Response to Reviewer#2

We sincerely thank you for your positive and constructive review of our manuscript. Your feedback helped us to improve the clarity and readability of the manuscript. We hope the addition of a new schematic figure and a more quantitative analysis of wind forcing, as you recommended, will assist readers in understanding the key mechanisms of WGIW renewal more clearly.

Please find our detailed responses in blue below. Most of your comments have been fully addressed. In addition, several further improvements were made while addressing Reviewer 1's comments, including incorporation of spatial surveys from 2022-2024, extension of Monitoring Station data until November 2024, and a more concise and structured presentation of our results and discussion. These changes have refined our interpretation of the source of the observed autumn along-isopycnal warming, whilst ensuring that the results on WGIW renewal remain central to the paper.

Best regards,

Linda Latuta on behalf of all co-authors.

Reviewer#2 Summary

This manuscript by Latuta et al. presents analyses of hydrographic dataset in Disko Bay, Greenland. It provides insights into the seasonality and spatial variability of the water masses in the bay system and gives explanations on the potential physical mechanisms that drive the seasonal cycles. Overall, I believe the manuscript would contribute to further our understanding of the hydrography in this area and the finding are significant and timely. But I also think the presentations could be improved and some clarifications should be made before acceptance.

General comments

1. A key explanation shown in this work is the identification of wind-driven WGIW renewal via upwelling-favorable conditions at the EDS. However, this mechanism (e.g., around line 305) is complex and may be difficult to visualize for some readers. I recommend including a schematic figure showing the seasonal wind changes, upwelling over EDS and the resultant basin renewal.

   We appreciate this valuable suggestion. To improve clarity, we have added a new schematic figure illustrating the seasonal mechanisms of WGIW renewal. The figure builds on the schematic of Gladish et al. (2015, part 2, Figure 15) but is adapted to highlight the processes identified in our study. In particular, it shows wind-driven upwelling over the Egedesminde Dyb sill and the resulting basin renewal observed under favourable wind forcing in autumn 2022. We believe this schematic will help readers to visualise the dynamics better.

2. The manuscript suggests that upwelling-favorable winds caused WGIW renewal in November and December 2022, but the upwelling effect was not as effective during autumn and winter 2023-2024 (50m uplift; line 317). It would be helpful to provide an estimate of the threshold of the wind stress or its duration needed to cause upwelling

sufficient to lift WGIW over EDS. Is there any lag between wind stress and the dense water renewal? Could the authors quantify this relationship?

Thank you for this helpful suggestion. In the revised manuscript, we now quantify the relationship between wind forcing and calculated vertical velocities. Based on daily means, we find that "strong vertical velocities" (upper quartile of distribution) are characterised by velocities greater than ~1m day^{-1}. Such events typically lasted several days but often occurred in clusters extending over 2-3 weeks, associated with sustained upwelling-favourable winds with wind stress exceeding ≤ -0.1 N m^{-2}. Cross-correlation analysis indicated that the Ekman response follows negative wind stress within hours, as expected given its derivation from wind stress (Eq. 5). Using 10-day means to emphasise persistent conditions (as plotted in Figure 8), we find that vertical velocities of ~0.35–0.45 m day^{-1} were attained under an average wind stress ≤ -0.055 N m^{-2} sustained over multiple days to weeks. We also show that in autumn 2023, the wind stress was weaker and less persistent than these thresholds.

When relating upwelling to WGIW boundary depth, we found only a weak statistical relationship. This is expected for several reasons, and we note that quantifying this relationship with the available observations is complicated. First, our vertical velocities are calculated from wind stress and represent the potential Ekman pumping over the EDS. However, we lack hydrographic observations west of or over EDS to observe the actual upwelling, determine the actual density of the uplifted waters, the magnitude of that vertical displacement, and the extent to which other processes, such as coastal upwelling, may have contributed. Second, the vertical uplift at the sill is not necessarily proportional to uplift within the Disko Bay basin below sill depth. Third, the WGIW boundary depth time series combines data from two Floats and Monitoring Station data. These represent different sampling locations, and the WGIW boundary depth itself varies by ~30m across Disko Bay. We will include a new Table 2, along with other results from our newly improved spatial analysis. This inherent spatial variability limits our ability to define a robust quantitative relationship between wind forcing and WGIW boundary depth. Finally, the advective timescales between the inflow of dense waters across EDS and their arrival at the observation sites are not well constrained.

3. The sampling frequency in Table 1 seems a bit long to capture variability in shorter time scales. It would be great if the authors could discuss whether the variability in higher frequencies would affect the water mass exchanges in the bay system.

We appreciate this comment and suggestion. While the sampling frequency of our data may appear sparse, it is unique in that it includes late autumn, winter, and early spring observations (repeated over two annual cycles). These periods are rarely sampled in Disko Bay. The Monitoring Station profiles (weekly-monthly, repeated three years, with a targeted autumn campaign in 2023 to enhance observational frequency) combined with the floats sampling at 5-day intervals provide the longest and highest-frequency seasonal timeseries available. Together, these complementary datasets resolve the seasonal processes we focus on, with signals that are persistent and repeated from year to year.

We agree that higher frequency variability is certainly present, but in the context of seasonal forcing, we believe that the main physical processes are well captured. As part of the revision (see response to Reviewer 1), we have substantially shortened the manuscript and therefore, respectfully, choose not to add an additional discussion about higher-frequency variability, which lies beyond the scope of this study.

Specific comments

Figure 1 and lines 61-70: I notice the lack of labels for locations in the diagram, and it was difficult to follow the statement without further searching for another map online. Please include some key locations such as Vaigat Strait to help the reader navigate.

We have revised Figure 1 with the suggestions implemented.

Line 165 and Figure 2 caption: I realize the mixing line definition is not explicitly indicated in the Figure 2 caption. It would be more straightforward if the reader could find the definition of the mixing line end-points without referring back to the T-S statement in the manuscript.

Thank you for this helpful suggestion. We revised the figure caption accordingly.

Figure 7a: please label the boxes with eastern, northern, and central.

In the revised manuscript, Figure 7 (2018 spatial analysis) has been removed and replaced with updated spatial analyses from 2022–2024. In all the updated figures, we have now ensured clear labelling of regions/locations.

Line 319: it seems that in March and April 2024, the wind forcing and upwelling were strong (the same period in Figure 9c as the orange shading in Figure 9ef). Why does the statement here say “not evident”?

Thank you for pointing this out. The original statement that wind forcing was not evident during spring 2024 was unclear. Our revised results (strengthened with a more quantitative analysis of winds following the general comment #2) confirm that upwelling-favourable winds were indeed present during this period, although they were weaker than those observed in spring 2023.

Figure 10: please label the panels (a) and (b).

We labelled the panels in the former Figure 10 (now Figure 9 in the revised manuscript).