

Interactive comment on “Inter-annual variability of the carbon dioxide oceanic sink south of Tasmania” by A. V. Borges et al.

A. V. Borges et al.

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Reply to Referee #3

Referee comment : This is a very useful paper addressing with a great amount of measured data the role of inter-annual variability. The paper is well written.

Reply : We thank the reviewer for her/his encouraging comments and useful suggestions.

Referee comment : General The authors show monthly SST and pCO_2 anomalies and give an explanation using a varying SAM. What I miss is an answer to the question whether changes in SAM can possibly lead to hydrographic changes at such short (monthly) time scales. Since the explanation with the aid of SAM

is so prominent in the paper, this question should be discussed thoroughly as well.

Suggestion

There is a long-term trend of the SAM, mainly in the austral summer. If the SAM plays such a dominant role in causing anomalies, the authors may look for an increasing trend in the occurrence of anomalies towards 2003.

Reply : We used monthly anomalies to deseasonalize SST and pCO_2 data. This was the only way to detrend the observations since they are irregular in time (not a continuous regular time-series). However, the use of monthly anomalies to analyze inter-annual variability does not imply that changes in SAM lead to hydrographic changes at monthly time scales. Changes in SAM lead to inter-annual variability that also affects the seasonal cycles. We modified several sections of the text to clarify the timescales of interest. A figure showing SAM index and deseasonalized SST and wind speed was added and discussed. This figure does not reveal a distinct long term trend in SAM from 1982 to 2005. This figure does show that there are strong inter-annual changes in SAM that are correlated to equally strong interannual variations in wind speed and SST.

Referee comment : Data of pCO_2 are referenced to the year 1997. This presumes that the ocean follows the rise of atmospheric pCO_2 exactly. Is there any evidence that this is allowed in this region? This question is even more important as anomalies are considered on a seasonal scale. Even if the ocean follows the atmosphere, this will not occur evenly distributed over the whole year. In the season in which the wind speed is highest (probably autumn), most CO_2 will be taken up by the ocean. This will lead to skewed anomalies. By the way, the fact that the sink might increase during periods of anomalous SST by

itself is a contradictio in terminis that the ocean follows the atmosphere. I think the authors should explain this much better and clear the issue because it is basic for the whole paper.

Reply : Based on four cruises carried out between 1969 and 2002, Inoue and Ishii (2005) showed that pCO_2 in surface waters in the STZ and SAZ close to Tasmania increases at a rate very close to the increase of atmospheric CO_2 . This information was added to the text.

Referee comment : p3644, I16-22 The climatological trends for pCO_2 are not similar for all regions, as written in the manuscript. In the CS the seasonal cycle of pCO_2 is very different. Is there an explanation for that?

Reply : We do not agree that the seasonal cycle of pCO_2 is “very” different in CS. We find it to be fairly similar to the one in STZ, in agreement with the fact that the water mass on the CS is mainly of STZ origin. It is well established that the close coupling of benthic and pelagic compartments and strong terrestrial inputs characteristic of continental shelves have a significant impact on DIC dynamics (e.g. Borges 2005). Since this is not the main objective of the ms we did not discuss this in detail. But since the SST and pCO_2 anomalies also occur on the CS, we kept the CS data in the analysis.

Referee comment : p3646-3647 SAM I think the discussion about SAM is not clear enough. Are the authors talking of seasonal changes in SAM or is it lower frequency variations that may be associated with SAM? A figure with the SAM trend to refer to would certainly be very illuminating here. This should also show whether the SAM trends and the anomalies match.

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Reply : A figure showing SAM index and deseasonalized SST and wind speed was added and discussed.

Referee comment : p3652, I16-18 I think this conclusion should be toned down. The paper did not explicitly address this question.

Reply : This question is now explicitly addressed with a figure showing SAM index and deseasonalized SST and wind speed.

Referee comment : Technical comments p3641, I28 analyses

Reply : Indeed. Text was changed accordingly.

Referee comment : p3641, I10-11 ... studies show that warm ...

Reply : Indeed. Text was changed accordingly.

Referee comment : p3646, I13-17 This sentence is illogical, i.e. it is an anacoluthon.

Reply : Indeed. Text was changed by removing the word “simultaneously”

Referee comment : p3651, I22 hypotheses

Reply : Indeed. Text was changed accordingly.

References

Borges A.V. (2005) Do we have enough pieces of the jigsaw to integrate CO_2 fluxes in the Coastal Ocean ? *Estuaries*, 28(1):3-27

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