Authors' response to Review No 1

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First, we would like to thank the reviewer for their helpful and detailed feedback on our manuscript. The additional questions and enquiries helped us to improve the quality of the text and further our understanding of the different processes and their connections.

In the following, we answer the reviewers' comments in turn in blue. New text added to the manuscript or modified from the original manuscript appears in *italics*.

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.

   This is a valid point. Within the scope of this study, we are unable to cleanly separate the effects of higher resolution in the forcing data and the different physics of the two atmospheric models. The aim of this study was to analyse the effect of different atmospheric forcings on a) intrusions of mWDW into Filchner Trough and b) the stability of the ASF. The effects are briefly discussed in the introduction and the discussion of the manuscript. We realize that we should have been more careful in how and when to use 'high-resolution' as a descriptor for the COSMO model data to highlight differences to the second forcing dataset. We thus went through the text and corrected the wording wherever it seemed useful. An additional paragraph has been added to the section "Discussion: Limitations and caveats" containing the following: *Based on the results in REF and FECO, the two atmospheric data sets impact the ocean in different ways. However, it is not straightforward to cleanly separate the effects of a higher atmospheric resolution and the different atmospheric states the two atmospheric models provide. It remains unclear whether the higher resolved model output from*

CCLM impacts the ocean differently than the AWI-CM data because it simulates a different mean climate (e.g. warmer air temperatures) or because it resolves small-scale variability in the atmosphere. We note that the differences in the wind field between CCLM and AWI-CM can be explained by the improved representation of gradients in the orography of Antarctica (Mathiot et al., 2011, Elvidge et al., 2011; Cape et al., 2015), supporting, at least in part, the importance of resolving small-scale atmospheric variability.

Additionally, we also hypothesised that resolved mesoscale atmospheric processes may intensify the seasonality of the V-shape, the on-shore mWDW transport and the export of DSW in the Weddell Sea. While we definitely see an increase in the on-shore transport of mWDW in FECO compared to REF (see Fig. 10d for 2086 to 2100), FECO exports on average a bit less DSW from the shelf than REF. These changes are consistent for the historical time period from 2000 to 2014 and the scenario simulations 2036-2050 and 2086-2100. FECO also produces changes in the seasonality of the V-shape compared to REF that change the geometry of the V-shape over the course of a year. We do not identify an increase in the seasonality itself (e.g. depth changes). These results have been added to the Results and are summarized in the Conclusion as follows: *We could show that the application of forcing data with resolved mesoscale atmospheric processes increases the on-shore mWDW transport as hypothesized. However, we observed a small decrease in the average DSW export from the shelf and no visible increase in the seasonality of the V-shaped density distribution above the continental slope.*

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.

Thank you for the feedback. We reduced the length of sentences and added more structure to the text.

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?

We acknowledge that regime and regime shift are not defined in the title. As it might not easily recognisable what a regime shift in this environment includes, we decided on the new title: *"Simulated density reorganization on the Weddell Sea continental shelf sensitive to atmospheric forcing"*

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"

Done.

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

Done.

L11: I suggest rewriting to "Using forcing data from an atmospheric model"

Done.

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

The density changes on the shelf are happening faster in the model runs forced with COSMO output in comparison to the simulation forced with ECHAM data. To clarify, we added: *"...compared to the simulation forced with ECHAM output."*

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

We reworded the previous sentence to include: *"...into the Filchner Trough in the southern Weddell Sea..."*

L14: "grade of connectivity" – spatial connectivity? Please specify.

It is spatial connectivity. We rephrased the sentence to: *"...we define a spatial grade of connectivity to ..."*

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.

We rephrased the paragraph and moved the mentioned sentence further up.

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.

Very nice suggestion. This has been changed throughout the text.

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

In this case it concerns temporal variability, caused by changes in both DSW export and mWDW import. It has been changed to: *Temporal variability of the V-shape has been linked to ...".*

L42: The text says seasonality is important but the examples are for specific storm events and not seasons. The connection is not clear to me.

The V-shape is sensitive to changes in the wind field. A storm event is just a more extreme example. We changed the sentence around to first describe sensitivity to winds and then seasonality (which is still wind related): *"The V-shape has been shown to be sensitive to the wind field (Graham et al., 2013). [...] Additionally, the V-shape shows seasonal variability in depth that has been associated with variations in the along-shore wind strength (Graham et al., 2013)."*

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.

The overflow transport is geostrophically controlled. Lighter water masses at greater depth enhance the density gradient across the shelf break and therefore the overflow transport. To clarify, we added: *"... geostrophically controlled..."*

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?

Based on published literature, the community does not seem to agree on whether or to what extent the DSW export is sensitive to the surface winds. Previous studies (listed in the text) suggest yes, however Stewart & Thompson (2015a) suggest only a 20 % variability in response to wind. We added to the text: *However, existing studies do not all agree on the importance of winds. [...] In contrast, three-dimensional eddy-resolving simulations by Stewart & Thompson (2015a) showed only low sensitivity of the DSW export to wind strength.*

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

It is important to use a global model to include remote atmospheric and oceanic connections. These influences can not be incorporated adequately within a regional model. We added the following to the introduction: *On longer timescales, the ASF is remotely influenced by large-scale climate modes such as the Southern Annular Mode (SAM) and the El Niño-Southern Oscillation (ENSO; Armitage et al., 2018, Spence et al., 2014, 2017).* The discussion was expanded by the following: *Armitage et al. (2018) found that the southward contraction of Westerlies during positive SAM enhances northward Ekman transport, dropping coastal sea level and weakening the ASF. In negative SAM phases the opposite happens. While*

the impact of long-term positive SAM trends on the ASF are uncertain, modelling studies suggest that a drop in Antarctic coastal sea level could weaken the ASF, leading to shoaling of the isopycnal on the continental slope (Spence et al., 2014, 2017). Similar events take place during El Niño events, where an anticyclonic atmospheric pressure anomaly over the Amundsen and Bellinghausen Seas lead to a weakening of the ASF in the Pacific Sector of the Southern Ocean (Armitage et al., 2018, Spence et al., 2014). ENSO should show their influence in REF and FECO in the same manner, because its origin in equatorial latitudes is not part of the CCLM domain and therefore any influence they have does not differ between REF and FECO. While the analysis of remote connections is not included in this study, it should be considered in the future.

L67: "regime shift": Please define the regime and what a shift of it means.

The regime shift changes the main water mass in the Filchner Trough from cold DSW to warm mWDW by increasing mWDW inflow. We specified: *"...from a DSW-dominated trough circulation to a mWDW-dominated circulation in the Filchner Trough."*

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

Consequences include flooding of the ice shelf cavity with warm water from the deep ocean, a rise in basal melt rates of the ice shelves, reduced density of the exported shelf waters a, less efficient deep-ocean carbon and oxygen transfer. The studies cited in the text all produce a regime shift in the Filchner Trough before the end of the 21st century. The following has been added to the text: *Previous studies have described a possible regime shift in the Filchner Trough from a DSW-dominated trough circulation to a mWDW-dominated circulation in the trough and possible consequences, including flooding of the ice shelf cavity with warm water from the deep ocean, a rise in basal melt rates of the ice shelves, reduced density of the exported shelf waters and a less efficient deep-ocean carbon and oxygen transfer (Hellmer et al., 2012, Timmermann et al., 2013, Naughten et al., 2021, Nissen et al., 2022, 2023, 2024).*

Methods

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

The sentence has been rephrased to: *"FESOM is a global ocean general circulation model with an unstructured mesh..."*

L89: Reword to "three-equation parametrisation"

Done.

L92: I suggest removing "via"

Done.

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

We kept these sentences as they were because we would like to keep the distinction of REF as the reference simulation, but we removed the brackets.

L100: I suggest rewording to "component, and which was developed as a contribution to"

Instead, we added the following to split the sentence: *"The data was created..."*

L199: I suggest rewording to "The follow variables"

Changed to: *"The following atmospheric variables..."*

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

The forcing variables are the same for REF and FECO. We changed the paragraph to make this clear: *The following atmospheric variables are used to drive all simulations: 2m-temperature, 10m-wind, downward longwave and shortwave radiation at the ocean surface, mean sea level pressure, 2m specific humidity and total precipitation.*

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

The V-shape describes indeed the shape of the cross-slope isopycnals. We added this specification at the first mentioning of the V-shape in each subsection.

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

The paragraph has been changed to: As a second step, we find the horizontal density minimum at the chosen depth of 250 m (in the example in Fig, **??**a it is 27.5 kg/m^3). This is repeated for each meridional grid coordinate, creating a number of density minima (red dots in Fig. **??**b).

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

Done

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

It has been changed.

Results

L152: I suggest rewording to "is found approx. 500 m deeper above. . . "

Done.

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

It is visible in the downward shift of the warm core just at the off-shore edge of the profiles in Fig. 3. We reworded to: *"...due to the deepening of the warm core of the mWDW transported by the slope current along its path along the continental slope (Fig. 3).*

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

Done.

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

The depth of the isopycnals reacts with a lag to changes in the sea ice formation, but more immediately to changes in the wind field. The following text has been added to the paragraph: *The minimum sea ice extent is reached in general in February. While near-coastal sea ice formation starts again in March, the increased export of DSW from the continental shelf is delayed due to the distances involved between the area of sea ice formation along the coasts and the continental slope (see also Fig. S6e-h). The isopycnals at the continental slope therefore only deepen later, leading to the shallowest maximum depth being 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)?

Between 600 and 750 m, layer thickness increases from 20.6 to 21.7 m. An average depth difference of 50 m covers 2 to 3 mesh layers, making the change not irrelevant. We added: *"Such a vertical distance corresponds to two to three layers in the ocean grid."*

L170/171: I suggest rewording to "in autumn steepens the onshore arm again"

Done.

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

This has been changed to: *"the meridional temperature gradient at 300 m depth (Fig. S4)."*

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

Done.

L178/179: fig. 7 does not show Ekman downwelling, please provide evidence for the "weakened Ekman downwelling".

This is a typo and should have said Fig. 6 with positive surface stress curl being equivalent to Ekman downwelling on the southern hemisphere. The error has been corrected.

L187: I suggest rewording to "becomes asymmetrical and shallower towards the end"

Done.

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

This is visible in the uplift of the thermocline, of which we see the last 15 years of REF in Fig. 10a. A timeseries of the depth of the thermocline for the whole REF simulation has been added to the Supplementary material and is now referenced in the text (Fig. S11).

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

Instead of plotting the anomaly, we adjusted the axis limits for the panels a) to

d) which makes differentiating between the two curves much easier.

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

Yes. It has been changed.

L201: Please reword to "compared to the beginning of the century"

Done.

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

Regional variability means the frequent changes of in strength of the up- and downwelling following the profile from south to north, particularly in winter and spring (Fig. 6e-f). In summer, the distribution is much smoother, resembling the surface wind stress in summer (panel c). The sentence has been reworded: *Variability along the profile is slightly reduced so that the surface stress curl resembles the wind stress curl more closely at the end of the century (compare Fig. 6c/g).*

L204: "(not shown)" – fig. 4 does show sea ice concentration changes.

We only show sea ice formation rates and sea ice thickness, but no concentration.

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

This should have said *"northward shift of the wind field"* and has been changed accordingly. A figure of the difference in surface stress curl between winter and summer has been added to the supplements.

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.

The text has been adjusted to: *The impact of sea ice on the surface stress curl is especially visible in autumn when the Filchner Trough is partly covered by sea ice with a northward decreasing thickness (Fig. S8d).*

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

In this sentence, we wanted to describe overarching patterns in up-and downwelling instead of long-term trend. The text has been adjusted to: *... we conclude that the up-and downwelling patterns are created by the sea ice distribution rather than the wind field.*

L215: Please provide a figure reference for this statement.

In principle, the increased on-shore transport of mWDW can be seen in Fig. 11. However, this is not convenient for the flow of the manuscript. We therefore changed the sentence to: *The application of the regional higher-resolved CCLM forcing in FECO affects the heat transport onto the continental shelf (Fig. 7c)*

L217: "additional decrease" – additional to what?

Additional was meant in relation to the decreasing salinity already happening in REF due to the changing climate and reducing sea ice formation. Because this does not seem to be clear, the sentence has been reworded to: *Reduced freezing rates along the coasts in winter and higher melt rates in summer (Fig. S3) due to higher air temperatures (not shown) compared to REF lead to a decrease of the mean salinity in the Filchner Trough by up to 0.2 psu over the course of 10 years.*

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

Done.

L218-220: Please provide figure reference.

An additional figure showing the mean wind speed and mean wind speed anomaly between FECO and REF in a 5-year mean (2010-2014) has been added as Supplementary Fig. S9.

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

The suggestion has been added.

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

It is visible in FECO (Fig. 8d), where the bottom layers show high temperatures, as well as warm water filling the Filchner Trough from the bottom. The reference has been added to the text. Additionally, we provide an animated gif of monthly mean bottom temperatures in the southern Weddell Sea. The warm current entering the Filchner Trough is first prominently visible in 2093.

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.

REF shows increasingly stronger seasonal pulses but they do not lead to a regime

shift before 2100. FECO also shows these pulses, but here we find a regime shift happening in 2093. This can be seen in Fig.7. To clarify, the whole paragraph has been reworked.

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

Yes and no. At the beginning of the simulation, it should match the historical warming trend, because there is no reason it should experience a sudden change. That it does this, adds confidence to the model simulation. It is possible that the warming trend strengthens or slows down, but as we do not explore the mechanisms behind the warming of the slope current and ACC, it is difficult to evaluate at this stage. No changes to the text were applied.

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.

The slope current transports mWDW. In this context it is often easier to refer to the temperature of the current instead of the temperature of the mWDW transported by the current. We went through the manuscript to correct this oversight and added an introduction to the Antarctic Slope Current in the introduction.

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.

The whole paragraph has been restructured and split up. Previous comments have been taken into account.

L234: Please rephrase to "before the regime shift occurs in FECO"

Done.

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

Ekman downwelling is an aspect dictating the characteristics of the depth of the V-shape. With strong Ekman downwelling in autumn, the isopycnals deepen

again. However due to higher atmospheric temperatures, sea ice formation and in particular dense water formation start later. The isopycnals lose the characteristic V-shape because the continental shelf is filled with less dense water than later in winter. This creates a situation similar to fresh-shelf regions like at the coast of Dronning Maud Land, consisting of only the off-shore arm of the V-shape, with the isopycnals intersecting with the continental slope. We added the following clarifications in the text: *Stronger Ekman downwelling in autumn, but a late onset of the freezing season lead to a situation that temporarily resembles fresh-shelf regions like the Dronning Maud Land section (Fig.* **??***a) where the V-shape is missing its on-shore arm and the isopycnals cancel at the slope.*

L247: "reduction of density" – where is the density reduced? Please elaborate.

in the Filchner Trough has been added to the text.

L248: Please rephrase to "large in the Filchner Trough"

Done.

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

Yes, it is and has been changed to "in the trough"

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

In this instant, we describe the mWDW transported along the continental slope by the slope current. This has been specified: *...while the trend in the mWDW transported by the ASC is driven by a combination of warming and freshening (Fig. S11).*

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

As has been explained further above, reduced freezing rates along the coast in winter and higher melt rates in summer in FECO compared to REF lead to freshening of the shelf waters. And while this is indeed a prominent factor, changes in the temperature and salinity of the mWDW transported by the slope current also play a role in shaping the density distribution and development across the Filchner Trough sill. We added the information the the paragraph to make the connection clearer: *Separately assessing the trends in temperature and salinity reveals that the density trend in the trough is driven by freshening due to reduced*

freezing rates along coasts in winter and higher melt rates in summer, …

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.

While temperature and salinity do not contribute linearly to changes in density, plotting the mean temperatures and salinity values in a T-S diagram (Fig. S1) shows that in this case, salinity changes, in particular in the trough, are the dominating force behind the density changes. We amended the paragraph as follows: *The change in density is larger in FECO in the Filchner Trough than at the off-shore location. From this, we conclude that reduced sea-ice formation is not the only factor influencing the density distribution across the continental slope, but the dominating one for the existence of V-shaped cross-slope isopycnals.*

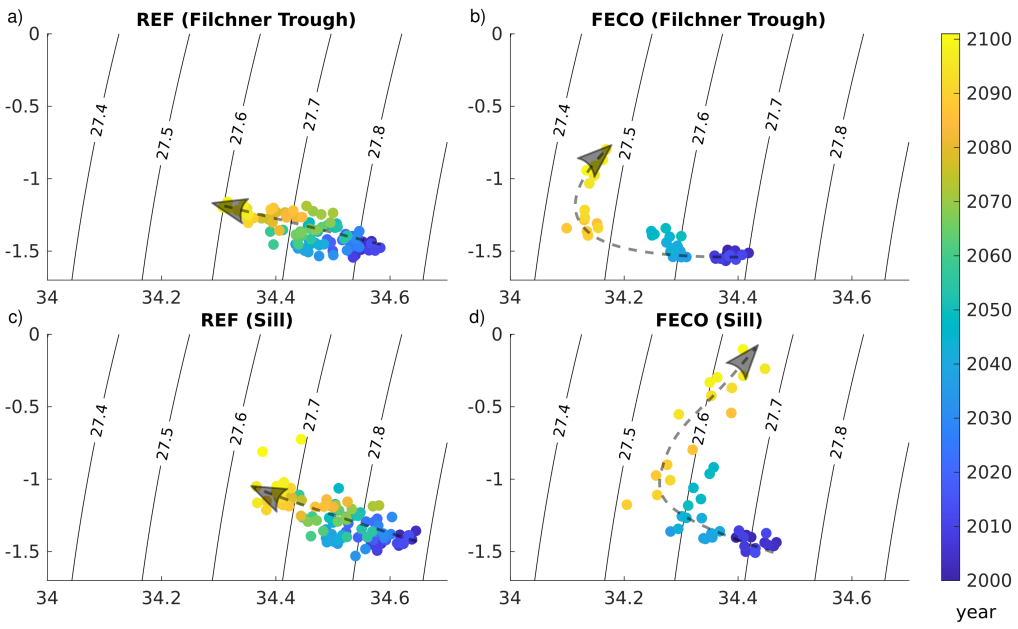

Figure S1: T-S-Diagram of annual mean potential temperature and salinity over time in REF (a, c) and FECO (b, d) in the Filchner Trough (a, b) and at the Filchner Trough sill depth off-shore (c, d). The arrows indicate the shift over time. Isopycnals relative to 1000 kg/m3 are shown in black.

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

The bottom current can be seen in Fig. 8d in the 2096-2100 mean temperature. This current starts to become visible in 2093. Also we refer to answer to comment on line 223. We changed the text to: *Visible as a sudden increase in the average temperature in the Filchner Trough (Fig. 7c), and as a layer of warm water at the bottom of the Filchner Trough (Fig. 8d), the inflow of mWDW in FECO in 2093*

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

In contrast to a fresh shelf, the Filchner Trough starts to fill with mWDW, creating a distribution that reminds more of the warm shelves in the Amundsen Sea. Because we have no profile of the Amundsen Sea for comparison, no changes were applied to the text.

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.

he V-shape is actually flatter/shallower. However the on-shore arm of the 27.4-isopycnal is pronounced, while in FECO, it is not. The main difference on the shelf is basically the range of density on the shelf with (as described) stronger stratification in FECO. The text has been amended to: *This has the effect of increasing the stratification of the water column. In combination with low sea-ice formation rates and reduced mixing (not shown) during the freezing season, the seasonal variations in the southern arm of the V-shape vanish at depths below approx. 450 m (Fig. 8d). In REF, the density distribution on the continental shelf leads to the formation of the typical V-shape(Fig. 8c). The isopycnals above the continental shelf also experience stronger seasonal depth variations. Seasonal variations of the depth and position of the V-shape and the position of the northern arm can be found in FECO and REF. The on-shore arm of the V-shape in FECO decreases strongly in vertical extent. [...] The weaker stratification in REF has the effect of making the on-shore arm shallower than 450 m more pronounced. Below this depth, the isopycnals take on a similar shape as in FECO.*

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.

We refer to the answer and changes explained above.

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

This part describes the relative height of the on-shore shape of the isopycnals, but not its depth. Due to the bottom of the Filchner Trough being filled with mWDW from off-shore, the isopycnals become more levelled. We changed the text to: *From a height difference in spring of approx. 200 m between the deepest point of the V-shape and the shallowest point above the continental shelf, the 27.4 kg m^{-3} isopycnal position reduces its vertical extend to a range of approx. 80 m after the bottom current onset.*

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

This describes the last period from 2086 to 2100 (where the interesting stuff is happening). We changed the text to: *In FECO, the thermocline remains above the Filchner Trough sill depth throughout the FECO simulation from 2086 to 2100...*

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?

The year 2000 is indeed not shown in Fig. 10. It has been added as Fig. S12 to the supplements and referenced in the text.

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?

The time series of the density ratio between the maximum density in Filchner Trough and the density at the Filchner Trough sill does not tip in favour of the the sill density in REF at all. In FECO this happens multiple times and over a longer period of time. These times agree well with times of increased on-shore heat transport when considering the slight delay caused by the time it takes the mWDW to flow into the trough. The paragraph has been extended to: *This agrees*

with the conclusions presented by Haid et al. (2023) suggesting that another key factor for or against an inflow of mWDW onto the continental shelf in addition to the depth of the mWDW at the slope is the density ratio between the dense water on the shelf and the mWDW of the ASC (see also Nissen et al., 2023). FECO only experiences the regime shift after the density ratio between the DSW of the Filchner Trough and the mWDW in the ASC changes in favour of the mWDW (Fig. 12b). And while the thermocline in REF does also cross sill depth during the last five years of the simulation, the density ratio remains in favour of the DSW, therefore preventing the intrusion of large amounts of mWDW into Filchner Trough.

L281: "fig. 11" Please reference fig. 11a

Done.

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=. . .)."

We modified the text to be easier to follow and included the suggestion :*After 2093, the southward mWDW (Θ >-0.8°C) transport (Fig. 12d)) and the GOC are significantly correlated with a 3 month lag in REF (p=7e-7, r=0.36) and in FECO (p=0.0005, r=0.35). There is also a weak correlation between the outflowing DSW (Θ <-0.8°C; Fig. 12d) and the GOC in REF (p=0.0001, r=0.29) while such correlation is missing in FECO (p=0.27, r=0.08).*

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

It was meant to highlight that the changes in the density of the DSW in the Filchner Trough are influencing the V-shape and with that the calculated GOC from the beginning of the simulation. The reduced density of the DSW leads to a change in the export behaviour and how or if it disturbs the V-shape. We replaced *decouple* with *remove*.

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”

Done.

figure 6:

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

Definitions of seasons have been added to subsection "Present-day seasonality of the V-shape at Filchner Trough (REF simulation)"

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.”

Yes, this makes the caption more compact and has been changed.

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.

Zonal average is correct, however the figure does not show the temperature at 300 m depth along the Filchner Trough Profile but averaged over the Filchner Trough Sill area as shown in Fig. 1. This was corrected. The colours have been changed.

figure S7:

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

We meant the map added to panel d). The area used for calculation lies within the red polygon. As this does not seem to be prominent enough, we added the polygon in a more prominent colour and replaced *(see inset)* with *outlined in red*

in the map in the figure caption.

figure S9:

- Please rephrase to “Linear regression”

Done.