Comment on bg-2021-48

Claudine Hauri (Referee)

Referee comment on "A modelling study of temporal and spatial pCO$_2$ variability on the biologically active and temperature-dominated Scotian Shelf" by Krysten Rutherford et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-48-RC2, 2021

The authors use output from a regional oceanic biogeochemical model and mooring/ship-board observations to study the seasonal cycle of surface pCO2 and sea-air CO2 fluxes. The general findings are that the Scotian Shelf acts as a net annual source of CO2 to the atmosphere and that biological activity and temperature are the main drivers of the pCO2 variability. The authors also try to show that coastal upwelling is responsible for low near-shore surface pCO2 in summer. Overall, I find the manuscript well organized. However, I have several concerns (see below) that need to be addressed.

Line 14: Might be good to mention here by how much pCO2 changes due to this steep increase in temperature.

Lines 33-36: Since you specify the type of measurements that suggest that the Scotian Shelf is a net CO2 source, it would be interesting to know what type of data suggests that it is a net sink.

Line 63: I would be careful calling any model "accurate"! If the model has been evaluated properly (if the region has an adequate amount of observations), then I bet these studies identified some deficiencies. I would suggest to briefly summarizing the previous model evaluation here and state unknowns due to lack of data, if applicable.

Line 105: What are the possible implications of using a river climatology to foroce the model? Is anything known about interannual or longterm changes to the riverine input?

Line 102: Again, a brief summary of deficiencies and skills of the model would be good.

Line123: Why is it drifting and how does the nudging impact the actual model skill. I was surprised that so much nudging was done for a relatively small model domain. Are the nudged areas not used in the analysis? And if these areas are used, how do you deal with them? Would be helpful to show the nudged areas in Figure 1.

Line 131: Model spin-up of a biogeochemical model usually takes 6-10 years. Can you show that 1 year is enough and the model won't drift anymore? For example run the model for 10 years perpetually, using the 2000 conditions. Does DIC remain relatively stable, without drifting?

Line 147: Need to label the location of the Halifax and Deep Panuke gas platform.

Line 163: "from top to bottom…" belongs into caption and not into main text. Also, describe method you used to temperature normalize pCO2 in caption.

Line 164: To me it is confusing to talk about days and months. I would just stick to months, since days are less obvious – The reader would have to first convert to the month before understanding what time of the year you are referring to. I don't see how pCo2 is relatively constant between day 0 to 75. Are you referring to the temp normalized pCO2? But even temp normalized pCO2 is increasing during this time. Might be better to give a range here?

Line178: add "buoy" to "… at the low end of the **buoy** observations

Line 182: I don't think the word "consistent" is appropriate here? The model seems to underestimate the DIC drawdown due to primary production compared to both types of observations (temp norm. pCO2).

Line 189: verb is missing.

Line 209: Figure 4 shows how the model struggles to simulate the spatial variability, which should be pointed out.

Line 212: add east or west to longitude description

Line 216: I don't think these events are all that obvious in the observations. There were

only a total 3 inner shelf observations during this time period, two of which are actually higher than an outer shelf observation point (also the only one during this period). I agree, that this is obvious in the model, but would be more careful with this statement for the observations. I just don't think that the observations can be interpreted that way… Im also not conviced by the proposed mechanism that leads to low pCO2, despite high DIC. What does the salinity profile look like? I think this section needs something like a Taylor decomposition to show that what is responsible for the low pCO2 (see details in

Rheuban, J. E., Doney, S. C., McCorkle, D. C., and Jakuba, R. W.: Quantifying the effects of nutrient enrichment and freshwater mixing on coastal ocean acidification, J. Geophys. Res.-Oceans, 124, 9085–9100, https://doi.org/10.1029/2019JC015556, 2019.

Or

Hauri, C., Schultz, C., Hedstrom, K., Danielson, S., Irving, B., Doney, S.C., Dussin, R., Curchitser, E.N., Hill, D.F, and Stock, C.A.: A regional hindcast model simulating ecosystem dynamics, inorganic carbon chemistry, and ocean acidification in the Gulf of Alaska, Biogeosciences, 17, 3837–3857, https://doi.org/10.5194/bg-17-3837-2020, 2020.

Line 264: "Accurate" means: "correct in all details; exact"- as mentioned earlier, I yet have to see a model that can be described as "accurate". I would tone it down… especially because you start the sentence with "This limitation aside…"

Line 270: would be nice to calculate how much the temperature change affects pCO2 and how much DIC increases affect pCO2….

Figures – I really like the color choices of the figures!

Figure 1: It would be nice to give the reader a better understanding of where the Scotian Shelf is located. Maybe a zoomed-out map as an insert? Label all location names you are mentioning in the paper e.g. Halifax Harbor. What are bin 1 and bin 2? Please describe in caption. Also, LAt and Lon labels are missing, including whether it is north or south, and east or west. This should be adjusted for all figures throughout.

Figure 2: Correct "Glider obser**v**ations"

Identify grey band in legend for consistency.

What are the two different x-axis?

Figure 4: What are these inserts? Zoom in? Does not seem to show what you see in the smaller box below. This figure is kind of confusing. What are we actually looking at? Are there 365/5 lines total per figure?

Figure 5: On the left, there is no top and lower panel... please adjust accordingly. Also, maybe identify "thick black line" as "vertical black line"

Figure 6:Please identify the variable that goes with each unit next to the colorbar. Always good to specify units of all variables in the caption too. Also, define abbreviations in all figures e.g. dissolved inorganic carbon (DIC). Figures and captions should be readable without reading the manuscript. Since you refer from figure 5 to this figure, you should mention here that July 11, 2000 is indicated in figure 5. Please show the transect line again in the map and label it with lat and lon. Why not also show a profile of pCO2 here to make the point that pCO2 decreases during upwelling event.

Figure 7: Add "the" to …the values from **the** nearshore bin…

Figure 8: What do the error bars mean? What are they based on? What are the numbers behind +/-? 1 STD? Needs to be defined in caption.

Figure 9: Why are some bars faded? Are all ingassing bars faded? Needs to be defined.