

Review of Regime shift caused by accelerated density reorganisation on the Weddell Sea continental shelf with high-resolution atmospheric forcing by Teske et al.

The study uses a forced ocean-sea ice model to analyse the density structure on the continental shelf and near the continental shelf break in the Filchner Trough of the Weddell Sea. The manuscript presents present-day conditions as well as future conditions using atmospheric forcing from atmosphere models run under the SSP3-7.0 emission scenario. Two different atmospheric forcing datasets of varying horizontal resolution are used. The simulation with atmospheric forcing from a higher-resolution model simulates onshore transport of Warm Deep Water resulting in a shift of the continental shelf waters from cold to warm. This change in the water mass properties does not occur in the simulation forced with atmospheric forcing from a coarser atmospheric model. The manuscript highlights the sensitivity of the simulated projection of water mass properties in the study region to the applied atmospheric forcing.

The manuscript is overall well structured, and the figures support the mechanisms described in the text. The data interpretation is robust, and the figures are clear and easy to read. My main comments are on the main effect of grid resolution for the atmospheric forcing product and the presentation of the results.

I detail below my main concerns followed by specific comments that are aimed to improve the manuscript.

Main comments

- 1) The manuscript highlights the role of high-resolution atmospheric forcing for the simulated ocean. The result is based on the comparison of the future scenario runs REF and FECO. The text mentions that the atmospheric forcing in FECO (from a higher-resolution regional model) e.g. results in warmer air temperatures. The manuscript does not discuss the following point: Is the higher resolution of the atmospheric model important because (i) it changes the mean climate (e.g. warmer air temperatures) and thereby the ocean or (ii) the small-scale variability itself changes the ocean? Or is the simulated atmosphere in the higher-resolution model different due to other aspects of the model configuration? The manuscript shows the sensitivity of the density structure to surface forcing but does to my understanding not explain why the high-resolution forcing is required. Another low-resolution model might simulate a different mean climate that could give similar results to FECO. Please elaborate.
- 2) I struggled multiple times to follow the argumentation as the text uses many long sentences and lacks summary sentences that guide the reader. The discussion and conclusion are an exception and much easier to follow. I encourage the author team to edit the other sections of the manuscript to enhance readability.
 - Introduction: lacks flow within the individual paragraphs
 - Method section: please add overview sentences that guide the reader. State the main observation first and then give more details. Also, the discussion and conclusion nicely highlight the relevance of the seasonality, but the point of the

seasonality is lost in the result section.

In the specific comment section below, I highlight some text passages, but the authors should edit the text beyond my comments below.

Specific comments

Title

- The title is very long and it is not clear what the message is. I encourage the authors to specify their main result of the paper. To me, the most interesting result is the sensitivity to the atmospheric forcing. I suggest to rewrite the title to something similar to “Simulated ocean density on the Weddell Sea continental shelf sensitive to applied atmospheric forcing”
- My main concerns with the current title are:
regime shift: definition of regime is missing
accelerated density reorganisation: accelerated compared with what? What is the density reorganisation?

Abstract

L3: I suggest replacing “characteristic V-shape in the density structure all along the continental slope” with “characteristic V-shape in the density structure **across** the continental slope”

L5/6: I suggest splitting the sentence into two: “...emission scenario. **The forcing is retrieved from** atmospheric model output from...”

L11: I suggest rewriting to “Using **forcing** data from an atmospheric model”

L11/12: “acceleration of the density redistribution” – not clear what this means, compared with what?

L12: First time the Filchner Trough is mentioned, it is not clear that this is the regional focus of the study.

L14: “grade of connectivity” – spatial connectivity? Please specify.

L16: “Our results also indicate...” this sentence repeats L11? This sentence is clearer to me, I suggest replacing the sentence in L11 with this one. Remove the “suggest” at the end of the sentence.

Introduction

L37: “southward direction” – here and elsewhere in the text southward/northward are used to describe directions. I suggest using “onshore” and “offshore” as the continental slope and cross-slope transects are often not meridional.

L40: “Variability” – temporal or spatial variability? Please clarify.

L42ff: The text says seasonality is important but the examples are for specific storm events and not seasons. The connection is not clear to me.

L48/49: I expect the overflow to be larger when there is less mixing with lighter surface waters / mixing with water that is not as light. Please clarify.

L49/50: This statement does not fit to the train of thought; the conundrum is not resolved: do we expect a sensitivity of DSW export to surface winds or not?

L57: Why is it important to use a global model? Is it because Antarctic meltwater has consequences for the global climate? Please elaborate.

L67: “regime shift”: Please define the regime and what a shift of it means

L69-71: What did these studies find? What ocean processes changed in response to different atmospheric forcing?

Methods

L87: “on unstructured-mesh methods” – please reword, grammatically not a correct sentence

L89: Reword to “three-equation **parameterisation**”

L92: I suggest removing “via”

L98: I suggest rewriting to “The FESOM **REF simulation** is forced” to match the wording of the next paragraph.

L100: I suggest rewording to “component, **and which was developed** as a contribution to”

L199: I suggest rewording to “The follow **variables**”

L120-121: Why are the variables listed here? Do they differ to the low resolution forcing in REF?

L125: “V-shape” of what? V-shape of cross-slope isopycnals? Please specify (here and elsewhere in the manuscript).

L133-134: It is not clear to me what was done in step 2. Please split up into shorter sentences and elaborate.

L134/135: Move sentence on delta y_n below equation (1) where the other parts of the equation are described.

L141: “disruptions in longitudinal direction” – should this be in zonal direction?

Results

L152: I suggest rewording to “is found **approx. 500 m deeper** above...”

L155/156: “due to the deepening of the slope current along its path following the continental slope” – please provide evidence for the statement.

L165: Fig. S3 is referenced before Fig. S2. Please swap order of the two figures.

L165: Comment on the fact that the shallowest maximum depth is reached in autumn.

L167: How do the 50 m variation in depth compare to the grid cell thickness of the model at this depth? Is it more than one grid cell (which would mean the changes is not as drastic)?

L170/171: I suggest rewording to “in autumn **steepens** the **onshore** arm again”

L176: Please reword to “the horizontal temperature gradient **at** 300 m depth”. Also: which direction does *horizontal* mean? Please specify.

L177: Give Fig. S4 reference earlier – it currently reads as if Fig S4 would show observations which is does not.

L178/179: Fig. 7 does not show Ekman downwelling, please provide evidence for the “weakened Ekman downwelling”.

L187: I suggest rewording to “becomes **asymmetrical and shallower** towards the end”

L189: Please provide evidence for “a shoaling of the slope current over the course of the century”

L197: “enhances existing wind stress curl patterns in winter” – The change is hard to see in Fig 6a-d, it is possibly better to plot the anomaly instead

L200: Should all panels Fig. 6e-h (not just Fig. 6e) be referenced here?

L201: Please reword to “compared to the beginning of the century”

L201/202: “Regional variability is slightly reduced” – what aspect of Fig 6e-h shows this? What does “regional variability” mean in this context?

L204: “(not shown)” – Fig. 4 does show sea ice concentration changes.

L204/205: “a southward shift of the wind field increases areas of downwelling above the continental slope” – please provide evidence.

L205/207: I suggest rewording to “The impact of sea ice on the surface stress curl is especially visible in autumn **when** the Filchner Trough is covered approximately halfway by sea ice.” Also please provide a figure reference for this statement.

L211: “long-term trend in up- and downwelling patterns”, please give evidence/elaborate.

L215: Please provide a figure reference for this statement.

L217: “additional decrease” – additional to what?

L218: I suggest removing “of transition time” to streamline the text.

L218-220: Please provide figure reference.

L222: Please define “regime shift”, e.g. “as seen by the much warmer shelf temperatures”

L223: “near bottom current across the sill” – please provide evidence

L224-226: This sentence is not clear to me and disturbs the flow of the text. Is the point here that REF shows increasingly stronger seasonal pulses, but they do not lead to a “regime shift”? Is this seen in the temperature field of Fig. 7? Please clarify.

L227-229: Do we expect the historic warming trend to match the projected warming trend?

L227: “warming of the slope current” – here and at multiple other locations in the text, the term “slope current” is used to describe changes in the offshore part of the continental slope. Maybe a better wording can be used as the slope current itself is a dynamical feature and was never introduced in the manuscript by showing the velocity field in the model. I was quite confused every time the slope current was mentioned.

L232-233: move this information up to (near) the beginning of the paragraph. This is a main observation that is very useful to give early on so the reader can follow the argumentations of the paragraph, i.e. please state the obvious first.

L234: Please rephrase to “before the regime shift **occurs** in FECO”

L242-243: “Stronger Ekman downwelling in autumn, but a late onset of the freezing season” – I do not understand this sentence, please clarify.

L247: “reduction of density” – where is the density reduced? Please elaborate

L248: Please rephrase to “large in **the** Filchner Trough”

L252: “on the continental shelf” – is this the Filchner Trough? Please clarify.

L253: “in the slope current” – and this is the offshore region? Please clarify, see also my comment on L227.

L254: “reduced sea-ice formation” – What is the connection here to sea ice?

L252-253: Changes in temperature and salinity do not contribute linearly to changes in density. Is this incorporated in the assessment? I find this sentence difficult to understand, please clarify.

L257: “onset of the near-bottom current” – please provide evidence.

L258-259: “loss of the southern arm of the V-shape” – Does this mean it is a fresh shelf now?

L263: “the V-shape is formed also at a greater depth” – I do not see this in Fig. 8c, the V-shape in temperature or density? The isopycnals in Fig 8c are shallower, what exactly is deeper? Please clarify.

L264: “however, ...” Please start a new sentence here. The second half of the sentence is not clear as the term V-shape is used when a few sentences earlier the text says the onshore arm is lost. Perhaps rewrite to “isopycnals are much deeper in FECO than in REF”. Or remove this part completely as the next sentence does not pick up on this point.

L265-266: Are the isopycnals deeper after the onset of the bottom current? Please clarify.

L271: “15-year”: Which time period is this exactly? FECO simulates multiple time periods.

L271: “approx. 1000 m” – Where is the information of the 1000 m thermocline depth in the year 2000 shown? Am I meant to see this in Fig. 10?

L275-277: Please rewrite the sentence and split into two. Also, the statement is the same as in the first sentence of the paragraph? Please clarify. Also I expected now a discussion of the density ratio but that is missing or do I misunderstand?

L281: “Fig. 11” Please reference Fig. 11a

L282-286: I suggest simplifying this text, e.g., to “The southward mWDW (...) transport and the GOC are significantly correlated with a 3 month lag in REF ($p=...$, $r=...$) and in FECO ($p=...$, $r=...$). There is also a weak correlation between the outflowing DSW (...) and the GOC in REF ($p=...$, $r=...$) while such correlation is missing in FECO ($p=...$, $r=...$).”

L288-289: “decouple the weak correlation” – I do not understand this sentence, please clarify.

Figures

Figure 1:

- I suggest rewording “red line” to “red **rectangle**” (same for green line)
- I suggest rewording “Location of areas” to “Location of **subregions**”

Figure 6:

- First time that seasons are defined – please give definition in the main text when seasons are first mentioned.

Figure 7:

- “Colored lines show the relative temperature change...” is this the orange line? Why is the orange line explained again below? Could this be streamlined to “Colored lines show the relative change of the horizontally and vertically averaged temperature and salinity compared to the year 2000. Orange lines are for REF and red lines for FECO.”

Figure S4:

- The red lines to highlight the -0.3°C and -0.7°C isotherms are difficult to see. Perhaps plotting them in black but bold improves readability.
- What does “zonal average” mean – only one (meridional) transect is shown here? Please clarify.

Figure S7:

- What is the “inset”? The map in panel d)? But that shows more than the continental shelf. Please clarify.

Figure S9:

- Please rephrase to “Linear regression”