Dear Editor Dr. Xinping Hu,

We appreciate the time and efforts dedicated by the reviewers and yourself in providing feedback about our manuscript and are grateful for the insightful comments that have contributed to improve our research work. We have now finalized the revision of our manuscript entitled "Biophysical coupling of seasonal chlorophyll-a bloom variations and phytoplankton assemblages across the Peninsula Front in the Bransfield Strait" for final consideration to the Journal of Ocean Science.

In the following, a detailed point-by-point response to every reviewers' comment is presented. To make a clear distinction, comments from the reviewers are marked in **bold font** while our response is in regular font. To ease their identification through this document, 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 revised manuscript, unless otherwise specified.

The structure of the point-by-point response follows, as requested by the Journal, the sequence: comments from referees, author's response and indication to author's changes in manuscript (when changes have been made).

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.

Regarding comments from Reviewer #1, we have produced an updated and revised Figure 1 where the transects of study have been added in panel b along with main features of the hydrography in BS. This combines with comments made by Reviewer #2, noting that panel b was too simple and should be combined into panel a. Accounting for all the suggestions, panels a and b in Figure 1 provide now useful information separately and, therefore, we have decided not to combine them into solely one panel because the result would be an overcrowded figure.

We have also revised Figures 2-4 (they are shown later in this document) following Reviewer's #1 comments. Lastly, minor comments regarding the text (removal of lines and combination of others) have also been included in the revised version.

Regarding major comments from Reviewer #2, as they are listed in his/her first reply in the Public Forum, we proceeded as follows:

1.- **We think the concern about the wind stress computation** has been already extensively addressed and argued in the Public Forum, and hopefully it **is now solved**. For further clarity in the revised text, more references were added supporting the procedure and use of the equations. See later the detailed point-by-point response.

2.- We agree former panel b was too simple, but now it has been improved with key information and suggestions derived from comments by reviewer #1. Accordingly, **we have produced an updated and revised Figure 1** where the transects of study have been added in panel b along with main features of the hydrography in BS. This is why we have decided not to combine panels a and b since the resulting figure was overcrowded (in any case we also produced the combination of the two panels and included the result later in this document so that the reviewer can have a look at it and get his/her own opinion). We hope the reviewer #2 understands this decision. Also, we have not included the SST or chl-a in the background because the figure got then even more overcrowded and found crucial to have maps where hydrography and transects of study are clearly shown overlying the bathymetry, which is not shown in any other figure while the SST and chl-a fields are. The revised Figure 1 is also presented later in this document.

3. The reviewer #2 demands discussion about front dynamics and frontal probability to identify the location of the fronts. Accordingly, **we have added text and produced a new figure** which is now part of the Appendix B. In this figure, we make use of the frontal probability. We use the added text and figure to set the basis to our upcoming follow-up manuscript. This new research, which is already prepared for submission, investigates the interannual variability of the chl-a bloom in the BS and uses different methodologies, not only the calculation of frontal probability.

4.- **This is the only comment we do not understand its origin. We do not claim at any part of the manuscript that the creativity of our work relies on the intercorrelation of chl-a among different parameters** and find surprising the straightforward comparison with the work by Yu *et al*. (2019, JMS) in the South China Sea. If one searches in the literature, the list of papers underscoring the dependence between chl-a and other environmental factors (many of them using the frontal probability) is endless, thus becoming a classical topic in oceanography. The novelty of our work does not rely on defining an existing topic, differently, we aim to contribute with a new region of the world's oceans where this topic seems to have a worthy place not previously accounted for as we do, combining the knowledge about the governing dynamics with cruise data, remotely sense observations and a comprehensive revision of the literature on phytoplankton assemblages up to date. In our study we integrate all those pieces of information and propose the use of the SST front location for the long-term monitoring of the surface chl-a blooms in the BS, providing the necessary information to do so (characteristic environmental values in this region) as well as how to interpret the results in the context of the Antarctic marine ecosystems and likely potential changes of the food web. We do not see a resemblance between that and the work by Yu *et al*. (2019, JMS) in the South China Sea to understand why the reviewer suggests we claim their creativity, besides the fact that both studies fall within the same world-wide topic studying front dynamics and chl-a blooms [also, Yu *et al*. (2019, JMS) focuses solely on remotely-sensed observations].

If Reviewer #2 have detected that we claim creativity regarding the intercorrelation of chl-a among different parameters at some part of our text as he/she seems to suggest, we would appreciate an indication to the lines where that may occur and we will be happy to remove them or rephrase them for clarity because we agree that is not a novelty of our work.

5.- **A major revision has been performed** throughout the entire manuscript to address the reviewer's comment regarding the existence of typos, errors in reference formats and acronyms use or variable units.

6.- The governing dynamics of the Bransfield Current system based on the cruises we use have been actually the focus of a series of papers by the co-authors of this work. We discuss this in the detailed point-by-point response, making reference to the lines in the manuscript where the main findings in those works are already discussed for the context of the present study. **The governing**

dynamics are not novel, we must leave that clear and refer to existing works. Accordingly, we highlight and discuss only the findings needed for the reader to understand the bio-physical coupling. For further discussion on the governing dynamics of the Bransfield Current system, the reader must address the papers we cite, otherwise we would be unfocusing the present research and message, extending the paper unnecessarily.

Nevertheless, **for clarity, in the detailed point-by-point response we indicate the lines in the manuscript where a discussion of the governing dynamics is presented** not only in the context of our in situ observational cruise data, but also against the satellite data and against the literature (Table 1). May the reviewer not be convinced by our arguments, we would appreciate some counter argumentation letting us know why more discussion is still needed, as well as guidance about in what section more discussion is particularly missed, and we will be happy to work on it.

We look forward to hearing back from you.

Sincerely,

Marta Veny

POINT-BY-POINT RESPONSE

REVIEWER #1

This manuscript presents the results of the study of spatio-temporal variations of Chl-a blooms in the Bransfield Strait at a climatological scale (1998–2018). An original technique, based on the results of remote sensing and hydro-meteorological data obtained in situ, is proposed for a suitable monitoring of these blooms.
The material is well structured and clearly presented.

We thank reviewer #1 for the careful reading of our work and for the time and effort dedicated to providing feedback about our research work.

In my opinion, the manuscript should be accepted to publication, taking into account the minor concers, stated below:

Figure 1: The indices (a) and (b), marked in the figure's caption are absent in the images.

Thanks for noting this. We have corrected their absence in the revised Figure 1. Also, we have added the locations of transects T I-III in Figure 1(b) to support the changes that the Reviewer #1 suggests for Figures 2-4 in the following.

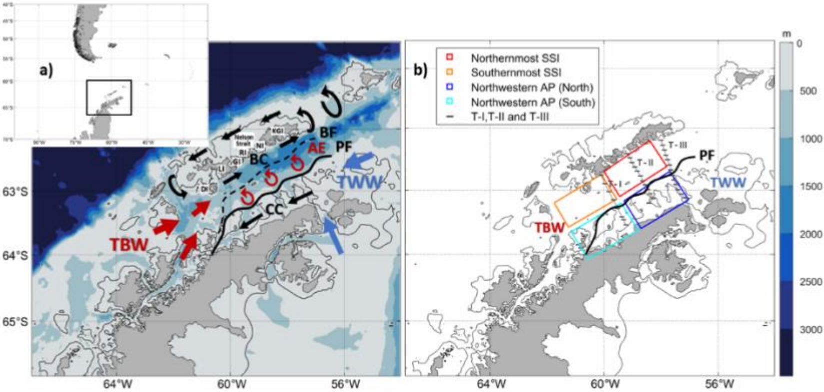


Figure 1. (a) Sketch of the circulation in the Bransfield Strait. Acronyms for South Shetland Islands (SSI) include DI (Deception Island), LI (Livingston Island), GI (Greenwich Island), RI (Robert Island), NI (Nelson Island) and KGI (King George Island). Acronyms for major oceanographic features are as follows: AE (Anticyclonic Eddy), BC (Bransfield Current), BF (Bransfield Front), CC (Antarctic Coastal Current), PF (Peninsula Front), TBW (Transitional Bellingshausen Water), TWW (Transitional Weddell Water); (b) Map showing cruise transects and boxes selected for dedicated analysis. The transects are from two different oceanographic cruises and include T-I and T-III from CIEMAR (December 1999) and T-II from COUPLING (January 2010). Additionally, four boxes are defined between the SSI and the Antarctic Peninsula (AP): Northernmost SSI (red), Southernmost SSI (orange), Northwestern AP - North (dark blue) and Northwestern AP - South (light blue). The 200 m isobath is highlighted with a black contour in both panels.

Line 129 -130: These sentences should be deleted.

Agree, we have removed these lines.

Figures 2, 3 ,4: It's practically impossible to distinguish the colours of the stations in the map on the subfigure on right below that does not allow identification of the corresponding T,S curves on the subfigure above.

We appreciate the valuable suggestions regarding Figures 2-4. We have applied these changes to improve them. Please see the revised Figures 2-4 and captions below.

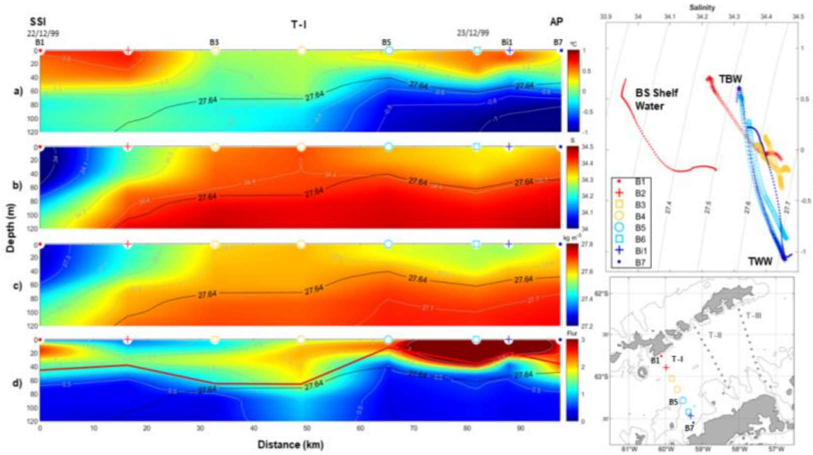


Figure 2. Vertical sections of ocean properties along transect T-I surveyed during the CIEMAR cruise (December 1999), running from Livingston Island to the Antarctic Peninsula. (a) Potential temperature, (b) salinity, (c) potential density, and (d) fluorescence are shown in the left-hand side panels. The solid black line represents the isopycnal of 27.64 kg m^{-3}, used as a reference to distinguish between Transitional Zonal Water with Bellingshausen influence (TBW) and Transitional Zonal Water with Weddell influence (TWW; Sangrà *et al*., 2017). The solid red line in panel d) shows the upper mixed layer depth computed following Holte and Talley (2009). The top right-hand side panel displays a Temperature-Salinity diagram to highlight water masses: Bransfield Strait (BS) Shelf Water, TBW, and TWW. Different marks and colours are displayed to represent data in each station. The bottom right-hand side panel shows a map depicting the stations of the transect T-I.

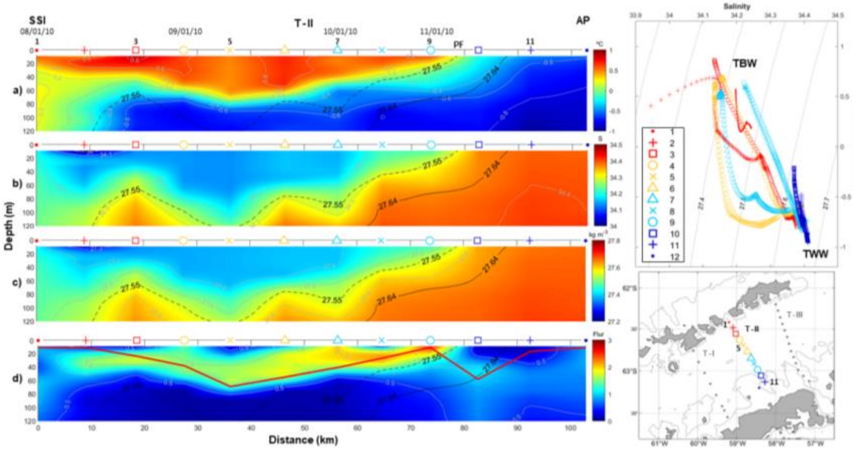


Figure 3. Same as in Figure 2 but for T-II, surveyed during the COUPLING cruise (January 2010) and running from Nelson Strait to the Antarctic Peninsula. Additionally, the dashed black line represents the isopycnal of 27.55 kg m^{-3} which is used as a reference more adjusted to our dataset to distinguish between TBW and TWW.

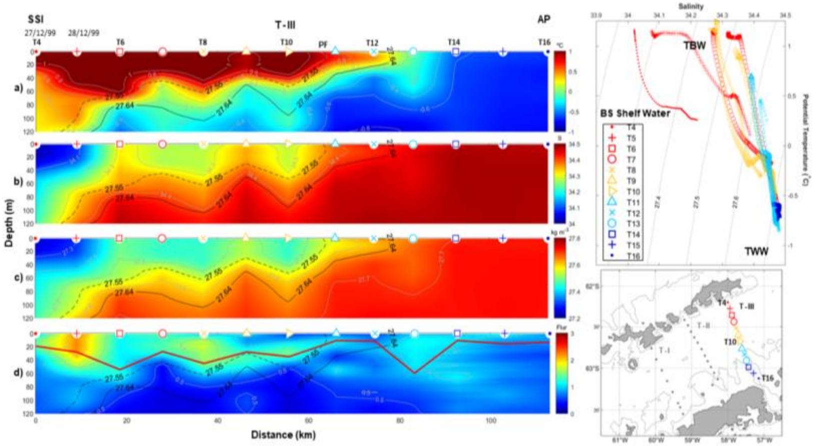


Figure 4. Same as in Figure 2 but for T-III, surveyed during the CIEMAR cruise (December 1999) and running from King George Island to the Antarctic Peninsula. Additionally, the dashed black line represents the isopycnal of 27.55 kg m^{-3} which is used as a reference more adjusted to our dataset to distinguish between TBW and TWW.

Line 542-543 should be combined.

Agree, we have combined these lines.

REVIEWER #2

The study presented in the abstract provides valuable insights into the spatio-temporal variations of chl-a blooms in the Bransfield Strait over a climatological scale. The researchers tackle an important problem of monitoring these blooms using remotely-sensed observations and propose a novel approach by dividing the Bransfield Strait based on the Peninsula Front. This approach is supported by the characterization of various climatological fields and guided by both novel and historical in situ observations. One of the strengths of this study is the identification of two distinct phytoplankton assemblage niches: the Transitional Bellingshausen Water (TBW) and Transitional Weddell Water (TWW) pools. By analyzing the characteristics of these pools, such as water temperature, salinity, and mixing, the study provides a comprehensive understanding of the environmental factors influencing chl-a blooms in the Bransfield Strait. The monthly climatological description of the two blooms occurring on both sides of the Peninsula Front enhances our understanding of the interplay between chl-a blooms in the TBW and TWW pools.

The integration of SST and chl-a data for monitoring chl-a blooms is another essential aspect of this study. By combining these datasets, researchers can track the year-to-year variations of chl-a blooms in the Bransfield Strait and gain insights into the long-term dynamics of phytoplankton assemblages. Similar approach has been applied in some of the coastal ocean that is useful to reveal the dependence of chl-a to dynamical factors. However, the authors failed to calculate the wind in correct approach that can lead to significant error in estimation.

In conclusion, the study offers valuable contributions to the understanding of spatio-temporal variations of chl-a blooms in the Bransfield Strait. The proposed approach of dividing the strait based on the Peninsula Front, the identification of distinct phytoplankton assemblage niches, and the integration of SST and chl-a data for monitoring are all commendable. This research has the potential to enhance our knowledge of chl-a blooms in the region and contribute to the field of marine ecology and remote sensing. However, there are some unclear descriptions, even errors, as well as careless in writing; thus, a major revision is necessary to improve the quality.

Major comments:

A major error is the calculation for wind stress shown in equation (1). The zonal and meridional wind stress should be calculated respectively for both wind speed and wind vector. However, the authors applied the wind speed as the total wind speed. This is definitely resulting in significant over estimation of wind stress.

We have performed several tests to address this concern and reviewed the methodology we applied. In order to be clear, we have included Equations 1-3 in the revised version. These equations are used to compute the wind stress, and its components, as widely employed in the literature (see references below). Furthermore, for a better approach, we incorporate a drag coefficient that depends on the magnitude of the wind speed. This was not the case in the submitted version of the manuscript. However, the same spatial patterns stand out within the same order of magnitude as shown in the previously submitted version.

We find no significant over estimations of the wind stress following either of the two procedures. All equations, and their applications, have been double-checked against the literature, as well as with real case scenarios. I all cases, the equations are proven to be correct.

Lines 174-179 in the original manuscript read:

"We calculate the wind stress (τ) and its components following Equation 1:

$$\tau_x = \rho\, C_D U_{10} u \; ; \quad \tau_y = \rho\, C_D U_{10} v \; , \tag{1}$$

where τ_x and τ_y are the zonal and meridional wind stress components, respectively; ρ is the air density (1.225 kg m^{-3}); C_D is the drag coefficient (1.25×10^{-3}; Kara *et al*., 2007); $U_{10}=\surd\sqrt{u^2+v^2}$ is the wind speed at 10 m above the surface; u and v are the eastward and northward velocity components; and, x and y are the eastward and northward spatial coordinates, respectively."

The above lines in the revised manuscript, lines 167-176, read:

"We calculate the wind stress (τ), and wind stress zonal (τ_x) and meridional (τ_y) components, following Equations 1-3 (Patel, 2023):

$$\tau = \rho \cdot U_{10}^{2} \cdot C_D \; , \tag{1}$$
$$\tau_x = \rho \cdot U_{10} \cdot u \cdot C_D \; , \tag{2}$$
$$\tau_y = \rho \cdot U_{10} \cdot v \cdot C_D \; , \tag{3}$$

where ρ is the air density (1.2 kg m^{-3}); $U_{10}=\sqrt{u^2+v^2}$ is the absolute value of the wind speed at 10 m above the surface (u and v are the eastward and northward wind speed components, respectively); x and y are the eastward and northward spatial coordinates; and, C_D is the drag coefficient, which is a function of wind speed, U_{10}. The equations used for wind stress computation are based on Gill (1982) formula and a non-linear C_D based on Large and Pond (1981), modified for low wind speeds (Trenberth *et al*., 1990). We note that the mean C_D we obtained for our climatological maps in the BS is $1.4 \times 10^{-3} \pm 0.16 \times 10^{-3}$, analogous to the values reported by Kara *et al*. (2007) over the SO."

A more extensive discussion on the equations we use was held in the Discussion Forum, where we clarified the doubt of reviewer #2; however, we think the references provided above already support sufficiently their use. If needed, we can repeat in this document all the explanations provided in the Forum but though it would be more convenient to stick here simply to the changes that were made in the revised manuscript to clarify further the procedure.

References

Gill, A. E.: Atmosphere-Ocean Dynamics, Academic Press, 30, 662, 1982.

Kara, A. B., Wallcraft, A. J., Metzger, E. J., Hurlburt, H. E., and Fairall, C. W.: Wind stress drag coefficient over the global ocean, J. Clim., 20, 5856-5864, https://doi.org/10.1175/2007JCLI1825.1, 2007.

Large, W. G., and Pond, S.: Open ocean momentum flux measurements in moderate to strong winds, J. Phys. Oceanogr., 11, 324-336, https://doi.org/10.1175/15200485(1981)011%3C0324:OOMFMI%3E2.0.CO;2, 1981.

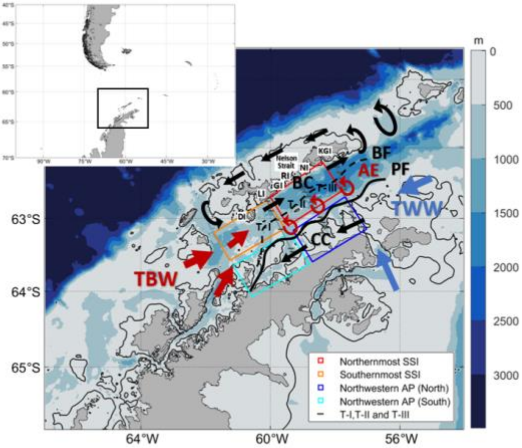
Patel, R. S.: Wind Stresses computation, MATLAB Central File Exchange, https://www.mathworks.com/matlabcentral/fileexchange/53391-windstresses-computation, 2023.

Trenberth, K. E., Large, W. G., and Olson, J. G.: The mean annual cycle in global ocean wind stress, J. Phys. Oceanogr., 20, 1742–1760, https://doi.org/10.1175/15200485(1990)020%3C1742:TMACIG%3E2.0.CO;2, 1990.

The major feature in Figure 1(b) is less helpful and can be combined into Figure 1(a). While the mean SST or chl-a (contour) can be shown instead for readers to understand the major patterns in the study region.

We have worked on a revised Figure 1, we agree the former panel b was too simple and lacked on valuable information. However, we think it may not be optimal to combine Figure 1(b) into Figure 1(a) as this could potentially overload the figure as is now after update of panels and (a) and (b), especially considering the new addition of the three observational data transects which derive from suggestions of Reviewer #1. Reviewer #1 made suggestions to make clearer the stations in Figures 2-4, and the changes we applied to that aim had a necessary impact in Figure 1(b). As a result, we think the present suggestion of Reviewer #2 may now not be that optimal anymore.

Nevertheless, to show the case, we present below the Figure 1 as it would look following Reviewer #1 and Reviewer #2 suggestions. We hope the reviewers and Editor may agree this is too crowded (<u>transects T-I, T-II, T-III are not visible</u>) and we prefer to stick to the revised Figure 1, as shown earlier in this document and in the revised manuscript. We think that is better to stick to clarity.



The front is generally identified using the SST gradient and the frontal probability is usually applied for identifying the location of fronts. The identified frontal distribution from satellite observation can be compared with the cruise observation. The authors should elaborate more discussion related with front dynamics in current study.

We have carefully read the manuscript recommended by the Reviewer #2 later on (Yu *et al*., 2019), and find the Frontal Probability (FP) tool of high interest to elaborate more discussion. We think the FP tool is highly valuable to explore the front dynamics regarding the existence of a recurrent oceanic front; however, we also think the use of this tool becomes more meaningful when aiming to automate the process of identifying the front in interannual variability studies. In our case, the focus is on seasonal variability, particularly during one unique season, the summer chlorophyll-a bloom. To achieve this, we generate a climatological map (i.e. a map with historical memory) of summer Sea Surface Temperature (SST) and a climatological map of summer chlorophyll-a concentration, where the adjustment of the thermal front and chlorophyll bloom boundaries is straightforward.

To reinforce this adjustment, two (among many other) approaches may be considered: (1) confirming the overlap between a gradient of SST and the chl-a using Frontal Probability over remotely-sensed observations, as in Yu *et al*. (2019); (2) exploring a straightforward match in remotely-sensed climatological maps against *in situ* oceanographic data over different years to ascertain whether the recurrent nature of this adjustment actually holds in water. In our case, we have chosen option 2, as we have data validating the physical-biological coupling along the front. Furthermore, we substantiate this adjustment with an extensive literature review (Table 1), shedding light on our hypothesis of frontal coupling in the BS using information reported by previous authors over several decades. The pieces of information were always there; we have just assembled them to form the narrative. While acknowledging that using Frontal Probability may be of use, we think it would be more beneficial in future studies of interannual variability using solely remotely-sensed observations through an automated algorithm, where such a tool (the Frontal Probability) could potentially play a central role.

In the current study, we think that employing Frontal Probability as a central tool would require rewriting the whole manuscript, and would unnecessarily extend the paper, given its already substantial length.

However, we accept the reviewer's request about elaborating some more the discussion related to the front dynamics in the context of chl-a blooms and the use of frontal probability. With the intention of not extending the length of the main body of the manuscript, we have added this new text as closure thoughts of the results and discussion section, before heading towards the conclusions. Furthermore, we have also added Appendix B (new text and new figure), where we validate our approach of constructing climatologies of SST and chl-a to define the characteristic isotherm and isoline of chl-a of the Peninsula Front.

In the revised manuscript, lines 679-687 read the following, as a closure of Section 3, and after discussing Figure 10:

"Lastly, it is worthwhile noting that the alignment of the chl-a spatial distribution along an oceanic front is not a novel feature in the world's oceans, and it has been already investigated in the literature (Moore and Abbott, 2002; Baird *et al*., 2008; Von Bodungen *et al*., 2008). Thus, the novelty of our work lies in demonstrating through *in situ* observations and remotely-sensed measurements that such a biophysical coupling has the potential to be used to monitor the chl-a blooms and phytoplankton assemblages occurring seasonally in BS. This aspect is particularly relevant because BS is a key region for the sustainability of marine Antarctic ecosystems, which is challenging to monitor due to the hazardous prevailing conditions in polar regions. In future studies, we expect the calculation of the frontal probability (Yang *et al.*, 2023) of the PF through a multi-year time-series of SST data may be beneficial to assess and co-locate interannually the alignment of the thermal front and the chl-a bloom domains using an automated algorithm for the Bransfield Strait study case (See Appendix B for further insights)."

References

Baird, M. E., Timko, P. G., Middleton, J. H., Mullaney, T. J., Cox, D. R., and Suthers, I. M.: Biological properties across the Tasman Front off southeast Australia, Deep Sea Res. Part I Oceanogr. Res. Pap., 55, 1438-1455, 2008.

Moore, J. K., and Abbott, M. R.: Surface chlorophyll concentrations in relation to the Antarctic Polar Front: seasonal and spatial patterns from satellite observations, J. Mar. Syst., 37, 69-86, 2002.

Von Bodungen, B., John, H. C., Lutjeharms, J. R. E., Mohrholz, V., and Veitch, J.: Hydrographic and biological patterns across the Angola-Benguela Frontal Zone under undisturbed conditions, J. Mar. Syst., 74, 189-215, 2008.

Yang, K., Meyer, A., Strutton, P. G., & Fischer, A. M.: Global trends of fronts and chlorophyll in a warming ocean. *Commun. Earth & Environ.*, *4*(1), 489, 2023.

The same approach is actually applied by Yu et al. (2019, JMS) for underscoring the dependence between chl-a and other factors. Thus, the creativity is not relying on the intercorrelation among different parameters, unless the difference between current and former study is highlighted.

While we acknowledge that intercorrelation among chl-a and marine environmental factors is a well-known aspect in the literature since several decades ago (Martinez *et al*., 1990; Sasaoka *et al*., 2002; Schwarz *et al*., 2010; Yu *et al*., 2019; Moradi and Moradi, 2020), we would like to highlight that our study focuses on the unique context of the Bransfield Strait.

Unlike Yu *et al*. (2019), who conducted their research in the South China Sea, our study is situated in a region where the different ocean dynamics prevent us from concluding beforehand that an analogous approach, applied elsewhere, will also apply here. This idea is especially relevant considering the particular environmental conditions of the Southern Ocean as a high-nutrient low-chlorophyll (HNLC) domain. Unless research such as the one we presented here is performed, one cannot assume that the approach previously followed by Yu *et al*. (2019), and many others, can be applied in BS.

Also, because we are conscious that many previous papers address biophysical coupling in the ocean combining remotely-sensed chl-a and SST data, we do not claim at any moment the creativity of this research relies on the intercorrelation among different parameters; differently, we simply state that (lines 110-111) "We hypothesize that this biophysical coupling is strongly conditioned by the spatio-temporal variability of the Peninsula Front, as has been already argued."

Also, we focus on a very specific feature which applies to the BS case, the alignment of the surface chl-a blooms in BS along the Peninsula Front. This is also addressed in lines 10-12 (Abstract); and, in more detailed in lines 689-694 (Conclusions), where we account for the following:

"In this study, we address the hypothesis that the spring-to-summertime biophysical coupling controlling the chl-a bloom in the BS could be monitored through combination of remotely-sensed observations of chla and SST, which strongly conditions the spatio-temporal variability of the phytoplankton assemblage across the Peninsula Front. Our approach is based on the characterisation of climatological fields, following the motivation from novel and historical synoptic *in situ* observations (discussed in Section 3.1) which reveal that the Peninsula Front may be used as a guideline to contour two distinctive niches for phytoplankton assemblage in the BS, both horizontally and vertically."

We agree that it is essential to always emphasize the differences between a present study and previous works; however, we disagree that we have claimed creativity on the intercorrelation among different parameters. Nevertheless, in order to make this point clearer, we have added in the revised version the following lines 679-687 as a closure of section 3, Results and Discussion (same text that we use previously to address the former reviewer's request):

"Lastly, it is worthwhile noting that the alignment of the chl-a spatial distribution along an oceanic front is not a novel feature in the world's oceans, and has been already investigated in the literature (Moore and Abbott, 2002; Baird *et al*., 2008; Von Bodungen *et al*., 2008). Thus, the novelty of our work lies in demonstrating through *in situ* observations and remotely-sensed measurements that such a biophysical coupling has the potential to be used to monitor the chl-a blooms and phytoplankton assemblages occurring seasonally in BS. This aspect is particularly relevant because BS is a key region for the sustainability of marine Antarctic ecosystems, which is challenging to monitor due to the hazardous prevailing conditions in polar regions. In future studies, we expect the calculation of the frontal probability (Yang *et al.*, 2023) of the PF through a multi-year time-series of SST data may be beneficial to assess and co-locate interannually the alignment of the thermal front and the chl-a bloom domains using an automated algorithm for the Bransfield Strait study case (See Appendix B for further insights)."

See also the new Appendix B at the end of this document, or in the revised manuscript.

References

Martinez, R., Arnone, R. A., and Velasquez, Z.: Chlorophyll a and respiratory electron transport system activity in microplankton from the surface waters of the western Mediterranean, J. Geophys. Res. Oceans, 95, 1615-1622, 1990.

Moradi, M., and Moradi, N.: Correlation between concentrations of chlorophyll-a and satellite derived climatic factors in the Persian Gulf, Mar. Pollut. Bull., 161, 111728, 2020.

Sasaoka, K., Saitoh, S. I., Asanuma, I., Imai, K., Honda, M., Nojiri, Y., and Saino, T.: Temporal and spatial variability of chlorophyll-a in the western subarctic Pacific determined from satellite and ship observations from 1997 to 1999, Deep Sea Res. Part II Top. Stud. Oceanogr., 49, 5557-5576, 2002.

Schwarz, J. N., Raymond, B., Williams, G. D., Pasquer, B., Marsland, S. J., and Gorton, R. J.: Biophysical coupling in remotely-sensed wind stress, sea surface temperature, sea ice and chlorophyll concentrations in the South Indian Ocean, Deep Sea Res. Part II Top. Stud. Oceanogr., 57, 701-722, 2010.

Yang, K., Meyer, A., Strutton, P. G., & Fischer, A. M.: Global trends of fronts and chlorophyll in a warming ocean. *Commun. Earth & Environ.*, *4*(1), 489, 2023.

Yu, Y., Xing, X., Liu, H., Yuan, Y., Wang, Y., and Chai, F.: The variability of chlorophyll-a and its relationship with dynamic factors in the basin of the South China Sea, J. Mar. Syst., 200, 103230, 2019.

Many careless in the writing, such as forgetting to upper case the unit of chlorophyll, the reference (Sangrà et al. (2017)), chl-a and SST among others should be used after defining the abbreviation. The authors should double check the text throughout the manuscript.

We have carefully re-read the manuscript, and identified the issues mentioned by the reviewer, making corrections where it was needed. When the reviewer #2 indicates that we forgot to upper case the unit of chlorophyll, we must note that the unit of chlorophyll here is mg m^{-3}, there is nothing we should uppercase. May the reviewer #2 refer to fluorescence, we must note this is unitless as was collected during both cruises.

The governing dynamics should be discussed with observational evident, though only two cruises were available. Additional satellite observations or literature result can be applied as supplementary proof for the underlying dynamics.

The Bransfield Current System hydrography and dynamics have been extensively addressed and described in a handful of relatively recent papers (Sangrà *et al*., 2011, Sangrà *et al*., 2017, Veny *et al*., 2022), some of them co-authored by the co-authors of this manuscript. Please note where we discuss the main features and governing dynamics concerning our research in the Introduction (**lines 32-59**), Results and Discussion (**lines 224-237; 248-256; 329-340; 375-378; 653-672**), and Conclusions sections (**lines 699-713**).

We agree it is key to bear in mind the governing dynamical features of the Bransfield Current System; however, we consider we do so extensively in the above-mentioned lines.

Lastly, we would like to recall that the aim of the present manuscript is to link the well-known governing physics of the Bransfield Current System with the spatial distribution of the surface chl-a blooms and phytoplankton assemblages developing in the study region. To this aim we use observational, satellite data and *in situ* measurements from two available cruises and discuss profoundly these results against existing literature that use the same tools (satellite observations and cruise data). Based on all that information, eventually, we propose the approach to monitor the surface chl-a blooms in BS through the location of the Peninsula Front by combining remotely-sensed SST and chl-a. This enables the separation of two chl-a blooms regimes in the BS in accordance to two distinct environmental scenarios: the TBW and TWW pools. To support this approach, besides the study of the two cruises presented in this work, we discuss results from a variety of previous studies in **lines 202-211; 273-281; 298-311; 331-340; 351-358; 387-389; 407-419; and 518-539**. We think the studies mentioned in these lines cover the satellite observations and literature review the reviewer is asking for. Furthermore, an extensive and carefully detailed summary-table reviewing the existing literature supporting the approach we propose is presented in Table 1, and discussed in **lines 557-624**.

May the reviewer not be convinced by our arguments, we would appreciate some counter argumentation letting us know why more discussion is still needed, as well as guidance about in what section more discussion is particularly missed, and we will be happy to work on it.

Appendix B: Frontal probability of the Peninsula front

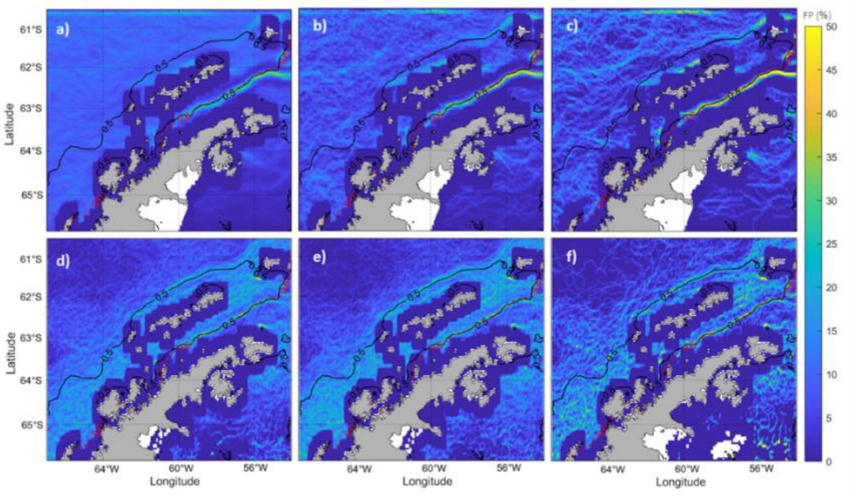


Figure B1. From left to right, the upper panels (a,b,c) show the frontal probability (FP) based on daily, monthly-averaged and seasonally-averaged data for Sea Surface Temperature through 21 years of summertime. Lower panels (d,e,f) show the same as upper panels but based on chl-a concentrations. The climatological summertime isotherm of 0.6ºC (dashed red line) and the isoline of 0.5 mg m^{-3} chl-a concentrations (solid black line) as obtained for Figures 5 and 7 highlight the goodness of our methodology to select them as characteristic environmental values contouring the Peninsula Front in Bransfield Strait.

Figure B1 presents the Frontal Probability (FP; Yang *et al.*, 2023) from the SST and chl-a fields in Bransfield Strait for the period 1998-2018. The Canny edge-detection algorithm (Canny, 1986) is applied to identify coherent frontal segments. Then, the summertime FP is calculated based on three different cases, using fronts detected on daily data, monthly-averaged data, and seasonally-averaged data over a period of 21 years (in all cases the information corresponds solely to summertime). The FP is defined at each pixel as a percentage where the times that the pixel is identified as a front is referred to the number of total valid pixels for a given time interval.

Results support the choice of the characteristic isotherms and isoline of chl-a used in this study to distinguish in the BS two different pools of chl-a development. Additionally, we note that the signal of the Peninsula Front increases in FP, especially in SST, when based on time-averaged fields (panels b,c,e,f) as compared to daily fields (a,d). We attribute this to the recurrence of the Peninsula Front, which gets better defined when a time-average procedure is followed before applying the Canny edge-detection algorithm. Simultaneously, a noisier signal emerges regarding other nonrecurrent fronts which are present only occasionally in time-average fields, thus leading to their presence only in a few fields when computing the FP.

We suggest that the FP may be used in future studies to code an automated algorithm capable of monitoring the chl-a blooms in Bransfield Strait based on remotely-sensed SST and chl-a data, using the South Shetland Islands and the Antarctic Peninsula as physical boundaries, and the Peninsula Front location as the oceanographic frontier contouring the TBW and TWW pools. Thus, co-locating interannually the alignment of the thermal front and the chl-a spatial distribution will enable the computation of accurate areas of integration for the assessment of the surface blooms acting in the Bransfield Strait.

References:

Canny, J.: A computational approach to edge detection, IEEE Trans. Pattern Anal. Mach. Intell., (6), 679-698, https://doi.org/10.1109/TPAMI.1986.4767851, 1986.