

***Interactive comment on “Air–sea CO<sub>2</sub> fluxes and the controls on ocean surface *p*CO<sub>2</sub> variability in coastal and open-ocean southwestern Atlantic Ocean: a modeling study” by R. Arruda et al.***

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**Final comment**

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We would like to thank the referees for their careful review of our manuscript. Their comments were taken into careful consideration. A point-by-point reply together with the latest changes on the manuscript is presented separately for each referee. We hope that the changes adequately address the reviewer's comments and that the new version is suitable for publication in Biogeosciences.

In consideration with the reviewer's comments and after discussions with the co-authors, additional changes were made in order to clarify and improve our manuscript:

- **L3 - Abstract** – Changed "the region acts as sink" to "the region acts as a sink".
- **L11 - Abstract** – Changed "particularly important on shelf regions" to "particularly important on shelves".
- **L23 - Introduction** – Changed "0.589 PgC/year" to "roughly 0.6 PgC/year".

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- **L44 - Introduction** – Removed "characterized as".
- **L49 - Introduction** – Changed "maybe" to "might be".
- **L66 - Introduction** – Changed "spatial and temporal" to "spatially and temporally".
- **L70 - Introduction** – Rephrased sentence to "Our model domain includes the location of the global node mooring that is soon to be deployed as part of the Ocean Observatories Initiative (OOI) at 42°S, 42°W (oceanobservatories.org)".
- **L83 - Material and Methods** – Rephrased sentence to "Our model domain spans from 15°S to 55°S, and from 70°W to 35°W, i.e., covering the southwestern Atlantic from its subtropical to subantarctic latitudes and from the continental shelf all the way out to the open ocean".
- **L94 - Material and Methods** – Added "and the  $CaCO_3$  parameters as in (Hauri et al., 2013)".
- **L103 - Material and Methods** – Added "at the surface" and QuikSCAT reference "Risien and Chelton, 2008)".

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- **L106 - Material and Methods** – Added "and without seasonal variations".
- **L147 - Analysis** – Added "therefore effects from dilution of  $DIC$  and  $ALK$  through freshwater input are not included in  $DIC^s$  and  $ALK^s$  terms.", and rephrased next sentence to "The dilution effect is considered instead in the freshwater component (FW) as it includes the effects of.."
- **L175 - Analysis** – Changed "photosynthetic" to "photosynthetically".
- **L204 - Model Evaluation** – Changed "represents" to "simulates".
- **L216 - Model Evaluation** – Changed "from inner to outer shelf" to "across both inner and outer shelves".
- **L225 - Model Evaluation** – Changed "characterizing these regions as" to "which make these regions".
- **L227 - Model Evaluation** – Added "while".
- **L275 - Model Evaluation** – Rephrased last sentence to "While there is clearly room for improvement, we deem this level of agreement as sufficient for proceeding to

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the analysis of the processes and parameters affecting  $p\text{CO}_2$  variability in this region."

- **L240 - Model Evaluation** – Added reference "Stow et al.,2009".
- **L282 - Results 4.1** – Added "prevailing" and "found".
- **L286 - Results 4.1** – Rephrased sentence to "Even though with a smaller role,  $ALK^s$  influence on  $p\text{CO}_2$  anomalies presented ..."
- **L296 - Results 4.1** – Rephrased sentence to "We investigate the role of each of these processes in controlling ..."
- **L296 - Results 4.1** – Rephrased sentence to "We investigate the role of each of these processes in controlling ..."
- **L328 - Results 4.2** – Changed "appears" to "is relevant"
- **L330-333 Results 4.2** – Rephrased sentence to "This is likely due to our large and heterogeneous domain, which results in much spatial gradients than what is modeled over the seasonal cycle."

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- **L389 Results 4.2** – Added "the temporal variability."
- **L419 Results 4.3** – Fixed fluxes estimates on the Patagonia shelf to " $(-1.0$  to  $-3.0$   $\text{molCm}^{-2}\text{yr}^{-1})$ ".
- **L452 Conclusions** – Changed "hydrodynamical model coupled with" to "hydrodynamic model coupled to".
- **L461 Conclusions** – Added " $ALK^s$  is a secondarily".
- **Throughout the text** – Changed "Patagonian" to "Patagonia"
- **Throughout the text** – Changed "SouthWestern" to "southwestern"
- **Throughout the text** – Changed "annual average" to "annual mean"
- **Throughout the text** – Changed "modelled" to "modeled"
- **Throughout the text** – Changed "surface ocean" to "ocean surface"

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- **Throughout the text** – Changed "*DIC*" and "*ALK*" to "*DIC<sup>s</sup>*" and "*ALK<sup>s</sup>*" where appropriate.
- **Throughout the text** – Changed typeset to Roman on "S", "W", " $\text{molCm}^{-2}\text{yr}^{-1}$ ", " $\mu\text{atm}$ ", and " $\text{CaCO}_3$ ".
- **acknowledgements** – Changed project to "the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES Process 23038.004299/2014-53)".
- **acknowledgements** – Added "This work was carried out with the aid of a grant from the Inter-American Institute for Global Change Research (IAI) CRN3070 which is supported by the US National Science Foundation (Grant GEO-1128040)." and "Supported by Global Environmental Facilities (GEF) in the frame of PNUD ARG/02/018-GEF BIRF N° 28385-AR, subproject B-B46, and by Servicio de Hidrografía Naval. Additional support was provided by the ARGAU Project, Instituto Antártico Argentino, Institut National de Sciences de l'Univers, Processus Biogeochimiques dans l'Océan et Flux, Université Pierre et Marie Curie."
- **Table 1** – Added columns for Bias, Correlations and number of observations (N). Rephrased caption to "Statistical indicators of model skill for surface ocean  $p\text{CO}_2$  in the three areas (A1, A2 and A3 - Fig.4). The indicators are: ME (Model Efficiency); CF (Cost Function); and PB (Percentage of Bias). Additionally, showing total bias ( $\mu\text{atm}$ ), correlation and total number of observations (N) available on each area. Bold values indicate "good/reasonable" model skill."

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- **Figure 1** – Fixed latitudes on fig-b to be the same as fig-a
- **Figure 2 and 3** – Added months for each season: "Summer(JFM),Autumn(AMJ),Winter(JAS),Spring(OND)". Changed "First row" and "second row" to "upper row" and "lower row"
- **Figure 4** – Changed boxes and texts to white color in fig-a.
- – All small changes in the text are detailed in the marked-up version of the manuscript.

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