Response to review of "*The effect of storms on the Antarctic Slope Current and the warm inflow onto the southeastern Weddell Sea continental shelf*" by Vår Dundas, Kjersti Daae, Elin Darelius, Markus Janout, Jean-Baptiste Sallée, and Svein Østerhus.

Dear reviewers,

Thank you all for reading our manuscript so thoroughly and for all your input. Your comments have substantially helped us improve the manuscript, and we hope we have addressed all your comments satisfactorily. Below, we first respond to comments by Keith Nicholls, then anonymous reviewer nr 2, and finally Angelika Renner. We address your suggestions as follows: Your submitted comments are in black text, and our responses are in green. We apologize for the errors in some of the figure references; these have been corrected. Specific changes to the text are in italics, and line numbers refer to the new version of the manuscript.

Sincerely,
Vår Dundas, on behalf of all co-authors

Dear reviewer, K. W. Nicholls,

Thank you for reading our manuscript so thoroughly and for all your comments on the language and conciseness – your input helped improve our manuscript substantially. We highly appreciate the effort put into the attached PDF document. Minor changes from your attached PDF document are not commented on here. Still, they can be identified in the track-change version of the manuscript (submitted as a PDF) and in the returned version of your submitted PDF, which is included at the end of this document.

We hope we have addressed your comments satisfactorily.

Sincerely,
Vår Dundas, on behalf of all co-authors

The authors wind-derived anomalies of surface stress caused by storm events over the southern Weddell Sea, upstream of the Filchner continental shelf. They then investigate the impact of those periods of high surface-stress on the Antarctic Slope Current (ASC) near the Filchner sill, and on the flow both of warmer waters onto the continental shelf, and the southward flow of warm waters already on the shelf toward Filchner Ice Front.

This work is a continuation of observational and idealized numerical studies by many of the same authors. Here the mooring time series has been significantly extended. Seven moorings, with time series up to four years in length have been used. Obtaining those moorings has been a colossal effort, and they represent a very impressive resource.

As a continuation, the study is in some ways incremental, providing confirmation of key findings from the previous work, but also raising some interesting questions. I would like to see it published in this journal, after some relatively minor revisions.

Overall, the English is good, in that it is entirely understandable. However, the text could be substantially tightened up, perhaps by a co-author? I've submitted a marked-up PDF with many comments and an incomplete list of minor textual suggestions, but very often sentences could be redrafted more concisely. That is perhaps an editorial decision. Some of the comments are more substantive but most are requests for clarifications that can be very easily dealt with.

Thank you for your effort in reviewing our study and for the overall positive assessment.

A couple of more significant questions.

1. Section 3.4

This reviewer was a bit confused about what the authors were trying to say in this section, where they describe a shift in July 2019 in the response to storms events: the response on the shelf to storms went from being inconsistent to consistent, while the reverse was the case for the response at the sill. At the same time the flow direction on the shelf migrated from being primarily north-eastward to primarily eastward.

In line 275 they mention the importance of changes in the upstream wind forcing as a possible reason behind the shift as discussed in an earlier study, but later in the paragraph note that the mean surface stress over the Upstream box doesn't seem to change during the shift. In the next paragraph (line 282) there is a comment about the correlation between wind direction and the current direction at M_CS2; the correlation shifts from negative to positive. Where is this wind? Is it over the Upstream box? If so, I don't see how the mean direction of the stress isn't changing, but the correlation between wind direction and current at M_SC2 is switching sign: the current direction is only changing by 45 degrees.

The paragraph starting at line 297 then seems initially to repeat the statements about the Daae et al paper's findings mentioned in the para starting in Line 275.

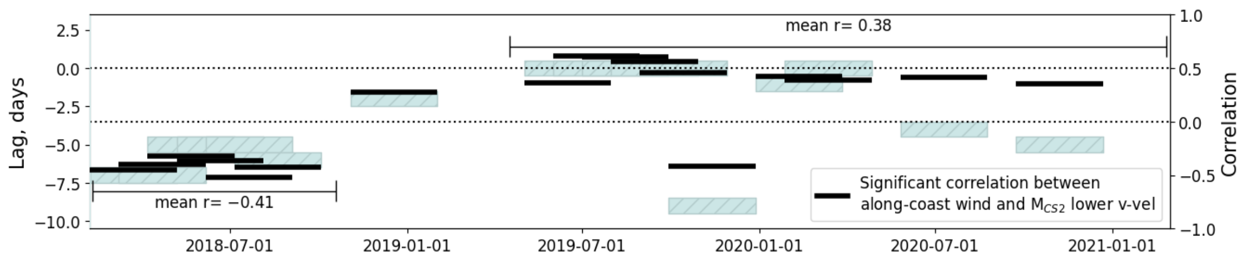
I think this section needs to be tightened up considerably. Clearly, the authors have an interesting finding, and haven't yet got an explanation that satisfies them. I feel that it could be explained very much more concisely and clearly.

Re.: We agree with your comments regarding this section. We find the changes we describe interesting to note, but we cannot yet explain how the different shifts are connected to each other and what drives them. We think it is important to mention that there appears to be a shift in 2019 since it emphasizes that interannual variability affects how the warm inflow on the continental shelf responds to atmospheric forcing – and this is clearly something we need to understand if we are to predict how the system evolves in the future. However, we have followed your advice and simplified this section substantially.

In the updated version of the manuscript, we have moved panels b) and c) from Fig. 10 to the appendix, while the information in panel a) has been included in Fig. 4. We have also moved the detailed description of circulation and hydrographic changes, as well as the speculation associated with Ronne- and Berkner modes, to the appendix.

We have modified the paragraphs starting on lines 275 and 297 to avoid repetition.

Regarding the specific comment about the correlation between stress and ocean current at M_CS2, we hope the following clarifies the aspect: The correlated time series have daily resolution, band-pass filtered at 24h - 30 days (specified in the updated manuscript). Although the mean surface stress does not change direction, and the mean current direction changes by 45 degrees, the sign of the correlation between the band-pass filtered time series might change. We allow for a variable lag, so while the shift in correlation could be associated with a changed lag between the stress and the ocean current's variability, the shift is not purely the result of a changed lag interpreted as a reversed sign of the correlation. There is a tendency for a systematic change in lag related to the shift in correlation (see the figure below). The lag is usually longer (~6 days) when the correlation is negative than when the correlation is positive (~1 day); however, the pattern is not consistent towards the end of the time period. The indication would thus be that the wind forcing affects the current in the Filchner Trough more efficiently during the second part of the mooring period. The positive correlation is what we expect from rapidly propagating barotropic Kelvin waves, which agrees with the short lag. This also reflects the result of more significant storm response events post mid-2019.



A major difference between the correlation presented in this study and the study by Daae et al., (2018) is that they specifically wanted to filter out storm events and used 15-day low-pass-filtered data to capture variability on monthly time scales. We have made this distinction clearer in the updated manuscript as follows:

L261-263: "*Interannual variability in the sensitivity to wind forcing on monthly time scales was also observed in the Antarctic Coastal Current (M_CC , mooring location shown in Fig. 1) and on the sill of Filchner Trough (15-day low-pass-filtered, Daae et al., 2018).*"

Caption of Figure B1: *"Time series from MCS2 of 90-day long, 33% overlapping windows of significant correlation (black bars) and lag (blue bars) between the along-coast wind and the southward bottom current (24 h-30 days bandpass filtered. Positive correlation indicates that roughly south-westward wind corresponds to current toward Filchner Ice Shelf)."*

2. Certainty in the ocean response

I think the authors have generated a time series of the strength of the westward component of surface stress and used an algorithm to identify storm events. They then calculate the strength in the response of the mooring time series around the time of each storm. To be reassured of the robustness of the identification of the response, would it be helpful to carry out a randomized test: create a set of random times of pseudo-storm events, and carry out the same calculation of the strength of the "response" as measured by the mooring time series. Carry out the same test for a many different sets of pseudo-storm events. Highly variable currents as measured by the moorings will often have peaks that will occasionally correlate with peaks in storm forcing, regardless of whether they are being caused by the storm events. A Monte Carlo-like approach such as this will make clear whether the relationship between ocean response and storm forcing is robust. If this analysis is not possible for some reason, perhaps sample time series from the current data would help give confidence in the relationship.

Re.: We agree that it is important to distinguish "storm response" from background variability, but argue that we have already done so by including the significance test described in section 2.5 "Significant storm response" in the paragraph starting on line 162.

From your comment, however, we acknowledge that we have not described this well enough, and we have rewritten this section as indicated below. We brought in the term "Monte-Carlo like approach" to give the reader the correct association.

L162-169*: "To assess whether a storm response is significant, i.e., whether the observed increase in current strength is larger than the background variability, we use a Monte-Carlo-like approach. We cannot conduct a traditional Monte-Carlo procedure due to the length of the storm events relative to the length of the time series – the overlap between sample periods would be too large to act as randomized tests. Instead, we estimate the current increase (U_response) during all 10-day-long, 50% overlapping, storm-free windows (an example for Mslope1 is shown in Fig. A2c). If U_response during a storm is higher than the 90th percentile of U_response during the non-storm periods (vertical blue line in Fig. A2c), we consider the storm response significant. Each mooring has its own threshold for significance due to differences in the background variability (Table 2). The number of 10-day-long storm-free periods ranges from 96 to 215."*

In relation to comment nr 2 by anonymous reviewer #2 concerning the choice of region for the ocean surface stress, we conducted an analysis that is also relevant for the evaluation of the significance of the storm response: We investigated the periods when the current increase at the slope moorings is large enough to be classified as a significant storm response independently of the storm events. By comparing the timing of these events to the identified storms, we get an estimate of the fraction of events that are associated with a storm.

Since we set the significance threshold at the 90th percentile of the current increase in periods without storms, we accept that the current sometimes increases significantly, unrelated to storm events identified by our algorithm. We also do not expect all the strong current events to match up with storms over any specific region, as wave signals might propagate along the shelf break from even further east. The described procedure, however, provides an additional indication of how common it is to have a substantial current increase that is unrelated to storm events.

We find that for both slope moorings, roughly 60% of all significant current increase events (using the significance threshold from the main analysis as stated in Table 2) appear to be associated with storm events over the Upstream box. While running this "backwards" procedure, starting with the ocean current variability and manually comparing it with the identified storm events, is not our main argument for a reliable relationship between the storms and the oceanic response, it strengthens our confidence in the relationship between ocean stress forcing and increased current.

Comments from the pdf:

L165: I don't understand the need for this iterative approach. Combining equation (6) with the surface freezing point formula (substituting $S_0*A + B$ for T_0, where A and B are from the linearized seawater freezing point) will provide the salinity at the intersection directly. If the problem is that the authors don't want to use the linearized version of the freezing point formula, then that's fine, but they should say that's why they are using this method. My guess is that the difference in this application (and virtually all other similar applications) will be vanishingly small., although I haven't done the comparison directly. Other simplifications already inherent in equation (6) will dominate the error budget.

Re.: Using the example in Fig. C1, the resulting source salinity ends up a bit different when using the linearized freezing point function as described in e.g., Jenkins et al., 2010, directly in Eq. 6 versus the iterative method described in section 2.4. The resulting source salinity differs by 0.006 when using the linearized freezing point function directly in Eq. 6 and the iterative method. This is a small offset relative to the absolute salinity values, but in the context of source salinity variability in this region, this is a noticeable magnitude. We therefore prefer to use the iterative method and use GSW's function for the surface freezing point to obtain the source salinity.

When setting $T=-2.16$, $S=34.8$ from Fig A3, and using $T_0=AS_0+B$, where $A=-0.0573$ and $B=0.0832$ (as in Jenkins et al., 2010), we get $T_0=-1.917$ and $S_0=34.906$.

When using the function CT_freezing from the GSW package and the two-step iterative method for the same T and S, we get $T_0=-1.904$ and $S_0=34.912$.

The difference in source salinity is thus $34.912-34.906=0.006$.

L200: The mooring records are nice and long, but with only 10 storms over three years, discussing statistics in this way might make it sound like the conclusions about seasonality are stronger than the data can support. Perhaps rephrase this a bit? Just to give a sense of the uncertainty. The word "tendency" is used later, and that's quite nice.

Re..: We agree, and have rephrased our comments on seasonality:
L208-209: *"There is also a tendency for a seasonal signal at the slope moorings, where 70% of the events that cause a significant storm response occur in this period."*

L207: I don't understand why this sentence is constructed like this. The sense is "*Even though* the mean current ....other moorings, the average significant storm response ......". These two observations are unconnected, surely?

Re.: We understand the confusion. The point we were trying to get across was i) the storm response is northward, as expected, and ii) although the background current speed and its variability are higher than at the other moorings, we detect significant storm responses.

The latter point is, however, crucial to specify, and we have simplified the sentences as follows:
L214-216: *"We therefore expect the storms to induce enhanced outflow (i.e., northward flow) at M_sill5 and this is confirmed by the observations (Fig. 7c, Table 2)."*

L212: This reads as though it was found in only one year (2009). I assume that is not what is meant here?

Re.: This interpretation is correct - we mean to state that this seasonality in correlation between the overflow and the wind is found for this year only in this study. There is, however, a typo here; it should be 1977 and not the year 2009. We have, however, removed this paragraph altogether from the updated manuscript.

L216: what does this refer to? Is this the mooring period from the previous sentence? Perhaps move it to before the opening bracket? "...response events during the same period"

Re.: The sentence where this was mentioned is removed in the revised manuscript.

Section 3.3: This is quite difficult to interpret - not a helpful section title.

Re.: We have changed the section title to: "*Which atmospheric conditions trigger a storm response?"*

L275: I think it would be helpful to spell out what is correlating with what . Or perhaps delete this?

Re.: We have changed the sentence as follows:
L261-263: "*Interannual variability in the sensitivity to wind forcing on monthly time scales was also observed in the Antarctic Coastal Current (M_CC , mooring location shown in Fig. 1) and on the sill of Filchner Trough (15-day low-pass-filtered, Daae et al., 2018)."*

Figure 10, caption: I'm not sure if I missed it, but what are the two different thetas? Little theta is potential temperature and big theta is what? And does the change in salinity really make so much difference that an average value couldn't be used?

Re.: The difference is that little theta is potential temperature and big Theta is conservative temperature (CT). As you suggest, we have checked whether it seems OK to use average salinity to present CT instead of potential temperature for consistency. The change is minor, and we now present the conservative temperature instead. The panel is now part of Figure B1, and the caption is updated as follows: *"f) Progressive vector diagram of the current at the bottom sensor of M_CS2 colored by temperature. The temperature is based on the average absolute salinity (at the nearest sensor level) because the salinity sensor stopped recording in early 2020."*

L340: But the authors already have already suggested a link ("related to") in the previous sentence. Perhaps redraft?

Re.: We agree that this is unclear referencing. We have rewritten to clarify:
L329-333: *" Following the start of 2019, Ronne-sourced ISW is already consistently present at 76◦S and the current has veered eastward (Fig. B1c,f). Due to this offset in timing between the shift in hydrography and circulation following the transition from Berkner to Ronne mode and the shift in storm response along the continental slope (Mslope1 and Mslope2) and in Filchner Trough (MCS2), we are hesitant to suggest a direct link between the events. "*

L350: I think this could be redrafted. The circulation is clearly the way heat is brought towards the ice shelf, and the present study confirms (the authors assert) that storms play a role in strengthening that circulation. A possible replacement for the sentence might be something like: "The present study, however, provides evidence that storms over the continental shelf upstream of the Filchner Trough are able to strengthen the southward flows of heat towards the Filchner Ice Front.", provided that's what the authors mean.

Re.: Thank you for the suggestion. We have updated the final sentence as follows (L296-298): *"The present study, however, provides evidence that storms along the coast upstream of Filchner Trough can enhance the circulation on the shelf, potentially allowing heat to reach the ice front before it is lost to the atmosphere through wintertime convection."*

Fig A2d: In this figure it looks like the ocean speed is increasing long before the start of the stress anomaly. Is that intended by the sketch?

Re.: Thanks for pointing this out – this is not intended. The purpose is to specifically indicate tau_max, but it is more realistic that the peak in stress is broader. We have updated this subpanel (now Figure A1d) to avoid this confusion.

Figure A3b: What is the rationale for selecting <-2.05C as the definition of ISW? I assume it's to make the identification unambiguous and avoid "dithering" in the identification?

Re.: We use -2.05C as the threshold to highlight the presence of the very coldest water masses. When setting the threshold to -2.0C, the pattern is very similar as shown by the grey vertical lines (now Figure B1b). The higher the temperature threshold, e.g., at -1.8C, the more we are simply highlighting the seasonality of the temperature at M_CS2 - which is not what we want to emphasize. We want to emphasize that there appears to be a shift in how often the very coldest water is present, and thus we chose -2.05 as our threshold.

Dear reviewer,

Thank you for reading our manuscript so thoroughly and for your input. Your major comments helped us clarify several aspects and helped us improve our manuscript substantially.

We hope we have addressed your comments satisfactorily.

Sincerely,
Vår Dundas, on behalf of all co-authors

The authors present an observational analysis investigating the effect of storm events on warm inflow at the Filchner Trough. I am not that familiar with the existing literature on this topic in this particular region, so can not comment on the novelty of the work. However, I found the results interesting, the manuscript well-written and figures nicely presented. I recommend publication after my comments are addressed.

Major comments:

1. The authors appear to treat ERA5 as 'truth' and do not discuss how inaccuracies in the wind stress they use from ERA5 may impact their findings. How good is ERA5 in this region? Have any past studies validated it against nearby in situ weather station data (if any exists)? Is it possible that inaccuracy in the representation of wind stress in ERA5 could be the explanation for the complicated ocean response. e.g. Imagine ERA5 overestimates the wind stress for some storms but not others, could that explain why there is no response to some storms?

   Re.: Thank you for pointing this out. ERA5 underestimates coastal wind and wind speeds over 20 m/s in this region (Caton Harrison et al., 2022). It is therefore likely that the strongest wind events we look at during our study period are even stronger than what we estimate.

   To highlight this issue, we have added the following to sections 2.3 "Atmospheric and sea ice data":

   L125-128: "*We consider the ERA5 reanalysis a suitable data source for our purposes, as in situ observations are sparse and have limited spatial coverage. Caton Harrison et al. (2022) conducted a detailed comparison of coastal easterlies in three reanalysis products with satellite and in situ observations and concluded that ERA5 has the overall best performance. However, ERA5 underestimates coastal wind and wind speeds exceeding 20m s−1 in this region (Caton Harrison et al., 2022). It is therefore possible that the strongest wind events identified during our study period are underestimated in magnitude.*"

2. I am confused by the specific choice of the 'Upstream box'. It would be helpful to discuss further the sensitivity of the storm response to the location of the 'Upstream box'. The authors argue that it is not sensitive to location based on Fig A1. However that figure shows perhaps a correlation of only ~0.5 between the upstream box and the region closer to the trough inflow. Intuitively I would have thought that moving the box say 20 degrees west (to 20-25W) would result in a stronger connection to the inflow. If there is a physical justification why the chosen upstream box has the strongest connection to trough inflow, it would help future studies to explain further why this particular region is dynamically important.

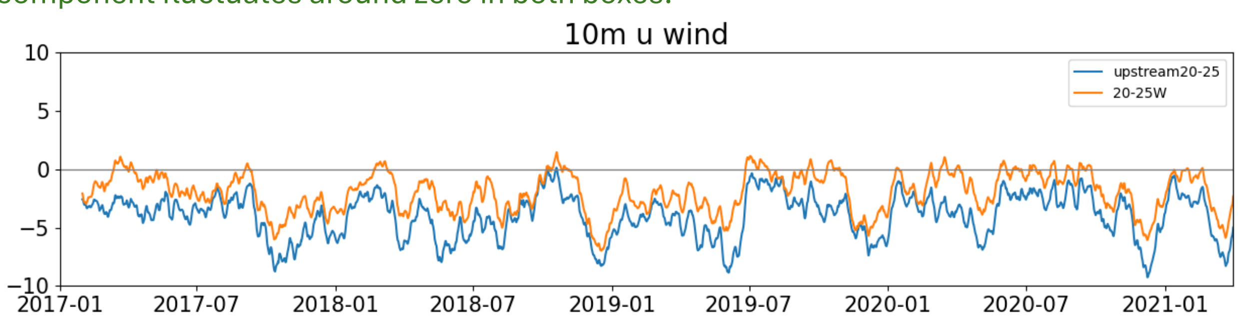
Re.: We appreciate this comment (and apologize for the somewhat lengthy response).

We base this mainly on:

- Previous results by e.g., Daae et al (2018) and Lauber et al (2023), who find that upstream atmospheric conditions are of particular importance for the local current speed along the Weddell Sea continental shelf break,
- We do not want to choose a substantially larger box, as this would smooth the time series of the ocean surface stress and potentially average out the strongest stress events. Therefore, we cannot, e.g., use the bounding applied by Daae et al., 2018.

Before settling on the Upstream box, we did parts of the initial analysis with the wind field over a more local box over the Filchner Trough's sill region. We concluded that, although the overall stress in this region is weaker, the main variability and statistics remain similar. The atmospheric patterns are generally large relative to our study region, and thus, we expect similar wind stress forcing along the coast east of Filchner Trough. The sea ice cover might, however, vary considerably.

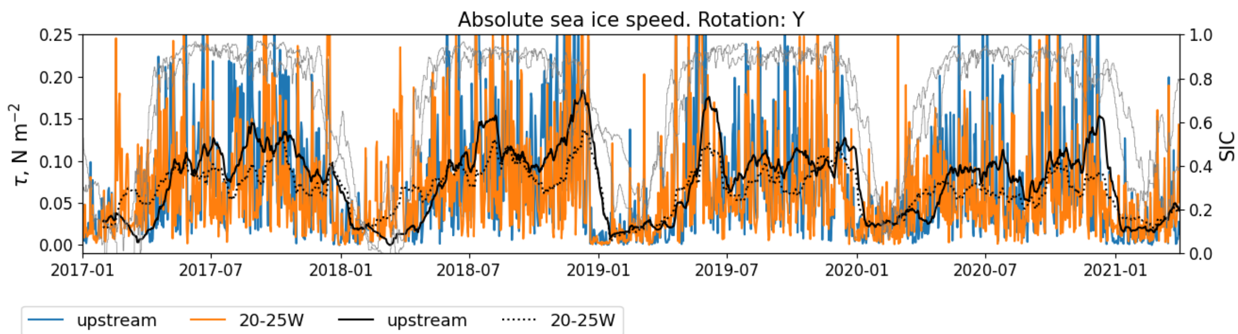
In response to your comment, we have run through the final version of the storm-identification algorithm with the suggested region, from 25W-20W and 74S-72S. The 10m u-component of the wind has very similar variability on both monthly and daily time scales (figure below), but the 25W-20W box has lower wind speeds. The v-component fluctuates around zero in both boxes.



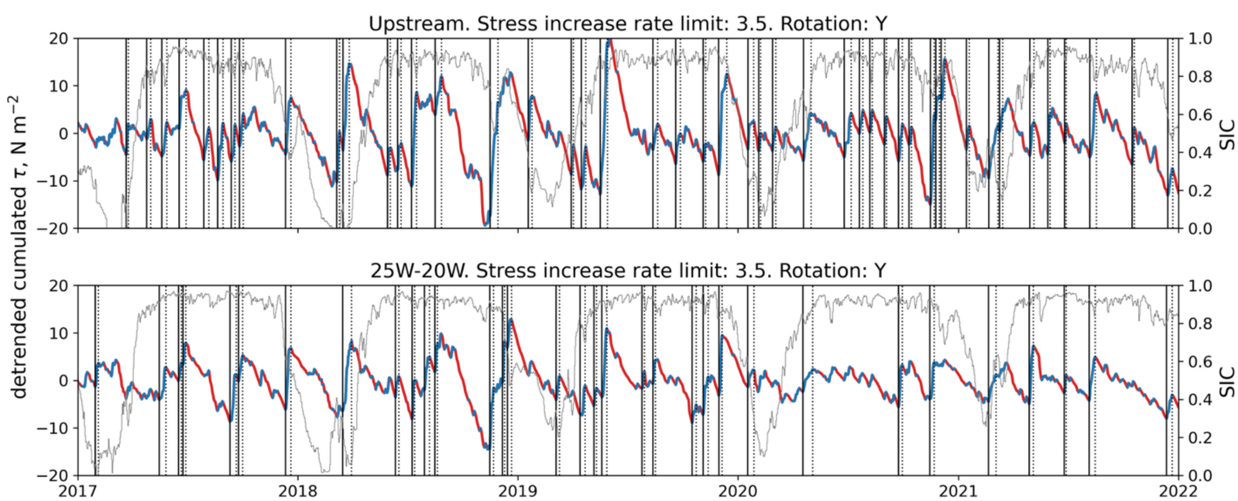
Similarly, the sea ice movement has a similar variability in both regions, but the movement is generally less in the more western box (figure below titled "Absolute sea ice speed”). The grey lines in the background are SIC for both regions, and the black lines are the 30-day rolling averages of the sea ice movement.

We would like to emphasize that the figures below differ from the figures submitted in our review response in the previous step of the revision process, since we found a mistake in the estimation of sea ice stress.

Following the correction of this error, the stress and identified storms over the 25-20W box and the Upstream box are more similar. The absolute values of the total stress are also higher, and thus we have raised the required limit of stress increase rate to 3.5N m-2 for both regions. Some summer-time storms are thus no longer included as they no longer meet the criteria for stress increase. The storms are, consequently, now spread more evenly throughout the seasons.



Running the “storm”-identification algorithm yields these storm events. Vertical black solid and dashed lines indicate the start and end of storm events:



As mentioned in the letter to reviewers in the previous step of the revision process, we have also investigated the events of significant current increase at M_slope1 and M_slope2 independently of the storm events and compared this to the identified storm events as an independent procedure.

We find that for both slope moorings, roughly 60% of all significant current increase events (using the significance threshold from the main analysis as stated in Table 2) appear to be associated with storm events over the Upstream box. When identifying storm events using the 25-20W box, the value is reduced to roughly 40% for both moorings. This strengthens our confidence in using the Upstream box in our analysis.

Since the identified storms over the two regions are similar, but more events are registered over the Upstream box, and the coherence between current increase and storm events is higher for the Upstream box, we keep the choice of the Upstream box. However, we note that any choice of region used to estimate storm events will miss out on some atmospheric forcing that might trigger a sudden increase in ocean currents.

To explain these aspects better, we have added lines 144-151 to the manuscript: *"The "Upstream box" was chosen because upstream wind forcing has been found to drive variability in circulation in this and similar regions on longer timescales (Daae et al., 2018; Lauber et al., 2023). The wind-speed variability in the Upstream box is representative of the conditions in a large area surrounding the box (Fig. A2). A comparison of storm events identified using the Upstream box and a more local box (Fig. A3) gave similar but slightly poorer coherence between storm events and storm response at the slope moorings for the local box. The variability in the ASC strength observed at the slope moorings is relatively high and caused by e.g. baroclinic eddies, continental shelf waves Jensen et al. (2013), and remote wind forcing (Webb et al., 2019). We therefore do not expect to explain all ASC variability by using our Upstream box, but rather aim to identify regionally forced peaks in ASC strength"*

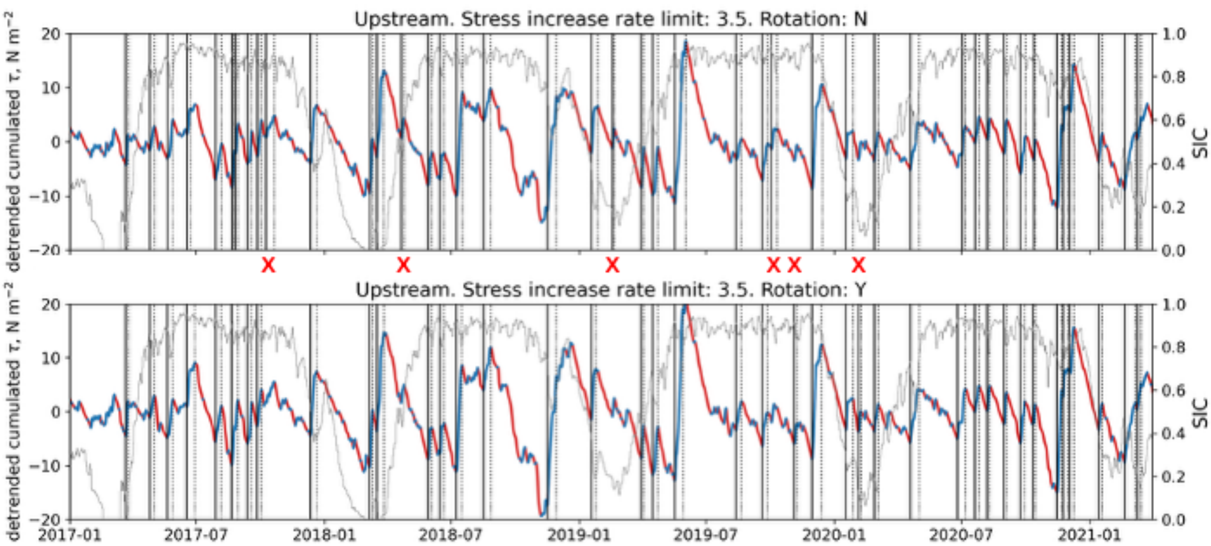
3. I found it unclear whether total stress or westward stress is used in the identification and characterisation of storms. Mostly throughout the text just "stress" on its own without a direction is used. I would interpret this as total stress. But sometimes (e.g. line 130) "westward stress" in particular is used. Please be clear throughout the manuscript whether stress is total or westward only.

   Re.: Previously, we consistently used westward stress since the difference between this and stress rotated to match the bathymetry was minor. However, we have decided to rotate the stress in the revised study as this makes more physical sense in relation to coastal Ekman transport processes and buildup of SSH anomalies. More details are provided in the response to the next question.

4. In relation to the last point, does the direction of the wind stress have an impact on the storm response? Based on the mechanism described in the introduction, I would have thought that along-slope wind stress would be more important than westward wind stress (which is what I think has been used).

Re.: When working on why the storms sometimes give enhanced current and other times not, the direction of the ocean surface stress both before and during the event was one of the aspects we considered. We did, however, find that this did not appear to explain the difference in storm response.

When running the storm-identification algorithm with and without a 30-degree counterclockwise rotation of the coordinate system, which roughly corresponds to the angle of the bathymetry in the upstream box, there is only a minor change in the identified storms (figure below). Black solid and dashed lines indicate the start and end of storm events, and the storms that are identified using one method but not the other are indicated by a red "x".



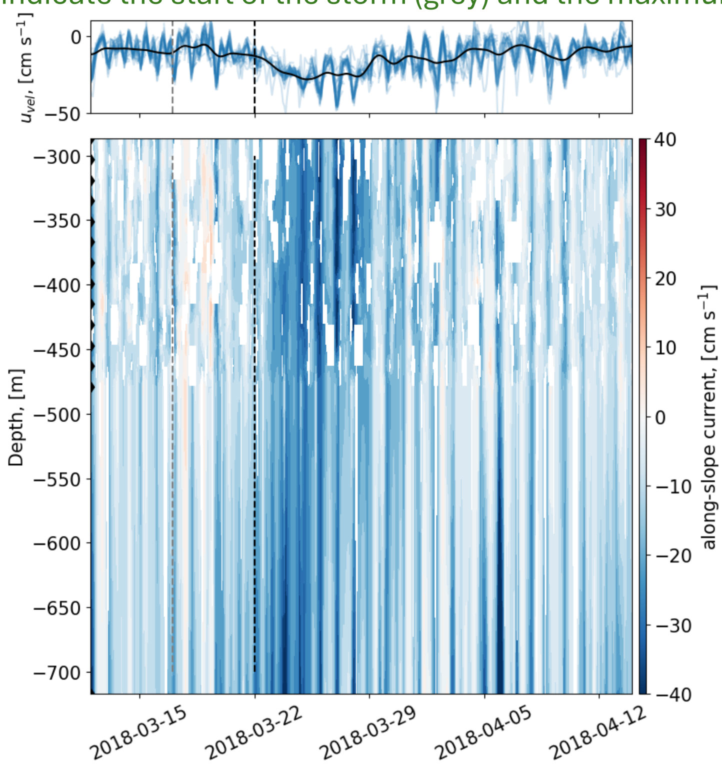
While the difference between rotating the coordinate system and not is small, we agree that it makes more physical sense to apply a rotation with the bathymetry, and thus, we rotate 30 degrees counterclockwise in the analysis in the revised manuscript.

We have added lines 115 to 116 to specify: *"The coordinate system is rotated 30◦ counterclockwise to roughly align with the coast in the Upstream box, and we use the along-slope component of the ocean surface stress in the following analysis."*

5. Out of curiosity, how barotropic is the response in the moorings? From what I can tell, only depth-averaged flow is used in the analysis. Also, is there any response in temperature or salinity after storms? This point does not need to be included in the manuscript if the authors do not wish to. I am just asking in case there is something interesting to say there that could add to what is currently in the manuscript.

Re.: This question is a bit tricky to address, as the resolution of velocity measurements varies from mooring to mooring, and thus, we cannot state a common statement for all locations. The best vertical resolution is at the moorings Mslope1 and Mslope2, and these indicate that the response is relatively barotropic, as expected from the proposed coastal Ekman transport mechanism. There is, on average, a clear baroclinic component of the current at these two slope moorings with a bottom-intensified velocity field (Darelius et al., 2024), but the increase in the westward current following the storm is (relatively) depth independent.

Below is an example of the storm response with depth at M_slope2 during the storm event in March 2018, used in the case study. The upper panel shows the time series at each depth in pale blue, while the depth-average is shown in black. The color in the lower panel indicates the along-slope velocity in cm/s. The dashed vertical lines indicate the start of the storm (grey) and the maximum stress during the storm (black).



We comment on the response in the temperature field on page 11, third paragraph (line numbers are not given since this paragraph is next to the long Figure 5):

"The thermocline over the slope, represented by the −1.7◦C isotherm, is only weakly pushed down (on average ~30m at Mslope1 and ~40m at Mslope2 during the storms with a significant response at Mslope1 and Mslope2, not shown). This is substantially less than the high-frequency fluctuations in thermocline depth caused by shelf waves and tides (which are on the order of 100 − 200m, Semper and Darelius, 2017; Jensen et al., 2013), and thus, depression of the thermocline caused by the storms does not

substantially impede the access of warm water onto the continental shelf. The thermocline response to storm events is similar in summer and winter (28m and 33m at Mslope1, respectively). Our results, therefore, do not support the hypothesis that the ASF may be protected from the wind by the fresh and warm surface layer during summer, as suggested by Daae et al. (2017) and Hattermann (2018).

Since the impact on the thermocline is relatively weak and we do not detect a strong seasonal dependency, we have not commented on this further in the manuscript.

Minor comments:

1. Line 10: “increased southward current speed”. It would help readers who only read the abstract to clarify that this is speed of mWDW, and not e.g. surface speed.

   Re.: We have rewritten this sentence as follows to make this distinction clear (L10-11): *“[...] while roughly 25% of the identified events also cause increased southward current speed on the shelf at depths where mWDW is expected to be present during the summer and autumn.”*

2. Figure 1 caption: The units of ‘5 cm s−1’ are not formatted correctly.

   Re.: Thank you for noticing. We have corrected this in the updated version of the manuscript.

3. On page 10: The authors use “fall” as the season. Please change to “autumn” or MAM.

   Re.: We have changed “fall” to “autumn” throughout the manuscript.

4. Figure A2c needs an x-axis label.

   Re.: Thank you for noticing. We have corrected this in the updated version of the manuscript. It now says “U_response, cm s-1”.

Dear reviewer, Angelika Renner,

Thank you for reading our manuscript so thoroughly and for all your comments – your input helped improve and tidy up our manuscript substantially.

We hope we have addressed your comments satisfactorily.

Sincerely,
Vår Dundas, on behalf of all co-authors

The authors present a study into the effects of storms on the Antarctic Slope Current and southward heat transport towards the Filchner Ice Shelf based on data from a network of moorings. The study is a continuation of a previous model-based exploration of storm-driven flow in the region. While the mooring data had been used previously in various studies, the authors did a commendable job in pulling them together and providing a combined analysis. The manuscript is well organised and written. I only have minor comments for improvement before publication.

- Formatting of units: I'm sure the journal will apply their typesetting before publication, but there's quite a mix of i) space or no space between number and unit, and ii) inconsistency in use of superscript, e.g., cm/s versus cm s^{-1}, even within the same figure (e.g., Figs. 5, 6, 9, A3).
  Re.: Thank you for pointing this out. We have made sure all such typesetting is consistent in the resubmitted manuscript.

- Line 23: typos/grammar: «intrusionS» and «extend»
  Re.: Corrected.

- Line 49: what sort of distances does this traverse of the continental shelf imply?
  Re.: Roughly estimated, the distance from shelf break to cavity is 400 km.

  We have rewritten this sentence (L49-52) to specify this: *"In the current climate, the water column on the shelf is homogenized during winter (Ryan et al., 2017; Sallée et al., 2024), and all heat is lost to the atmosphere. The warm inflow must therefore traverse the roughly 400km-wide continental shelf during the summer season if it is to reach the ice front and the Filchner Ice Shelf cavity."*

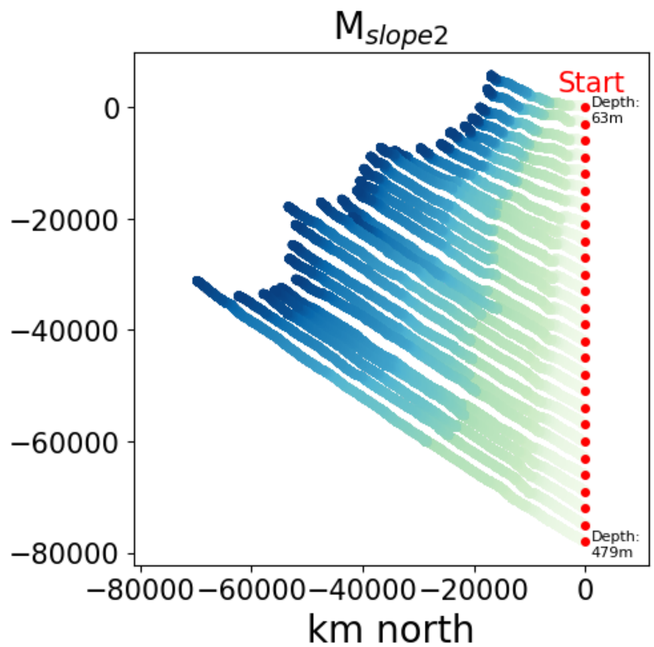
- Lines 60-63: What is the Berkner mode then?
  Re.: We have included a comment on the Berkner mode characteristics as follows (L63-65): *"The "Ronne"-mode is characterized by large-scale cavity circulation and enhanced outflow of high-salinity Ronne-sourced ISW through Filchner Trough, while the "Berkner"-mode is characterized by more prominent local circulation and locally sourced ISW with lower source salinities (Hattermann et al., 2021; Janout et al., 2021)."*

- Section 2.1: Do you have any information on the types of instruments, calibration and processing procedures?
  Re.: This information can be found in the data publications. We have added references to the data publication in Table 1 to make this information more accessible.

- Figure 2: Introduce ADCP and explain the variable T, S, v…
  Re.: The caption of Fig. 2 is updated as follows to specify the variables in the sketch: *"Sketch of the moorings indicating the depths with observational records according to the legend. Tightly spaced turquoise lines indicate ADCP (Acoustic Doppler Current Profiler) bins (Msill1, Mslope1, and Mslope2), and dotted lines indicate discarded bins."*

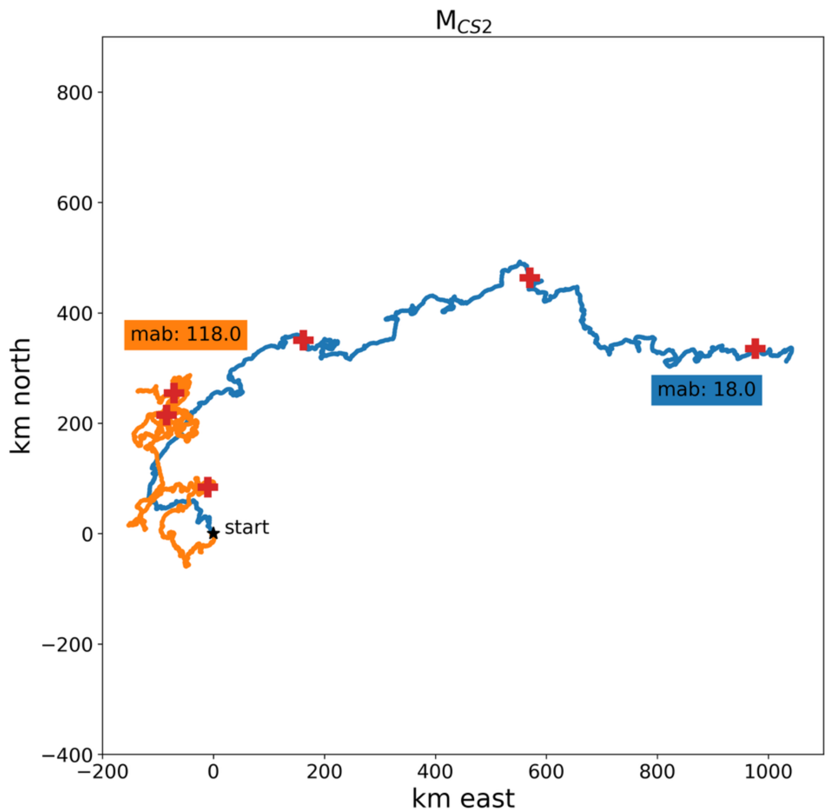
- Line 92-93: Why do you treat M_{CS2} differently?
  Re.: We treat M_CS2 differently mainly because we're interested in the transport towards the cavity. The mean current direction during the mooring period was both uncharacteristic compared to previous observations and not southward. Also, we expect the storms to set up a relatively barotropic response, which follows the bathymetry. Therefore, we align the coordinate system at MCS2 with the southward bathymetry. At the other moorings, the main current is already more or less aligned with the bathymetry, and thus rotating the current with the mean current direction makes physical sense here, but not at M_CS2.
  We have added a comment on this as follows (L90-92): "*At MCS2 we align the coordinate system with the local isobaths as the mean current direction shifts (Ryan et al., 2017, and Fig. 1). After rotation, a negative sign indicates flow towards the southwest.*"

- Line 96-102: How do you justify the choices to use depth-average currents (do you include the bottom sensors even though they stopped early?), longest time series, or depth with highest velocity? And which depths are those then?
  Re.: The overall reason is that we try to use the most complete observations we have available at each mooring location.
  The ASC has a strong baroclinic component, however, we expect the storm-driven current response to be barotropic, and we find no abrupt changes in the velocity with depth (see figure titled M_slope2 below). Thus, using depth-averaged currents fits our purpose. For the slope moorings we ran the storm-response algorithm both with and without including the bottom sensor, which stopped working before recovery, and found that this does not substantially impact the results. The incomplete resolution of the current in the upper levels of the ASC hinders a detailed assessment of barotropic vs baroclinic components and responses at the slope moorings. An example of the vertical current response to a storm event is included in the response to reviewer number 2's comment number 5.



M_Sill1 had an ADCP that sampled the lower water column, but this stopped sampling nearly halfway through the deployment period. We therefore chose to only consider the data from the instrument that sampled the full time period for the most consistent comparison of surface stress forcing and oceanic response. mWDW is indeed present at the upper velocity instrument depth (Steiger et al., 2023), and thus the storm response in the current at this depth is relevant for transport of warm water southward into the Filchner Trough.

At MCS_2, the lower sensor has higher velocities than the upper sensor, shown in the progressive vector diagrams below. The red "+" signs indicate the 1st of January each year, and the black star is the starting location. Due to the weak and unstructured nature of the current in the upper level, at 118 mab (orange), we have focused on the currents closer to the bottom (blue).



To make it clearer which velocity levels we use in our analysis, we indicate unused levels by dashed lines in Figure 2 and include lines 95-98: "*Where possible, we have used the depth averaged current as we expect the storm response to be mainly barotropic (Mslope1, Mslope2, MST). At Msill1 where the time series from one level is significantly longer than the others we chose to include only data from that level. At mooring MCS2, the currents at the upper instrument are weak and erratic, and we chose to include only the lower level. The levels included are marked in Fig. 2.*"

- Table 1: Maybe add the relevant references for each mooring so that it's easier to find information on the sensors and the processing?
  Re..: We agree, and have added references to the data publication in Table 1 to make this information more accessible.

- Line107: Should this be Figure 6 instead of 5?
  Re.: Correct, thank you for pointing this out.

- Line 123: Add that rho_water and rho_air are densities
  Re.: Included as suggested.

- Line 165: Explain what cp and L_f are
  Re.: Included as suggested.

- Sections 3.1 and 3.2: Check the figure references, I think they point to the wrong figure(s)
  Re.: We apologize for the errors in figure referencing, and have made sure that all figure references are correct in the updated version of the manuscript.

- Line 192: change "which is" to "which are"
  Re.: Corrected.

- Line 231: correct bracket around reference
  Re.: Corrected.

- Section 3.3: The text in this section should be streamlined a bit, could be more concise and precise.
  Re.: We have gone through this section and rewritten it to make it more concise.

- Lines 247-257: What about potential influences of seasonality in hydrography on the storm response?
  Re.: In section 3.2 we comment on the effect of storms on the thermocline at the slope moorings in relation to studies by Hattermann (2018) and Daae et al., (2017) who find that a freshwater layer protects the ASF from deepening. We do, however, not see such a substantial seasonal difference in the deepening of the thermocline due to storms during summer vs. during winter. If we did observe a seasonal difference in the deepening of the thermocline, this could have indicated a seasonal dependency of how efficiently the surface momentum is transferred into the ocean layers, and that the hydrography itself might affect the ability of the storms to cause enhanced circulation. The lack of such a difference in thermocline deepening suggests that the stratification does not affect this rapid storm-enhanced circulation.

  The sea ice cover can, however, have a large impact on the ocean surface stress, which makes seasonality relevant for the storm response. But we have not found evidence that the seasonality in the hydrography itself plays a major role in the storm response.

- Discussion & abstract: I miss a broader impact discussion or statement – how much does this storm-driven heat transport contribute to the total heat transport towards the Filchner ice shelf, i.e., how important is it actually? And what are implications?
  Re.: Regarding this, we agree that we can make this clearer and have rewritten the end of the abstract and parts of the conclusion to emphasize these implications.

  End of the abstract (L13-16): "*This study highlights the potential importance of storms for southward heat transport: an accelerated circulation on the shelf increases the likelihood for warm summer inflow to reach the ice shelf front and cavity before the heat is lost to the atmosphere through winter convection.*"

Start of conclusion (280-285): "*We analyze a network of moorings and confirm that storms can enhance the circulation on the southeastern Weddell Sea continental shelf. These events do not have a systematic significant ocean current response but when they do, they clearly strengthen the westward Antarctic Slope Current (ASC), the dense outflow from Filchner Trough, the southward flow along the eastern flank of Filchner Trough, and the inflow through the Small Trough. Our findings provide observational evidence that storms can enhance the southward transport of warm water towards the Filchner Ice front, as suggested by Darelius et al. (2016) and by the numerical experiments of Dundas et al. (2024).*"

We have rephrased and simplified the next-to-last paragraph of the conclusion to make the potential importance of the shift we observe in 2019 clearer (289-292): *"The interannual variability in the storm response - notably the apparent shift in 2019 that we are unable to explain – highlights the importance of ambient conditions in determining the response of the ASC and the currents on the continental shelf to wind forcing. It also points to a knowledge gap that needs to be addressed if we are to predict how the system evolves in a future of climate change."*

End of the conclusion (293-298): *"Longer observational time series from the region, in combination with designated experiments in a regional model setup, would help us to further understand the observed variability in storm response. A regional model could also provide estimates of the storm-driven heat transport across the shelf and its importance relative to the heat transport driven by the background flow. The present study, however, provides evidence that storms along the coast upstream of Filchner Trough can enhance the circulation on the shelf, potentially allowing heat to reach the ice front before it is lost to the atmosphere through wintertime convection."*

As mentioned at the end of the conclusion, it would be useful to quantify the southward heat transport added by the storm activity during the study period, but such a quantification based on the mooring data would be connected to too much uncertainty to provide practical information. We do not know whether the moorings capture the core of the warm current, how broad the warm current is, or what the hydrography looks like in the upper 300 m of the water column. Furthermore, although the velocity response comes rapidly and can be associated with specific ocean surface stress events, the hydrographic response is advective. It is thus much trickier to associate increases in temperature than velocity with ocean surface stress events based on observational data.

We note that it appears that the most significant storm response events occur during periods of reduced sea ice. In a future with less sea ice and a weaker sea ice cover during a larger portion of the year, the number of significant storm-driven circulation events might thus increase. Less sea ice is also a primary suggested mechanism for driving enhanced presence of warm water on the Southeastern Weddell Sea continental shelf (Hellmer et al., 2012, 2017). This implies that combined, these two mechanisms (an increased number of significant storm-driven circulation events and increased availability of warm water on the shelf) might play a role in transporting an increasing volume of warm water into the Filchner Ice Shelf cavity before the on-shelf heat is ventilated to the atmosphere.

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The effect of storms on the Antarctic Slope Current and the warm inflow onto the southeastern Weddell Sea continental shelf

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Abstract. The southern Weddell Sea and the Filchner Ice Shelf ~~cavity~~ are locations of dense bottom water production and are thus connected to the global climate system. However, it has been suggested that increased heat transport from the deep ocean onto the continental shelf and towards the ice cavities would disrupt ~~the~~ dense water production and increase ice shelf melt rates. Processes that affect the southward heat transport are~~,~~ therefore~~,~~ important to understand. Sudden strong westward ocean surface stress events – "storms" – ~~are~~ suggested to drive enhanced southward transport of modified Warm Deep Water across the continental shelf in the Filchner Trough region in the southeastern Weddell Sea. We use ~~a mooring network with up to four year long mooring records from the region~~ to investigate how the ocean circulation responds to storm events. We find that about 70% of the events that last longer than four days, have a cumulative westward stress increase larger than $0.4\,\mathrm{N\,m^{-2}\,day^{-1}}$, and a maximum stress above $0.25\,\mathrm{N\,m^{-2}}$ leads to a significant increase in the speed of ~~the~~ Antarctic Slope Current (ASC) just upstream of Filchner Trough. Roughly one-third of the identified storm events cause an increased southward current speed on the shelf. At the southernmost mooring, 76°S, storm responses are observed mainly during the latter part of the record (mid-2019 to early 2021). This interannual variability in storm response indicates a potential dependency on background hydrography and circulation that remains to be fully explained. This study highlights the potential importance of storms for southward heat transport towards ~~the~~ Antarctic ice shelves. Warm water that is present on the continental shelf during a storm will likely be pushed southward by the enhanced circulation, increasing the southward heat transport and the likelihood that it reaches the ice shelf front before the heat is lost to the atmosphere during winter.

1 Introduction

Sudden strong ocean surface stress events – "storms" – are suggested to cause enhanced southward transport of modified Warm Deep Water (mWDW, ~ -1.5°C to 0.0°C, Nicholls et al., 2009) across the continental shelf in the southeastern Weddell Sea (Darelius et al., 2016; Dundas et al., 2024), which is today characterized as a cold, dense shelf region (Thompson et al., 2018). Southward intrusions of mWDW, originating from the open ocean north of the continental shelf break (Ryan et al., 2016),

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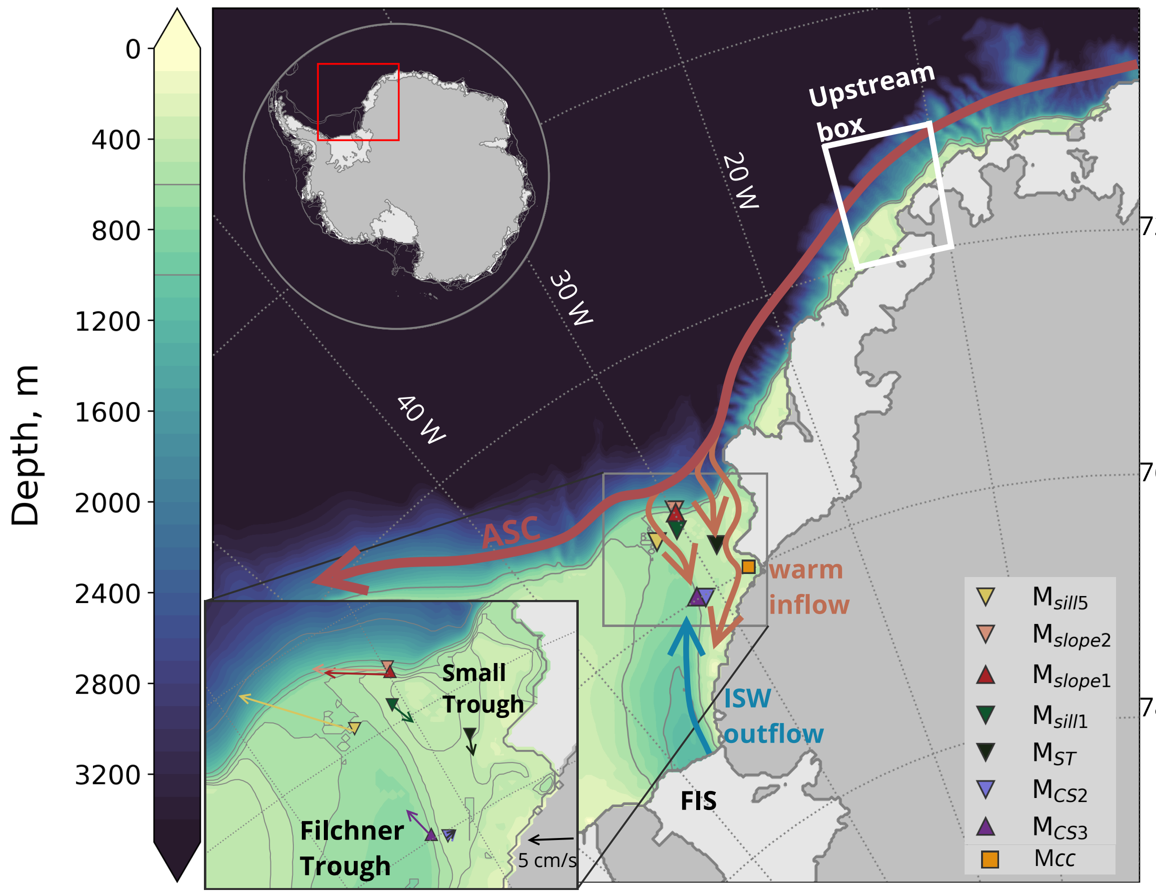

Figure 1. Bathymetry, the ice shelves, and the ice sheet from Bedmap2 (Fretwell et al., 2013) with selected depth contours (gray lines on map and colorbar). The red box in the inset in the upper left corner indicates the study region. The mooring locations of M_{slope2}, M_{slope1}, M_{sill1}, M_{ST}, M_{sill5}, M_{CS3} and M_{CS2} are indicated by colored markers. The orange square (M_{CC}) indicates the location of a mooring that captured the Coastal Current from 2003 to 2004 (Daae et al., 2018; Nicholls, 2005). The inset in the lower left corner zooms in on the mooring locations and shows their vertically averaged current, with a black scale arrow of 5 cm s$^-$1. The white box ("Upstream box") is used for estimates of the ocean surface stress. Filchner Trough, the Small Trough, and Filchner Ice Shelf (FIS) are labeled, and the main currents are indicated. The ASC (red arrow) and the Coastal Current and warm inflow through Filchner Trough (orange arrows) are based on Nicholls et al. (2009), while the northward ISW (blue arrow) is based on Darelius et al. (2014).

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are mostly limited to the summer season when the thermocline is shallow (e.g., Darelius et al., 2024b; Årthun et al., 2012). These intrusion of mWDW onto the continental shelf extend~~s up~~ ~~to~~ roughly 300 m depth, creating a thick layer of warm waters below the cold surface waters (e.g., Steiger et al., 2024; Årthun et al., 2012). The warm water then propagates southward throughout fall, reaching 76°S, roughly halfway south to the Filchner Ice Shelf, several months later (Steiger et al., 2024; Ryan et al., 2017). Darelius et al. (2016) suggested storms as a driver of particularly far-reaching intrusions of warm water as they observed coincid~~ing~~ events of strong, short-lived anomalies in wind speed and enhanced ocean currents carrying mWDW southward along the eastern flank of the Filchner Trough toward the Filchner Ice front. ~~In m~~odel studies~~,~~ mWDW entering the Filchner Ice Shelf cavity along this path ~~has been suggested to~~ potentially cause the system to change into a warmer regime with dramatically increased melt rates in the future (Hellmer et al., 2012, 2017). Enhanced basal melt affects sea level, hydrography on the continental shelf, deep water production~~,~~ and, by extension, the global climate (Orsi et al., 1999; Marshall and Speer, 2012; Jacobs, 2004). Given these implications, this study aims to deepen our understanding of how sudden strong wind events affect the circulation and the transport of heat in the region.

A strong horizontal density gradient known as the Antarctic Slope Front (ASF), separates the cold shelf waters from the warm water of the open ocean (e.g., Gill, 1973; Jacobs, 1991; Thompson et al., 2018). In the Weddell Sea, the ASF relaxes during summer due to weaker wind and stronger surface stratification (Hattermann, 2018; Daae et al., 2017) and allows warm water to access the continental shelf (e.g., Årthun et al., 2012; Ryan et al., 2017; Steiger et al., 2024). The persistent westward wind field (Hazel and Stewart, 2019) and the ASF support the strong westward Antarctic Slope Current (ASC, e.g., Thompson et al., 2018; Gill, 1973). The ASF and the ASC thus make up a strongly coupled system. The strong easterlies during winter lead to Ekman convergence and coastal downwelling that will act to steepen the ASF and sustain a strong ASC (Thompson et al., 2018). The winds are generally weaker during summer while the surface stratification is stronger (Hattermann, 2018). This allows for a relaxation of the ASF and a weaker ASC. ~~However,~~ the relationship between the wind, the ASF, and the ASC is different on short time scales.

Sudden strong easterlies increase the Sea Surface Height (SSH) slope through Ekman transport towards the coast, which enhances the barotropic component of the ASC. This is the main mechanism by which storms are suggested to enhance the heat transport towards the Filchner Ice Shelf cavity: a barotropically increased ASC due to storm-driven enhanced SSH-slope ~~accelerates~~ the circulation on the shelf and ~~moves~~ warm waters already present on the continental shelf ~~faster towards the south~~ (Darelius et al., 2016; Dundas et al., 2024). The water column on the shelf is homogenized during winter and all heat is lost to the atmosphere (Ryan et al., 2017), so the warm inflow must traverse the continental shelf during the summer season if it is to reach the ice shelf cavity.

The deep Filchner Trough crosscuts the southeastern Weddell Sea continental shelf and acts as a southward gateway for mWDW towards the Filchner Ice Shelf cavity in the south (Fig. 1). At the mouth of Filchner Trough, the ASC bifurcates as the diverging isobaths steer a small branch of the current southward along the eastern flank of the trough (leftmost orange arrow in Fig. 1, e.g., Nicholls et al., 2009; Foldvik et al., 1985). Part of this southward-flowing current recirculates on the sill and joins the northward flow of Dense Shelf Water (DSW, Daae et al., 2017; Foldvik et al., 2004). The remainder of the current continues south (e.g., Daae et al., 2017; Steiger et al., 2024), advecting warm mWDW southward along the eastern

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flank of Filchner Trough and onto the continental shelf east of the trough (e.g., Ryan et al., 2017; Darelius et al., 2016; Daae et al., 2020). Intrusions of mWDW have also been observed further east as indicated by the two easternmost arrows in Fig. 1 (Steiger et al., 2024; Nicholls et al., 2009). In addition to the effect of the shelf break processes, this overall circulation in Filchner Trough is affected by large scale variability in the ice shelf cavity such as shifts between the "Berkner" and "Ronne" modes of Ice Shelf Water production (ISW, below-freezing temperatures, e.g., Foldvik et al., 2004), where the "Ronne"-mode is connected to enhanced ISW outflow (Hattermann et al., 2021; Janout et al., 2021).

Numerical experiments performed in an idealized setup of the Regional Ocean Modeling System (ROMS, Shchepetkin and McWilliams, 2009) support the hypothesis that storms can enhance the southward heat transport as long as warm water is present on the continental shelf and the storm is sufficiently strong and long-lasting to cause a substantial increase in the circulation (Dundas et al., 2024). Previous mooring observations from the region, however, do not consistently show a relationship between southward transport and strong winds at 76°S (Ryan et al., 2017).

In this paper, we investigate how the circulation responds to strong wind forcing using up to four-year-long records of concurrent mooring data from the upper continental slope, the Filchner Trough sill, and the continental shelf east of the trough. We investigate the conditions during which strong ocean surface stress drives enhanced currents over the slope and into Filchner Trough. We first present a case study that shows the current's potential response to a sudden, strong ocean surface stress event. Secondly, we look at composites of the response to the strong ocean surface stress events as well as the average atmospheric conditions during these events. We then consider why some events cause strongly enhanced currents while others do not, and lastly, discuss a shift in hydrographic conditions and circulation that occurred during 2019, which appears to have impacted the potential of the ocean surface stress to cause strongly enhanced circulation on the southern part of the shelf. We, thus, provide new insights into the importance of storm events for the ASC and the southward heat transport in the ~~Filchenr~~ region and describe the nuances of why and when strong ocean surface stress events cause enhanced circulation in the region.

2 Data and methods

2.1 Mooring records

We analyze velocity, temperature, and salinity records from ~~seven~~ moorings in the Filchner Trough region in the Southeastern Weddell Sea (Fig. 1). The mooring names indicate their geographic location: M_{slope1} (Darelius et al., 2024a) and M_{slope2} (Darelius et al., 2023b) were positioned on the ~~upper~~ part of the continental slope and captured the ASC just upstream of Filchner Trough. M_{sill5} (Østerhus, 2024) and M_{sill1} (Steiger et al., 2024) captured the outflow and inflow on the Filchner Trough sill, respectively. M_{ST} (Steiger et al., 2024) was located in the trough just east of Filchner Trough, which we refer to as the "Small Trough" (Fig. 1). M_{CS2} (Darelius et al., 2023b) and M_{CS3} (Steiger et al., 2024) were located on the continental shelf on the eastern flank of Filchner Trough. The mooring locations are shown in Fig. 1, and their deployment details are given in Fig. 2 and Table 1. The mooring records span a varying period between 2017 and 2021, but their velocity records overlap for at least 20 months (Fig. 4).

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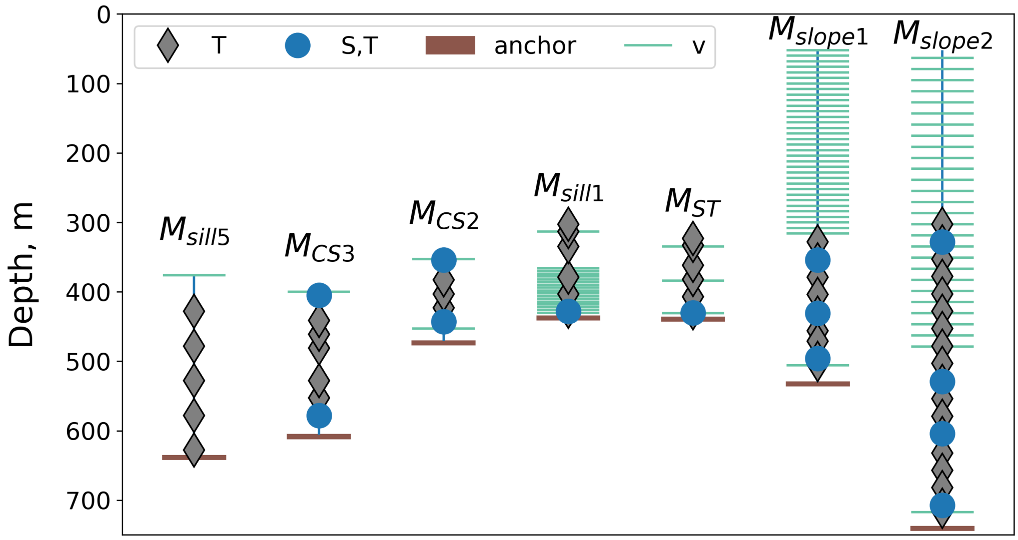

Figure 2. Sketch of the moorings indicating the depth of available observation records. Horizontal turquoise lines indicate measurements of velocity. Frequent turquoise lines indicate ADCP measurements (M_{sill1}, M_{slope1}, and M_{slope2}). The brown horizontal line indicates the bottom.

We rotate the coordinate system at each mooring to align with the mean flow direction (see Fig. 1), where a negative sign indicates current speed in the mean flow direction since the mean flows are roughly westward (M_{slope1} and M_{slope2}) and southward (M_{sill1} and M_{ST}). M_{CS2} and M_{sill5} are the exceptions: at M_{sill5} a positive sign indicates current in the main flow direction since the main flow direction is roughly northward, and at M_{CS2} we align the coordinate system with the local isobaths (see Fig. 1) with a negative sign indicating flow towards the southwest.

All analyses are carried out using hourly mean velocity records: we interpolate the data from moorings M_{slope2}, M_{CS2} and M_{sill5}, which are on a two-hourly frequency, onto hourly time steps.

For moorings with high vertical resolution (M_{slope1}, M_{slope2}, M_{ST}), we base the analysis on depth-averaged currents. At M_{slope1} and M_{slope2}, the data quality of the upper bins is poor during winter (due to too few scattering particles), and we've discarded levels with less than 43% data coverage at M_{slope1} and M_{slope2}. Data gaps shorter than six hours are filled by linear interpolation. The bottom sensor (Fig. 2) at both these moorings, which had the highest data quality and the strongest current (Darelius et al., 2024a), stopped recording in June 2019. For moorings with varying record lengths at different depths (M_{sill1}), we use the data with the longest time series, and for the moorings with strong vertical variability (M_{CS2}), we use the depth with the highest velocities.

We present temperature and salinity as conservative temperature, Θ, and absolute salinity, S_A, following TEOS-10, unless otherwise stated. We use the Gibbs seawater package for Python in conversions (McDougall and Barker, 2011).

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Table 1. Overview of the moorings. The indicated significance values for storm response are negative for all moorings except M_{sill5} because their main observed flow directions are westward or southward. The significance value at M_{sill5} is positive because the main flow direction is northward. No significance value is indicated for M_{CS3} because this mooring is dominated by northward flowing ISW and not used in the storm response analysis.

Mooring name	Original name	Deployment/ Recovery	Lon/ Lat	Bottom depth [m]	Significance value [cm s^{-1}]
M_{slope2} (UiB)	M3	24.02.2017 14.02.2021	29°54.48'W 74°33.00'S	740	-9.06
M_{slope1} (UiB)	M6	24.02.2017 13.02.2021	29°54.97'W 74°35.70'S	530	-7.64
M_{sill1} (LOCEAN)	P4	11.02.2017 15.02.2021	30°23.01'W 74°51.00'S	435	-6.01
M_{ST} (LOCEAN)	P5	09.02.2017 09.03.2021	28°38.22'W 75°23.38'S	437	-5.67
M_{sill5} (NORCE)	S2	07.02.2018 16.02.2021	31°49.84'W 74°51.32'S	636	17.75
M_{CS2} (AWI)	A253-3	05.02.2018 01.03.2021	31°01.42'W 76°02.74'S	471	-7.26
M_{CS3} (AWI)	A253-4	05.02.2018 02.03.2021	31°29.79'W 75°57.68'S	606	N/A

2.2 Atmospheric and sea ice data

We use 10 m wind velocity, sea ice concentration (SIC), and mean sea level pressure from ERA5 (Hersbach et al., 2023). For the maps in Figures 5 and 9, we use daily averaged output from ERA5. The anomalies of wind velocity and mean sea level pressure are referenced to monthly averaged March fields from 1990 to 2023. The sea ice concentration is referenced to the monthly climatology (average past 30 years), linearly interpolated onto daily values.

To estimate the ocean surface stress, $\vec{\tau}$, we average the three-hourly 10 m wind and SIC over a region upstream of Filchner Trough ("Upstream box", Fig. 1). We chose this region because upstream wind forcing has been found to drive variability in circulation in this and similar regions on longer time scales (Daae et al., 2018; Lauber et al., 2023). Since we investigate the effect of sudden strong ocean surface stress events, we make the Upstream box relatively small – we want to avoid smoothing out maximum stress values. To estimate the sensitivity to the choice of box, we estimate the correlation between the wind speed averaged over the Upstream box and the wind speed in the surrounding regions (Fig. A1). The correlation is high in a large region surrounding the Upstream box, so we infer that the sensitivity to the exact choice of the box is small.

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Ocean surface stress is estimated following Dotto et al. (2018), which estimates the air-ocean stress and ice-ocean stress separately and then combines these stresses as fractions of the SIC as follows:

$$\overrightarrow{\tau} = \alpha\overrightarrow{\tau}_{ice-water} + (1-\alpha)\overrightarrow{\tau}_{air-water}, \tag{1}$$

$$\overrightarrow{\tau}_{ice-water} = \rho_{water} C_{iw} |\overrightarrow{U}_{ice}| \overrightarrow{U}_{ice}, \quad \text{and} \tag{2}$$

$$\overrightarrow{\tau}_{air-water} = \rho_{air} C_d |\overrightarrow{U}_{air}| \overrightarrow{U}_{air}, \tag{3}$$

$$\tag{4}$$

where α is the SIC, $\rho_{water} = 1028\,\mathrm{kg\,m^{-3}}$, $\rho_{air} = 1.25\,\mathrm{kg\,m^{-3}}$, $C_d = 1.25\times10^{-3}$ and $C_{iw} = 5.50\times10^{-3}$ are the drag coefficients between air and ocean and ice and ocean, respectively~~,~~ and $\overrightarrow{U}_{ice}$ and $\overrightarrow{U}_{air}$ are the velocities of the ice and the air.

We use sea ice motion from the Upstream box (Fig. 1). The sea ice motion data is from NSIDC (Tschudi et al., 2019a) and ~~stored~~ on the 25 km EASE-Grid (NSIDC, 2019). We~~,~~ thus~~,~~ average over the grid cells that overlap with the Upstream box and convert the data to northward and eastward components by applying a rotational matrix as described in the data set's user resources (NSIDC, 2024) to estimate the ocean surface stress.

The records of westward ocean surface stress are de-trended and then high-pass filtered using a fourth order 180 day Butterworth filter to remove seasonality. We then identify storm events as periods when the cumulative stress increases monotonically for more than 12 h and where the total increase is at least $1.5\,\mathrm{N\,m^{-2}}$. We combine two storm events into one if they are less than 15 hours apart. This condition is based on idealized model results from Dundas et al. (2024), which indicates that the circulation increases throughout the storm duration and stays enhanced for a few days after the storm has passed. This means that a storm that occurs shortly after another adds momentum to an already enhanced current field. With this algorithm, we disregard the shortest and weakest wind events from further analysis, as we do not expect them to cause increased circulation (Dundas et al., 2024).

We use the cumulative ocean surface stress instead of the ocean surface stress directly because of the highly variable nature of the raw ocean surface stress signal. To avoid identifying a large number of events above a chosen ocean surface stress threshold a low-pass filter would have to be applied, which makes the identification of storm start and end imprecise. The benefit of our procedure is illustrated in Fig. A2a,b.

2.3 Significant storm response

We need a definition of the current's "storm response" and an algorithm to evaluate whether an increase in ocean circulation is associated with a storm event or part of the background variability. The procedure is illustrated in Fig. A2d. Prior to the analysis, the current records are low-pass filtered using a fourth order Butterworth filter with a cut-off at 40 h to remove shelf waves (Jensen et al., 2013) and tides.

We find that the largest current anomalies generally occur after the maximum ocean surface stress, τ_{max}. Therefore, for each storm, we estimate the increase in current strength relative to the time ($t = t_0$) of τ_{max} (sketch in Fig. A2d). We identify the

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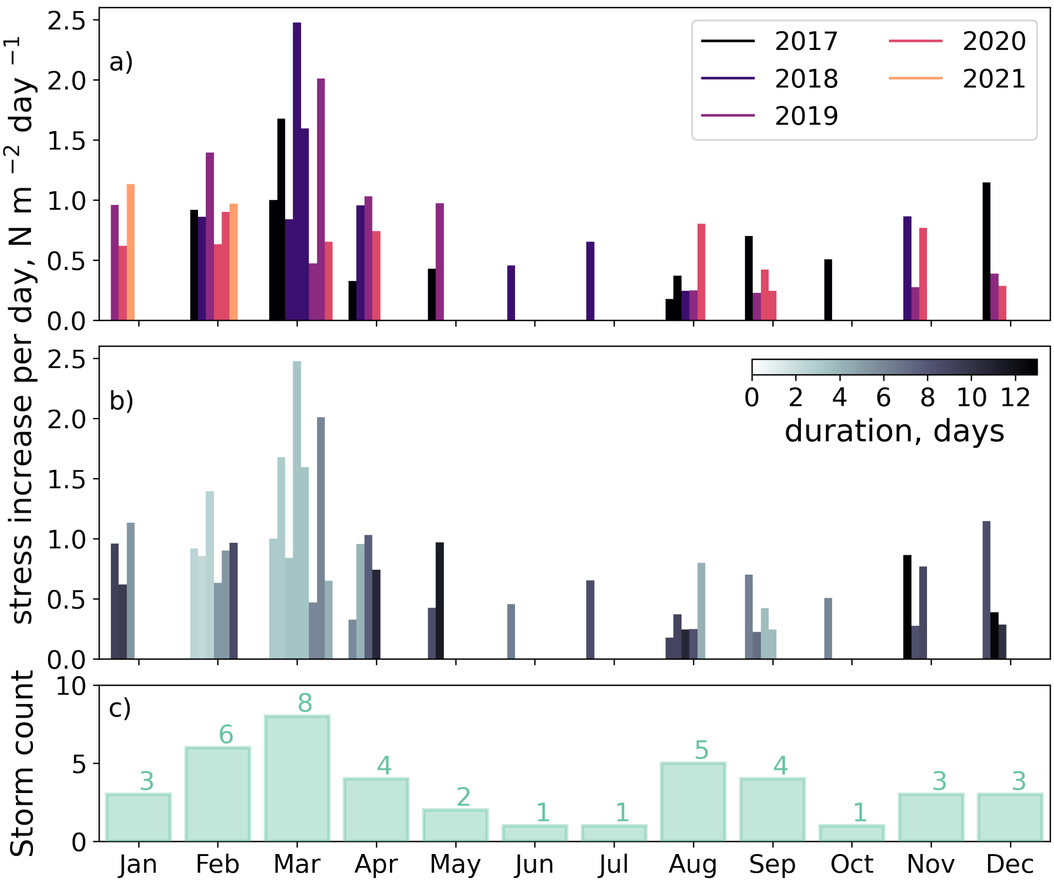

Figure 3. Distribution of storms throughout the mooring period (February 2017 to February 2021). Panels a) and b) show the increase in ocean surface stress per day for each storm on the y-axis, with a) year and b) storm duration in color. c) shows the total storm count per month.

maximum current strength during a ten-day period spanning three days before to seven days after τ_{max} ($U_{max}(t_0 - 3\,\text{days} : t_0 + 7\,\text{days})$). This maximum current is compared with the average current two days before the ten-day period ($U_{mean}(t_0 - 5\,\text{days} : t_0 - 3\,\text{days})$). We define the difference between the two-day average and the maximum current as the current's "storm response" ($U_{response}$, Fig. A2d),

$$U_{response} = U_{max}(t_0 - 3\,\text{days} : t_0 + 7\,\text{days}) - U_{mean}(t_0 - 5\,\text{days} : t_0 - 3\,\text{days}) \tag{5}$$

To assess whether a storm response is significant, we compare the responses with the current increase during 10-day long, 50% overlapping, storm-free windows. If a storm response is higher than the 90$^{\text{th}}$ percentile of these non-storm periods, we consider the storm response significant (example for M_{slope1} in Fig. A2c). Each mooring consequently has its own threshold for significance due to differences in the background variability (Table 2). The number of 10-day-long storm-free periods ranges from 88 to 213.

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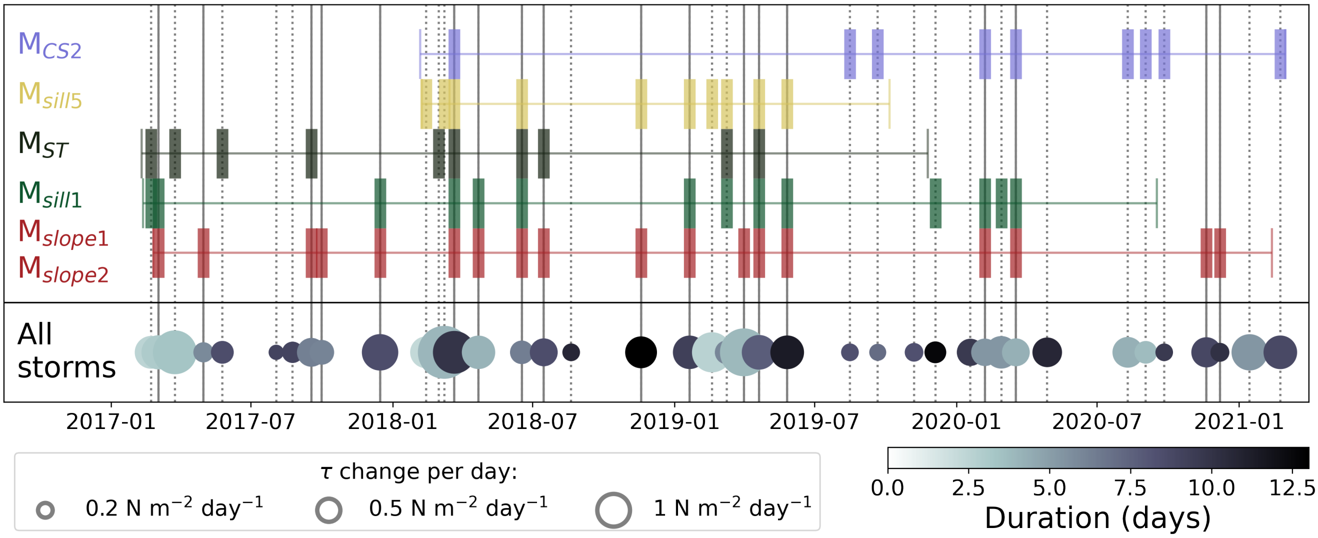

Figure 4. The duration of mooring records (horizontal colored lines) with colored vertical bars indicating a significant storm response. The vertical black solid lines indicate a significant response at both M$_{slope1}$ and M$_{slope2}$, while vertical dotted lines indicate storms that do not give a significant response at M$_{slope1}$ and M$_{slope2}$. The grayscale circles at the bottom indicate the duration (color) and change in ocean surface stress, τ, per day (size) for the identified storms.

2.4 Source salinity estimates

To estimate the arrival of the shift from Berkner to Ronne mode described by Hattermann et al. (2021) and Janout et al. (2021), we estimate the source salinity of the waters at M$_{CS3}$ by identifying the intersection between the Gade line (Gade, 1979) and the surface freezing point in ΘS_A space (illustrated in Fig. A4). Solving the linear relationship given by Wåhlin et al. (2010) for the source salinity, S_0, gives

$$S_0 = S\left[1 + \frac{cp}{L_f}(T_0 - T)\right], \tag{6}$$

where $cp = 4186$ J kg^{-1} K^{-1} and $L_f = 3.34 \times 10^5$ J kg^{-1}. By first estimating the surface freezing temperature, T_0, at the recorded salinity, S, and then using Eq. 6 to estimate the corresponding source salinity, S_0, we obtain an initial estimate of where the salinity-dependent surface freezing point intersects with the Gade line. The calculation is repeated once, replacing S by S_0 to find a new T_0 and S_0 (Fig. A4).

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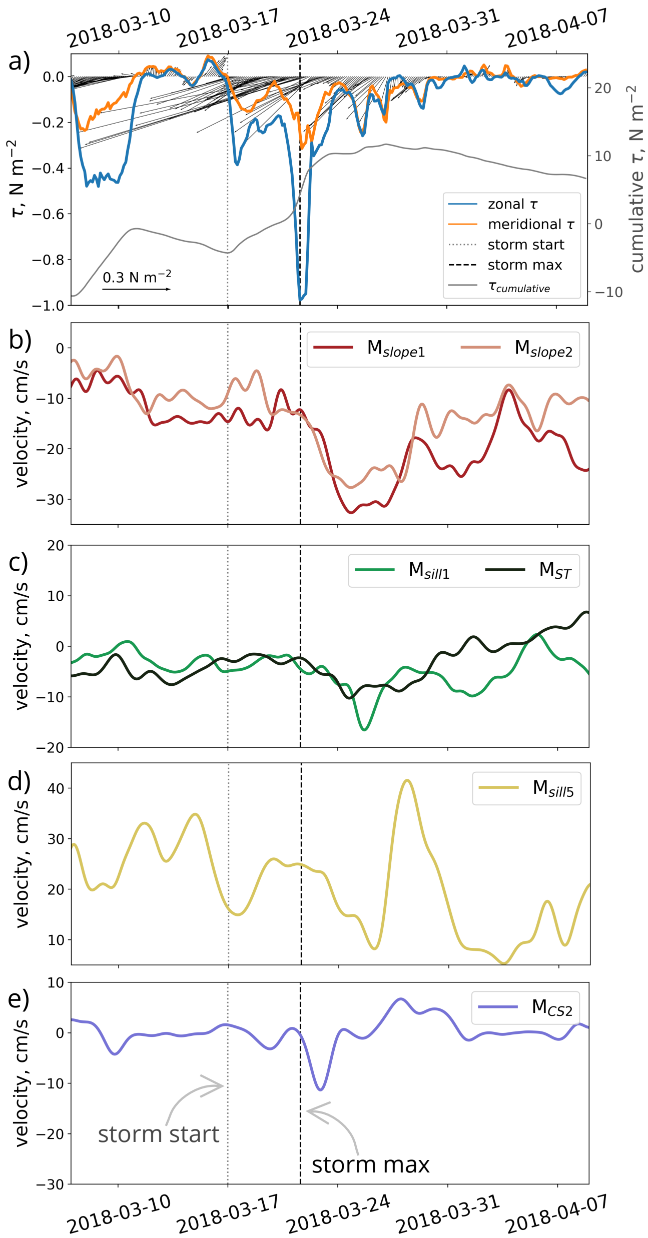

Figure 5. The response to the storm that started on 17-03-2018 (dotted, gray vertical lines, labeled in panel e) and reached maximum ocean surface stress, τ_{max}, on 22-03-2018 (dashed, black vertical line). Time series of a) ocean surface stress (τ) averaged over the Upstream box (black sticks), the strength of the zonal (blue) and meridional (orange) components, and the cumulative westward τ (gray, de-trended and 180 day high-pass-filtered). The along-flow current speed at b) M_{slope1} (red) and M_{slope2} (pale red), c) M_{sill1} (green) and M_{ST} (gray), d) M_{sill5} (yellow), and e) the current speed following the bathymetry at M_{CS2} (purple). See Figure 1 for mooring locations.

3 Results and discussion

We identify 41 strong wind events that we classify as “storms” between February 2017 and February 2021 (Fig. 4). The storms are spread throughout the four years, though the strongest and longest storms occur during fall (Fig. 3). All moorings consequently experience several storm events, and even the M_{sill5} mooring, which has the shortest record length (20 months), experiences 17 storms (Fig. 4). We find that while multiple storms cause a significant response in the circulation at many of the mooring locations, several storms do not (Fig. 4). Additionally, several storms cause a significant response at some of the mooring locations but not at all of them (Fig. 4).

3.1 Case study: Storm-driven circulation increase at all moorings

We select a long (10 days) and strong ($\tau_{max} = 1\,\mathrm{N\,m^{-2}}$) storm in March 2018 to provide an example of how a storm can affect the current at the mooring locations (Fig. 5a). We choose this storm because it is particularly strong and thus provides an example of how the circulation reacts to intense surface forcing. The storm response at M_{slope2} and M_{slope1} occurs directly after the maximum peak in ocean surface stress, and the current is enhanced by roughly $15\,\mathrm{cm\,s^{-1}}$ westward (Fig. 5b) for about four days. At both M_{sill1} on the eastern flank of the sill and M_{ST} in the Small Trough, the response is significant, although it ~~lasts~~ shorter (1-2 days, Fig. 5c). At M_{sill5}, the storm causes a significant northward response (i.e. an increased outflow of DSW), although this is less evident in Fig. 5d ~~relative to~~ the other mooring locations due to the high variability during the storm period at M_{sill5}.

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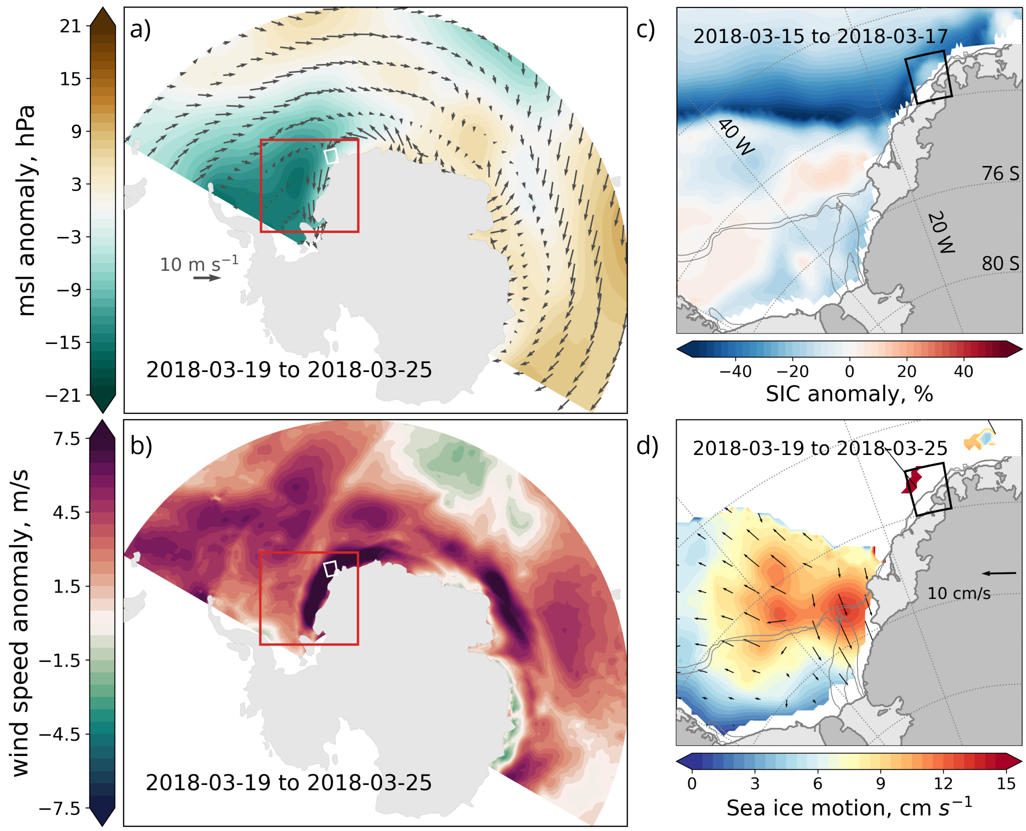

Figure 6. The atmospheric and sea ice conditions during the storm that started on the 17$^{\text{th}}$ of March 2018 and reached maximum ocean surface stress, τ_{max}, on the 22$^{\text{th}}$ of March. Anomalies of the a) mean sea level pressure with 10 m wind velocity vectors and b) absolute 10 m wind speed averaged ±3 days of τ_{max} relative to the average March field (1990-2023). c) SIC averaged over the two days before the storm starts relative to the SIC climatology (past 30 years). d) Sea ice movement (Tschudi et al., 2019b) averaged ±3 days of τ_{max}. White regions indicate missing data or no sea ice. In a,b), the Upstream box and the region shown in c,d) are indicated, and in c,d), the 1000 m and 600 m isobaths are indicated by gray lines (Fretwell et al., 2013). All SIC, pressure, and 10 m wind data are from ERA5 (Hersbach et al., 2023).

At M_{CS2}, along the eastern flank of Filchner Trough at 76°S, the southward storm response reaches $10\,\mathrm{cm\,s^{-1}}$, and the maximum current occurs shortly after the maximum stress during the storm (Fig. 5e).

This storm, which gives a clear current response all the way south at M_{CS2}, is caused by a large low-pressure system positioned over the southern Weddell Sea (Fig. 5f). The cyclonic circulation of the low-pressure system hugs the coastline, creating a patch of anomalously high along-coast wind speeds stretching from roughly 30°W to 20°E (Fig. 5g). During the three days before and after τ_{max}, the high wind speed builds up and dies down without an evident along-coast propagation (not shown). The average SIC on the eastern continental shelf and upstream of the trough is lower than the sea ice climatology, and the sea ice movement is relatively high over the continental shelf break (Fig. 5h,i). We hypothesize that the location and

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structure of the low-pressure system are important for the resulting oceanic response. It also emphasizes the effect of upstream ocean surface stress conditions, in agreement with, e.g., Daae et al. (2018) and Lauber et al. (2023).

3.2 Composite analysis: the mean storm response

Following the case study, which ~~provides evidence~~ that a storm can cause both an enhanced ASC and enhanced current far south along the flank of both Filchner Trough and the Small Trough, we conduct a composite analysis of the current at the moorings during all the identified storms. We group the composites into two classes: those that give a significant response and those that do not. The composites give several consistent indications of the effect of a storm event on the circulation at the moorings.

At M_{slope2} and M_{slope1}, where we expect the strongest storm response since they are located over the slope and capture the acceleration of the ASC directly, more than half of the storms cause a significant increase in the westward current (average response: $\sim 10\,\mathrm{cm\,s^{-1}}$ westward, Fig. 4, 7c,e, and Table 2). The mean current speed during the response-giving storms is 65% higher than the record mean current at M_{slope1} and 42% higher at M_{slope2}.

The thermocline over the slope at M_{slope2}, represented by the -1.7° isotherm, is only weakly pushed down (on average 30 m during the storms with a significant response at M_{slope1} and M_{slope2}, not shown). This is substantially less than the high-frequency fluctuations caused by shelf waves and tides (which is on the order of 100-200 m, Semper and Darelius, 2017; Jensen et al., 2013) and thus, depression of the thermocline caused by the storms do not substantially impede the access of warm water onto the continental shelf. Although the development of a fresh and warm surface layer has been suggested to “protect” the (deeper) ASF from the influence of wind during summer (Hattermann, 2018), there is no substantial difference between the storm’s short-term effect on the thermocline in summer and winter.

Both within the inflow on the sill and in the Small Trough (M_{sill1} and M_{ST}) more than one-third of the storms cause a significantly increased southward current (average response: $7.8\,\mathrm{cm\,s^{-1}}$ and $7.2\,\mathrm{cm\,s^{-1}}$, Fig. 7a,d, Table 2). At M_{sill1}, all events with a significant response occur between December and June, i.e., from late spring to early winter (Fig. 4) ~~although just~~ 66% of all the storms ~~occur~~ during these months (Fig. 3c). The same is true for 80% of the events that cause a significant storm response at M_{ST} (Fig. 4).

Within the observed ISW outflow, at the location of M_{sill5}, periods of strong along-slope wind co-vary with enhanced overflow on monthly (Daae et al., 2018) time scales. Idealized numerical experiments (Dundas et al., 2024) also suggest that storms can drive an adjustment of the SSH across a trough, thus connecting the southward inflow and the northward outflow. This is similar to the situation described by Morrison et al. (2020) and observed by Darelius et al. (2023a), where the downslope flow of DSW along a canyon or ridge causes an SSH anomaly that drives an upslope flow of WDW east of the corrugation. We therefore~~,~~ expect ~~that~~ the storms induce enhanced outflow (i.e. northward flow) at M_{sill5}. While the mean current and the high-frequency variability of the outflow at M_{sill5} are higher than at the other moorings, the average significant storm response is northward flow at $16\,\mathrm{cm\,s^{-1}}$ (Fig. 7e).

~~Just as at~~ the other moorings close to the shelf break, there is a tendency for a seasonal signal in the significant storm response at M_{sill5}. Here, 90% of storm responses occur between December and June. This agrees with the seasonality in the observed

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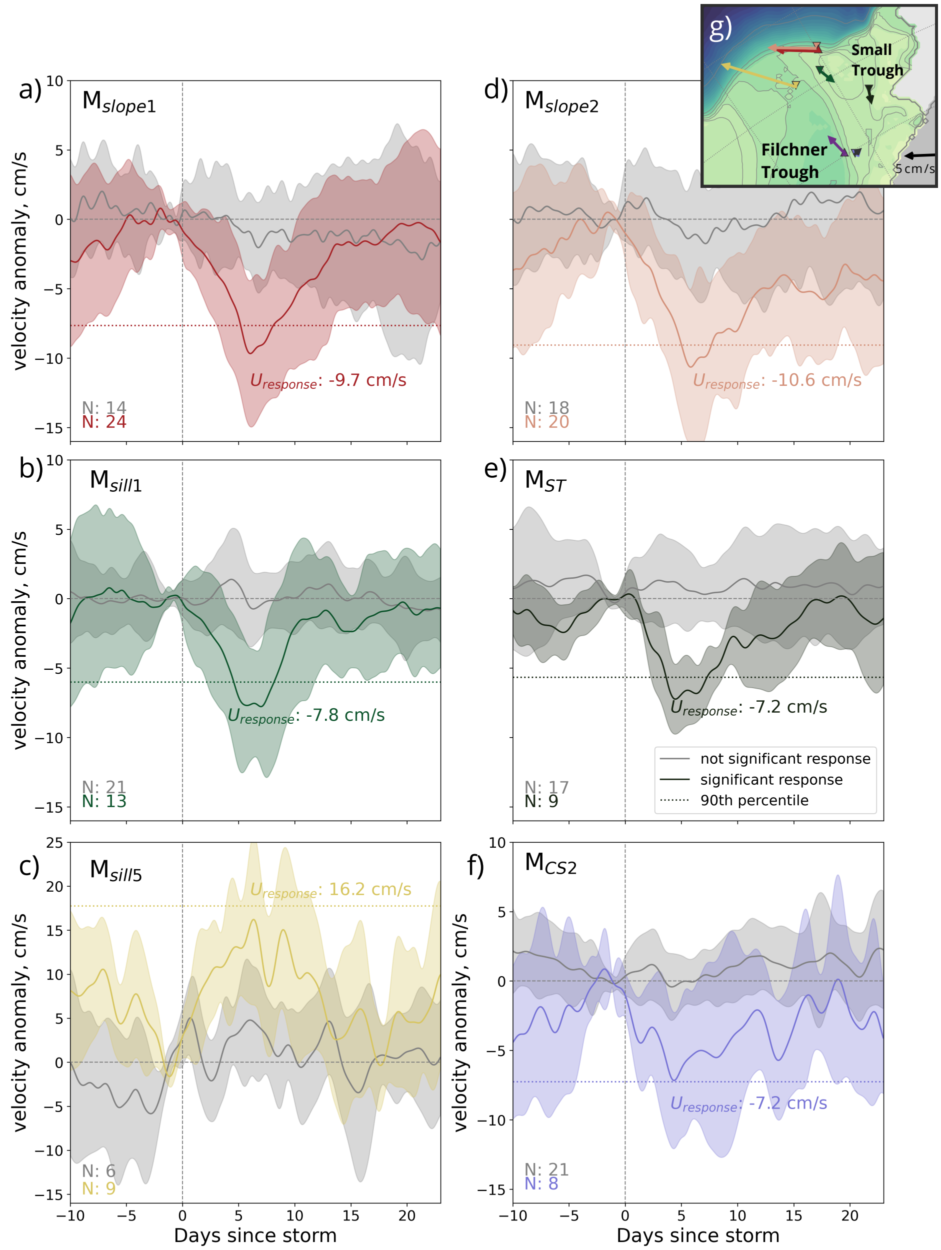

Figure 7. The composite average storm response at a) M$_{slope1}$, b) M$_{sill1}$, c) M$_{sill5}$, d) M$_{slope2}$, e) M$_{ST}$, and f) M$_{CS2}$. In each panel, the average response (line) and the standard deviation (area) to storms that give a response (increased velocity anomaly) are shown in color, while the average current following storms that do not give a significant response is shown in gray. The legend in e) is common for all panels. The threshold for significance (see Table 1, horizontal colored, dotted lines) and the number of events (N) included are indicated. Since these composites are estimated individually for each mooring, the specific storms driving the response shown are not always the same (see Fig. 4). Day zero is the start of the period used to estimate $U_{response}$, i.e., $t_0 - 3\,days$ (see Fig. A2). We only include the events where we have data for the 33 days shown in each panel. Events close to the start or end of each mooring period are consequently not included in this figure. The map in the upper corner (g) shows the mooring locations and their mean current directions.

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Table 2. Overview of parameters from the composite analysis of storm response ($U_{response}$: Equation 5 and Fig. A2d) at the moorings. The % of response-giving storms is estimated relative to the storms occurring during each moorings record.

Mooring name	Average anomaly $U_{response}$ [cm s^{-1}]	Response-giving storms, N/total
M_{slope2}	-11 ± 6	21/39 (54%)
M_{slope1}	-10 ± 5	25/39 (64%)
M_{sill1}	-8 ± 4	14/34 (39%)
M_{ST}	-7 ± 3	10/28 (36%)
M_{sill5}	16 ± 10	10/17 (59%)
M_{CS2}	-7 ± 5	9/31 (29%)

relationship between wind and the overflow on the sill in 2009 (Daae et al., 2018). ~~We note that the~~ M_{sill5} mooring stopped recording current velocities after roughly 1.5 years. ~~Thus, 17~~ storm periods are captured within this ~~mooring~~ period, which ~~leaves few samples on which to base our conclusions regarding~~ the seasonality in response at M_{sill5}. However, this location displays a high fraction of significant storm response events (59% vs. 53% at M_{slope1} and M_{slope2}, 41% at M_{sill1}, and 35% at M_{ST} during the same period, Fig. 4).

The ocean surface stress increase per day is largest in summer and fall (Fig. 3). Strong and long storm events are expected to cause the largest current response (Dundas et al., 2024), and thus, the seasonality in storm intensity likely contributes to the seasonality in storm response at M_{sill1}, M_{ST}, and M_{sill5}. The seasonality could also be linked to the seasonal signal in the strength and the baroclinicity of the current at M_{slope1} and M_{slope2}, which are both strongest during fall and winter (Darelius et al., 2024a). However, we find that the storm response at M_{slope1} and M_{slope2} does not appear to depend on the baroclinicity prior to the storm (not shown). The enhanced current during winter (Darelius et al., 2024a) could, however, cause a larger overshoot at the mouth of the trough (Daae et al., 2017), preventing the storm signal from propagating southward along the trough and reaching M_{ST}, M_{sill1}, and M_{sill5}.

At the southernmost mooring location, at M_{CS2} along the eastern flank of Filchner Trough, 29% of the storms cause a significant response (Fig. 4). The average southward flow anomaly during these events is 7.2 cm s^{-1} (Fig. 7c). The fact that significant storm responses are recorded at this location highlights the potential for storms to increase the heat transport towards Filchner Ice Shelf in the south. If warm water is present on the continental shelf during a response-giving storm, this warm water will likely be pushed southward as observed by Darelius et al. (2016). However, it will not necessarily reach the mooring during the storm event due to the relatively long background advection time scales (5-9 weeks) from the continental slope to 76°S Steiger et al. (2024).

3.3 Atmospheric conditions: storm response or not?

The composite analysis of the current's response to storm events shows that while many storms drive a significant increase in the current at the various mooring locations, several storms do not. We note, however, that the results are sensitive to our choice of

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significance threshold. When we lower the threshold for significance from the 90th to the 70th percentile of current increase, the number of storms that give a significantly enhanced current at both slope-moorings (M_{slope1} and M_{slope2}) increases from 46% to 74% (Fig. 10a). At M_{CS2}, two storms in 2018 become significant when lowering the threshold (Fig. 10a). This emphasizes that the storms we identify as not giving a significant current response may still influence the circulation although we do not resolve this response with our method due to the high background variability.

Most storms that cause a strong response on the Filchner Sill and in the Small Trough also enhance the ASC and show a significant response at the slope moorings (Fig. 4). Since the records from the slope moorings are the longest, we focus on these when investigating the atmospheric conditions that give a significant storm response.

The response of the ASC to a storm depends on the storm duration, the ocean surface stress increase during the storm, and the maximum stress (Fig. 8). We find that 70% of storms that are i) longer than four days, ii) have a stress increase larger than $0.4\,\mathrm{N\,m^{-2}\,day^{-1}}$, and iii) have ~~higher~~ maximum stress than $0.25\,\mathrm{N\,m^{-2}}$, give a significant increase in the ASC speed during 2017 to 2021.

Periods of low ocean surface stress correspond to periods of low variability in the ASC (not shown) and storms occurring during this period are generally without significant storm responses in the ASC. Low ocean surface stress periods generally occur during mid-winter (not shown). We, therefore, hypothesize that the mid-winter sea ice pack dampens the momentum transfer into the ocean. This dampening might be caused by a highly compact sea ice cover (Martin et al., 2014), low rigidity (Steele et al., 1997), low surface and bottom roughness (Martin et al., 2016; Tsamados et al., 2014), or a combination of these factors. When the SIC approaches 100%, the total ocean surface stress is nearly entirely determined by the momentum transfer from the sea ice to the ocean (Eq. 4). Within these periods, the weakest ice-ocean stress is, thus, when the sea ice is the least mobile, which also occurs during mid-winter (not shown). During mid-winter, the mooring locations ~~consequently~~ experience low total ocean surface stress, weak storms (Fig. 3), and weak air-sea momentum transfer. Consequently, there are both few storms (34% of storms, Fig. 3c) between July and November and few (28%) significant storm response events within the ASC (Fig. 4).

Zooming out to large-scale atmospheric patterns, the low-pressure systems that significantly enhance the ASC are generally deeper and more structured than those that do not enhance the ASC (Fig. 9a,e,i). The wind speed is strongly enhanced along the coast upstream of the study area (Fig. 9b,f,j), and the sea ice movement is high (Fig. 9d,h,l). Prior to the storm events, the SIC is also, on average, lower compared to the climatology when there is a response than when there is not (Fig. 9c,g,k). We hypothesize that the relatively low SIC, high sea ice mobility and strongly enhanced wind along the coast upstream of the southeastern Weddell Sea favor efficient momentum transfer into the ocean. This enhances the cross-slope SSH and results in overall enhanced ASC and on-shelf circulation. This suggestion is ~~supported by~~ the ~~same~~ patterns occurring during the case study (Fig. 5f-i).

3.4 A shift in mid-2019

At M_{CS2}, along the eastern flank of Filchner Trough at 76°S, there is an apparent shift in storm response during 2019 (Fig. 10a). Before July 2019, only one storm event causes a significant storm response at M_{CS2}. After July 2019, 50% of the storms cause a

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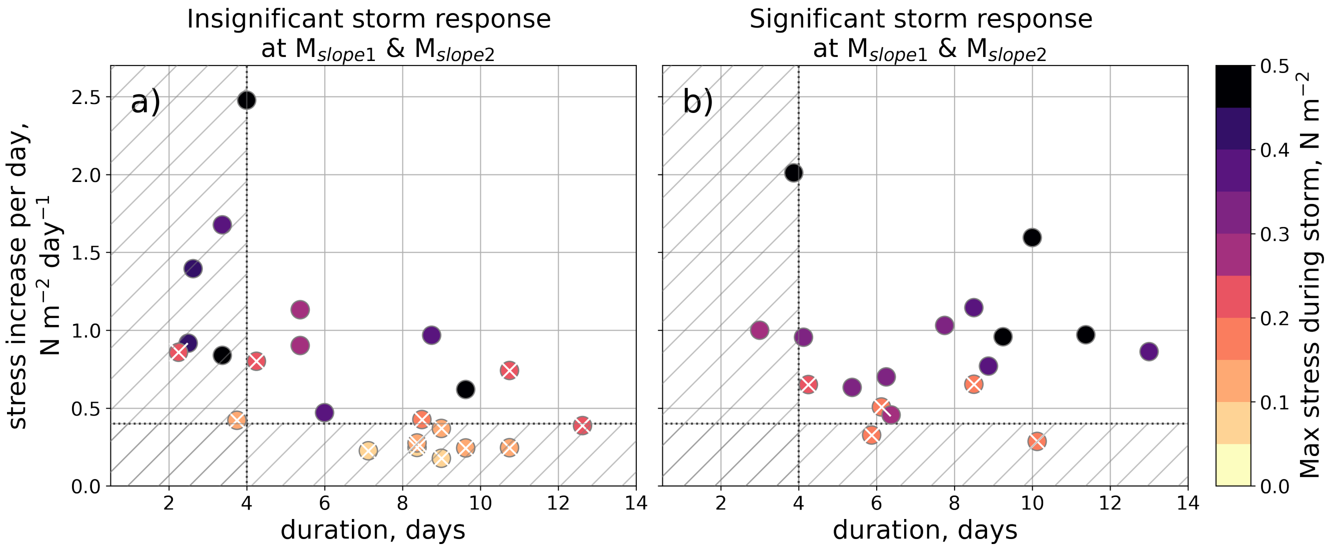

Figure 8. Scatter plots of storm duration and ocean surface stress increase per storm day, colored by the corresponding τ_{max}. The storms that do not induce a significant response at M$_{slope2}$ and M$_{slope1}$ are shown in panel a), and those that do are in panel b). The hatched area indicates a duration shorter than four days and/or a stress increase smaller than $0.4\,\mathrm{N\,m^{-2}\,day^{-1}}$. White crosses mark storms with τ_{max} <$0.25\,\mathrm{N\,m^{-2}}$.

significant storm response (Fig. 10a). ~~Along~~ the slope~~,~~ there is a similar~~,~~ but opposite~~,~~ tendency towards fewer significant storm response events after July 2019 (Fig. 10a). While we cannot rule this out as a coincidence, these results indicate that while all locations are susceptible to storm-driven enhanced along-flow currents, i) the potential for a significant storm response appears to depend on conditions that vary interannually and ii) a storm response at M$_{CS2}$ is not necessarily driven by an enhanced ASC that then translates southward along Filchner Trough, i.e., a storm does not necessarily enhance the circulation over the full domain, contrary to suggestions by the idealized numerical simulations in Dundas et al. (2024).

Similar shifts in the response to wind forcing (correlation on monthly time scales) from one year to another were observed within the Antarctic Coastal Current (M_{CC}, mooring location shown in Fig. 1) and on the sill (slightly further east than M$_{sill5}$) by Daae et al. (2018). These shifts were associated with shifts in the average wind direction and its strength along the coast upstream of Filchner Trough: When the wind had a northwestward component and the windspeed was low, correlation with the current weakened. We do not observe a substantial change in the direction of the mean ocean surface stress before and after mid-2019 (not shown), and while there is a reduction in the variability and average ~~speed~~ of the zonal stress, these changes are small (Fig. A3a).

Since there is neither an apparent change in the strength nor in the duration of the storms (Fig. ~~4 and 3)~~ in July 2019, we investigate if the shift during 2019 might be caused by a change in background circulation or hydrography on the shelf. We note that after July 2019 i) the current at M$_{CS2}$ veers eastward (Fig. 10b), ii) the correlation between the wind and the southward current at M$_{CS2}$ shifts from negative to positive, where a positive correlation indicates that a southwestward wind corresponds to a southward current (Fig 10c), iii) ISW starts to dominate the winter hydrography at M$_{CS2}$ and is associated with increased

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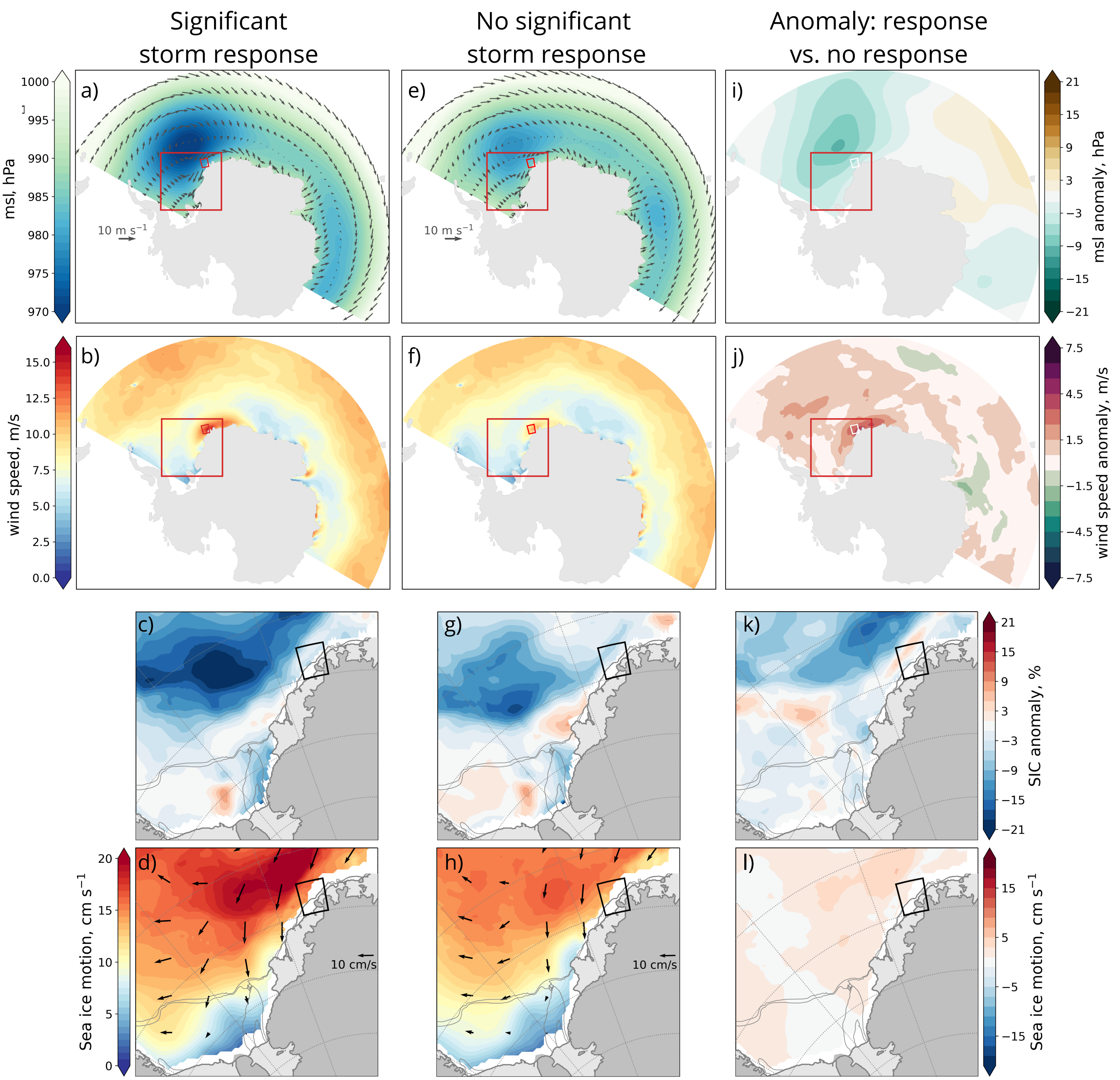

Figure 9. Composite mean atmospheric fields during storms a-d) with and e-h) without a significant storm response at M_{slope1} and M_{slope2}. The difference between the fields during storms with and without a response is shown in i-l). The first row shows the mean sea level pressure (color) and the mean 10 m wind (grey arrows) ± 3 days of τ_{max}. The second row shows the wind speed in color and is otherwise equal to row one. The third row shows the mean SIC anomaly (seasonal climatology removed) in a two-day-long window ending when the storm starts. The fourth row shows the speed of the sea ice motion (color) and its velocity (black arrows) in a six-day-long window centered at τ_{max}. White regions along the coast indicate missing data or no sea ice.

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variability in the current (Fig. A3b), iv) at the shelf break, the warmest water is anomalously warm after mid-2019 and the seasonal cycle is disrupted (Darelius et al., 2023b), and v) the summertime SIC increases (Steiger et al., 2024).

The consistent eastward direction of the current at M$_{CS2}$ from 2019 and onwards (Fig. 10b) is in stark contrast to the current at this location from 2014 to 2016: Then, the current had a strong seasonal cycle with a southwestward current during the warm season and west or northward during the cold season (Ryan et al., 2017). We speculate that the interannual variability in storm response might be related to variable interaction between the southward current along the eastern flank of Filchner Trough, the inflow through the Small Trough, and the Coastal Current as they all interact where the zonal extent of the continental shelf east of Filchner Trough shrinks. The complex bathymetry in the region of M$_{CS2}$ might thus play an important role in impeding the southward signal from propagating neatly southward as it does in the model setup with idealized geometry (Dundas et al., 2024).

Since the shift is not only local but also appears to affect the storm response on the slope, it is possible that properties of the Antarctic Coastal Current (M_{CC}, Fig. 1) might affect the shift. Daae et al. (2018) observe a shift in the correlation between wind and the currents (on monthly time scales) at moorings from the Filchner Sill and the Coastal Current between 2003 and 2004 (locations indicated in Fig. 1). The Coastal Current (on the shelf) had strongest correlation with the wind in 2003, and the outflow at the sill showed the highest correlation in 2004 (Daae et al., 2018). This shift is hence similar to the shift in storm response we observed in 2019: the storm response on the shelf increases when the storm response on the slope decreases. One possible explanation could be that the storm-enhanced signal under certain conditions propagates mainly along the shelf break, causing a strong signal at the slope moorings, and in other not yet identified conditions, mainly propagates along the coast, causing a strong signal at the M$_{CS2}$ mooring. In such a scenario, we would, however, also expect a stronger storm-response at a mooring located just east of M$_{CS2}$ from mid-2019 onwards, but this is not the case (not shown).

In mid-2018, the circulation under the northern section of Filchner Ice Shelf changed from "Berkner mode" to "Ronne mode" (Hattermann et al., 2021; Janout et al., 2021). This means that the source waters of the ISW observed in the Filchner cavity originated from the Ronne Trough after 2018 rather than from the Berkner Shelf. We considered the possibility that the mid-2019 shift in storm response at the M$_{CS2}$ location could be a delayed response (roughly one year lag) to this large-scale shift in circulation and hydrography. However, at M$_{CS3}$, which captures the northward-flowing ISW leaving the cavity, indications of the change from Berkner to Ronne mode appear already in 2018 (Fig. A3c,d). It, therefore, seems unlikely that the shift in hydrography and circulation due to the shift from Berkner to Ronne mode is a direct driver of the shift in storm-response potential at M$_{CS2}$. What causes the interannual shift in storm response in the southeastern Weddell Sea thus remains an open question.

4 Conclusions

We analyze a network of moorings and confirm that sudden strong ocean surface stress events – "storms" – can enhance the circulation on the southeastern Weddell Sea continental shelf. These events strengthen the westward Antarctic Slope Current (ASC), the dense outflow from the Filchner Trough, the southward flow along the eastern flank of the Filchner Trough, and the

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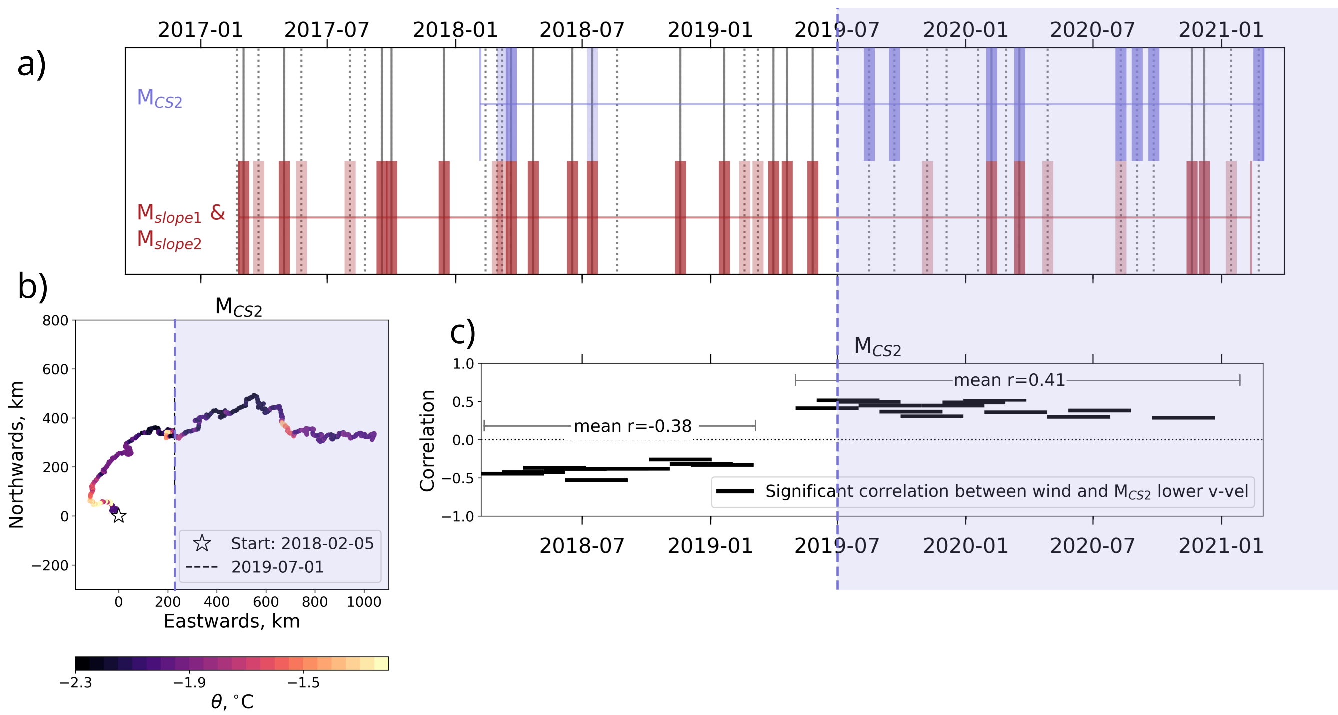

Figure 10. Indications of a shift around 2019 in the southeastern Weddell Sea shelf region. Panels a) and c) have a shared x-axis, the purple background indicates the period after July 2019, and the vertical purple dashed line indicates the 1st of July 2019. Panel a) is a simplified version of Fig. 4 showing only moorings M$_{slope2}$ and M$_{slope1}$ (red) and M$_{CS2}$ (purple). The dark bars indicate significant storm responses, and the light bars show storm responses stronger than the 70th percentile of background current increase (see methods 2.3). Panel b) is a progressive vector diagram of the current at the bottom sensor of M$_{CS2}$ colored by temperature. The temperature is based on θ and not Θ because the salinity sensor stopped recording in early 2020. The start of the time series (star) and the 1st of July 2019 (dashed line) are indicated. c) Time series from M$_{CS2}$ of 90-day long, 33% overlapping windows of significant correlation (black bars) between the along-coast wind and the southward bottom current.

inflow through the Small Trough. These observations thus support the suggestions by Darelius et al. (2016) and the numerical experiments of Dundas et al. (2024). Our findings provide observational evidence that storms impact the southward transport of warm water in this region and suggest that this signal may extend beyond 76°S, potentially reaching the front of the Filchner Ice Shelf (Darelius et al., 2016). Since storms have the potential to enhance the southward current on the shelf, they also have the potential to push warm water southward whenever warm water is present along the eastern flank of Filchner Trough or in the Small Trough. We suggest that this is also true whenever warm water is present on the continental shelf east of Filchner Trough.

The duration of a storm, the total cumulated ocean surface stress during the event, and the maximum stress, will, to a large extent, determine whether a storm event will cause a response in the current or not. The response is, as expected, particularly

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clear in the moorings on the upper part of the slope, i.e., within the ASC. 70% of the observed storms that are longer than four days, have a larger stress increase than $0.4\,\mathrm{N\,m^{-2}\,day^{-1}}$, and τ_{max} >$0.25\,\mathrm{N\,m^{-2}}$, give a significant increase in the ASC.

The enhanced circulation is, however, not so structured and steady that it can consistently be followed neatly from moorings on the slope via the sill to moorings on the shelf at 76°S. While some storms enhance the circulation in the whole region, not all storm events cause such a consistent response. This differs from the results of an idealized model Dundas et al. (2024), where storm events initiated an overall cyclonic circulation over the continental shelf east of Filchner Trough. We suggest that the complex bathymetry – and potentially the interplay between the Antarctic Coastal Current and the ASC – are important factors that explain the differences between the results of the idealized model and the observations presented here.

The cause of the shift during winter 2019 from conditions that favor a storm response in the ASC to conditions that favor a storm response on the shelf at 76°S remains an open question. Other properties change around the same time, such as ~~warmer~~ temperatures along the slope (Darelius et al., 2023b), a shift from negative to positive correlation between the along-shore south-westward wind and the southward current, and a shift from low to high variability in the current itself at 76°S. Following the start of 2019, Ronne-sourced ISW is consistently present at 76°S. This change is related to an overall shift from Berkner mode to Ronne mode (Hattermann et al., 2021; Janout et al., 2021) and co-occurs with a shift in the current direction at 76°S. However, as the timing of these shifts is offset by roughly half a year, we are hesitant to suggest a link between the events. These inter-annual shifts in atmospheric forcing, hydrography, and circulation emphasize the importance of ~~background~~ conditions for the potential effect of storms in the southeastern Weddell Sea.

The ~~up to four-year long~~ mooring records analyzed here give clear indications of the effect of storms on the ocean circulation in the Filchner Trough region~~;~~ however, longer observational time series at the mooring sites or experiments run in a regional model setup would ~~be~~ help~~ful~~ ~~to~~ understand the observed variability in storm response. ~~Based on the results presented here, a~~ regional model could also enable a realistic estimate of the potential heat transport at the ice front driven by the storm events and its importance ~~relative to~~ the heat transport driven by the background flow. While this would yield additional information about the importance of storms for the basal melt of the Filchner Ice Shelf, the present study confirms the ability of storms to enhance circulation, which is the basis for bringing warm water southward towards Filchner Ronne Ice Shelf.

Data availability. The mooring data is, or will be, publicly available. M_{slope1} is available at Darelius et al. (2024), M_{slope2} at Darelius et al. (2023), M_{CS2} and M_{CS3} at Janout et al. (2022), and M_{ST} and M_{sill1} at Steiger and J.-B. (2023). M_{sill5} will be available at NMDC (Østerhus, 2024). The data published before 2022 can be accessed through the Southern Ocean moored time series (south of 60°S) (OCEAN ICE D1.1) compilation (Zhou et al., 2024). The atmospheric data and sea ice concentration from ERA5 reanalysis (Hersbach et al., 2019) is available at Hersbach et al. (2023), the sea ice movement data from NSIDC is available at Tschudi et al. (2019a), and the data of bathymetry, ice shelves, and ice sheets from bedmap2 (Fretwell et al., 2013) is available at Fretwell et al. (2022).

Appendix A: Supporting figures

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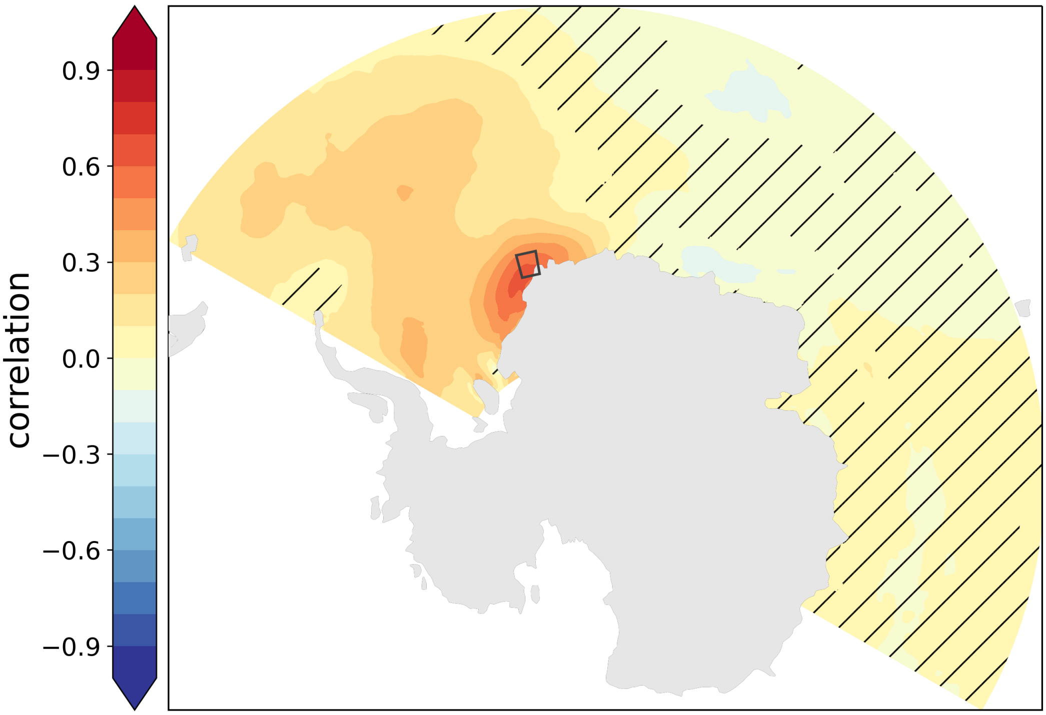

Figure A1. Correlation map of the average wind speed in the Upstream box (black rectangle) vs. the overall wind field during the observation period (2017-2021). Hatched regions indicate insignificant correlation at the 0.95 significance level.

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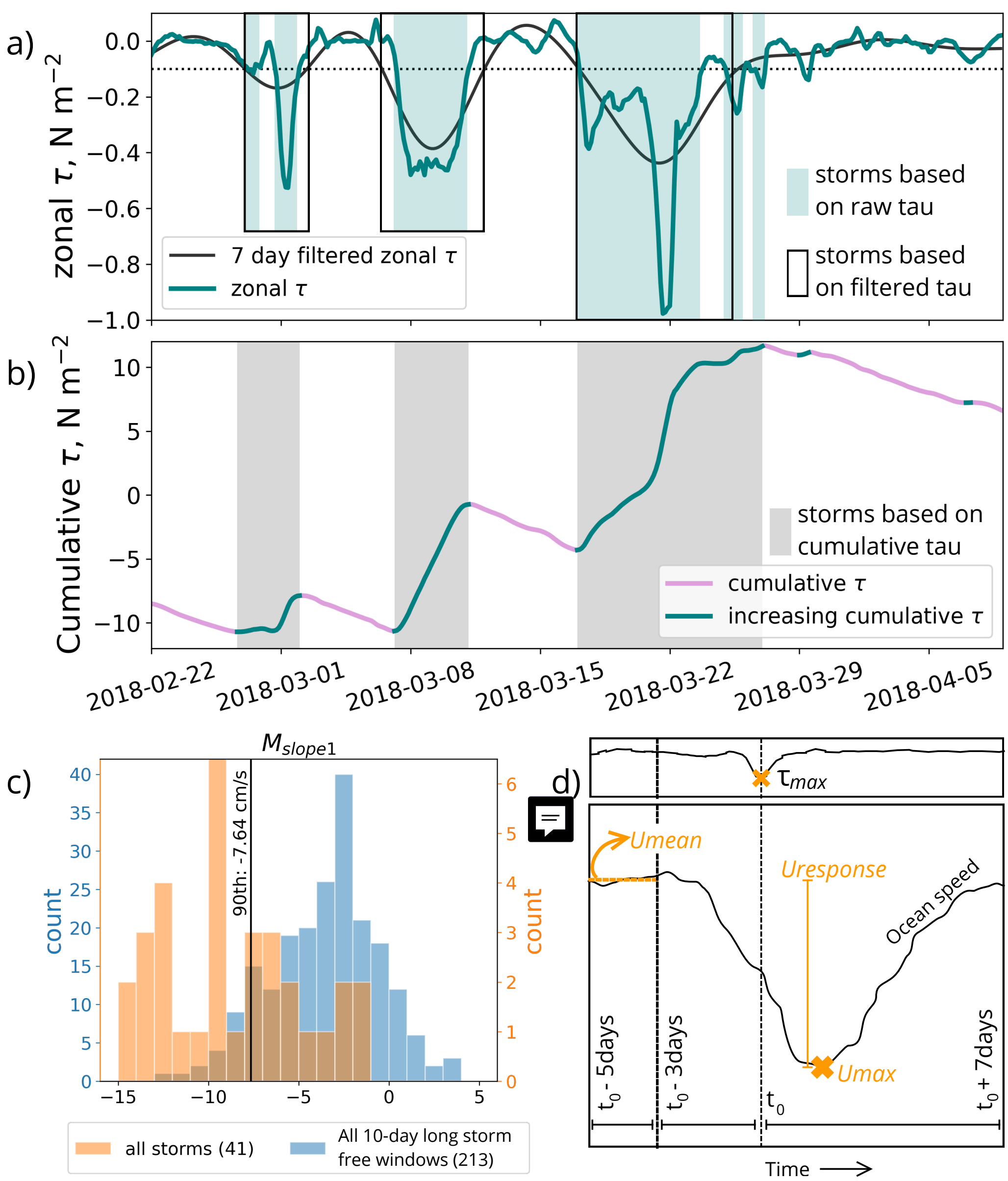

Figure A2. Example of the storm detection algorithm a,b) described in section 2.2. Time series of a) eastward ocean surface stress and b) the cumulative westward ocean surface stress. Identified storm periods based on a) the raw ocean surface stress (blue shading) and lowpass filtered ocean surface stress (black boxes) and b) based on cumulative ocean surface stress, which is the algorithm we use throughout our analysis (gray shading) are indicated. c,d) Illustrate the procedures used to determine significance and to identify $U_{response}$ as described in section 2.3. c) Histogram of $U_{response}$ (orange) and the current increase during all 10-day long storm-free windows (blue) at M_{slope1}. The 90th percentile, which is used to determine significance, is indicated (black line). d) A sketch of the procedure used to identify $U_{response}$, indicating the definition of τ_{max} in the upper sub-panel and U_{mean}, U_{max}, and $U_{response}$ in the lower sub-panel.

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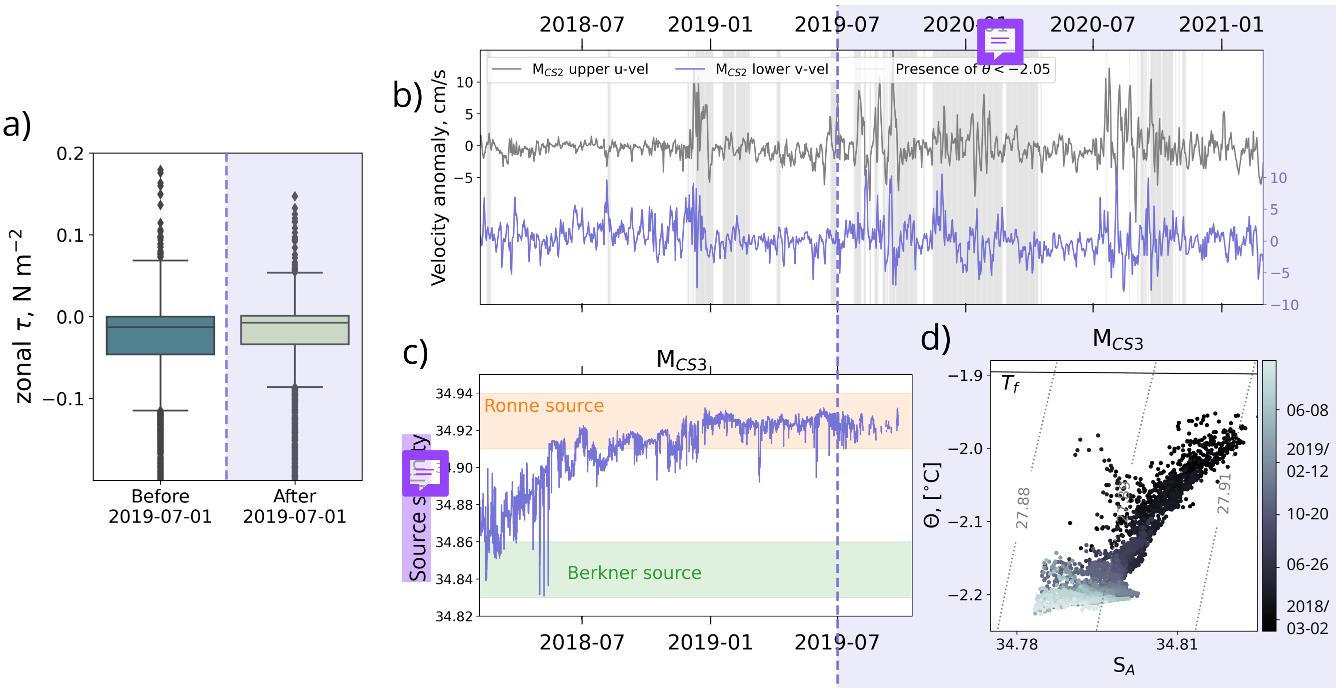

Figure A3. Additional indications of a shift around 2019 in the southeastern Weddell Sea shelf region following the same setup as Fig. 10: The purple background indicates the period after July 2019, and the vertical purple dashed line indicates the 1st of July 2019. Panel a) shows box plots of the zonal ocean surface stress before (blue) and after (green) July 2019. Panels b) and c) have a shared x-axis. b) Time series from M_{CS2} of current anomalies; eastward component at the upper sensor (gray) and the northward component at the lower sensor (purple). The gray shading indicates periods when water colder than $\theta = -2.05\,^{\circ}\mathrm{C}$ is present. c) Time series of the estimated ISW source water salinity at M_{CS3}. The shading indicates approximate ranges of Berkner (green) and Ronne (orange) mode source waters (Hattermann et al., 2021). d) ΘS_A-diagram from M_{CS3} colored by time, with darker colors at the start of the record. For clarity, we have omitted observations with $\sigma < 27.885\,\mathrm{kg\,m^{-3}}$ in panels c) and d).

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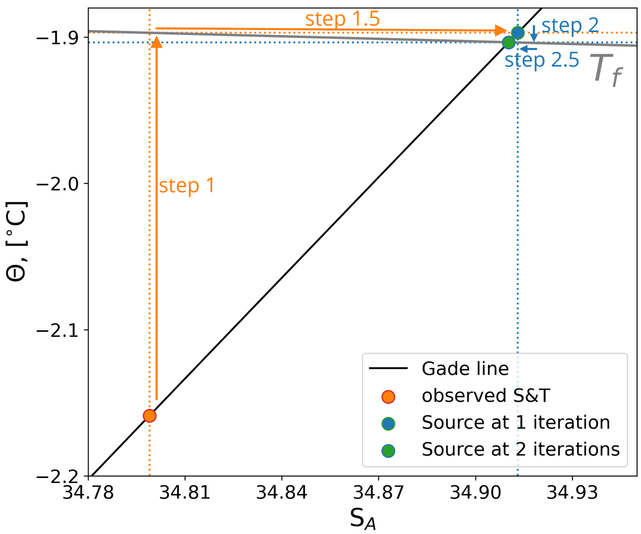

Figure A4. Illustration of the method to estimate source salinity following Equation 6. The desired value is the temperature and salinity at the intersection between the relevant Gade line and the salinity-dependent freezing point (green dot). The process is as follows: given an observed temperature and salinity pair (orange dot), the freezing point is estimated (step 1). Then, the salinity at this temperature of the Gade line is estimated (step 1.5). This completes iteration 1 and the first approximation of the source temperature and salinity (blue dot). Completing one more iteration (steps 2 and 2.5) gives a good approximation of the source water properties (green dot).

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360 *Author contributions.* VD analyzed the mooring and atmospheric data, prepared the figures, and drafted the paper under the supervision of KD and ED. MJ prepared the data from the M_{CS2} and M_{CS3} moorings, JBS prepared the data from the M_{sill1} and M_{ST} moorings, SØ prepared the data from the M_{sill5} mooring, and ED prepared the data from the M_{slope1} and M_{slope2} moorings. All the co-authors read and contributed to the text and the discussion.

Competing interests. The contact author has declared that none of the authors has any competing interests.

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Preprint. Discussion started: 14 April 2025

References

Årthun, M., Nicholls, K. W., Makinson, K., Fedak, M. A., and Boehme, L.: Seasonal inflow of warm water onto the southern Weddell Sea continental shelf , Antarctica, Geophysical Research Letters, 39, 2–7, https://doi.org/10.1029/2012GL052856, 2012.

Daae, K., Hattermann, T., Darelius, E., and Fer, I.: On the effect of topography and wind on warm water inflow—An idealized study of the southern Weddell Sea continental shelf system, Journal of Geophysical Research: Oceans, 122, 2622–2641, https://doi.org/10.1002/2016JC012541, 2017.

Daae, K., Darelius, E., Fer, I., Østerhus, S., and Ryan, S.: Wind stress mediated variability of the Filchner trough Overflow, Weddell sea, Journal of Geophysical Research: Oceans, 123, 3186–3203, https://doi.org/10.1002/2017JC013579, 2018.

Daae, K., Hattermann, T., Darelius, E., Mueller, R. D., Naughten, K. A., Timmermann, R., and Hellmer, H. H.: Necessary Conditions for Warm Inflow Toward the Filchner Ice Shelf, Weddell Sea, Geophysical Research Letters, 47, https://doi.org/10.1029/2020GL089237, 2020.

Darelius, E., Makinson, K., Daae, K., Fer, I., Holland, P. R., and Nicholls, K. W.: Hydrography and circulation in the Filchner Depression, Weddell Sea, Antarctica, Journal of Geophysical Research C: Oceans, 119, 5797–5814, https://doi.org/10.1002/2014JC010225, 2014.

Darelius, E., Fer, I., and Nicholls, K. W.: Observed vulnerability of Filchner-Ronne Ice Shelf to wind-driven inflow of warm deep water, Nature Publishing Group, pp. 1–7, https://doi.org/10.1038/ncomms12300, 2016.

Darelius, E., Daae, K., Dundas, V., Fer, I., Hellmer, H. H., Janout, M., Nicholls, K. W., Sallée, J. B., and Østerhus, S.: Observational evidence for on-shelf heat transport driven by dense water export in the Weddell Sea, Nature Communications, 14, https://doi.org/10.1038/s41467-023-36580-3, 2023a.

Darelius, E., Dundas, V., Janout, M., and Tippenhauer, S.: Sudden, local temperature increase above the continental slope in the southern Weddell Sea, Antarctica, Ocean Science, 19, 671–683, https://doi.org/10.5194/os-19-671-2023, 2023b.

Darelius, E., Janout, M. A., Fer, I., and Sallée, J.-B.: Physical oceanography and current velocity data from mooring M3 on the upper continental slope, east of Filchner Trough, February 2017 – February 2021, https://doi.org/10.1594/PANGAEA.962043, 2023.

Darelius, E., Fer, I., Janout, M., Daae, K., and Steiger, N.: Observations of the Antarctic Slope Current in the Southeastern Weddell Sea: A Bottom-Enhanced Current and Its Seasonal Variability, Journal of Geophysical Research: Oceans, 129, https://doi.org/10.1029/2023JC020666, 2024a.

Darelius, E., Fer, I., Janout, M. A., Daae, K., and Steiger, N.: Observations of the Antarctic Slope Current in the southeastern Weddell Sea: a bottom-enhanced current and its seasonal variability, Journal of Geophysical Research: Oceans, https://doi.org/10.1029/2023JC020666, 2024b.

Darelius, E., Janout, M. A., Fer, I., and Sallée, J.-B.: Physical oceanography and current velocity data from mooring M6 on the upper continental slope, east of Filchner Trough, February 2017 – February 2021, https://doi.org/10.1594/PANGAEA.964715, 2024.

Dotto, T. S., Naveira Garabato, A., Bacon, S., Tsamados, M., Holland, P. R., Hooley, J., Frajka-Williams, E., Ridout, A., and Meredith, M. P.: Variability of the Ross Gyre, Southern Ocean: Drivers and Responses Revealed by Satellite Altimetry, Geophysical Research Letters, 45, 6195–6204, https://doi.org/10.1029/2018GL078607, 2018.

Dundas, V., Daae, K., and Darelius, E.: Storm-Driven Warm Inflow Toward Ice Shelf Cavities—An Idealized Study of the Southern Weddell Sea Continental Shelf System, Journal of Geophysical Research: Oceans, 129, https://doi.org/https://doi.org/10.1029/2023JC020749, 2024.

Foldvik, A., Gammelsrød, T., and Tørresen, T.: Hydrographic observations from the Weddell Sea during the Norwegian Antarctic Research Expedition 1976/77, Polar Research 3, pp. 177–193, 1985.

Foldvik, A., Gammelsrød, T., Øterhus, S., Fahrbach, E., Rohardt, G., Schröder, M., Nicholls, K. W., Padman, L., and Woodgate, R. A.: Ice shelf water overflow and bottom water formation in the southern Weddell Sea, Journal of Geophysical Research: Oceans, 109, 1–15, https://doi.org/10.1029/2003jc002008, 2004.

Fretwell, P., Pritchard, H. D., Vaughan, D. G., Bamber, J. L., Barrand, N. E., Bell, R., Bianchi, C., Bingham, R. G., Blankenship, D. D., Casassa, G., Catania, G., Callens, D., Conway, H., Cook, A. J., Corr, H. F., Damaske, D., Damm, V., Ferraccioli, F., Forsberg, R., Fujita, S., Gim, Y., Gogineni, P., Griggs, J. A., Hindmarsh, R. C., Holmlund, P., Holt, J. W., Jacobel, R. W., Jenkins, A., Jokat, W., Jordan, T., King, E. C., Kohler, J., Krabill, W., Riger-Kusk, M., Langley, K. A., Leitchenkov, G., Leuschen, C., Luyendyk, B. P., Matsuoka, K., Mouginot, J., Nitsche, F. O., Nogi, Y., Nost, O. A., Popov, S. V., Rignot, E., Rippin, D. M., Rivera, A., Roberts, J., Ross, N., Siegert, M. J., Smith, A. M., Steinhage, D., Studinger, M., Sun, B., Tinto, B. K., Welch, B. C., Wilson, D., Young, D. A., Xiangbin, C., and Zirizzotti, A.: Bedmap2: Improved ice bed, surface and thickness datasets for Antarctica, Cryosphere, 7, 375–393, https://doi.org/10.5194/tc-7-375-2013, 2013.

Fretwell, P., Pritchard, H., Vaughan, D., Bamber, J., Barrand, N., Bell, R. E., Bianchi, C., Bingham, R., Blankenship, D., Casassa, G., Catania, G., Callens, D., Conway, H., Cook, A., Corr, H., Damaske, D., Damn, V., Ferraccioli, F., Forsberg, R., and ... Bodart, J.: BEDMAP2 - Ice thickness, bed and surface elevation for Antarctica - standardised shapefiles and geopackages (Version 1.0) [Data set], NERC EDS UK Polar Data Centre, https://doi.org/https://doi.org/10.5285/0f90d926-99ce-43c9-b536-0c7791d1728b, 2022.

Gade, H. G.: Melting of Ice Sea Water: A Primitive Model with Application to the Antarctic Ice Shelf and Icebergs, Journal of Physical Oceanography, pp. 189–198, https://doi.org/https://doi.org/10.1175/1520-0485(1979)009<0189:MOIISW>2.0.CO;2, 1979.

Gill, A. E.: Circulation and bottom water production in the Weddell Sea, Deep-Sea Research and Oceanographic Abstracts, 20, 111–140, https://doi.org/10.1016/0011-7471(73)90048-X, 1973.

Hattermann, T.: Antarctic thermocline dynamics along a narrow shelf with easterly winds, Journal of Physical Oceanography, 48, 2419–2443, https://doi.org/10.1175/JPO-D-18-0064.1, 2018.

Hattermann, T., Nicholls, K. W., Hellmer, H. H., Davis, P. E. D., Janout, M., Østerhus, S., Schlosser, E., Rohardt, G., and Kanzow, T.: Observed interannual changes beneath Filchner- Ronne Ice Shelf linked to large-scale atmospheric circulation, Nature Communications, 12, 1–11, https://doi.org/10.1038/s41467-021-23131-x, 2021.

Hazel, J. E. and Stewart, A. L.: Are the near-Antarctic easterly winds weakening in response to enhancement of the southern annular mode?, Journal of Climate, 32, 1895–1918, https://doi.org/10.1175/JCLI-D-18-0402.1, 2019.

Hellmer, H. H., Kauker, F., Timmermann, R., Determann, J., and Rae, J.: Twenty-first-century warming of a large Antarctic ice-shelf cavity by a redirected coastal current, Nature, 485, 225–228, https://doi.org/10.1038/nature11064, 2012.

Hellmer, H. H., Kauker, F., Timmermann, R., and Hattermann, T.: The fate of the Southern Weddell sea continental shelf in a warming climate, Journal of Climate, 30, 4337–4350, https://doi.org/10.1175/JCLI-D-16-0420.1, 2017.

Hersbach, H., Bell, B., Berrisford, P., Horányi, A., Sabater, J. M., Nicolas, J., Radu, R., Schepers, D., Simmons, A., Soci, C., and Dee, D.: Global reanalysis: goodbye ERA-Interim, hello ERA5, ECMWF Newsletter, pp. 17–24, 2019.

Hersbach, H., Bell, B., Berrisford, P., Biavati, G., Horányi, A., Muñoz Sabater, J., Nicolas, J., Peubey, C., Radu, R., Rozum, I., Schepers, D., Simmons, A., Soci, C., Dee, D., and Thépaut, J.-N.: ERA5 hourly data on single levels from 1940 to present. [Data set] (Accessed on 08-02-2023), Copernicus Climate Change Service (C3S) Climate Data Store (CDS), https://doi.org/https://doi.org/10.24381/cds.adbb2d47, 2023.

https://doi.org/10.5194/egusphere-2025-1537
Preprint. Discussion started: 14 April 2025

Jacobs, S. S.: On the nature and significance of the Antarctic Slope Front, Marine Chemistry, 35, 9–24, https://doi.org/10.1016/S0304-4203(09)90005-6, 1991.

Jacobs, S. S.: Bottom water production and its links with the thermohaline circulation, Antarctic Science, 16, 427–437, https://doi.org/10.1017/S095410200400224X, 2004.

Janout, M., Hellmer, H. H., Hattermann, T., Huhn, O., Sültenfuss, J., Østerhus, S., Stulic, L., Ryan, S., Schröder, M., and Kanzow, T.: FRIS Revisited in 2018: On the Circulation and Water Masses at the Filchner and Ronne Ice Shelves in the Southern Weddell Sea, Journal of Geophysical Research: Oceans, 126, 1–19, https://doi.org/10.1029/2021JC017269, 2021.

Janout, M. A., Hellmer, H. H., and Monsees, M.: Raw data of physical oceanography and current velocity data from moorings AWI252-3, AWI253-3 and AWI254-3 in Filchner Trough, February 2018 – March 2021, https://doi.org/10.1594/PANGAEA.944430, 2022.

Jensen, M. F., Fer, I., and Darelius, E.: Low frequency variability on the continental slope of the southern Weddell Sea, Journal of Geophysical Research: Oceans, 118, 4256–4272, https://doi.org/10.1002/jgrc.20309, 2013.

Lauber, J., Hattermann, T., de Steur, L., Darelius, E., Auger, M., Nøst, O. A., and Moholdt, G.: Warming beneath an East Antarctic ice shelf due to increased subpolar westerlies and reduced sea ice, Nature Geoscience, https://doi.org/10.1038/s41561-023-01273-5, 2023.

Marshall, J. and Speer, K.: Closure of the meridional overturning circulation through Southern Ocean upwelling, Nature Geoscience, 5, 171–180, https://doi.org/10.1038/ngeo1391, 2012.

Martin, T., Steele, M., and Zhang, J.: Seasonality and long-term trend of Arctic Ocean surface stress in a model, Journal of Geophysical Research: Oceans, pp. 1723–1738, https://doi.org/10.1002/2013JC009425.Received, 2014.

Martin, T., Tsamados, M., Schroeder, D., and Feltham, D.: The impact of variable sea ice roughness on changes in Arctic Ocean surface stress: a model study, Journal of Geophysical Research: Oceans, 121, 1931–1952, https://doi.org/http://dx.doi.org/10.1002/2015JC011186, 2016.

McDougall, T. and Barker, P.: Getting started with TEOS-10 and the Gibbs Seawater (GSW) Oceanographic Toolbox, ISBN 9780646556215, 2011.

Morrison, A. K., McC. Hogg, A., England, M. H., and Spence, P.: Warm Circumpolar Deep Water transport toward Antarctica driven by local dense water export in canyons, Science Advances, 6, 1–10, https://doi.org/10.1126/sciadv.aav2516, 2020.

Nicholls, K. W.: JR097 Cruise Report Autosub Under Ice Cruise to the southern Weddell Sea, https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/jr97_05.pdf, 2005.

Nicholls, K. W., Østerhus, S., Makinson, K., Gammelsrød, T., and Fahrbach, E.: Ice-ocean processes over the continental shelf of the southern Weddell Sea, Antarctica: A review, Reviews of Geophysics, 47, https://doi.org/https://doi.org/10.1029/2007RG000250, 2009.

NSIDC: What are the EASE Grid., https://nsidc.org/data/ease, https://nsidc.org/data/ease, date Accessed: 2019-09-29, 2019.

NSIDC: How to convert the horizontal and vertical components to east and north, https://nsidc.org/data/user-resources/help-center/how-convert-horizontal-and-vertical-components-east-and-north, date accessed: 28 September 2024, 2024.

Orsi, A. H., Johnson, G. C., and Bullister, J. L.: Circulation, mixing, and production of Antarctic Bottom Water, Progress in Oceanography, 43, 55–109, https://doi.org/10.1016/S0079-6611(99)00004-X, 1999.

Østerhus, S.: Physical oceanography and current velocity data from mooring S218E, 2024.

Ryan, S., Schröder, M., Huhn, O., and Timmermann, R.: On the warm inflow at the eastern boundary of the Weddell Gyre, Deep-Sea Research Part I: Oceanographic Research Papers, 107, 70–81, https://doi.org/10.1016/j.dsr.2015.11.002, 2016.

Ryan, S., Hattermann, T., Darelius, E., and Schröder, M.: Seasonal cycle of hydrography on the eastern shelf of the Filchner Trough, Weddell Sea, Antarctica, Journal of Geophysical Research: Oceans, 122, 6437–6453, https://doi.org/10.1002/2017JC012916, 2017.

Semper, S. and Darelius, E.: Seasonal resonance of diurnal coastal trapped waves in the southern Weddel Sea, Antarctica, Ocean Science, 13, 77–93, https://doi.org/10.5194/os-13-77-2017, 2017.

Shchepetkin, A. F. and McWilliams, J. C.: Computational Kernel Algorithms for Fine-Scale, Multiprocess, Longtime Oceanic Simulations, Handbook of Numerical Analysis, 14, 121–183, https://doi.org/10.1016/S1570-8659(08)01202-0, 2009.

Steele, M., Zhang, J., Rothrock, D., and Stern, H.: The force balance of sea ice in a numerical model of the Arctic Ocean, Journal of Geophysical Research: Oceans, 102, 21 061–21 079, https://doi.org/https://doi.org/10.1029/97JC01454, 1997.

Steiger, N. and J.-B., S.: Hydrological and current velocity data from moorings P1, P2, P4, P5 and P6 in the Filchner Trough region in the southern Weddell Sea, February 2017 to March 2021., https://doi.org/https://doi.org/10.17882/100680, 2023.

Steiger, N., Sallée, J. B., Darelius, E., Janout, M., and Østerhus, S.: Observed Pathways and Interannual Variability of the Warm Inflow Onto the Continental Shelf in the Southern Weddell Sea, Journal of Geophysical Research: Oceans, 129, e2023JC020 700, https://doi.org/https://doi.org/10.1029/2023JC020700, e2023JC020700 2023JC020700, 2024.

Thompson, A. F., Stewart, A. L., Spence, P., and Heywood, K. J.: The Antarctic Slope Current in a Changing Climate, Reviews of Geophysics, 56, 741–770, https://doi.org/10.1029/2018RG000624, 2018.

Tsamados, M., Feltham, D. L., Schroeder, D., Flocco, D., Farrell, S. L., Kurtz, N., Laxon, S. W., and Bacon, S.: Impact of Variable Atmospheric and Oceanic Form Drag on Simulations of Arctic Sea Ice, Journal of Physical Oceanography, 44, 1329 – 1353, https://doi.org/10.1175/JPO-D-13-0215.1, 2014.

Tschudi, M., Meier, W. N., Stewart, J. S., Fowler, C., and Maslanik, J.: Polar Pathfinder Daily 25 km EASE-Grid Sea Ice Motion Vectors, Version 4, https://doi.org/10.5067/INAWUWO7QH7B, 2019a.

Tschudi, M. A., Meier, W. N., and Stewart, J. S.: An enhancement to sea ice motion and age products, The Cryosphere Discussions, pp. 1–29, https://doi.org/10.5194/tc-2019-40, 2019b.

Wåhlin, A. K., Yuan, X., Bjork, G., and Nohr, C.: Inflow of Warm Circumpolar Deep Water in the Central Amundsen Shelf, Journal of Physical Oceanography, 40, 1427–1434, https://doi.org/10.1175/2010JPO4431.1, 2010.

Zhou, S., Dutrieux, P., Giulivi, C., Silvano, A., Auckland, C., Abrahamsen, P., Meredith, M., Vaňková, I., Nicholls, K., Davis, P., Østerhus, S., Gordon, A., Zappa, C., Sebaginazzi Dotto, T., Scambos, T., Gunn, K., Rintoul, S., Aoki, S., Stevens, C., Liu, C., Kim, T.-W., Lee, W. s., Janout, M., Hattermann, T., Lauber, J., Darelius, E., Wåhlin, A., Middleton, L., Castagno, P., Budillon, G., Heywood, K., Graham, J., Dye, S., Hirano, D., and Miller, U. k.: Southern Ocean moored time series (south of 60°S) (OCEAN ICE D1.1), https://doi.org/10.17882/99922, 2024.