

## ***Interactive comment on “Transport and storage of anthropogenic C in the Subpolar North Atlantic: Model–Data comparison” by Virginie Racapé et al.***

**Anonymous Referee #2**

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The paper “Transport and storage of anthropogenic C in the Subpolar North Atlantic: Model-Data Comparison” by Racapé et al. compares the anthropogenic carbon budget as derived from a model with observation-based estimates along the OVIDE section. Based on this evaluation, the authors analyze drivers and mechanisms of the carbon budget under high and low NAO conditions.

General comments:

The idea to use a model to re-produce and extend the results from Perez et al (2013) is very up-to-date and could give new and insightful results about the response to the subpolar North Atlantic carbon sink to different NAO-phases and increasing carbon emissions. While the idea is intriguing, the title already specifies what the “problem” of the paper is: It is indeed, more a model-data comparison and does not spend much

C1

space and time to use the unique ability of having a model-run and being able to analyze mechanisms and drivers in much more detail. Therefore, I think that this paper needs major revision before it can be published.

Specific comments:

(1) Model-data comparison: This part of the paper is way too long and descriptive. Furthermore, it seems problematic to compare the model mainly along one section. What if the model’s circulation-field is slightly displaced and shows an acceptable overall performance for the subpolar North Atlantic, but fails to do it exactly for the OVIDE section? A comparison with more data-points would be preferential, or at least to use a larger surrounding of the OVIDE-section.

(2) Limits of the findings: In comparison with Perez et al. (2013), the considered model clearly seems to under-estimate transport into and out of the subpolar gyre box. Is it justified to use this model to infer about mechanisms governing the subpolar gyre? If so, then the limits should at least be clearly mentioned. It is possible that the weak MOC of the model does not allow for general conclusions.

(3) Anthropogenic Carbon: The carbon difference between the historical and control run is NOT anthropogenic carbon. Instead, this kind of difference includes also climate change induced alterations in the natural carbon cycle, even though these alterations are probably small (see, for example, Frölicher, 2015).

(4) NAO-phases: I am not convinced by the MOC weak and strong phases as presented in Figure 9. I would much rather see this presented together with the NAO-index of the model over this time-period. With this approach, it should also be possible to find more than 3 different NAO-phases and back the results up for all positive and negative NAO phases. After all, that is the advantage of a model over data.

(5) Mechanisms: The paper should focus a bit more on the detailed mechanisms that the model simulates that are leading to these different NAO-responses, i.e. what mech-

C2

anism is behind a different carbon uptake. Are those mechanisms seen in reality or by other models?

Technical Comments:

- Figure S1: It would be useful to illustrate the actual OVIDE section as well as the model's representation of it
- Line 42: "have increased substantially"
- Line 48: "which prevents from a correct detection of changes in the ocean sink ("
- Line 69: "Between 1997 and the yearly 2010's"
- Line 70: "This has caused"
- Line 71: "a slowing down"
- Line 80: by which model studies? References!
- Line 82: As these are several studies, there should be more than one reference
- Line 109: "46 vertical levels whereof 10 levels lie in"
- Line 114: reference for ERAInterim?
- Line 115: "covers the years"
- Line 117: "to levels from the year 1870."
- Line 127: "at 284 ppm."
- Line 158: "presented on Fig. 2."
- Line 191: ". That"
- Line 204/205: I don't understand the sentence about the heat transport
- Line 267: "without any clear and obvious seasonal cycle"

C3

- Line 273: "true, yet"
- Line 310: "the modeled close to zero"
- Line 326: " are 6.3.. lower than the observation-based"
- Line 359: "three times. . .two times"
- Line 367: "better representation of temperature"

Literature:

Frölicher, T.L., J.L. Sarmiento, D.J. Paynter, J.P. Dunne, J.P. Krasting, and M. Winton, 2015: Dominance of the Southern Ocean in Anthropogenic Carbon and Heat Uptake in CMIP5 Models. *J. Climate*, 28, 862–886, doi: 10.1175/JCLI-D-14-00117.1.

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C4