlies

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I thank Jorge Sarmiento for his helpful review. Following his suggestion, I have included explicit statements both in the abstract and in the conclusion that the reduced efficiency of the oceanic carbon uptake is due to the back flux of CO2 that occurs when atmospheric CO2 is reduced.

A few more caveats have been added about the uncertainties in the pCO2 sensitivity of the terrestrial carbon storage, both in the abstract and in the concluding section 5. The work of Caspersen et al. (2000) is now referred to, who find no CO2 fertilization effect in temperate latitude forest inventories.

I agree with the comments about the possible dependence of the results to the time trajectory of the background atmospheric CO2. Unfortunately, it is more complicated to set up runs equivalent to VEGconst (and to some extent CLIMconst) with increasing background CO2 than it is for constant background CO2. To keep climate and/or vegetation identical to a control run with increasing background CO2, one would have to prescribe the evolution of climate and/or vegetation for the fertilization run.

To explore the sensitivity of the results reported above to background pCO2 typical for historical and expected future CO2 levels, two model runs corresponding to COUPLED and ATCO2const were performed for prescribed increasing C:N ratios and increasing background atmospheric CO2 levels corresponding to anthropogenic emissions. The COUPLED experiment, and a control experiment with constant C:N ratios, were forced by historical emissions until A.D. 2000 and the SRES A2 emission scenario thereafter. The ATCO2const experiment was forced by the evolution of atmospheric pCO2 taken from the control run.

The COUPLED experiment forced by CO2 emissions resulted in an atmospheric CO2 drop of 27.5PgC with respect to the control run by A.D. 2100, an additional oceanic carbon uptake of 30.8PgC, and a terrestrial carbon loss of 3.4PgC. That is, for the same increase in C:N ratios , the atmospheric CO2 reduction is about twice as high as in the runs with pre-industrial background atmospheric pCO2 (12.7PgC, Table 1), whereas the ocean uptake is only 14% larger than the value under pre-industrial background pCO2 (26.9PgC). The larger sensitivity of atmospheric pCO2 to changes in the C:N ratio (or ocean fertilization) is caused by an increase in the Revelle factor at higher CO2 levels (Kurz and Maier-Reimer, 1993). Additional nonlinearities come from the terrestrial biosphere's response to changes in background CO2, temperature, and hydrological cycle. The cumulative terrestrial response to the perturbation induced by increasing C:N ratios by year 2100 is smaller in the emission scenario (-3.4PgC) than in the run with pre-industrial background CO2 (-14.1PgC).

For the experiment with prescribed increasing pCO2 (corresponding to ATCO2const), the oceanic uptake amounts to 46.1PgC by year 2100, which is 12% larger than the oceanic uptake of run ATCO2const under pre-industrial background CO2 (41.0PgC, Table 1). That is, the relative differences between experiments ATCO2const and COUPLED are similar in the emission scenario and the pre-industrial pCO2 scenario. Since the main focus of this paper is on relative rather than absolute differences among different model configurations, this gives some support for the robustness of our results obtained for a pre-industrial set-up.

A discussion of these matters is added as a new section 3.4 "Sensitivity to background CO2 levels" in the revised paper.

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