

Review of the paper “A model study of the seasonal and long term North Atlantic surface pCO₂ variability”; by Tjiputra, Olsen, Assmann, Pfeil, and Heinze; submitted for publication to Biogeosciences.

This paper reports a study to simulate the past half-century variations of surface pCO₂ in the north Atlantic using biogeochemical OGCM and to assess the relationship between NAO and basin-scale pCO₂ variability. The manuscript is well written and organizes fairly by discussing both the efficiencies and deficiencies. I think the manuscript publishable to Biogeosciences after revising based on the following comments.

General comments:

1) Insufficient information for air-sea CO₂ flux

Authors should indicate results of calculations for seasonal and inter-annual variability of air-sea CO₂ fluxes that correspond to Figure 3, and then discuss those consistencies to observations and deficiencies if it would exist. Although they show only seasonality-filtered trends on Fig. 4, net annual fluxes (air to sea or sea to air) are masked in this figure. Validation whether annual CO₂ flux at each location is positive or negative must be rather essential than its inter-annual variability. For example, Caribbean region appears to release CO₂ to air in model while it appears to uptake in observation from what I can look at Fig. 3. How different? Why different? How to improve it?

2) Lack of perspectives for improving the model used

Authors mention current model deficiencies fairly based on the comparison with observed results. It's favorable, however, they describe little what to improve the model used in this study. Both general and expert readers would like to know perspectives for further modification. Need higher spatial resolution, improved biogeochemistry and so on. Or observation insufficient?

Specific comments:

Introduction: Recent study by Levine et al. (Global Biogeochem. Cycl. 25, GB3022) should be involved.

4.2 Regional trends in fCO₂ and sea-air CO₂ flux: I recognize large mismatches between observation and model could be found in NASPG and BATS region/station. For former and latter, no observed results are found during 2002-mid2003 and mid2006-2008, respectively, while another two regions equip completely. May these deficits attribute the mismatch? Especially for BATS, could authors fill the deficit after mid 2006 and recalculate? At least they had better describe gaps for these two locations.

P10198L3-5: Add a description for the case if simulated SST and SSS would be used for calculating CO₂ flux.

P10199L20 and Table 1: The unit of inter-annual trends of annual sea-air CO₂ fluxes must be “mol C m⁻² yr⁻²”.