

Reviewer 2

General comments

The study describes a nearly 30-year monthly time series of natural (C_{nat}) and anthropogenic carbon (C_{ant}) concentrations and transports in the subpolar North Atlantic at the A25 section, using a combination of ship-based observations, ocean reanalysis, neural networks, and a back-calculation approach. As pointed out by the authors the study is the first quantitative assessment of C_{ant} seasonality in the SPNA, making it impossible to validate the findings. Nevertheless, the agreement in transports and changes from other studies is impressive and give confidence in the approach. It is a very interesting and mostly well written work, which deserves publication. I have some mostly minor comments that should be dealt with before publication.

One comment is on the Results section. This is fully packed with details and frankly took me some time to get through. This may in part be needed when there is so much information to juggle but this makes it less approachable for the reader. It is difficult to put the finger on specific parts, but I simply ask the authors to go through the Result sections and see if something could be described somewhat more accessible. The Discussion and Conclusions are all excellent.

Thank you a lot for your comments. All the authors agreed that your remarks improved the clarity of the manuscript.

We tried to reformulate whenever possible the Results section to make it more accessible, as also pointed in RC1. We suppressed unnecessary details, in particular in section 3.1 and 3.2.

We answered your specific comments in the following in blue.

Specific comments

L67: This is a minor remark, but it should read "GO-SHIP". (See also other instances in the manuscript.)

We changed GOSHIP to GO-SHIP in the manuscript.

L109 + 111: Since $[C_{ant}]$ means “concentrations of C_{ant} ” I am not sure this should be used here. “The inventory of ...” would be “ C_{ant} ” and not the concentration of C_{ant} , right? Same for “the influence of ...”. The same may be true for L274.

$[C_{ant}]$ was changed to C_{ant} in L109+111, L274 as well as wherever we reported “fraction of ...” or “... fraction”.

P5, Fig. 1 caption: The EGC is shown in the figure but not defined in the caption, and WBC is defined in the caption but not shown in the figure.

We changed the figure label to WBC, and added in the caption “..(WBC) including the East Greenland Current (EGC) ..” .

Also, a comma after “respectively” after “top panels”. (L4 of the caption)

Comma added after “top panels”.

L260-261: The transport numbers presented, are they shown in a table or figure? I was looking in table 3, but don't fully recognise the values.

We reported uncertainties on the transport numbers computed from A25 observations and not from reanalysis. This was misleading. This information has been moved to Table 3 caption.

P14, Fig. 2: As far as I can find this figure is first referred to on page 18, and there in the figure caption of Figure 4. Since Figure 3 and 4 are referred to before, you should renumber this figure (Fig. 2 that is) for clarity.

As Fig. 2 is the key figure of the concentration time series (before seasonal and interannual filtering), we added reference to it before Fig. 3 and Fig. 4 for consistency in the manuscript.

L306-07: It is not clear to me how this is calculated (the seasonality by taking an annual value of $[C_{nat}]$). There is a reference to Figure 3a, and the figure caption say something more (but not enough, to me), but this should also be added in the methods, as I see it. (I may of course have missed this information.)

An explanation was added at the end of Section 2.7: “To better quantify the effects of seasonal changes in ML and uMOC thickness on the seasonality of $[C_{nat}]$ and $[C_{ant}]$, we calculated an idealized seasonal anomaly for ML and uMOC using the annual mean vertical profile of the property ($[C_{annual}]$), rather than monthly varying concentrations, and the full variability of ML depth and uMOC thickness. This

approach isolates the impact on ML concentrations of physically-driven seasonal changes in layer thickness from biologically-driven seasonal variations in concentration. "

L319-321: Since it has been stated that C_{nat} is much larger than C_{ant} the difference in amplitudes is of course expected. The same goes for the opposite max/min of C_{nat} and C_{ant} with deepened ML.

We deleted the two sentences that were providing too much detail.

L403: Be clear in the phrasing; the net transport does not define a layer (as the sentence may be read as).

We delete "other" and give their name.

L411: These two maxima for the seasonal net signal are very small, and in addition there is another small maximum in June, and the value in December is as large as the maxima in March and September.

We delete the monthly description for the seasonal net signal, and simply highlight that it is "very small".

L450-451: The way I read Fig. 8c is that IMOC shows no trend between 1993 and 2008/09, after which it increases. Thus, saying it is an increase over the time series is misleading.

We reformulated: "In contrast, the IMOC C_{ant} southward transport shows no trend until 2008, after which it increases. This results in an overall increase between 1993 and 2021 from -0.19 ± 0.03 PgC/yr to -0.32 ± 0.04 PgC/yr (0.047 PgC per decade, Fig. 8c)."

L554-555: Maybe more a technical comment but there must be some words missing in this sentence, between North Atlantic and Steinfeldt.

Added parenthesis.

L558: Does this need to be true what you are suggesting? The deeper ML would lead to a minimum in $[C_{ant}]$, and wouldn't this be true even if the $[C_{ant}]$ in the NAC was higher or unchanged? Possible I am misunderstanding something, but please have a look if this can be made clearer.

You're right. As you noted, there might be two mechanisms that explain the reduced C_{ant} increase. We rephrased it in the discussion section and added: "In addition, deeper ML (as in the 2014 decade) would lead to a minimum in $[C_{ant}]$, even if the $[C_{ant}]$ from NAC was higher or unchanged."

L590: The 36°N section is not defined in Figure S9. Yes, it is section A03 (right?), but please make this clear.

We now refer only to A03 for consistency.

L613-14: From Fig. 3b I can't see an order of magnitude difference, but then I read that you refer to the difference between ML and ML annual, but maybe this is not true? Please make this clearer. If you compare the variability between C_{nat} and C_{ant} then yes.

We clarified the text. We were comparing variability between C_{nat} and C_{antr} and then variability between direct ML concentration and ML concentration for an annual mean profile of property.

L662: It may be suitable to mention the lack of observational evidence of this reduction until today. If there are indeed any documentations of such a change then refer to that.

We added a reference on the observational reduction: "We speculate that the projected reduced AMOC, which may already have begun (e.g. Caesar et al. 2018), will reinforce the $[C_{ant}]$ gradient between the upper and lower limbs of the MOC as the accumulation of $[C_{ant}]$ at depth will be less rapid and C_{ant} will continue to grow."

Technical comments

Table captions: This is a very minor remark but there is an inconsistency in the placement of the table captions, where the ones in the main paper are below the tables and the ones in the Supplementary are found above. Typically, I think they should be on top, but this may of course differ among journals.

We put all captions on top.

L182: A typo: remove "Irminger" (in the "East Greenland Current").

L182: We removed "Irminger"

L220: "RMSD" is used here for the first time (unless I missed an earlier one) but only defined in the paragraph after.

Added the definition of the acronym at the correct place.

L265: Should this refer to Table 3, and not 4?

We also added the reference to Table 3, as the number is as well on Table 4.

L305: You refer to Fig. 1b, but there is no such figure (only Fig. 1).

We changed the reference to Fig. 1.

L325: Maybe use "hence" instead of "for"?

Changed to "hence".

P20, Fig. 5: The numbers/details of the figure are difficult to read due to the small size/font. Maybe this is mostly in the printout, but please consider this when revising the manuscript.

We redo the figure with bigger tick labels and, and make it bigger in the manuscript.

L438: Do you mean "magnitude" here (instead of "amplitude")?

We meant "magnitude", now changed in the text.

L532: Should it be "average" instead of "averaged"?

It should be "average", changed in the text.

Supplementary Information:

The table caption information should be made clearer for Tables S2-S5. Now it reads "Table 3 details" (for Table S2) or "Table 4 details" (for Tables S3-S5).

We specify the specific detailed variables in each supplementary Table at the beginning of the caption to better readability. We also added "The spread between ocean reanalysis is illustrated by this Table." or "The spread between A25 years is illustrated by this Table." when necessary.

Fig. S3-S4: The figures are very small making it difficult to read numbers. Also, change "Iceland basin" to "Iceland Basin" in the caption.

We increased the size of S3-S5 figures in the Supplementary Information. We also changed "Iceland basin" to "Iceland Basin" in the captions of Fig. S3, S5.

Fig. S9: As mentioned earlier please define that section 36°N refers to section A03.

We only refer to A03 now for consistency.