



EGUsphere, referee comment RC3
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Comment on egusphere-2022-1334

Anonymous Referee #3

Referee comment on "Seasonal overturning variability in the eastern North Atlantic subpolar gyre: a Lagrangian perspective" by Oliver John Tooth et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-1334-RC3>, 2023

The manuscript by Tooth et al. presents a detailed and thorough model analysis of the seasonal overturning variability happening between the OSNAP array and the Greenland-Scotland Ridge. Combining insights from a Eulerian analysis at the OSNAP array and a Lagrangian framework where the sensitivity of the transformation to inflow characteristics is tested, the authors show that the majority of the seasonality in the overturning is due to water parcels that exhibit a relatively short (< 8.5 months) recirculation time within the eastern North Atlantic Subpolar Gyre.

The analysis is scientifically sound, very well embedded in the existing literature and is valuable to e.g. better interpret OSNAP measurements and improve our understanding of water mass transformation processes. However, I do agree with most of the comments of the other reviewers. The paper is very long, and, due to the smart but tricky to understand Lagrangian method, it can be challenging for the readers to fully grasp the content. Also, the motivation of the study can be more clearly defined in the abstract and introduction. Therefore, I hope to provide some recommendations and suggestions to improve the readability of the manuscript and would advise minor revisions before publication, but with sufficient revision time to restructure the paper.

General Comments

1. Abstract

- More clearly state the motivation / current lack of knowledge in your abstract and how your approach provides new insight. E.g. One of your main findings is that you are only able to explain the minimum MOC in autumn seen in the OSNAP measurements if you use a Lagrangian approach ("This convergence of southward... wind forcing"). This is at the moment not clear in your abstract.
- The statement "recirculation race against time" is nice to mention in the paper, but might confuse readers in the abstract. And I don't think you need it in the abstract, as it is already clear from the last sentence what your main finding is ("The seasonality of Lagrangian overturning... in the eastern SPG").

2. Introduction

- Try to get to the main research question / motivation for this study within the first two

paragraphs. I find some hint for motivation in Ln.78, but I would suggest to get to this much quicker, and state clearly how this is related to the research question and approach of your study.

- In general, this introduction can be shortened quite a bit, there are many details that are not needed to understand the motivation of the study, and some can be moved to relevant parts in the manuscript.
 - g. Ln. 35-39 not necessary in the introduction (can move that to the method section where you explain how you define overturning)

3. General structure of the paper

- The structure in the abstract differs from the general structure of the paper, and I think it makes a bit more sense to indeed first fully discuss the insights from the Eulerian analysis, before moving on to the Lagrangian one. That would also help to more clearly state what the added benefit is for looking at the relevant mechanisms from a Lagrangian perspective. So e.g. move largest part of section 6 to follow 3.1. Or, have a full section 3 focused on the Eulerian perspective where you have a dedicated section for validation (what now is mainly section 3.1) to also argue why the model you're using is the right choice to address the seasonal variability and related mechanisms. Furthermore, it would make the interpretation of the Lagrangian results a lot easier when readers have seen the general Eulerian flow structure in this region and the full overturning characteristics from a Eulerian perspective.
- The different seasonal cycle seen when comparing the Eulerian to the Lagrangian framework can be explained a little better. I'm not sure whether readers fully understand this. Maybe as a thought experiment, think what would happen when you would define the Lagrangian overturning "backwards". So, tracing the Southward flow backwards, and define the LMOC overturning in that way. This would again change the seasonal variability observed as you would focus on the seasonality of the outflow, instead of the inflow.
- Check the length of your paragraphs, some of them are extremely long. Try to keep it to one or two main take-aways per paragraph, and keep them in general short (e.g. max length ~12 lines in the current template format).

4. Discussion and conclusions

- Currently the focus is too much on conclusions, and the relevance and importance of the results can be more strongly communicated.
- Maybe also put your findings more in the context of the OSNAP observations.

Specific Comments

- 1 - Why MOC and not AMOC?
- 2 - I find the SPG abbreviation confusing (maybe change to ESPG?), in particular for people that only read the abstract. Even when mentioning the eastern part of the Subpolar Gyre I have a bigger area in mind than the one North of OSNAP and south of GSR. I think the region of interest should be more clearly defined already in the abstract.
- 7 - Also here, it is not clear for the reader where exactly you are defining this seasonal cycle (minimum AMOC), I do think you should mention the OSNAP array in the abstract.
- 142 - How did you define the Greenland-Scotland Ridge in your model?
- 2 - If I understand the calculation correctly, it should be $V_{\text{south}}(\sigma, t < \tau < \tau_{\text{max}})$, to make clear that any parcel that returns within this period of 7 years is added to the LMOC?

- 220-225 – You could already make a link here why you need a Lagrangian framework to explain why this is the case (now this text might insinuate that already cold and dense waters transported Northward somehow lead to maximum overturning strength).
- 243 – Confusing what the transports mentioned in the brackets are
- 244 – 243 – I don't understand what is meant here with 'close correspondence', is that somehow visible in one of the figures? Did you calculate a correlation?
- 267 and elsewhere. In general I think care should be taken when talking about seasons in relation to the LMOC definition as there is a time lag involved in the actual calculation (e.g. when the transformation of the water masses occurs), so it is very difficult to interpret what a minimum in May actually means.
- 277 – "in contrast", how does the context of this sentence is in contrast with the previous one?
- 302 – The recirculation time itself is probably also seasonally variable? Maybe already address that here?
- 316 – Unclear sentence, which is better explained in the following sentences. Maybe just say "We have identified a threshold recirculation time of 8.5 months". And then continue with explaining what happens to particles < recirculation time, and then > recirculation time.
- 330 and elsewhere – I would change the abbreviation of this pathway to Ic-Irm and Ro-Irm, as all pathways are defined by their entry and exit locations and not by crossing RR. Makes it easier to remember for the reader.
- 335 – "70%" make clear where the reader can find this result and in which figure.
- Section 5.2 – This section is extremely long, and due to all the different decompositions very difficult to keep track of what is happening. I would suggest to restructure this, shorten, and maybe split in different sub-sections if needed.
- 515-519 – This is one of your key findings, the built-up to this result can be made clearer, by already talking about Wang's conclusions in the introduction and stating why these might be insufficient arguments?

Figures

Figure 1

- I could not find in the text where you reference panel 1b. Also, refer to 1a relatively early in your introduction, to make clear how you define the Eastern SPG (and maybe then use as abbreviation "ESPG" instead of "SPG").
- Caption: " volume transports across *the model-defined OSNAP East array.*" (also in caption Fig. 2 and Fig. 3)
- Dotted line panel b at 1990 does not seem necessary for the storyline.

Figure 4

- Panel b, it would be good to add the main flow features already here (not wait until Fig 8d)
- Panel b, unclear what the thick black line represents
- Use of white region vs. white line is confusing, also because the white line is missing in your colorbar. I do like the use of the white line to indicate the threshold-time, but then maybe use gray for the masked areas?

Figure 5

- You start introducing different decomposites based on pathway at the beginning of section 5.1, but then continue to further decompose them (e.g. IC and IG, and the eastern and western part of the IC-Irm pathway). Maybe it would be good to directly make this clear in one figure, so readers can better follow the story and understand the choices made?

- Specify I_c and R_o separately in the figure, now it is unclear how you kept these two pathways separate in your analysis. Maybe, as the decomposition is based on in- and outflow location, add those separation lines in panel b instead with all relevant abbreviations and switch the two panels ($b = a$). In panel (b) also add 'Reykjanes Ridge'.
- Use of color, check the 'colorblind' rules, I think the difference between red and orange is very difficult to distinguish (especially in panel b).

Figure 6 & 7

- What do the colored boxes represent? Again, difference between the purples and blue not well visible.
- Panel c and d can be left out, as this is also seen in e and f.
- I would merge this figure with Fig. 7, and panel 7b is not needed. Also make clear why you only look at $I_c - I_{rm}$, and not $R_o - I_{rm}$.

Figure 8

- As mentioned earlier, move this figure to section 3a.