

Interactive comment on “A model study on the sensitivity of surface ocean CO₂ pressure with respect to the CO₂ gas exchange rate” by P. Landschützer et al.

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The authors would like to thank referee#3 for the constructive comments.

Referee#3: General comments: I do not understand why the Takahashi pCO₂-climatology is compared to one single year (year 2000) in order to elucidate potential improvements in the predictions by using an increased piston velocity. Wouldn't it make more sense to average around year 2000 to remove interannual variability? If only one year is taken the results are not robust at all.

Response by authors: on page 10807 lines 23-25: We state in the manuscript for G03 which shows the strongest interannual variability that “Additionally, due to the
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stronger inter-annual variation of the CO₂ fluxes in G03 the model mean results from the years 1995 to 2004 were compared to the Takahashi climatology (not shown). The results indicate that averaged over the 10 yr period the G03 outputs show higher uptake fluxes compared to the model standard run and therefore do not improve the model performance for the CO₂ fluxes, whereas the pCO₂ values only slightly differ from the numbers obtained in Table 3”. We have now included the results from the 10 year average in table 3 and related text of our revised manuscript and removed above original statement.

Referee#3: page 10801 / line 5 ... Is there a reason for prescribing pCO₂(atm.) instead of emissions?

Response by authors: We set the focus of our study on the air-sea flux of CO₂ in general and not specifically on anthropogenic fluxes. In addition, if we use emissions, instead of prescribing atmospheric pCO₂, the experiments will include additional feedbacks due to the different in the simulated atmospheric CO₂ and complicate the sensitivity analysis. By Keeping the atmospheric CO₂ the same in all experiments, we can isolate better the sensitivity of the gas transfer velocity, which is the main goal of this study.

Referee#3: page 10803 / line 12 “where flux differences exceeding +/-2 molC/m²/yr can be identified.” How can it be identified when the colorbar of Fig. 1 is only in the range of +/- 2 molC/m²/yr?

Response by authors: We extended the colorbar in our revised manuscript.

Referee#3: page 1087 / line 22 “potentially”?

Response by the authors: We did not explicitly test if a decreasing gas transfer rate would improve the results, therefore the use of potentially. However our findings support this.

Referee#3: page 10808 / line 7 ... For the North Atlantic, a similar conclusion was

drawn by Friedrich et al. [2006, GRL] who showed that interannual changes in piston velocity explain only ~25% of the interannual CO₂-flux variance whereas wind-stress is responsible for about twice as much. Referee#3: page 10808 / line 20 Another study worth citing is Groeger and Mikolajewicz [2011, Ocean Modelling] on the CO₂ air- sea gas exchange rate at high ocean temperatures

Response by authors: Further literature as suggested (Friedrich (2006) and Groeger and Mikolajewicz (2011) and other with the focus on the parametrization of the gas transfer rate are now included in the revised manuscript.

Refree#3: page 10808 / line 11 “substantially”?

Response by authors: We have re-written this statement in the revised manuscript, because we discuss the 10 year average which does not improve the results.

Refree#3: Table 1 May I suggest to find more self-explanatory experiment names?

Response by authors: We changed the experiment names in the revised manuscript as follows: G01 is now ControlEx; G02 is now HighExNo; G03 is now HighExEq; G04 is now HighExSo;

Refree#3: Figure 1+2, caption: “difference between the model standard run and the G02 scenario (top),...” Vice versa?

Authors comments: We revised “...difference between the model standard run and the G02 scenario (top),...” to “...difference between the G02 scenario and the model standard run (top),...” for both figures

Refree#3: Figure 6 I find the panels very complicated to understand. Maybe there is a simpler way to visualize the findings.

Authors comments: We now changed figure 6 in the revised manuscript, as we now plot the difference between all experiments (G01, G02, G03, G04) to observation (Takahashi) instead

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