Dear Reviewer #2,

We appreciate the time and efforts you have dedicated in providing feedback about our manuscript and are grateful for your insightful comments. These comments have contributed to improve our research work. We have now finalized the revision of our manuscript entitled “On the Seasonal Western Boundary Current System of the Weddell Gyre”.

In the following, a detailed point-by-point response to comments by reviewer #2 is presented. To make a clear distinction, comments from the reviewer #2 are marked in bold font while our response is in regular font. To ease their identification through this document, the new text for the revised version of the manuscript is highlighted in blue font.

Please note that the lines indicated as LXXX in our response refer in all cases to the submitted manuscript. Please, note that new figures and tables mentioned in our response are presented at the end of this document. These new figures and tables will be indicated as Figure RY or Table RY, where R stands for Revision and Y stands for an ascending number. If we refer to Figures and Tables of the submitted manuscript, we will use the same format as in the submitted manuscript.

Before proceeding with the detailed point-by-point response, we provide below an overview of the main changes applied in the revised version to ease its assessment:

1.- After performing the analyses suggested by the reviewers, and carefully addressing their concerns jointly, we find their suggestions add so many important aspects to the story that the space left for discussion of differences among NEMO and HYCOM led us to decide to drop the latter from the revised version. We are happy the first submitted version shows the major differences among products, but we agree that maybe we were trying to cover too much at once and by doing so the main message may be unclear. The revised paper focuses on NEMO-based products and observations (direct velocity measurements and altimetry data) solely. We use this variety of data to characterize the seasonal variations of the Western Boundary Current System of the Weddell Gyre assessing an open-access product against existing observations and former modeling studies in order to enable its future use in studies about the interannual variability of this current system. Also, we describe the ocean dynamics governing the interior branch of the ocean gyre, demonstrating this is highly controlled by the basin-wide wind stress forcing as opposed to the most relevant role that thermohaline forcing plays as one approaches the coastal zone (sea-ice formation/melting dominates here).

Following the suggestion by #Reviewer1: to drop the HYCOM-based results from the manuscript.

2.- We have recomputed the wind stress-forcing in all cases accounting for the presence of sea-ice making use of the algorithms develop by Greene et al., 2019:

Chad A. Greene, Kaustubh Thirumalai, Kelly A. Kearney, José Miguel Delgado, Wolfgang Schwanghart, Natalie S. Wolfenbarger, Kristen M. Thyng, David E. Gwyther, Alex S. Gardner, and Donald D. Blankenship. The Climate Data Toolbox for MATLAB. Geochemistry, Geophysics, Geosystems 2019. doi:10.1029/2019GC008392 https://doi.org/10.1029/2019GC008392.

Following the suggestion by #Reviewer2: to account for the sea-ice presence when computing wind stress.

Also, we have included in our analysis correlations of the volume transport and the wind stress curl.

Following the suggestion by #Reviewer1: to account for the basin-wide wind forcing acting over the ocean gyre.

3.- We have filled in the gaps near the bottom-sea accounting for the bottom-intensified jets. To do so we have used an algorithm available in MATLAB code that we have previously used successfully in Veny et al. (2022) to perform a similar exercise where data near an island slope needed to be filled prior to volume transport calculations. This algorithm* accounts for the surrounding gradients to perform a realistic extrapolation. We will discuss this method in the revised version as well as include a mention of the bottom-triangle approach described by Thompson and Heywood (2008).

John D'Errico (2024). inpaint_nans (https://www.mathworks.com/matlabcentral/fileexchange/4551-inpaint_nans), MATLAB Central File Exchange.
Following the suggestion by #Reviewer1: to account for the gaps near the sea bottom.

We look forward to hearing back from you.

Sincerely,

Tania Pereira-Vázquez

POINT-BY-POINT RESPONSE

REVIEWER #2

This presented manuscript investigates the Wendell Gyre's western boundary current system structure using three different reanalysis products with addition of in-situ hydrographic data and altimetry data. The main motivation is to assess the capability of open-access reanalysis products in producing relevant dynamics and variability of the system. The authors, highlight the existence of a bottom reaching, broad current extending up to 600km offshore eastward of the Weddell Front, which they name Inner Weddell Current.

The southern hemisphere subpolar gyres constitute an important role in our climate systems by modulating the poleward heat transport and ultimate supply of heat that drives basal melting of the Antarctic ice shelves. On the other hand, the western boundary current system transports transformed water masses northward where they can participate in the global thermohaline circulation. Given the challenges in observing, in particular remote and ice-coverage regions, gridded reanalysis datasets are a popular and tempting choice to do data analysis. However, a careful validation is needed, thus this study has potential to be a valuable contribution to the community's understanding of the regional dynamics and variability as well as providing insights about the performance of existing broadly used reanalysis products.

Overall, the manuscript is written clearly and presented figures support the main conclusions of the work. However, I have several comments and concerns about this work as presented in more detail below. I recommend rejection with encouragement of resubmission.

We thank reviewer #2 for the careful reading of our work and for the time and efforts dedicated to providing feedback about our research work. Now, we proceed to the point-by-point review.

Major comments

It would be better to not refer to the section as ADELIE section but actually as SR04 WOCE. To my understanding ADELIE refers to the specific project/cruise in 2007, which steamed along the WOCE SR04 transect to release drifters. If the authors want to keep their current terminology this should at least be mentioned, as actually also done in Thompson & Heywood (2008).

We appreciate the comment and will clarify this information regarding the transect in the revised version of the manuscript.

We have decided to maintain our current terminology, referring to it as the E-ADELIE transect. However, we agree with R#2 that it is important to mention the similarity with the SR04 WOCE section. Therefore, we will rephrase the submitted manuscript to specify that the E-ADELIE transect is a portion of the existing SR04 WOCE section. This will ensure clarity and proper context for our readers while retaining the terminology we have used throughout the manuscript.

Before, these lines (237-246) read:

2.2.1 The E-ADELIE transect

To characterize the variability of the WBCS of the Weddell Gyre we focus on a key location, the historical ADELIE transect (Fig. 2), where the current system is well defined and has been previously described as a multi-jet structure current system (Thompson & Heywood, 2008). The ADELIE transect is located northeast of the AP, where the Weddell waters may either turn around the Antarctic Peninsula towards the Bransfield Strait, leave the gyre circulation towards the Scotia Sea and the South Atlantic Ocean, or recirculate within the Weddell Gyre. Different from the traditional ADELIE transect, we analyse a version of that one which extends farther oceanward into the gyre interior and which we name E-ADELIE transect. This transect aims to account for the dynamics of the western branch of the Weddell Gyre to its full extent. We address the comparison of the horizontal and vertical structure of the WBCS jets as depicted by the two reanalysis products, SADCP measurements and altimetry data.

Now, these lines read:

2.2 Methods

To characterize the variability of the WBCS of the Weddell Gyre, we focus on a key location, the western part of the historical SR04 WOCE section. The western portion of this section was previously studied by Thompson & Heywood (2008), who refer to this section as the ADELIE transect (Fig. 2), where the current system is well defined and described as a multi-jet structure current system. Different from the ADELIE transect, we analyze a version that extends farther oceanward into the gyre interior, which we name the E-ADELIE transect. Here, E-ADELIE refers to the western portion of the SR04 WOCE section. This transect aims to capture the dynamics of the western branch of the Weddell Gyre in its entirety, including the IWC jet. We address the comparison of the horizontal and vertical structure of the WBCS jets as depicted by the two reanalysis products (GLORYS2V4 and GLORYS12V1), SADCP measurements, and altimetry data.

Wind stress calculation: wind stress in ice covered regions is altered by presence of sea ice, so in order to get the actual surface stress for the ocean, sea ice should be considered. Overall, the discussion of sea ice and how it mediates momentum transfer at the ocean surface is missing. It is concerning to me if authors are not aware of this process.

We agree with R#2 and have revised our wind stress and wind stress curl calculations to account for Sea Ice Coverage, utilizing the toolbox developed by Greene et al. (2019):

Chad A. Greene, Kaustubh Thirumalai, Kelly A. Kearney, José Miguel Delgado, Wolfgang Schwanghart, Natalie S. Wolfenbarger, Kristen M. Thyng, David E. Gwyther, Alex S. Gardner, and Donald D. Blankenship. The Climate Data Toolbox for MATLAB. Geochemistry, Geophysics, Geosystems 2019. doi:10.1029/2019GC008392 https://doi.org/10.1029/2019GC008392.

By integrating these adjustments into our analysis, we ensure that the impact of sea ice on wind stress and its implications for momentum transfer at the ocean surface are properly considered. We have also updated the methodology section to include these considerations.

Before, these lines (264-291) read:

We calculate wind stress as follows, using the formula proposed by Kara et al. (2013):

$$\boldsymbol{\tau = \rho \cdot U_{10}^{2} \cdot C_{D}} \ (3)$$

where ρ represents the air density (1.2 kg m-3); $U10 = \sqrt{}u10'2 + v10'2$ is the wind speed at 10 m above the surface (with v10' and v10' denoting rotated eastward and northward velocity components, respectively); and, CD is the drag coefficient, which is a function of wind speed, U10.
To ensure alignment with volume transport calculations, we compute cross- and along-ADELIE wind velocities. v10' and u10' are utilized to calculate U10, maintaining the same rotation angle (α) through the expressions:

$\boldsymbol{v_{10}}' = \boldsymbol{v_{10}} * \boldsymbol{cos}\,(\boldsymbol{\alpha})$ - $\boldsymbol{u10} * \boldsymbol{sin}(\boldsymbol{\alpha})$ (4)

$\boldsymbol{u_{10}}' = \boldsymbol{v_{10}} * \boldsymbol{sin}(\boldsymbol{\alpha}) + \boldsymbol{u10} * \boldsymbol{cos}(\boldsymbol{\alpha})$ (5)

We conduct basin-scale calculations to assess the average wind patterns across our study area. Subsequently, we analyse the relationship between the seasonal cycles of wind and volume transport, considering wind as a potential influencing factor. To do this, we delineate the boundaries of the study are as follows: the northern boundary corresponds to a distinct change in wind direction at 64ºS; moving southward, the limit is established by identifying the point where the signal of the WBCS becomes evident, which occurs at 74ºS; the western boundary is demarcated by the Antarctic Peninsula (AP) at 62ºW, while the eastern boundary is determined by an observable shift in both wind and current directions at 38ºW. The products employed for wind stress computation derived from the two reanalysis products used in this study. GLORYS2V4 and GLORYS12V1 use ERA-interim and ERA5 datasets, respectively. Since ERA-interim was discontinued in 2019, ERA5 forcing fields have been applied starting from January 2019, accessible at https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-interim and https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels?tab=overview. GLBv0.08 uses NCEP-CFS and NCEP-CFSV2 products. NCEP-CFS was discontinued in 2010. The corresponding data sets are accessible at https://www.hycom.org/dataserver/ncep-cfsr and https://www.hycom.org/dataserver/ncep-cfsv2.

Now, these lines read:

We calculate wind stress as follows, using the formula proposed by Lüpkes et al. (2005):

$$\tau = \rho \cdot \mathbf{U}_{10}^{2} \cdot Ci \qquad (2)$$

where ρ represents the air density (1.2 kg m^{-3}); $U10=\sqrt{(\mathbf{U'}_{10}^{2}+\mathbf{V'}_{10}^{2})}$ is the wind speed at 10 m above the surface (with u'_{10} and v'_{10} denoting rotated eastward and northward velocity components, respectively); and, Ci is the drag coefficient calculated following Lüpkes et al. (2005), after specifying the sea ice concentration.

Wind stress curl is calculated after obtaining the τ_x and τ_y components of the wind stress, accounting for sea ice over the Weddell Basin. Basin-scale calculations are performed to assess the average wind patterns across our study area (see Fig. YY in the appendix). We then analyze the relationship between the seasonal cycles of wind and volume transport, considering wind as a potential influencing factor.

The authors should give some clarification about the satellite altimetry product used. This seems to be the standard sea level product used in the global open ocean. My understanding is that the traditional gridded altimeter products cannot be readily used in ice covered regions. It might be useful to at least also use the Dynamic topography and sea level anomaly product by Armitage et al., 2018. The authors mention as well in L123-126 that remote sensing products have caveats during the ice- covered season, however they do not further discuss this in relation to the data they use for the analysis or the discussion. This is another concern, leaving me wondering how careful the authors were in their analysis and choice of data.

The Weddell Sea is characterized by harsh winter conditions, with extensive sea-ice coverage for most of the year except summer. This presents a significant challenge for the use of traditional altimetry products, particularly during the winter season. The altimetry product we utilized in this study is detailed in the 'Quality Information Document' (Ref: CMEMS-SL-QUID-008-032-068, https://doi.org/10.48670/moi-00148). This document stipulates a baseline of 15% sea ice concentration to flag data, following Lavergne et al. (2019). In addition, for our analysis, we only used altimetry data when at least 50% of the dataset along the E-ADELIE transect contained valid values, resulting in the absence of winter season data. Note also that the altimetry data shown in Fig. 3 represents a seasonal composite of thirty years of data. Moreover, our choice and careful handling of data are consistent with previous studies in the Weddell Sea area and Bransfield Strait, such as:

Oelerich, R., Heywood, K. J., Damerell, G. M., du Plessis, M., Biddle, L. C., & Swart, S. (2023). Stirring across the Antarctic Circumpolar Current's southern boundary at the prime meridian, Weddell Sea. Ocean Sci., 19, 1465–1482. https://doi.org/10.5194/os-19-1465-2023.

Frey D, Krechik V, Gordey A, Gladyshev S, Churin D, Drozd I, Osadchiev A, Kashin S, Morozov E and Smirnova D (2023). Austral summer circulation in the Bransfield Strait based on SADCP measurements and satellite altimetry. Front. Mar. Sci. 10:1111541. https://doi.org/10.3389/fmars.2023.1111541.

Before, lines (238-246) read:

The surface geostrophic circulation of the study area is derived from SEALEVEL_GLO_PHY_L4_MY_008_047 (Global Ocean Gridded L4 Sea Surface Heights and Derived Variables Reprocessed 1993 Ongoing), hereafter ALT. This product is derived from various altimeter missions and encompasses data from GEOSAT to Jason-3. The altimeter data is processed using the DUACS multimission altimeter data processing system. The spatial resolution is 0.25° × 0.25°, with a temporal resolution of daily covering the period from 1993 to 2020.

Now, these lines read:

The surface geostrophic circulation of the study area is derived from SEALEVEL_GLO_PHY_L4_MY_008_047 (Global Ocean Gridded L4 Sea Surface Heights and Derived Variables Reprocessed 1993 Ongoing), hereafter ALT. This product is derived from various altimeter missions and encompasses data from GEOSAT to Jason-3. The altimeter data is processed using the DUACS multimission altimeter data processing system. The spatial resolution is 0.25° × 0.25°, with a temporal resolution of daily covering the period from 1993 to 2020.

Since the Weddell Sea is characterized by harsh winter conditions, with extensive sea-ice coverage for most of the year except summer, the use of traditional altimetry products becomes a significant challenge. The altimetry product we employ accounts for the presence of sea-ice coverage, as indicated in the quality information document (CMEMS-SL-QUID-008-032-068). This document indicates that a baseline of 15% sea ice concentration is used to flag data, following Lavergne et al. (2019). Furthermore, we established a threshold criterion requiring a minimum of 50% spatial coverage for the altimetry data along the E-ADELIE transect to be included in our analyses. Consequently, this results in the exclusion of winter season climatology due to insufficient data coverage.

The authors base their description of the new current (Inner Weddell Current) on two SADCP sections. I believe there are more SADCP sections that could be used, e.g. https://doi.pangaea.de/10.1594/PANGAEA.735277 Furthermore, the altimetry product has to be treated with great caution as this region is partially ice covered all year round, even in summer.

We appreciate the comment about the SADCP data. We have analyzed more than ten SADCP sections in this region. The decision to include the two transects presented in the manuscript was based on their comprehensive coverage of the study transect across different years and seasons (the campaigns correspond to LG0003a of R/V Laurence M. Gould in April 2000 and NBP0106 of R/V Nathaniel B. Palmer in November 2001). We think this approach helps to support the presence of the Inner Weddell Current (IWC) across different temporal contexts.

We consider the objective of the study is not to provide a rigorous analysis of all the existing SADCP data around the study transect but to compare the main features of the Western Boundary Current System against some observational data. If the reviewers consider necessary to show additional SADCP transects, we can do so as a part of the Appendix.

Regarding the altimetry product, we hope the explanation provided in the previous point raised by R#2 was clear henough.

I am not 100% convinced that it is necessary to name what the authors refer to as Inner Weddell Current if it basically is the western part of the gyre circulation. Maybe there is another clear distinction, which I am not picking up. If that is the case, it would be great to specifically highlight that distinction. The authors state themselves in L619-620 "… seems to drive largely the recirculation of interior water within the gyre", which, again, to me is just the western branch of the gyre circulation and does not qualify as a 'newly discovered' current.

We think it is important to keep the definition of the inner circulation as IWC since this is not simply the western part of the gyre circulation. The WBCS of the Weddell gyre is composed of a multi-jet structure rather than by one unique branch. Each current has been shown to display its own spatial pattern and downstream recirculation (as discussed in the submitted manuscript); not every jet follows the same fate. Downstream of the ADELIE transect, the CC recirculates around the Antarctic Peninsula, and the ASF and

WF split into different branches (some leaving the basin and some recirculating within the gyre) while the IWC belongs to the inner recirculation of the gyre where flows are shown not to leave the basin (Fig.3). We think it is important to account for all these branches separately, especially when the IWC is shown to carry significantly different amounts of volume transport as compared to the other jets (Lines 466-477 of the submitted manuscript).

Minore comments

A map with the full Weddell Gyre would be helpful in introduction. Maybe the one already shown can be then used as an inset

We agree with R#2 and, in line with comments from R #1 (Line 41, Line 77), we have modified Fig. 1 to ensure a better representation of the study area (see Fig. R1 at the end of this document). However, we prefer to maintain the study area as the main map instead of an inset. This approach ensures that the dynamics of the area remain clear. The revised Fig. 1 will now include a map showing the full Weddell Gyre, providing a comprehensive overview while keeping the detailed study area prominent.

Careful in comparing snap-shots with time mean averages of products of different length

We appreciate this important point raised by Reviewer #2 and also by Reviewer #1 (Major comments). Direct comparisons between observations and reanalysis products are inherently challenging due to the limitations in both datasets. Observational data often do not reach the bottom in all stations, and reanalysis products vary in their temporal coverage and resolution. To address these concerns, we will highlight these limitations in our discussion and the comparison of the estimates derived from reanalysis products and those reported in the literature. While a straightforward comparison may not be possible, we think the results remain valuable and fall within the expected range of volume transport values. Furthermore, this is a traditional approach followed by former studies (Matano et al., 2002; Neme et al., 2021, their Table 1) where estimates from modelling or reanalysis products are compared with existing observations, with a clear acknowledgment of the limitations involved. In the revised version we make the readers aware of these limitations and provide a careful discussion of our findings.

Figures:

Add isobaths for orientation (e.g. in Figure 3)
Figure 3: It would be helpful to add some markers for distance or mark the individual fronts, described in the right side panels, in the maps. To me the jets are not readily visible on the surface fields

We agree with your suggestion and have added isobaths and distance markers along the E-ADELIE section for better orientation (see Fig R2).

Line-based comments:

L33: Grammar: '…approaches the real ocean … the closest when compared…' does not seem correct

We agree. In the revised version we have replaced these expressions.

Before, these lines read:

Results from this study suggest that the high-resolution version of NEMO (GLORYS12V1) approaches the real ocean in the western Weddell Sea the closest when compared to observations and literature.

Now, these lines read:

Results from this study suggest that the high-resolution version of NEMO (GLORYS12V1) better captures the major features of the western Weddell Sea when compared to observations and literature, namely the location and spatial distribution of the multi-jet structure and the volume transport driven by each current of the WBCS.

L61: Not just a leakage of subsurface but also surface waters? It could be relevant to refer to Morrison et al., 2023 here.

We agree and have rephrased this line: The CC drives the exit of Weddell waters towards Bransfield Strait, allowing the leakage of near-freezing surface subsurface waters (Morrison et al., 2023).

L70: known as WDW within the Weddell Sea. Mention that CDW enters the gyre at its eastern boundary (e.g. Schroeder et al., 1999 and Ryan et al., 2016)
L69/70: ' Down the continental slope…' this statement is not correct in my opinion. Down the slope AABW is found, or potentially refer to Weddell Sea Deep and Bottom Water. High salinity shelf water is formed due to Brine rejection on the Filchner Ronne shelf and the Larsen shelf, which is then exported locally and flows down the continental slope.

We agree with this point, previously raised by R#1, and we proceed to better explain the process occurring in the area.

Before, these lines (65-70) read:

Across this front there is a rapid change in temperature and salinity due to the interaction between the colder and fresher waters of the Antarctic continental shelf, formed as a result of sea ice formation and melting processes, and the relatively warm and saline waters sourced by the Antarctic Circumpolar Current (ACC) (Thompson & Heywood, 2008; Vernet et al., 2019). The former water mass is known as Antarctic Surface Water (AASW), while the latter water mass is a modified Circumpolar Deep Water known as Warm Deep Water (WDW). Down the continental slope, dense Antarctic Bottom Water (AABW) is formed following brine rejection in the upper ocean surface.

Now, these lines read:

Across this front there is a rapid change in temperature and salinity due to the interaction between the colder and fresher waters of the Antarctic continental shelf, formed as a result of sea ice formation and melting processes, and the relatively warm and saline waters sourced by the Antarctic Circumpolar Current (ACC) entering the gyre from the eastern part (Thompson & Heywood, 2008; Vernet et al., 2019). The former water mass is known as Antarctic Surface Water (AASW), while the latter water mass is a modified Circumpolar Deep Water known as Warm Deep Water (WDW) within the Weddell Sea (Schröder & Fahrbach, 1999). Over the continental shelf, dense shelf water produced during sea ice formation cascades down the continental slope and mixes with WDW. This process allows the dense water to reach the ocean bottom and continue its pathway through the global ocean. This dense bottom water is known as Antarctic Bottom Water (AABW) (Muench & Gordon, 1995; Stewart & Thompson, 2012).

L70-73: this is a very busy sentence which would profit from some citations, e.g. how does the ASF impact sea-ice dynamics and are there examples of impacting marine ecosystems?

We agree with this point, previously raised by R#1, so we have proceeded to reformulate the sentences.

Before, these lines read:

Thus, the ASF plays a crucial role in the exchange of heat, salt, and nutrients between the deep ocean and the Antarctic continental shelf waters with important implications for the distribution of marine ecosystems and sea-ice dynamics, where the WDW also conditions the melting of ice shelves.

Now, these lines read:

Thus, the ASF plays a crucial role in the exchange of heat, salt, and nutrients between the deep ocean and the Antarctic continental shelf waters, with important implications for the distribution of marine ecosystems and sea-ice dynamics (Vernet et al, 2018). In these regions, the WDW also influences the melting of ice shelves. However, the ASF is not entirely circumpolar; it is interrupted by the Antarctic Peninsula, separating the Pacific and Atlantic sectors of the Southern Ocean (Thompson et al., 2018). Specifically, it is absent along the West Antarctic Peninsula and large parts of the Bellingshausen Sea.

L73: how is the Weddell Front defined? Could be helpful to mark the fronts in the hydographic sections in the appendix

Following the suggestion of R#1, we have added a table in the appendix (see Table R1 and R2), clarifying the hydrographic characteristics of each jet:

Lines 75-76: An overview of the water masses which compose the multi-jet structure of the WBCS in the reanalysis products as compared to observations is provided in the Appendix, including their main characteristics (Fig. A1 and Table R1 and R2).

Appendix:

For clarity, we provide an overview of the characteristics of the main water masses encountered along the E-ADELIE transect in Table R1 and R2. This summary is based on the literature and data from the GLORYS12V1 product. These ocean property ranges are in agreement with those found for GLORYS2V4.

To address the reviewer's concern about the front's position, we have added a vertical dashed line marking the positions of the fronts (Fig. R3).

L172/173: DOI should be moved to acknowledgements or Data Availability section, same for url of ERA-Interim

We agree and have moved this information to the *Data Availability Section*, as required by the Journal.

All data we used in this investigation are publicly accessible. Global NEMO-based reanalysis products GLORYS2V4 and GLORYS12V1 are available at https://doi.org/10.48670/moi-00024 (last access 29/05/2024) and https://doi.org/10.48670/moi-00021 (last access 08/02/2024), respectively. Data of Sea Ice Coverage from GLORYS products are also accessible at the same link as the products (last access 13/06/2024). Regarding wind products, those forcing GLORYS products are ERA-interim and ERA5 datasets, which are available in open access at https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-interim (last access 29/05/2024) and https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels?tab=overview (last access 29/05/2024).
Regarding altimetry data, they are available at https://doi.org/10.48670/moi-00148 (last access 19/12/2022).
Both SADCP data are free accessible, LG0003a of R/V Laurence M. Gould cruise data are available at http://adcp.ucsd.edu/lmgould/lmgadcp/year2000.html#lg0003a (last access 14/02/2024), and NBP0106 cruise of R/V Nathaniel B. Palmer cruise data are available at https://currents.soest.hawaii.edu/nbpalmer/nbp0106/nb150/webpy/ (last access 29/02/2024).
Finally, in situ data from Cruise SOS-Climate II of RV Ary Rongel (Fig. A1 from appendix), are accessible at https://doi.pangaea.de/10.1594/PANGAEA.864578 (last access 26/05/2021).

L529: so are ERA5 and ERA-interim the same line?

Yes, we use the same forcing as specified in the technical documents of each product. We use ERA-Interim data until 2018 and ERA5 data from 2019 onwards. This is explained in the main text in section 2.2.3, Wind Stress.

L530: What do you mean by the same pattern? That larger windstress in NCEP CFS would driver larger transport in GLBv0.08? This should be clarified in the text.

In the revised version we have removed the HYCOM-based product following the suggestions by reviewer R1 and our own argumentation provided at the beginning of this document of response.

L540: citation should be Le Paih 2020

We thank the reviewer for pointing out this. We have corrected the citation to reference Le Paih (2020).

L628: Try to avoid subjective verbiage

Thank you for your suggestion. We have revised the entire document accordingly. However, if when providing the revised document, you still note specific instances where you feel the language could be improved, we will be happy to address the requested changes.

References

Armitage, Thomas W. K., Ron Kwok, Andrew F. Thompson, and Glenn Cunningham. 2018. "Dynamic Topography and Sea Level Anomalies of the Southern Ocean: Variability and Teleconnections." Journal of Geophysical Research, C: Oceans 123 (1): 613–30.

Morrison, Adele K., Matthew H. England, Andrew Mcc Hogg, and Andrew E. Kiss. 2023. "Weddell Sea Control of Ocean Temperature Variability on the Western Antarctic Peninsula." Geophysical Research Letters 50 (15): e2023GL103018.

Below you can find the new references of the revised version:

Chad A. Greene, Kaustubh Thirumalai, Kelly A. Kearney, José Miguel Delgado, Wolfgang Schwanghart, Natalie S. Wolfenbarger, Kristen M. Thyng, David E. Gwyther, Alex S. Gardner, and Donald D. Blankenship. The Climate Data Toolbox for MATLAB. Geochemistry, Geophysics, Geosystems. doi:10.1029/2019GC008392, 2019.

Heywood, K. J., A. C. Naveira Garabato, D. P. Stevens, and R. D. Muench, On the fate of the Antarctic Slope Front and the origin of the Weddell Front, J. Geophys. Res., 109, C06021, doi:10.1029/2003JC002053, 2004.

John D'Errico (2024). inpaint_nans (https://www.mathworks.com/matlabcentral/fileexchange/4551-inpaint_nans), MATLAB Central File Exchange. Retrieved June 17, 2024.

Kwok, R., & Cunningham, G. F. Variability of Arctic sea ice thickness and volume from CryoSat-2. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 373(2045), 20140157. https://doi.org/10.1098/rsta.2014.0157, 2015.

Lüpkes, Christof, and Gerit Birnbaum. "Surface drag in the Arctic marginal sea-ice zone: a comparison of different parameterisation concepts." Boundary-layer meteorology 117.2: 179-211, 2005.

Morrison, Adele K., Matthew H. England, Andrew Mcc Hogg, and Andrew E. Kiss. "Weddell Sea Control of Ocean Temperature Variability on the Western Antarctic Peninsula." Geophysical Research Letters 50 (15): e2023GL103018, 2023.

Smith, W. H., & Sandwell, D. T. Global sea floor topography from satellite altimetry and ship depth soundings. *Science*, *277*(5334), 1956-1962, 1997.

We add here new figures/ tables of the revised version:

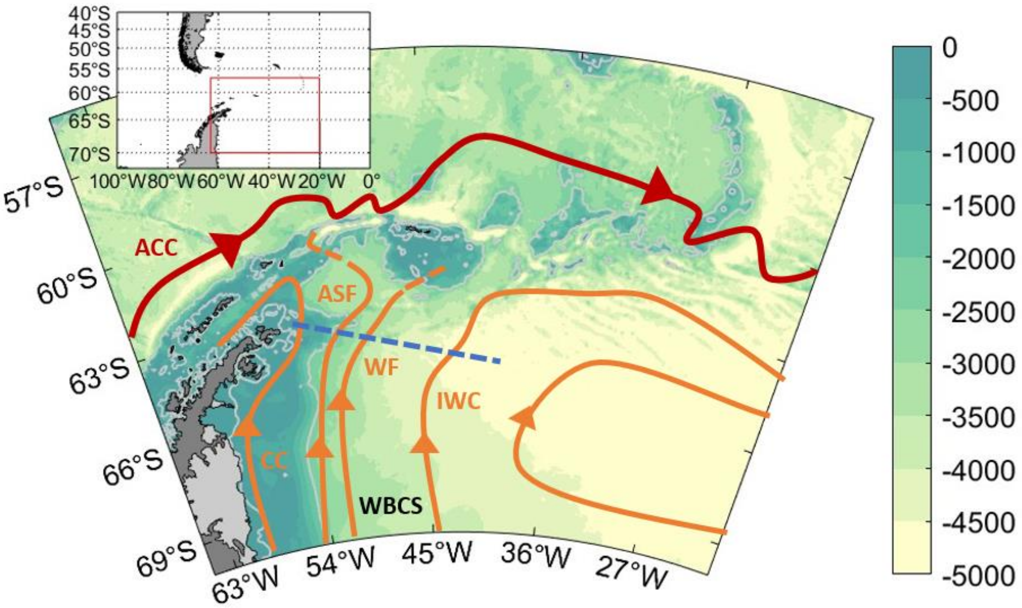

Figure R1. Bathymetric map of the north-western sector of the Weddell Gyre depicting the study area with an indication to the approximate location of major oceanographic features and currents with a surface signal. The E-ADELIE transect localization is indicated in blue (see section 2.2.1). Acronyms stand for: Southern Boundary of Antarctic Circumpolar Current (ACC), Western Boundary Current System (WBCS), Antarctic Coastal Current (CC), Antarctic Slope Front (ASF), Weddell Front (WF) and Inner Weddell Current (IWC).

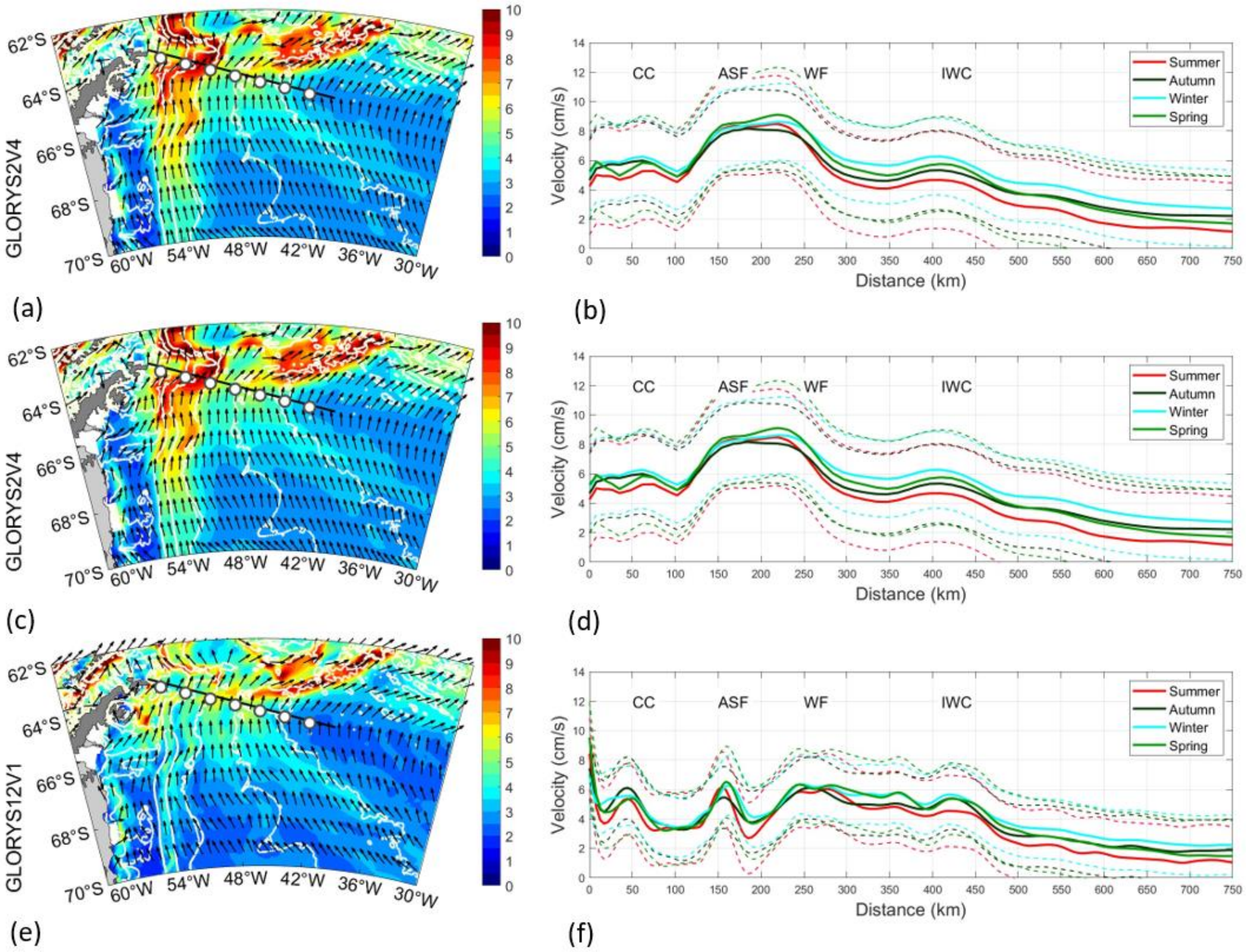

Figure R2. Panels a, c, e, present the horizontal structure of the WBCS of the Weddell Gyre following the time-averaged velocity field (cm/s) at surface. The displayed arrows represent unitary vectors. E-ADELIE is indicated with a black line, and white dots over the line are presented every 100 km. Fine white lines trace bathymetric contours at 200- and 400-meters depth, while white gross lines correspond to depths of 1000, 2000, 3000, 4000, and 4500 meters. Panels b, d, f, depict the seasonal surface velocity field (cm/s) along E-ADELIE with its standard deviation. In panel (b), the winter season is absent, based on the requirement that at least more than 50% of the dataset along the E-ADELIE contains not empty values. Computations encompass the complete time series of each dataset for all panels.

Water mass	**Conservative temperature (°C)**		**Salinity**		**Depth (m)**		**Density (Kg/m^3)**	
Data	*Bibliography*	*GLORYS12V1*	*Bibliography (PSU)*	*GLORYS12V1 (g/kg)*	*Bibliography*	*GLORYS12V1*	*Bibliography Neutral density*	*GLORYS12V1 Potential density*
AASW	-1.9~0	-2~1.5	33.8~34.50	32.50~34.50	0~250	0~200	≤ 28.00	≤ 27.60
HSSW	-	-1~-1.9	-	34.40~34.70	-	150~500	-	27.60~27.80
WDW	0~0.6	0.2~0.8	34.65~34.69	34.60~34.70	200~2000	200~2000	28.10~28.27	27.80~27.85
WSDW	-0.7~0	-0.2~0.2	~34.65	34.70~35.10	1500~4000	500~3000	28.27~28.40	27.85~27.86
WSBW	-1.4~0	-0.2~-1	34.60~34.65	~34.70	≥ 1000	≥ 1000	≥ 28.40	≥ 27.86

Table R1. Characteristics of the main water masses encountered along the E-ADELIE transect as seen in bibliography (Thompson and Heywood, 2008) and in GLORYS12V1 reanalysis product (averaged from 1993 to 2020). The table includes the key water masses for this region: Antarctic Surface Water (AASW), High Salinity Shelf Water (HSSW), Warm Deep Water (WDW), Weddell Sea Deep Water (WSDW) and Weddell Sea Bottom Water (WSBW).

Current	Conservative temperature (°C)		Salinity		Potential density (Kg/m^3)	
Data	*Bibliography*	*GLORYS12V1*	*Bibliography (PSU)*	*GLORYS12V1 (g/kg)*	*Bibliography*	*GLORYS12V1*
CC	-2~0	-1.6~-0.6	34.35~34.61	33.63~34.83	-	26.92~27.83
ASF	-2~ 1	-1.6~0.21	34.35~34.65	33.93~34.84	27.80~28.40	27.17~27.85
WF	0~0.6	-1.6~0.4	34.65~34.70	34.02~34.86	≥ 28.00	27.25~27.86
IWC	-	-1.7~0.4	-	34.08~34.86	-	27.30~27.87

Table R2. Characteristics of the main water masses encountered along each jet of the WBCS as seen in bibliography (Heywood et al, 2004) and in GLORYS12V1 reanalysis product (averaged from 1993 to 2020). The table includes currents described on the E-ADELIE transect: CC (Coastal Current), ASF (Antartic Slope Front), WF (Weddell Front) and IWC (Inner Weddell Current).

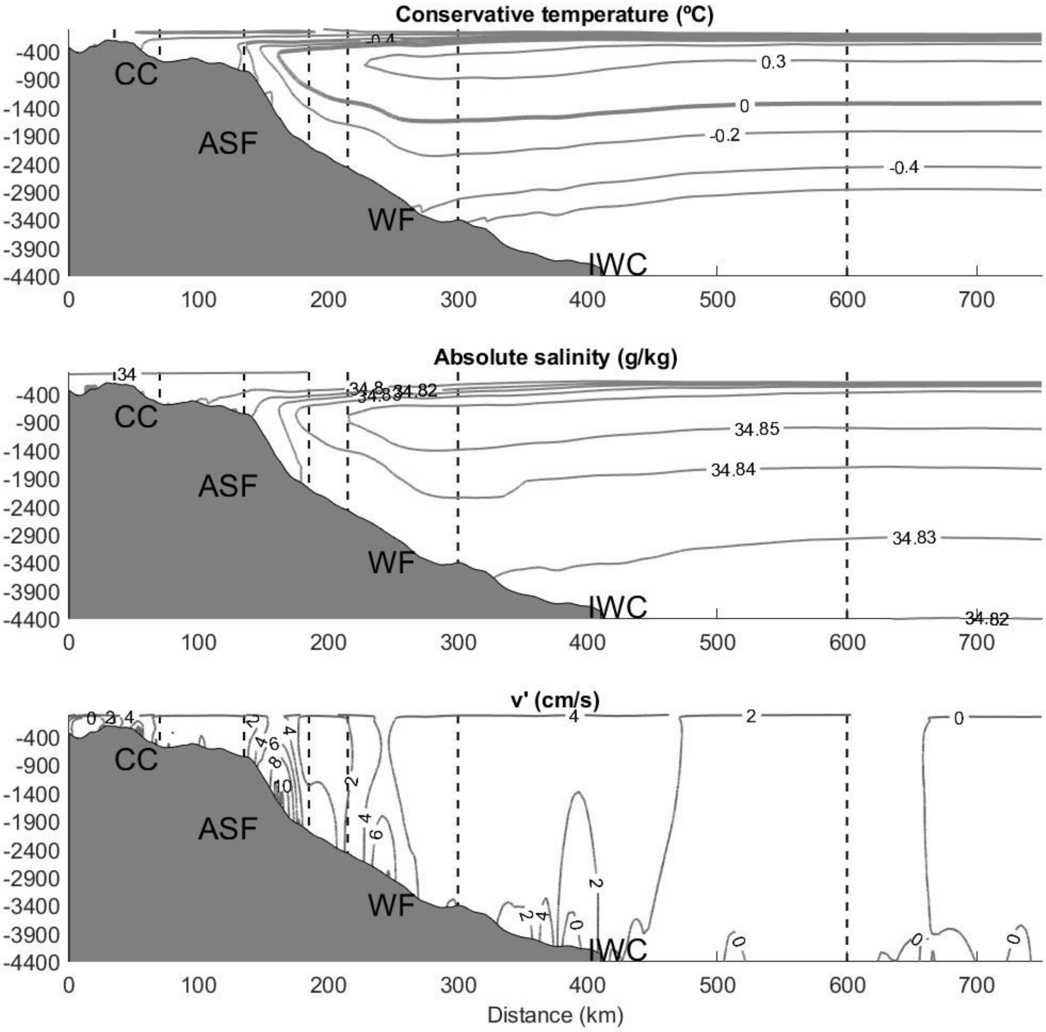

Figure R3. Vertical sections showing Conservative Temperature, Absolute Saltinity and v’ (cm/s) mean conditions (1993-2021) of each branch as depicted in GLORYS12V1 product. The position of the fronts is defined following the black dashed lines and their names, corresponding to: Coastal Current (CC), Antarctic Slope Front (ASF), Weddell Front (WF), Inner Weddell Current (IWC).