



EGUsphere, referee comment RC1  
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## **Comment on egusphere-2022-1044**

Anonymous Referee #1

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Referee comment on "On the drivers of regime shifts in the Antarctic marginal seas, exemplified by the Weddell Sea" by Verena Haid et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-1044-RC1>, 2022

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**Review of "*On the drivers of regime shifts in the Antarctic marginal seas*"** by Verena Haid, Ralph Timmermann, Özgür Gürses, and Hartmut H. Hellmer

The manuscript presents a set of model experiments used to explore a potential regime shift in the Antarctic marginal seas, with a strong focus on the Weddell Sea. The authors use various modifications of atmospheric forcing data to study the development of the HSSW and WDW density and find that the density difference between these water masses is a deciding element for shifting into a warm regime. The results agree with other model studies using various forcing combinations, but in this study, the regime shift is reversible, provided that the forcing returns to present-day conditions.

The manuscript builds on a series of model experiments that contribute to understanding a possible regime shift in the Weddell Sea. However, it is quite hard to follow the story as a reader, and I would recommend the authors revise the manuscript, considering the following major issues.

Major issues:

- One of my major concerns about this manuscript is the storytelling. The authors write well in terms of language and grammar, but many important aspects of the story are hard to extract from the text. As a reader, I had to go back and forth several times to find details and understand the paper's main findings. Therefore, I will encourage the authors to help the reader by looking into how to tell the story more directly. For instance:

- There exist many studies on the possible regime shift in the Weddell Sea. Can you make a stronger introduction to this study to show more clearly how this study differs from the others and what we can learn from it?
  - Understanding the suite of experiments and what you expect to learn from them is not straightforward. Could you, perhaps, make hypotheses you hope to answer based on sub-sets of the experiments to more clearly show the purpose of each experiment?
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- The forcing data needs more explanation. It is not clear how the ERA-Interim and the HadCM3 data differ. It would be helpful with text and figures to understand these differences. Figure 4 does show mean fields but not seasonal variability. It would also help if you described and perhaps showed a figure of the SA\_G experiment compared to REF. It is unclear if the seasonality is exaggerated or suppressed by removing the difference between ERA-Interim and the HadCM3 21C-A1B. I would also like to challenge you to make a graphical presentation of the various experiments to help the reader visualize the various alterations. Such a graphic could be in an appendix or supporting material.
  - It would be worthwhile to dig deeper into the coastal conditions before the regime shift. The author presents the temperature at sill depth, but it would be useful to also discuss and show how the Antarctic Slope Front (ASF) evolves.
  - The title of the study concerns Antarctic marginal seas more generally, but the main part of the study targets the Weddell Sea. The discussion of the Ross Sea appears to be disjoint from the rest of the manuscript, and it is unclear if you looked into other regions along the Antarctic coast for further comparisons. I would recommend keeping the focus on the Weddell Sea (also in the title) and leaving the Ross Sea as part of the discussion. There is a limited value added by the figures from the Ross Sea, given that they are similar to the Weddell Sea and can easily be explained or compared by text description.

In addition, here are some minor recommendations to pay attention to:

Figure 1: Is there a reference you can add to the caption? Is this adapted from other work?

Figure 3: It is very hard to decipher the different lines. It would be helpful with varying colors and line styles to make it possible for colorblind people to interpret the results and bigger panels or different vertical ranges to see the results better. Also, is there a reason you would analyze the Ross data in the SA\_W scenarios? It would be good to explain why.

Figure 4: What is the purpose of this figure? The datasets are very similar. If you want to show these figures, it would be helpful with a third set of panels showing the difference between the datasets to enhance the understanding of the differences.

Figure 5: I suggest plotting REF as it is, and plotting the others as anomalies (subtracting

REF). This would make it easier to compare differences. The divergent colormap also makes temperature variation near 1.5 degC appear stronger than they are. Is there a reason why you split the warm and cold colors at 1.5 deg C? If not, I would suggest to use a non-diverging color scheme.

Figure 7: I do not think you need to include this figure.

Paragraph 45: I am unsure if it is appropriate to flag specific projects and funding sources here. I would suggest putting this information in the acknowledgment and changing the sentence to target your contribution in general.

Paragraph 75: Is there a reference for the HadCM3 model data and the empirical relationships you are using?

Paragraph 95: It would be helpful to present a graphic that shows the REF and the SA\_G, and possibly the seasonal means for the datasets for at least one of the atmospheric variables.

Paragraph 105: How does it affect the forcing data when July and August are eliminated? Are there discontinuities that affect the results? What happens in Feb-August in the transition zone at 50 deg S?

Paragraph 125: Is the mean temperature an integral over the entire volume or only the deeper part (how deep)? The figure caption states that it is below 200 m, but you should mention this here too.

Paragraph 125: The sentence starting with "The coincidence of..." needs to be revised for clarity. It would also benefit from more elaboration as to the causality question.

Paragraph 125: All other references to figures use "Fig. X". I suggest you do this for Figure 5 here too.

Paragraph 135: Please refer to a figure where you find the results.

Paragraph 145: Some of the points here would be good to mention in the introduction to help motivate your selection of experiments.

Paragraph 175: How is the ACC altered in the SUMMER\_S? Is warm water available at the depths where it can access the shelf, and do you see a relaxation of the front?

Paragraph 180: Could you provide some motivation for why you compare the density in front of Ronne, and not the density in the Filchner Trough, where the warm water enters the shelf?

Paragraph 195: Please elaborate on what happens when the on-shelf density becomes lighter than the off-shelf waters. Is there any delay in response or any seasonal variation of interest?

Paragraph 325: This paragraph appears to be more appropriate for the discussion section

Paragraph 330: The final paragraph is irrelevant to the conclusion. I am unsure if it ok to advertise other parts of a specific project in this manner.