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Biogeosciences Discussions

Interactive comment on "A model study on the sensitivity of surface ocean CO_2 pressure with respect to the CO_2 gas exchange rate" *by* P. Landschützer et al.

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The authors would like to thank referee#2 for the useful comments.

Referee#2: In general referee#2 indicates that the manuscript does not provide enough new insight to be published, and suggests that changes in ocean circulation have to be included in the study to reach a substantial conclusion.

Response by authors: The comments of referee#2 concerning an additional sensitivity run where the ocean circulation should be changed are similar to those of referee#1. The focus of the paper is to investigate the effect of locally increasing wind speeds on the sea surface pCO2 and air-sea gas fluxes of CO2. While existing studies (p10799,

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lines 9-21) conclude that CO2 fluxes substantially alter with changing wind patterns due to circulation changes, our study is focused on the effect of increasing wind speeds on the gas transfer velocity alone. If we were to include change in the ocean circulation, it would be problematic to identify the gas exchange effect alone due to the non-linearity of the model system. We conclude that wind driven changes (as presented in the literature) in the global gas uptake mainly result from circulation changes, because our results show that changing the gas transfer velocity alone does not substantially change the global fluxes. To the authors' best knowledge, there is no study that looks at the effect of global CO2 fluxes to a regional perturbation of wind speed or gas transfer coefficient. The closest study we found is by Eden&Oschlies (2006), which looks at the sensitivity of the North Atlantic CO2 gas exchange to different gas exchange formulation in their model. At the moment a newer version of the MICOM-HAMOCC model is emerging, and it is therefore not possible to re-do the same model runs and to include changes in the ocean circulation with the identical model code and initial conditions as used for this manuscript. Also this former model version which had been used for our manuscript was running on a supercomputer with shared memory architecture (openMP). The respective supercomputer is not available any more unfortunately. In order to nevertheless follow the wish of the referee we further add on the innovation part of the manuscript. e We suggest including an analysis on the ocean carbon storage changes with respect to the presented sensitivity studies in the revised manuscript. This will offer an additional new inside into the impact of gas transfer velocities on the mode of carbon cycling. . As our results in the manuscript show that global changes in pCO2 and annual fluxes are low (with respect to all sensitivity runs), we now want to investigate in addition changes in the column inventory of the total CO2 and explore the effect of an enhanced gas transfer over the 52 years of model integration.

Referee#2: referee#2 is missing literature dealing with gas exchange parameterization.

Response by authors: The novel concept of our study is that we combine a global with a local view. Similar studies (e.g. Eden and Oschlies [GBC, GB2008,2006]; Müller

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et al. [GBC, GB3011,2008] Friedrich et al. [GRL, L21S04,2006], etc.) use different transfer velocity parameterizations or wind forcing for the entire study domain. To give an example: Eden and Oschlies (2006) find sea surface pCO2 values of 5ppm and CO2 fluxes of 10% higher in their study area (subpolar NA). While we do find that fluxes increase similar in our experimental area G02, we reckon that the difference in the global uptake is less than the increasing flux in G02 (p10805, lines 10-18). We included literature that present results from using different gas transfer parameterizations in the revised manuscript.

Interactive comment on Biogeosciences Discuss., 8, 10797, 2011.