

***Interactive comment on* “Influence of terrestrial inputs on continental shelf carbon dioxide” by L.-Q. Jiang et al.**

L.-Q. Jiang et al.

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Both reviewers have provided constructive comments and suggestions, which have helped to improve the quality and clarity of the paper. Note that all original comments are provided in plain text, with point-by-point responses provided after the mark “Response”.

Responses to Reviewer 1’s comments:

GENERAL COMMENTS The manuscript “Influence of terrestrial inputs on continental shelf carbon dioxide” by L.-Q. Jiang, W.-J. Cai, Y. Wang, and J. E. Bauer represents a substantial contribution to scientific progress within the scope of Biogeosciences. The manuscript describes a detailed analysis of DIC, DOC, and pCO₂ data from the mea-

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surements collected during several cruise transects on the U.S. South Atlantic Bight (SAB) continental shelf. The pCO₂ data from the cruises have been previously reported in a paper by Jiang et al. (2008a), in which air-sea CO₂ fluxes for the SAB were estimated. The present manuscript partitions the observed changes in the surface-water pCO₂ into various components, including biological sources and sinks combined with mixing on the continental shelf and the inputs from the rivers and salt marshes. The manuscript could benefit from a number of corrections that are suggested below. I highly recommend this manuscript for publication after my recommendations are taken into account.

Response: We thank the reviewer for his/her constructive and very careful review, which helps to improve the quality of our manuscript.

SPECIFIC COMMENTS The abstract and the introduction should be revised to state unambiguously that the present study is based on the cruise data first reported in Jiang et al. (2008a).

Response: We have added the suggested changes to the Abstract and Introduction to clearly state that some of the data in the current study was first reported in Jiang et al. (2008a). See page 2, lines 25-27, and page 4, lines 66-68.

The goal of the study is clearly defined in the last paragraph of the introduction, but the introduction would also benefit from a concise summary of the motivation for the study.

Response: We have now combined the goal and motivation. A motivation line is expanded.

In the introduction, the distinction is made between the proximal and the distal shelf. However, in the results section and in the figures, the area-average is taken for the inner, middle, and outer shelf. Either, the introduction, or the presentation of the results should be revised so that the area-average is consistent throughout the paper.

Response: We now clearly say the proximal shelf is roughly the inner shelf and distal

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is the mid and outer shelf. However, in the SAB, in order to conform with convention, we still use the inner, mid, and outer shelf definition of <20, 20-40, and 40-100m. See page 3 lines 46-47, and page 5, lines 83-84.

I suggest that throughout the paper the concentration units be changed to $\mu\text{molC m}^{-3}$.

Response: While we agree with the reviewer using a consistent unit is better, we will use $\mu\text{mol C kg}^{-1}$ for DIC but $\mu\text{mol C L}^{-1}$ for DOC as the tradition goes. If the editor decides we should stick with one, we'd be happy to make that change.

p. 9317 Line 1: atmospheric carbon dioxide (CO₂). Need a reference here.

Response: We have added new references - Borges et al., 2005; Cai et al., 2006; Chen and Borges, 2009. See page 3, lines 42-43.

Lines 1-6. This sentence is taken verbatim from Jiang et al. 2008a (p.1), which is unacceptable

Response: The sentences have been deleted.

p. 9318 Line 9: The SAB continental shelf is $\sim 10\text{--}15\text{m}$ deep inshore and $50\text{--}75\text{m}$ deep at the shelf break. Need to indicate source of this information.

Response: The depths are based on our own bathymetric data collected during the cruises. We will revise the text to "The SAB continental shelf has an average depth of only 30m and is $50\text{--}75\text{m}$ deep at the shelf break (Menzel 1993)." See page 4 lines 71-72.

Lines 21-22: This sentence is taken verbatim from Jiang et al. 2008a (p.3).

Response: The sentence has been deleted.

Line 23: the CFZ as the proximal SAB (roughly equivalent to the inner shelf, as defined in Jiang et al. 2008a)

Response: "as defined in Jiang et al. 2008a" has been added. See page 5 line 84.

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p. 9319 Lines 18-23: Did you check if changing the analyzing lab biased the DOC measurements?

Response: There is a clear statement in the methods about how the reference standards provided by Hansell's lab at U Miami were used and that these agreed within measurement error.

p. 9320

Line 1: Section title should be changed to: Calculation of temperature- and gas-exchange-corrected pCO₂

Response: We have changed the section title. See page 6, line 112.

Line 4: air-sea gas exchange, as shown by Jiang et al. (2008a) in shallow coastal waters of SAB.

Response: We have added “, as shown by Jiang et al. (2008a) in shallow coastal waters of SAB” to the sentence. See page 6 line 115.

Line 14: “Normalized” is misleading in this context. I suggest using “referenced” instead of “normalized” throughout.

Response: Our intention was to use the same wording as that used for previously published studies. However, this is a good suggestion in the context of this paper, and we have now used “referenced” throughout the revised manuscript. Line 16: I think that for completeness the differential form of Takahashi et al. 1993 relationship should be shown here and then it should be stated that to obtain (2), the Takahashi relationship was simply integrated, with SST bar and SST as the integration limits. Response: The Takahashi et al. 1993 equation was omitted in the original manuscript for brevity. We believe it is not necessary to be presented in the manuscript and readers can get the idea easily from the integrated form (or check the reference if ever needed).

Lines 24-25. This sentence seems unnecessary, unless the annual mean tempera-

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ture used for the calculation is somehow not the annual mean temperature from the observations but something else.

Response: Here we were trying to alert readers that the temperature normalized CO₂ is dependent on the temperature used, in case they ever needed to compare our normalized data with other studies. In the revision, we have deleted the second use of “annual mean”. Thus, the revised sentence is now (page 7, lines 135-136“ It should be noted that the pCO₂ change due to temperature deviation from the annual mean SST is relative to the temperature used for the calculation.” p. 9321 Line 4: (1) Need to include a reference where the formulas for the calculations of the CO₂ system in seawater can be found; (2) I do not see how this CA at in situ temperature and salinity is used later in the calculation.

Response: A new reference (Riebesell et al. 2010) has been added. See page 7 line 139. CA is used to calculate pCO₂ (average SST)prior. See page 8 lines 150-152.

Line 8: I suggest using a bar over Δ DIC (air-sea) to indicate that this is an estimate of a 30-day average gas exchange flux.

Response: We added a subscript to indicate the time span is “30-day”. See Equation 4 and line 145 on page 7.

p. 9324 Line 8: reference is to the wrong figure in Jiang et al. 2008a

Response: Fig. 4 has been corrected to Fig. 3. See Page 10 Line 212.

p. 9325 Line 1: reference is to the wrong figure in Jiang et al. 2008a

Response: Fig. 4 has been corrected to Fig. 2. See Page 11 Line 229.

p. 9328 Line 20: This statement needs a reference.

Response: This is a conclusion we reached based on our own data. To indicate this, we have added to the beginning of the sentence “Based on this study...”. See page 15 line 319.

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TECHNICAL CORRECTIONS

I suggest that throughout the manuscript, the writing, when describing the work that has been completed, should be changed into the past tense. E.g., on page 9316, the sentence starting on line 6 should read: Contributions from the rivers, marshes, and the continental shelf to the TG-corrected pCO₂ were then calculated.

Response: In the revised manuscript, we have chosen to use present tense to refer to data processing, and past tense for data collecting.

Everywhere in the paper “the temperature and air-sea gas exchange corrected pCO₂” should be changed to either “the temperature- and gas-exchange-corrected pCO₂” or “pCO₂, corrected for temperature and air-sea gas exchange”.

Response: Changes have been made. See page 2 line 24, page 6 line 112, page 6 line 118, and page 6 line 121.

Everywhere in the paper one consistent preposition should be used in the phrase “in/on the South Atlantic Bight”.

Response: All the “on the South Atlantic Bight” have now been changed to “in the South Atlantic Bight”.

Below is a detailed list of corrections I believe necessary in order to clarify the meaning of the sentences where they are found. However, I also suggest that the entire manuscript be edited by an English native-speaker, in order to correct multiple grammatical omissions, which do not necessarily obscure the meaning but are, nevertheless, undesirable in a published work. For example, “compared to” should be changed to “compared with” on p. 9316 (line 16), p. 9317 (line 11), p. 9324 (line 16), p. 9325 (line 27), p. 9327 (lines 9 and 22).

Response: All the “compared to” has been changed to “compared with”. One of our co-authors, Dr. Jim Bauer, is a native English speaker, and had edited remaining grammatical errors where necessary. We will make sure that Bauer reads the final

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version again before publication.

p. 9316 Line 1: Air-sea carbon dioxide (CO₂) fluxes have recently been reported for the U.S. South

Response: Changes have been made. See page 2 line 19.

Line 8: Contributions from rivers, salt marshes, and the continental shelf to the

Response: “the river, salt marsh and continental shelf” has been changed to rivers, salt marshes, and the continental shelf. See page 2 lines 24 and 25.

Line 10: rivers [pCO₂(river)] are the highest close to the coast and decrease with

Response: “the” has been added in front of “highest”. See page 2 line 28.

p. 9318 Lines 19-21: A Coastal Frontal Zone (CFZ), formed by a pressure gradient induced by freshwater discharge frequently occurs at 10–30 m isobaths, about 10–30 km offshore on the SAB shelf (Blanton, 1981).

Response: “isobath” has been changed to “isobaths”. See page 5 line 82.

Fig. 1 The figure is missing the following: “” labels for the states of NC and SC “” labels indicating depths on the bathymetry contours “” labels for C, D and E transects Figure caption should be revised: Study area on the U.S. South Atlantic Bight from Cape Lookout, North Carolina, to Cape Canaveral, Florida. Open circles are the sampling stations, which start from the shoreline and extend to ~ 500m water depth.

Response: All the suggested changes concerning Fig. 1 have been made.

Fig. 2 The figure is too small when printed. A vertical line, connecting DIC_i to Si should be added on panel (a).

Response: The vertical lines were there and are now thickened.

The last line in the figure caption should be revised to read: Henry’s constant

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Response: “Henry” has been changed to “Henry’s”.

Table 1 Title should be revised to read: Table 1. River, nearshore and open ocean end-members used for the calculation described in Section 2.5

Response: All suggested changes have been made.

Fig. 3 The figure is too small when printed. The figure caption should be revised to read: Fig. 3. Dissolved inorganic carbon (DIC) concentrations at depths shallower than 100 m, plotted against salinity and grouped by the sampling month. The dotted lines connect the river and ocean end-members.

Response: All suggested changes have been made.

Fig. 5 Font is too small when the figure is printed. Saturation line should be added on the “in situ” panel. In situ should not be hyphenated on y-axis label. “Normalized” should be changed to “TG-corrected” on y-axis label.

Response: All suggested changes have been made, except for the saturation line. The air CO₂ data have already been published in Jiang et al. 2008a. Here it is not critical to the conclusions of this paper.

Fig. 11 and 12 Physical interpretation of “total excess DIC and DOC” (as given at the bottom of p. 9326) should be included in the caption.

Response: All suggested changes have been made.

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Responses to Reviewer 2’s comments:

This is an important piece of work in that it quantitatively divided various components of terrestrial inputs of carbon on the pCO₂ on a continental shelf. The only thing I don’t understand is why normalize the air-sea exchange.

Response: We want to thank Dr. Arthur Chen for the constructive suggestions. The

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reviewer is correct that it is not typical to “normalize the air-sea exchange”; what is usually normalized is the sea surface pCO₂ to remove the temperature effect. Here we try to show how various processes will change seawater DIC or pCO₂. Thus, for the Delta-pCO₂ (air-sea) to be comparable clearly with other terms such as Delta-pCO₂ (river), we expressed all these Delta-pCO₂ terms under one temperature, so we and the readers can compare them easily. This is what we intended by “normalized.” However, in the revision, we have taken the other reviewer’s suggestion and changed this to “referenced to...”.

I do, however, have a few minor comments:

1. It is odd that the numerical value of the largest contribution, namely the shelf, is not mentioned in the abstract or anywhere in the text. Yet the value for the much smaller contribution from the rivers is given in the abstract and in the text.

Response: A new sentence has been added to the abstract page 2 lines 27-29.

2. It is common sense that the riverine contribution is larger near the coast and smaller off shore. Such a statement should not appear in the abstract.

Response: We would prefer to keep this in the abstract. The study included three major components: rivers, marshes, and the shelf. Only mentioning two of them and omitting the third one could be misleading. We now revised the sentence to put the inshore-offshore gradients for both river and marsh in the contrast with the shelf term (which has no clearly gradient).

3. The 1GtC/yr sink reported by Tsunogai is clearly in error and should not be cited so that the readers are not mislead.

Response: The citation and the bibliography have been removed.

4. The statement that the shelf is 10-15m deep near the coast is not accurate. Clearly the shelf reaches 0m in water depth.

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Response: 10-15m is the average depth of the inner shelf, not the depth of the shallowest part of the shelf. We have changed the sentence to “The SAB continental shelf has an average depth of only 30m and is 50–75m deep at the shelf break (Menzel 1993).” See page 4 lines 71-72.

5. The potential contribution from the submarine groundwater discharge ought to be mentioned.

Response: We have added a sentence. See Page 4 Lines 78-80.

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