Response to Reviewer Feedback on Wild et al., 2025

"Thwaites Eastern Ice Shelf Cavity Observations"

Reviewer 1:

RV1-1: This manuscript presents ice shelf cavity observations in Pine Island Bay. The value of these observations is indisputable, and they deserve to be published as proposed in this manuscript. I do not have any major criticism. If any, I wish the presentation should be improved to better highlight the novelty of the results, and to provide a slightly improved description of methodologies.

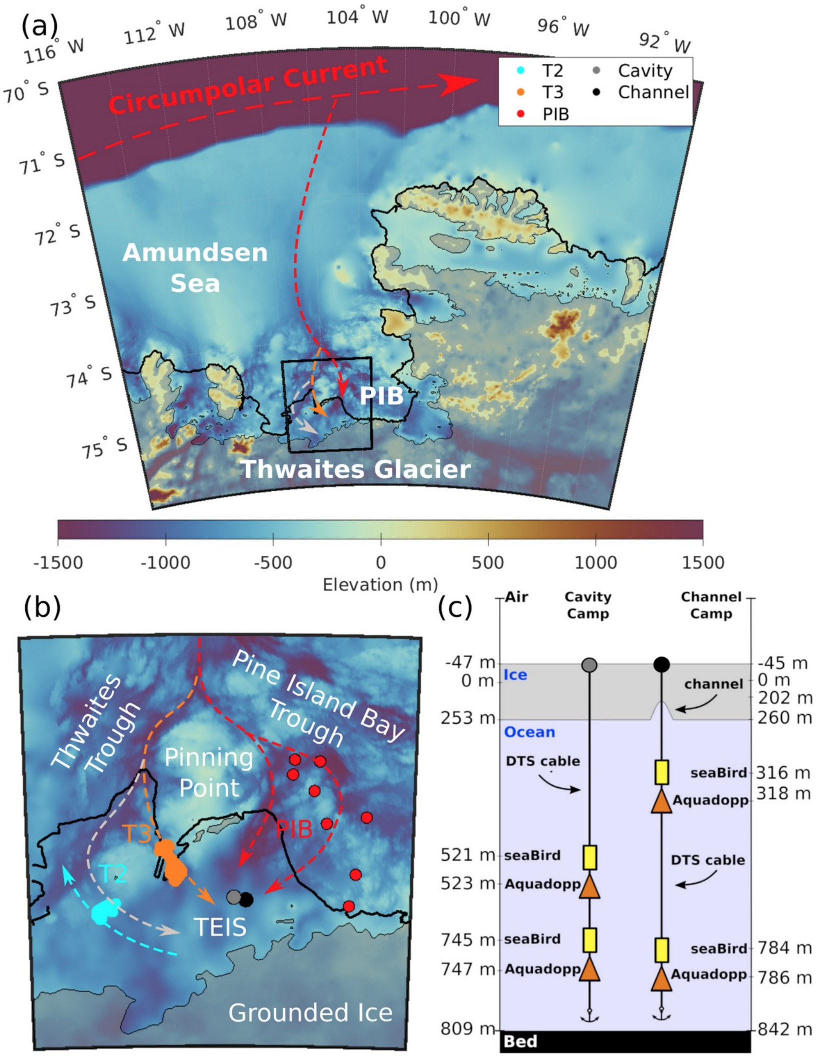
Thank you for your positive feedback and support for publication. We appreciate your suggestions and have enhanced the presentation of the novelty in the revised manuscript. The main changes include: (1) a rephrased abstract (see RV1-2) and parts of the introduction, (2) a more detailed explanation of the wavelet analysis, and (3) rewording of the section on thermal expansion of the water column for the reasons you provided.

RV1-2: Novelty: Reading the abstract only, I find it hard to appreciate what makes this study novel and unique. Could this be restated and improved?

We revised the abstract and parts of the introduction (related RV2-3).

Revised abstract: Pine Island Bay (PIB), situated in the Amundsen Sea, is renowned for its retreating ice shelves and highly variable sea ice. While brine rejection from sea ice formation and glacial meltwater influence seawater properties, the downstream impacts beneath the region's floating ice shelves remain poorly understood. Here, we exploit an unprecedented, multi-year (2020–2023) oceanographic time series from instruments deployed through boreholes beneath the Thwaites Eastern Ice Shelf (TEIS), immediately downstream of PIB, offering new insight into how ice-ocean-atmosphere interactions in PIB shape oceanographic conditions within the subshelf cavity. Our observations reveal a sustained warming and thickening of the modified Circumpolar Deep Water (mCDW) layer near the seabed since January 2020, critical in a region where mCDW drives basal melting beneath West Antarctica's most vulnerable outlet glaciers. Concurrently, the retreat of the multi-year sea ice edge by over 150 km across most of PIB has enhanced the advection of Winter Water, contributing to a cooling of more than 1°C in the upper 250 m beneath TEIS between July 2021 and January 2023. Superimposed on these trends are episodic temperature and salinity anomalies lasting several weeks, originating in PIB and advecting past the mooring. These events link mobile sea ice cover to subshelf hydrography, as mid-depth waters temporarily warm and increase in salinity, leading to an increase in density, while deeper mCDW simultaneously cools and freshens, reducing its density. Overall, these changes are associated with reduced stratification in the cavity. As sea ice continues to decline in a warming Antarctic climate, our results offer a glimpse into how ocean circulation and basal melting may evolve across the Amundsen Sea Embayment. This dataset provides a critical benchmark for refining process-based models and improving melt-rate parametrizations in coupled ice-ocean simulations.

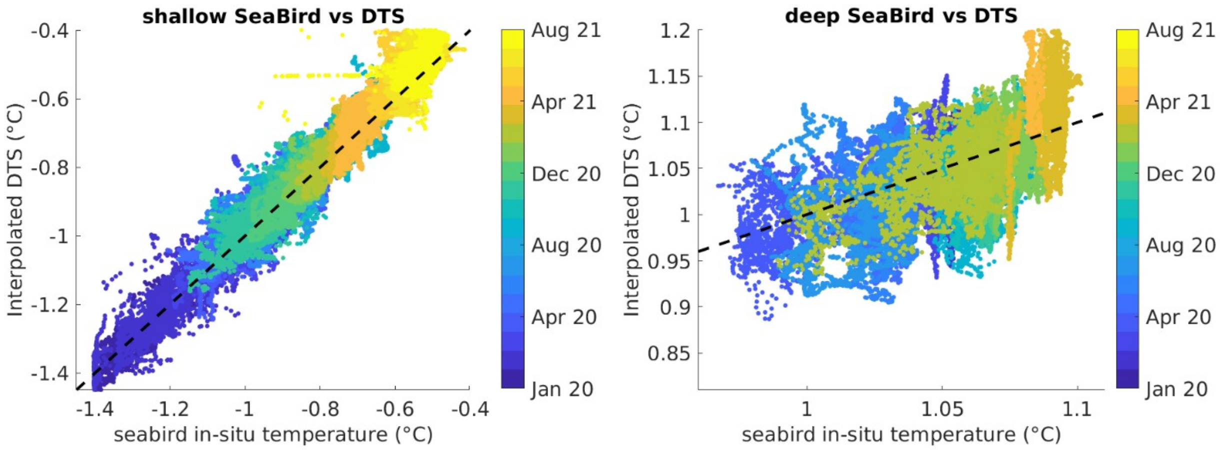
RV1-3: The map in Fig. 1 was so little that I found it hard to read. The choice of colors could also be improved.



Revised map of the study area (Figure 1). Rearranged and with improved colourmap.

RV1-4: DTS thermal profiling: I could not find a definition of the acronym DTS before l. 144. It would be nice to find information about the accuracy of these measurements. Is there a way to assess the potential for temporal drifts?

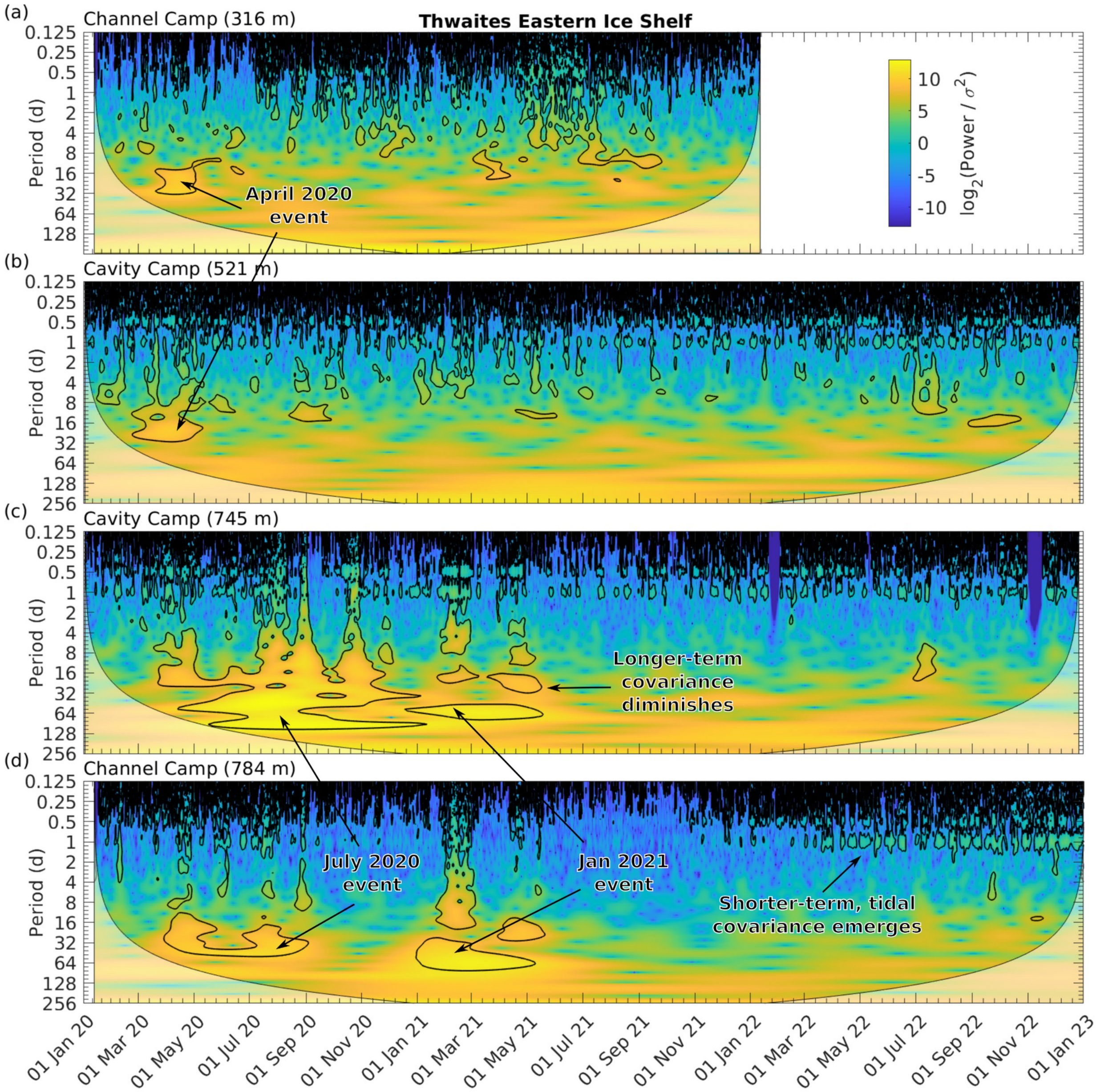
We have added the acronym to the caption of Fig. 1, and it is defined in the last paragraph of the introduction. Details on the accuracy and spatial resolution of the DTS measurements are included in Sect. 2.1.4, along with a new sentence addressing temporal drifts.



To address the issue of possible drifts, we show here a comparison of temperature measurements from SeaBird and DTS sensors at Channel Camp at the same time and depth, taken at (left) shallow and (right) deeper locations. We assume that the Seabird temperature sensors do not exhibit drift. The DTS data were calibrated using these SeaBird measurements, effectively correcting for temporal drift in the DTS. This calibration also affects the DTS throughout the entire water column.

RV1-5: Cross-wavelet analysis: I found the amount of information available on this method insufficient. What is the unit of the quantity derived from the cross-wavelet transform? How to interpret the result? More generally, would it not be useful to see a wavelet transform of the temperature signal alone? Also, the correlation between temperature and salinity implies some level of density compensation. Would it be possible to analyse the density variations directly? It is partially done in Fig. 6 but it could be better highlighted.

We agree with the suggestion and have now included the continuous wavelet transform of the density variations alone in Figure 3, which also necessitated rewording parts of Section 3.1. In Figure 6, we retain the cross wavelet transform to illustrate the covariance between density variations with wind and currents. Additionally, we have expanded the Methods section to provide further details on the wavelet analysis and clarify the interpretation of the results.



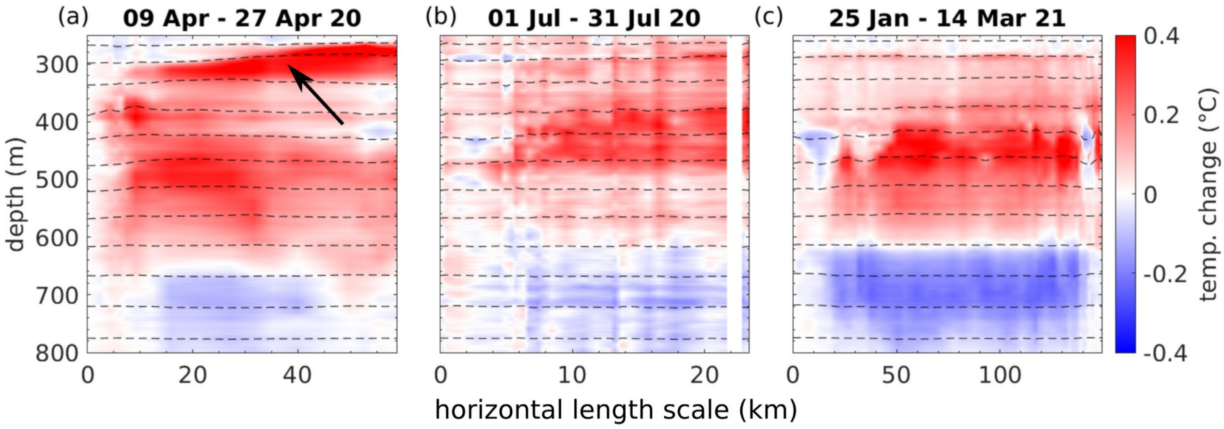
Revised wavelet Figure 3, now showing the continuous wavelet transform of density and labels for cross-referencing between Figures with a perceptually uniform colourmap.

RV1-6: l. 390: I do not understand the statement that warming leads to thermal expansion of the water column. The direct effect of thermal expansion on the position of an isopycnal would be at a centimetric scale at best, especially in such a cold region. This is not something I expect can be directly observed. Can you clarify?

We agree with the reviewer's point and have reworded to clarify that isopycnal displacements due to thermal expansion are minimal at mid-depth and deep layers, consistent with the expected centimetric-scale effect in this cold environment.

RV1-7: Fig. 8: I find it very hard to understand what the x-axis corresponds to and how to read this figure. More details would help.

The x-axis in Fig. 8 represents the estimated horizontal length scale of the advecting features. This scale is calculated by combining daily averaged DTS temperature anomalies with daily averaged Aquadopp current measurements. We assume that the average of the mid-depth currents (521 m) at Cavity Camp and the near-bottom currents (784 m) at Channel Camp approximates the mean current speed throughout the water column. While this assumption is a simplification, it reflects the best estimate possible given the available data. To improve clarity, we have revised the figure description in the main text and updated the x-axis label accordingly.



Revised Figure 8 with a new x-axis label, showing features located between (a) 5-40 km, (b) 5–24 km, and (c) 10–140 km. The approximate feature length scales are given by the range within each interval.