

The authors thank anonymous Referee2 for the constructive feedback on the manuscript. The revised manuscript is now revised to follow Referee2 suggestions. We have added a new subsection discussing the monthly sea-air CO₂ fluxes estimated from both the model and observation. Below, we address all of Referee2's comments in more detailed. We think that the revised manuscript is now considerably improved compare to its initial version.

Referee 2: 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.

In the revised manuscript, we have computed the monthly sea-to-air CO₂ fluxes associated with the surface fCO₂ shown in Fig. 3. We also added a new section (4.2. Regional Sea-air CO₂ fluxes), which discusses the model simulated CO₂ fluxes in different regions across the North Atlantic and how they compare to the observational-based estimates. A new figure (Fig. 5) is added to help illustrate the discussions. In general, the model-data bias in the seasonality for certain regions are closely link to the bias in the fCO₂ seasonal cycle as shown in Fig. 3.

Ref 2: 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?

For the net mean annual CO₂ fluxes, the model output has been validated with the observation from Takahashi et al. (2009) in Assmann et al. (2010) paper (also cited in the manuscript). Therefore, to avoid redundancy, it is not discussed again in this manuscript. Validation for the annual CO₂ fluxes with the SOCAT data is difficult because these underway observation, in most of the regions, has no coverage for every months of a single year. For example, for the period of our study (2002-2007), there is only one year and region where there is full 12-months data coverage (i.e., 2005 in NASPG).

Nevertheless, as suggested on the previous comment, we have added a new figure showing the model and data comparison of monthly sea-to-air CO₂ fluxes for all the regions studied here. This figure is also useful to provide a rough estimate of the annual CO₂ fluxes from both the model and data. We have also added more discussions in the manuscript on what are the potential issues of the model data misfit. For example, as the referee pointed out nicely that, in the Caribbean region, the model is outgassing CO₂ while the observation shows the opposite.

Ref 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?

In the revised manuscript we added the following:

“Presently, the next generation MICOM-HAMOCC model is being tested. The latest version of the model adopts a higher spatial resolution, improved physical mixing parameterization, as well as updated carbon chemistry. Together with more publicly available underway $f\text{CO}_2$ data that is soon to be released (SOCATv2), we intend on performing a similar study to further evaluate the model-data inconsistencies. Improving the ecosystem parameterization in the model, which is shown here to be one of the model deficiencies at high latitude, is also on the agenda.”

Ref 2: Introduction: Recent study by Levine et al. (Global Biogeochem. Cycl. 25, GB3022) should be involved.

The recent paper by Levine et al. (2011) is now included in the Introduction section of the manuscript.

Ref 2: 4.2 Regional trends in $f\text{CO}_2$ and sea-air CO_2 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.

Referee2 is right that the limited data could attribute to the model-data mismatch. For example, for the NASPG station, the revised manuscript (also in response to Referee1's comment) mentioned that the model-data discrepancy in the $f\text{CO}_2$ trend might also be attributed by the unusually low summer $f\text{CO}_2$ observed in 2007 (without this year, the observed trend would be closer to the model estimate).

Unfortunately at the time of the paper preparation (up to Summer 2011), these are all the publicly available data sets that we were able to get a hold to.

For the NASPG station, there is no data for the year 2002 and only three months for year 2003 (June, November and December). For BATS, the data we have are the one publicly available at the time of manuscript preparation, which was based on the study by Bates (2007). However, as mentioned above, for our next generation model we plan on performing a similar study including all the latest publicly available surface $p\text{CO}_2$ data both underway and different time-series stations.

In the revised paper, we also added a statement (see Section 4.3, fourth paragraph) to caution the readers in interpreting the long-term trend shown in Fig. 6, “We note that, due to the high surface $f\text{CO}_2$ deviation in the year 2007 (i.e., at NASPG), longer time series of observation is necessary to yield a more reliable trend analysis.”

In addition, as suggested by Referee 2, we have explained the reason for the data gaps for both the NASPG and BATS stations in the revised manuscript.

Ref 2: P10198L3-5: Add a description for the case if simulated SST and SSS would be used for calculating CO_2 flux.

For the observed CO_2 fluxes, we use the SST and SSS data that comes with the underway measurements, except when SSS is not available (in this case, we use SSS from the WOA). The model simulated SST and SSS are implicitly included for the computation of $f\text{CO}_2$ and, thus, CO_2 flux in the model. We have further clarified this

in the revised manuscript (Section 4.2).

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

The error is now corrected in the revised manuscript.