

General Comments

Your study explores the biophysical drivers of harmful algal blooms (HABs) using datasets collected during two research cruises on the Patagonian shelf and satellite-based analysis. I find this topic highly interesting and am pleased to assist you in showcasing its significance.

I find the paper difficult to read due to redundant paragraphs, a disorganized structure, and many long sentences. I recommend a major revision of the article's structure to improve readability and better emphasize the key questions and conclusions, which are currently unclear. I suggest providing a clearer description of the current limitations regarding the biophysical coupling responsible for HABs, the scientific question being addressed, and how your work advances your understanding beyond the limitations. Remember that every sentence must have a clear purpose, so words must be chosen with meaning and precision.

Note that I will not provide scientific feedback on the genetic and microscopic methods and analyses, as these are outside my areas of expertise.

Although English is not my first language, I have noticed several errors. I suggest a careful revision of the spelling and syntax.

1) Introduction

The structure should be reworked to improve its flow by organizing the paragraphs in a logical progression from general to specific. I recommend the following steps:

- **General context:** Begin by discussing HABs in general, their ecological and socio-economic impacts, and their relationship with the physical environment, without introducing the Patagonian shelf, as that will be covered in a subsequent paragraph. Provide a thorough overview of the current state of knowledge on HABs, supported by more citations. For example, you could move the paragraph starting at line 73, "The most conspicuous HABs are those formed..." and lines 91-94, "In oceanic waters..." as it provides a general perspective that is not specific to the Patagonian shelf. This will help establish a broader context before narrowing the focus to your specific study area.

Potential references:

Pitcher et al., 2010 <https://doi.org/10.1016/j.pocean.2010.02.002>

Ralston & Moore, 2020 <https://doi.org/10.1016/j.hal.2019.101729>

Wells et al., 2020 <https://doi.org/10.1016/j.hal.2019.101632>

Smayda, 1997 https://doi.org/10.4319/lo.1997.42.5_part_2.1137

Iriarte et al., 2023 <https://doi.org/10.1016/j.pocean.2023.103087>

- **Limitations and frontiers to address:** Clearly outline the current limitations in the study of HABs, emphasizing the challenges in understanding the biophysical processes driving them. Highlight the existing knowledge gaps that hinder a comprehensive understanding of these phenomena. Explain what remains unresolved and why these questions are significant. Finally, articulate the key objectives of your study, specifying what aspects of HABs you aim to uncover and how your work seeks to advance the field. For the moment, the limitations are diluted throughout the introduction when they should be

in the same place. For example, you mention at the end, lines 93-96, "...with few studies considering in situ sampling".

- **Specific question of your paper:** Clearly state the specific research question your paper addresses. This is also the appropriate place to introduce your study region—the Patagonian shelf—and explain why understanding the processes controlling HABs in this area is important. For instance, you could emphasize the significance of the Patagonian shelf by highlighting the statement from lines 77–78: “The maximum bloom abundances reported in the literature are from the Argentine Sea.” This key point should appear earlier in the paragraph to provide strong justification for your focus on this region. Currently, you present the specific question at the end of your introduction, in the lines “Furthermore, we aim ...,” whereas it is expected to appear earlier, before explaining your strategy.

- **Hypothesis:** Clearly state your hypothesis related to the specific research question. For example, you could propose, “Blooms within the Patagonian shelf are driven by a strong synergy between mesoscale processes and dinoflagellate communities.” Avoid repeating details about the physical characteristics of the Patagonian shelf or the importance of dinoflagellates, as these should already be covered in the preceding paragraph. Focus instead on presenting a concise and well-defined hypothesis to guide readers into the objectives and analysis of your study.

- **Your strategy:** Concisely describe the approach you implemented to address your specific research question. Focus on outlining the key methods and steps taken to achieve your objectives, providing a clear and logical connection to the hypothesis and study goals.

2) *Materials and Methods*

In general, I recommend a thorough revision of this section to better describe the methods, particularly by simplifying the sentences and reorganizing the sections. Additionally, some descriptions are missing (see Specific Comments below).

I suggest removing Section 2.1, as it is somewhat redundant with the introduction. Instead, you could synthesize additional informations and incorporate it into the section of the introduction that discusses the study region.

Next, I recommend presenting the cruise details with more emphasis on the strategy, such as how the station locations were selected, the duration of each station deployment, and the number of CTD casts performed... Following that, the in situ measurements (Section 2.4) should be presented immediately after the cruise description. I also wonder if it is necessary to have two separate sections for this.

Subsequently, the satellite products (Section 2.3) should follow, with the Lagrangian trajectories and FSLEs analysis after that. Sections 2.6 and 2.7 could be consolidated into the same section as the satellite-based observations, possibly as subsections. For example, Section 2.3 could be titled "Satellite-based observations and analysis," with subsections such as 2.3.1 "Remote Sensing of Surface Chla, SST, and ADT" and 2.3.2 "Lagrangian trajectories and FSLEs analysis".

3) *Results*

Similar to the introduction and M&M sections, I suggest improving the structure of the Results section. Start by describing the study region physically using satellite-based observations and analyses. Section 3.4 should be placed earlier in the Results section, as it would allow for a more direct comparison of chlorophyll-a surface distribution with surface physical dynamics. Following this, present the in situ dataset to integrate biological and physical data, which is the central focus of your article. I also have some suggestions regarding the figures (see Specific Comments below).

Moreover, I find that the description of the results is sometimes redundant with the M&M section or the Discussion. You should aim to present the results more concisely, avoiding repetition or interpretation (see Specific Comments below).

4) *Discussion*

I suggest adding a brief summary before Section 4.1 to recap the key points of your work.

The Discussion should clearly emphasize how you address with your results the specific question outlined in the introduction. Currently, I find the Discussion somewhat confusing, and it is difficult to identify the key conclusions of your study, primarily due to long sentences, lack of organization, and redundant descriptions with the Introduction. Specifically, I believe there is an excessive focus on describing other studies, with limited explanations of your own results. I recommend synthesizing the findings from other studies to better highlight your own contributions (particularly for sections 4.1 and 4.2).

I find the proposal of different scenarios (Fig. 12) interesting, but I was expecting more discussion of them in relation to your results. Specifically, the Lagrangian simulations are not discussed at all.

I suggest adding a short paragraph at the end of the Discussion to address the limitations of your study. For example, is two stations sufficient to answer the research question? What additional analyses or strategies could be employed in the future to study the biophysical causes of HABs (e.g., a Lagrangian in situ strategy to track these blooms in space and time)?

Finally, I recommend adding a Conclusion section from line 544 to the end. However, you should rework the text to avoid simply listing the “factors”.

Specific Comments

1)

- In the Methods section, you should provide sufficient information to allow readers to reproduce your work. For instance, if you used equations (e.g., for estimating chlorophyll-a concentrations), you need to specify the parameters used to parameterize these equations.

- Additionally, include key details for each method. For example, the description of nutrient measurements (lines 187–189) is unclear. Does the method have a specific name? What is the underlying principle? What parameters were used? Similarly, for the “screened mass transitions and instrument parameters” (lines 231–232), the explanation is vague and lacks clarity—what does this refer to, and how was it performed?

- For the Lagrangian simulations, you also need to provide more details, such as the timestep, initial conditions, and a small description of the algorithm's principle. The current sentence, "The algorithm computes the particle positions based on initial location and knowledge of the velocity field" (lines 239–240), is too brief. Similarly, in Section 2.7 (which could be combined with the preceding section since FSLEs are also part of Lagrangian analysis), you should begin with a clear definition of FSLEs and provide detailed information on how they were calculated. I strongly recommend combining the Lagrangian analysis with the satellite data section, as they are closely connected. This would prevent readers from having to flip back to earlier sections to recall where the data originated.

- In Section 2.6, the concept of ribotypes is not clear. I suggest adding a brief definition to clarify their purpose and how identifying them contributes to the study. Furthermore, the entire paragraph in this section requires a more detailed explanation, as it is currently unclear what the goal of this analysis is. It might also be worth considering combining this section with Section 2.5, as they appear to be complementary.

2) Regarding the figures, I suggest some modifications to improve their clarity.

- I suggest adding the vertical profiles of fluorescence to Figure 1. In the text, you state, "Surface water temperature and salinity remained similar at both stations GA01 and AA09," but this does not appear to be the case for temperature based on Figure 1 (~9°C for GA01 and ~11°C for AA09). It is also inconsistent with the values reported in Table 1.

- I recommend using a different color palette for Figures 2, 3, 8, 9, and D01, as the rainbow colormap is no longer widely used for mapping (see <https://doi.org/10.5194/hess-25-4549-2021> and <https://doi.org/10.5670/oceanog.2016.66>). Additionally, the current colormap makes it difficult to distinguish the station dots, especially in Figure 9.

- For Figures 8 and 9, you should include a colorbar label with units. In the legend of Figure 9, you should specify that the pink color represents the particle trajectories and indicated the initial positions of each particle with dots or crosses.

- For figures 2, 3, 8 and 9 it is confusing to use the same colormap to represent different types of data. I recommend using distinct colormaps for different variables (e.g., <http://dx.doi.org/10.1029/2018JC014392>). This would help differentiate between datasets and make the figures more intuitive for readers. Furthermore, why are the longitude and latitude limits not consistent across these maps (also with Figures 10 and 11)?

- I find the purpose of Figure 11 unclear. In the text, it is mentioned in just one sentence (lines 411–412), yet the figure is complex and takes up a significant amount of space. I suggest removing Figure 11, as the same information is already presented in Figure 10. However, you could modify Figure 10 to include, in addition to the large map, a zoomed-in view of the sampling stations (using only the inset subplot in pink from Figure 11).

3) My main concern about your work is the robustness and originality of the in situ observations.

- Having only two stations is not an issue for me; I understand the challenges of collecting in situ data, and I believe your discussion appropriately reflects the scope of your dataset without overextending the

conclusions. However, I could not find informations about the number of CTD casts, the number of replicates, or the timing of observations at stations GA01 and AA09 (e.g., were they conducted during the day or at night?). These details are essential for assessing the reliability of your results.

- Additionally, why were samples collected only at a depth of 5m? Was the bloom detected during the cruise or afterward? Were the locations of GA01 and AA09 specifically chosen for this reason? You should improve the section describing the cruise strategy (refer to my comments in point 2 of the General Comments) to provide more comprehensive detail and highlight why your data are both robust and original.

4) I wonder if the taxonomic composition of the bloom at stations GA01 and AA09 is the same as at the other stations. Did you compare the composition of these two stations with that of the others? Highlighting such a comparison could emphasize why this bloom is extraordinary. You briefly mentioned this in the Discussion (lines 537 to 540), but I believe it should be given more prominence. Instead of including it in this section of the Discussion, it would be better placed in the section where you describe the biological characteristics of the bloom.

5) I expected more discussion about the role of the frontal system, particularly in the final section of the Discussion. How does the presence of the front influence this bloom? In my view, the front acts as a hydrodynamic barrier, preventing the dispersion of the bloom. Additionally, smaller-scale physical phenomena, such as mesoscale and submesoscale eddies, also play a significant role in the bloom's behavior through horizontal stirring and retention processes. Your sentences on lines 509–511 and lines 515–518 are not very clear and could benefit from further clarification.

6) I like your final figure; however, why are you including the last scenario, “independent bloom patch,” if it is not likely? This figure should focus solely on the plausible explanations for your results.

Technical corrections

In general, be careful to keep your sentences shorter and to streamline your text by avoiding excessive use of extra words like "indeed," "for instance," etc... Moreover, ensure consistency in your notation style throughout the manuscript.

1) Lines 30 to 32: “The magnitude of this bloom is a global record for this group so far reported in the literature. The toxin azaspiracid-2 **[add “(AZA-2)”]** was detected in both stages of the bloom, with values up to 2122 pg L⁻¹. The most likely source of AZA-2 was *Azadinium spinosum* ribotype B.”

2) Sentence lines 33 to 35: “Water retention...” is too long.

3) lines 46: “Dinoflagellates produce a wide range of toxins” is redundant with the previous sentence.

4) Sentence lines 48 to 50: “In the Argentina...” is too long.

5) Line 52: “as documented for instance” to remove.

6) Line 56: “indeed” to remove.

- 7) Line 58 :“Furthemore” to remove.
- 8) Line 61: replace “important hazards” by “unexpectedly” or something like that
- 9) Line 68: “Thermohaline”
- 10) Line 70: “Additionally” to remove.
- 11) Line 79: “Liter” and not “Litre”. I noticed this mistake several times in the manuscript.
- 12) Line 81: “in the area” to remove.
- 13) Line 83: “Meter” and not “Metre”. I aslo noticed this mistake several times in the manuscript.
- 14) Sentence line 93 to 97: “Typically...” is too long.
- 15) Line 111: “The steep slope”, what are you talking about?
- 16) Sentence line 123 to 126: “Hence,...” is too long.
- 17) Sentence lines 137 to 138: “We first...” can be removed.
- 18) Sentence lines 151 to 152: “In order to” can be removed. Therefore, you will need to reformulate the next sentence.
- 19) Be careful to maintain consistency in your notations. For example, on line 157, you used a “-” between dates, whereas on line 158, you used “to”
- 20) Similarly, units should be presented in a consistent short format throughout. For example, on line 177, change “in meter” to “m” to align with line 179, where “5 m depth” is used.
- 21) Line 182: change “for 4h” by “during 4h”.
- 22) Line 204: a space is missing before “A1”.
- 23) Line 205: “Thereafter, they were...”, who are “they”?
- 24) Line 206: “Further” to remove.
- 25) Sentence lines 236 to 237 “We used...” can be removed.
- 26) Line 261: “an uniform...”
- 27) Figure 2: figure letters a), b), c), d) are missing.
- 28) Lines 271 to 272: “On November..” where do you see that?
- 29) Line 309: “A reddish water discoloration...” where do you see that?

- 30) Figure 4: “around 60m” it is more like 50m.
- 31) Line 334: “ITS”, what is it?
- 32) Sentence lines 339 to 340: “This distinction...” not useful as it should be in the method section.
- 33) Figures 6 and 7: either “scale bar = ...” or “scale bar is ...”.
- 34) Figures 2, 6 and 7: either a) or (a). Be consistent.
- 35) Line 373: “Lyapunov frontal systems” means nothing. I suggest to reformulate the title of this section as “Description of the frontal systems” or something like that.
- 36) Line 386: “80 cm/s” while in the figure it is in m/s.
- 37) Line 408: “Moreover” to remove. And “exponents (FSLEs)”
- 38) Figure 10: modify the caption as following or something like that “FSLEs fields computed...”
- 39) Lines 462-463: “And in particular” to remove.
- 40) Line 486: “In fact” to remove.
- 41) Line 533: “Additionally” to remove.
- 42) Sentence lines 540 to 542: “In this study...”, is incorrect. Retention is an in situ process and cannot be constrained by satellite observations.
- 43) Lines 548 to 558: Reorganize the sentences to avoid using a listing format.