

Biogeosciences Discuss., referee comment RC2
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Comment on bg-2021-171

Anonymous Referee #2

Referee comment on "Derivation of seawater pCO₂ from net community production identifies the South Atlantic Ocean as a CO₂ source" by Daniel Ford et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-171-RC2>, 2021

This manuscript explored the importance of biological factors in modeling the seawater pCO₂ via the inclusion of different biological proxies (chl-a, NPP and NCP) in the model construction. The results reveal a similar model performance with the inclusion of different biological components but in some cases, projected pco₂ with the inclusion of NCP as a predictor works better. Overall, the paper emphasizes the significance of biological activity in controlling the magnitude and temporospatial pattern of sweater pCO₂ and underscores the urgency to further improve the accuracy in NCP prediction. However, I have some major concerns regarding the model test and data display.

Major comments:

- 1) Lack of comprehensive evaluation of multiple NPP and NCP algorithms. The key goal of your study is to elucidate the role of biological proxies in modeling seawater. Also, the author concluded the accuracy of NCP simulation is critical. If so, it is quite important to test the with the inclusion of commonly-used NPP and NCP algorithms (i.e, CbPM and VGPM-based NPP, NCP models by Li & Cassar, 2016; carbon export model by Laws et al., 2011 or (Henson et al., 2011)), rather than a single model output. Given that the focus is on the surface pCO₂, I would say NCP model developed by Li and Cassar seems a better fit than model by Tilstone (2015) as the former provides mixed-layer integration of NCP rates and later is corresponding to euphotic-zone integration. At the very least, the author needs to clarify the reason why they chose the present NPP and NCP models (i.e., they are tuned by the Atlantic dataset and therefore they are supposed to do the best job in your study region). But I am still looking forward to seeing if other NPP and NCP products can further improve pco₂ simulations.
- 2) Unfair comparison between FNNbio and FNNNO_bio: The author used the model output without the inclusion of biological predictors (FNNNO_bio) as a reference to evaluate the improvement of FNNbio. However, FNNNO_bio was trained with inclusion of more physical parameters such as MLD, SST and salinity whereas FNN_bio just included SST. To assure a fair comparison, it should keep other predictors consistency except for the inclusion or exclusion of biological parameters
- 3) The overstatement of the performance of FNNbio_NCP: In many places, the author argued that FNNbio_NC did the best among the models (i.e., Line 235, 360 and 365).

However, it is hard to distinguish the visible improvement from the Figure. For example, I don't think the difference between 34% and 36% is significant enough to say NCP is much better than NPP given that uncertainty.

Minor comments:

1.p in pCO₂ should be italic.

Line 15: it is hard to understand the method description regarding the "reducing uncertainty". Please clarify or say more specifically,

Line35 : clarify the full name of chl-a when it appears in the main text for the first time

Line 60: do you have a specific reason why you focus on the Southern Atlantic instead of the entire Atlantic basin or larger scale. You need some statement herein and also add some brief introduction about the setting of your study region.

Figure 1. Please add the data distribution (i.e., SOCAT and AMT cruise) you used for construction and validation of the model. It should be useful to add the name of the sub-regions in the map so the reader can easily navigate what subregions you are talking about in the following part. Probably you need two figures to get two issues done. Add the citation for the region division on the legend.

Line 80: I would suggest changing pco₂(atm) to pco₂_air, which is more straightforward.

Table 1: does log₁₀ means log₁₀ (chl-a). It is very confusing. The error of 45 mmol O₂ m⁻² d⁻¹ is very scaring because the typical range of NCP is from -50 and 50 mmol O₂ m⁻² d⁻¹

Line 115: quite confused about what ropt means. Does it mean the optimal data numbers for the training dataset?

Line 125: The common practice for the data processing before training a neural network is to normalize the data to reduce the dynamics. Did you apply for it?

Line 126: please provide more details about the structure of FNN. How many layers and nodes do you set?

Line 145: Has pCO₂ measurement in AMT cruise been included in the SOCAT dataset already?

Table 2: you probably can bin Table 1 and Table 2 to make it easier for reading.

Figure 2: the most useful information to evaluate the model performance is to look at the comparison with validation or independent dataset. I would suggest removing the figures of the training dataset and moving the validation results for models with inclusion of chla and NPP into the main texts.

Figure 2: what does the color stand for? I don't think the blue line is useful. 1:1 line is enough. .

Line 2165: I have a very hard time understanding how you derived so-called maximum reduction. To achieve this goal, as I understand, you need to set a wide range of noise in the predictors (i.e., from -500% to 500%) and then find out the largest errors in pCO₂ compared to the white control (zero noise in predictors)?

Figure 4: how did you calculate the seasonality? Do you mean the amplitude of p_{CO_2} ? You can consider using Taylor diagrams to demonstrate the inter-model comparison, which provide more information.

Line 235: I don't think the difference between 34% and 36% is significant enough to say that the NCP is much better than NPP.

Line 360 and Line 365: I had a hard time detecting significant improvement in SA-FNNNCP compared to the other simulations.

Line 380: Can you find more straightforward evidence by examining the seasonality of chl-a, NPP and NCP products to support your argument regarding the disconnection?

Line 430: cite the corresponding Table and Figure when you talked about the result.

Line 440: it should be useful to plot a bar chart to display the annual CO_2 flux among the regions