Response to review comments by Angelika Renner on “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 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. Below, we address some of your larger comments. Your submitted comments are in black text, and our responses are in green. At this stage, we do not include responses to the most minor comments; however, we have worked through these comments as well, and agree with most of the comments. Upon resubmission, we will include all of these comments as well. We apologize for the errors in some of the figure references; these will be corrected before resubmission.

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.

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

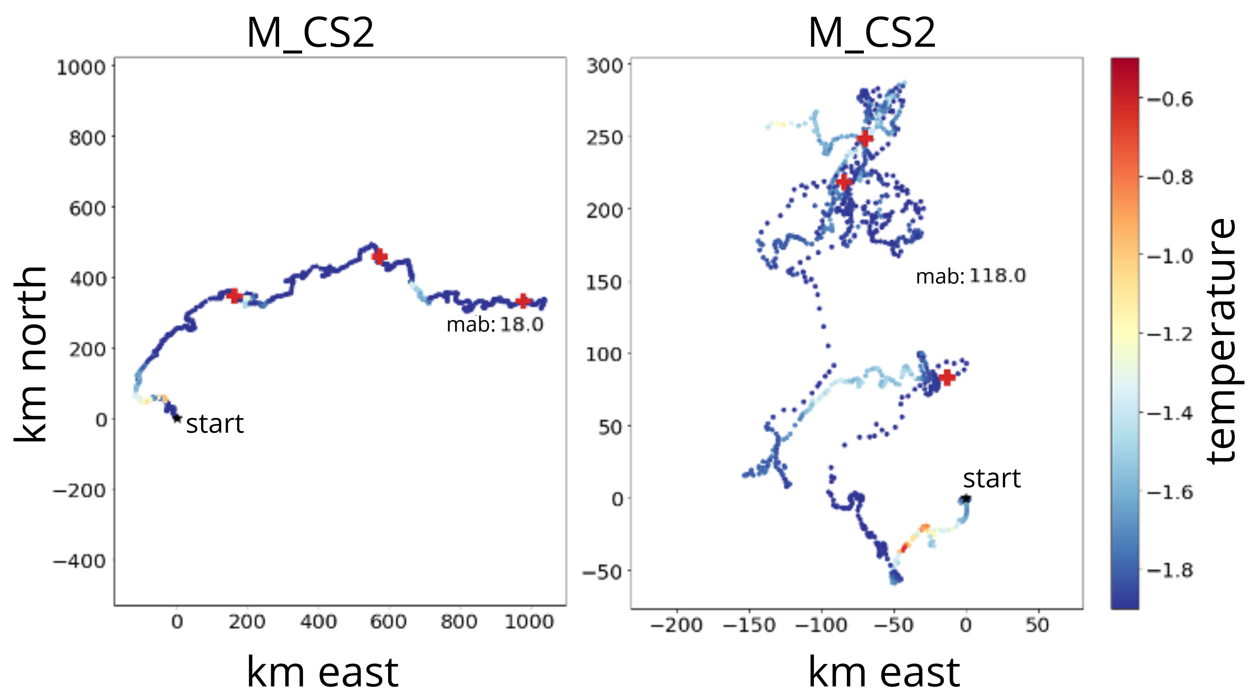
1. Line 96-102: How do you justify the choices to use depth-average currents (do you include the bottom sensors even though they stopped early?), longest time series, or depth with highest velocity? And which depths are those then?

   Re.: The overall reason is that we try to use the most complete observations we have available at each mooring location.

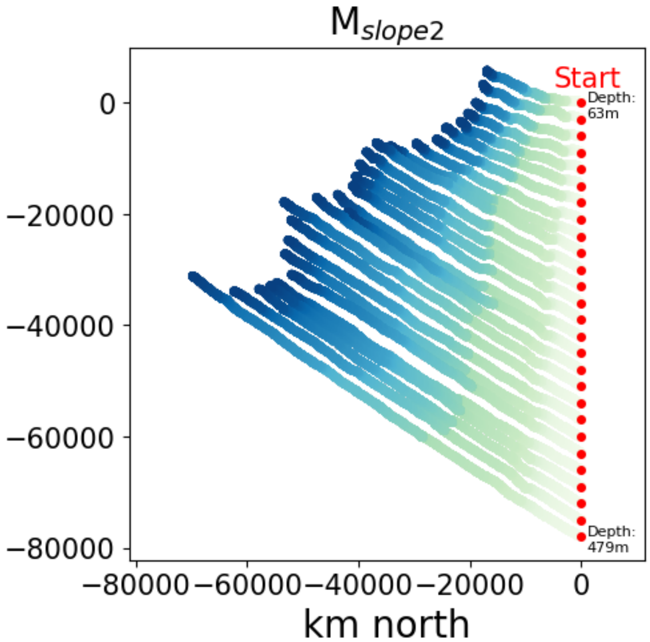
We are aware that the ASC has a strong baroclinic component. However, we expect the storm-driven current increase/response to be barotropic, and we find no abrupt changes in the velocity with depth (see figure titled M_slope2 below). Thus, using depth-averaged currents fits our purpose. For the slope 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 also hinders our assessment of barotropic vs baroclinic components at the slope moorings.

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 (left panel, 18 mab) has higher velocities than the upper sensor (right panel, 118 mab), shown in the progressive vector diagrams below. Notice the different x- and y-axis. The red "+" signs indicate the 1st of January each year, and the black star is the starting location. Color is temperature, and x- and y- are km east and north, respectively. Due to the weak and unstructured nature of the current in the upper level, at 118 meters above the bottom, we have focused on the currents closer to the bottom.



The lack of a coherent current structure with depth means that two different thresholds of significant current increase due to storms would be necessary for the velocity levels, and depth-averaging, such as at the slope moorings, is not an option. For comparison, a similar progressive vector diagram for M_Slope2 is included below. The color indicates time and the red dots indicate the start of the time series. The starting location is shifted along the y-axis to illustrate the variability with depth. At this location, the vertical current structure is much more coherent, which makes us more comfortable with depth-averaging here than at the M_CS2 mooring.



To make it clearer which velocity levels we use in our analysis, we will indicate unused levels by, e.g., dashed lines in Figure 2.

2. 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 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. This agrees with our expectation that this is a barotropic response and coastal Ekman transport is independent of salinity and temperature.

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.

3. 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?

   Regarding this, we agree that we can make this clearer and will incorporate some notes on the implications in the conclusion and abstract.

   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 or not, we do not know 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.

   While the estimation of ocean surface stress and the role of sea ice in these estimates is a topic on its own and there is uncertainty related to the choice of parameterization, it does appear that most of the significant storm response events occur during periods of less sea ice. In a future with less sea ice and a weaker sea ice cover during a larger portion of the year, it is thus possible that the number of significant storm-driven circulation events might increase. Less sea ice is also a main suggested mechanism for driving enhanced presence of warm water on the Southeastern Weddell Sea continental shelf (Hellmer et al., 2012, 2017). Combined, these two mechanisms (increased number of significant storm-driven circulation events and increased availability of warm water on the shelf) could play an important role in transporting warm water into the Filchner Ice Shelf cavity before the on-shelf heat is ventilated to the atmosphere.

   The model study by Dundas et al., (2024) which focused on similar processes in an idealized model setup of the southeastern Weddell Sea found that a temperature response south on the continental shelf can appear within the range of 4-23 days after the storm forcing by running the same storm forcing on seasonal hydrography. This range reflects the proximity of warm water to your measuring location prior to the storm forcing, and is another aspect of why we refrain from presenting a quantification of how much the storms contribute to the southward heat transport. For these reasons, we focus on the velocity and not direct estimations of the heat transport.

The same model study shows that there are distinct differences in the on-shelf conditions between the reference run with no storm activity and the experiments with storm activity. More heat is brought further south when storms enhance the ocean circulation on the shelf and in the Filchner Trough. In the present study we show that this does not just happen in an idealized model, but that storm events can enhance the circulation in this region. The implication of this study is thus that while we cannot quantify the added southward heat transport with the observations available, we show that strong ocean surface stress can enhance the circulation. Whenever there is warm water present, this will get a push in the current's direction. In a situation where warm water is present on the shelf but the background circulation is weak enough to inhibit the warm water from reaching the Filchner Ice Shelf cavity, such a storm-driven push on the circulation could be the difference between warm water entering the cavity or not.

We will also make the impact of the shift we observe in 2019 clearer. As we respond to a comment by reviewer #1, Keith Nicholls, we think the shift in 2019 emphasizes that interannual variability affects how the warm inflow on the continental shelf responds to atmospheric forcing. This is clearly something we need to understand if we are to predict how the system evolves in the future