Comment on gmd-2022-152

Anonymous Referee #1

Referee comment on "The emergence of Gulf Stream and interior western boundary as key regions to constrain the future North Atlantic Carbon Uptake" by Nadine Goris et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-152-RC1, 2022

Review Goris et al., Gulf Stream and interior western boundary volume transport as key regions to constrain the future North Atlantic Carbon Uptake

This study aimed for regional optimization of the emergent constraints for projecting future North Atlantic carbon uptake. A previous study (Goris et al., 2018) identified two indicators, i.e., seasonal pCO_2^{sea} anomaly in middle-to-high latitude and fraction of anthropogenic carbon inventory below 1000m, for future carbon uptake projection in the North Atlantic. The authors apply a genetic algorithm to further find out which spatial area and depth ranges are crucial for the emergent relationships. This study is scientifically interesting to constrain the projections of the North Atlantic ocean carbon uptake, and also practically provide guidance for monitoring and observational strategies. However, this manuscript needs some further work and clarification to be published.

Major comments:

-Inconsistency of the season for pCO_2^{sea} anomaly: it is winter time pCO_2^{sea} in this study, but the cited paper (Goris et al., 2018) used summer time pCO_2^{sea}. The correlations should be reversed but are the same in both manuscripts.

-The constrained relationship of winter pCO_2^{sea} anomaly is relative small (r=0.79), maybe it is because the definition of winter months (November to April) in this study. The variations in different months should be quite different, especially in the transit seasons, i.e., spring and autumn. Definition of the focus season with less months, e.g. December to February, or January to March, might end up with clear relationship and higher correlation.

-This study presented several predictors including the two from Goris et al. (2018). As shown in Fig. 8, each predictor provides an different estimate of the constrained range of future North Atlantic carbon uptake. Which estimate is more plausible?

-How are the uncertainty range of the predictand C_{ant*}-uptake in Fig. 1, 8 and Table 1 calculated? I suppose they should be determined by the cross points of the linear regression line and the vertical lines of the observational uncertainty, but apparently it is not the case as shown in Fig. 1(c and e) and Fig. 8.

- It is not very clear how to interpretate Fig. 5 and Fig. 7. The results in the two figures seem contradict to each other, both upper ocean (Fig. 5) and deeper ocean (Fig. 7) have high correlations. How to combine the information? In addition, L467-469: "…the deep ocean southward volume transport between 700m-4700m at 26N." Is this statement based on Fig. 7? This figure shows the 700m-5300m and 21N has reached the largest correlations.

Minor comments:

-The information of figures are incomplete. I would suggest the authors to ensure all the figures are more or less self-explainable.

Fig. 3: the titles of x-axis and y-axis are missing, the y-axis' title is relative easy to guess, but the x-axis is not so straightforward. The readers need to check back and forth of the context to figure out that it should be number of iterations.

Fig. 4: the unit of the presented variable is missing on both plots and in the figure caption. Why are the color shadings much lighter in Fig. 4c-d than in the Fig. 4b, as they are presenting the same quantity? The same question is also for Fig. 6c-f.

-Fig. 8: as specific model like CESM1-BGC is mentioned to perform well in L413-414, and more information and comparison can be made if the authors present the models with colors as in Fig. 1.

-Abstract L3: "A previous study…" needs to add the reference paper citation so that the readers get the context. From reading the main text, I guess this study refers to Goris et al. (2018).

-Abstract L5: "…winter pCO_2^{sea} – anomaly…", but the previous paper (Goris et al., 2018)

suggested the pCO_2^{sea} anomaly in summer (May to October) NOT winter (November to April). As the winter and summer are taken actually half a year in this study, respectively, I guess the counterpart season should be with the same magnitude of correlation but a reversed sign. So I am quite confused that this study based on winter months and the previous study based on summer months get exactly the same correlations as shown in Fig. 1c.

-Some relevant details need to be described in this paper, so that the readers don't need to refer to Goris et al. (2018) all the time. For instance: how is the pCO_2^{sea} anomaly defined, is it relative to the annual mean or long-term specific season mean? Which time periods are 1990s, 1997s, and 2090s?

-L350, 354, 363, Figs. S01, Figs. S03 and S04 are inconsistent with the figure numbering in the supplementary.

-L411: "…consistent which…" -> "…consistent with…"

-L487: "…averaged aver…" -> "…averaged over…"