

General comment

The present study entitled Massive and localized export of selected marine snow types at eddy edges in the South Atlantic Ocean, aims to describe the particles dynamic across physical feature induced by mesoscale eddies in Cape Basin (southwest of Africa). This study is based on BGC-Argo float data acquisition and more specifically the implementation of UVP6 images. The eddy distribution dynamics in the area occurring during the float deployment (17 months) has been characterized by the TOEddies algorithm (The Ocean Eddy Detection and Tracking Algorithm, Laxenaire et al., 2018).

The results presented in this study suggest that particle injection pump is induced by a frontogenesis-driven mechanism (edge of dipole eddy structure) and has the potential to boost the biological pump efficiency.

Globally the manuscript and presented results are clear and easy to get in. The phrasing is straight forward. However, some aspects could have been more carefully checked before the submission such as the figure indexation. The figure numbers in the text don't correspond to the figures presented... One figure (Figure 4) is shown but not presented and described in the text. It's a real pity to submit a manuscript with such errors. I would have expected more details and discussion about the different marine snow aggregates type (shape, density...). Because 'selected marine snow types' is mentioned in the title, I think some input can be done in the manuscript.

I don't require extra analysis in the manuscript. Nevertheless, the quality of the manuscript/figures could be considerably improved. **I recommend moderate revision of the manuscript.**

Please find below my comments and suggestions on the manuscript.

Principal criteria	Excellent (1)	Good (2)	Fair (3)	Poor (4)
Scientific significance: Does the manuscript represent a substantial contribution to scientific progress within the scope of Biogeosciences (substantial new concepts, ideas, methods, or data)?		X		
Scientific quality: Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?		X	X	
Presentation quality: Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)?			X	X (could be really improved)

Does the paper address relevant scientific questions within the scope of BG? **Yes**

Does the paper present novel concepts, ideas, tools, or data? **No, recent publications about ESP (Eddy Subduction Pump) have already highlighted such as processes on the biological carbon pump. The use of UVP5/6 imaging classification (e.g. elongated aggregates, dark solid aggregates, light aggregates...) is already known as an indicator of particles dynamic phenology.**

Are substantial conclusions reached? **Yes**

Are the scientific methods and assumptions valid and clearly outlined? **Yes**

Are the results sufficient to support the interpretations and conclusions? **Yes, but could be improved (see my comments and suggestions)**

Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? **Yes, if the author provides supplement data (raw data from Argo-Floats and UVP6 images), considering the FAIR protocol.**

Do the authors give proper credit to related work and clearly indicate their own new/original contribution? **Yes**

Does the title clearly reflect the contents of the paper? **Yes, but the use of the term ‘Massive’ could be nuanced**

Does the abstract provide a concise and complete summary? **Yes**

Is the overall presentation well structured and clear? **Yes**

Is the language fluent and precise? **Yes**

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? **Yes**

Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? **Yes, see my comments/suggestions**

Are the number and quality of references appropriate? **Yes, but some recent studies are missing in the manuscript e.g. about stokes influenced sinking aggregates, or stickiness index of particles)**

Is the amount and quality of supplementary material appropriate? **Yes**

Title

Line 1: Title, ‘Massive’ doesn’t sound appropriate. Maybe ‘Intense and localized export...’ or just ‘Localized export...’?

Introduction

Lines 35-36: ‘The solubility pump transports cold, dense, and DIC-rich waters to the deep ocean, as part of the ocean’s overturning circulation, primarily in high-latitude regions’ add a reference for this statement

Line 44: ‘produced by phytoplankton activity’, what type of activity? Must be precise or rephrased

Line 46: ‘and zooplankton fecal pellets (Turner, 2015).’ You might explain the actual process, repackaging by zooplankton induce by grazing and fecal pellet egestion...

Line 47: ‘export about 6 Pg of carbon’ this statement corresponds to the global carbon export led by gravitational pump alone, I think. If it’s what you meant you must precise ‘gravitational export flux’. Actual global BCP estimates are about 5-12 PgC yr⁻¹

Line 51: ‘10 to 100 m d⁻¹ from laboratory experiments (Shanks and Trent, 1980; Azetsu Scott and Johnson, 1992)’ you might find a more recent study that established faster sinking rate of laboratory made aggregates and fecal pellets.

Line 54: ‘remove ‘hopefully’

Line 59: ‘can affect all types of particles, from those suspended in the water column to sinking particle’, what is the point here? How do you separate the suspended particles in the water column from sinking particles? This sentence must be rephrased

Lines 61-62: ‘patchy distribution of animals’ what does it mean? Zooplankton grazing activities? What is the expected process here? (aggregation, fragmentation, ‘sloppy feeding’, consumption?)

Line 66: ‘to submesoscale (1-10 km, hours to days) ocean dynamics’, submesoscale dynamics could be smaller than a 1km (e.g: fronts and filaments). You must be sure about what spatial scale dynamic is involved in your study and add a reference to support the definition that you are using.

Lines 67-69: This sentence could be implemented. What specific process occurs inside mesoscale eddies that lead to particles aggregation and export? You should find several studies explaining what processes are involved.

Line 75: define ‘frontogenesis’ and ‘mesoscale activity’, is related to vertical mixing? Or horizontal mixing? Mesoscale activity could also be interpreted as inshore/offshore exchanges (coastal influence).

Lines 67-74: It could be more convincing if you input some detail of the important process on BCP induced by eddies here. E.g. Eddy subduction pump (ESP).

Line 77: why ‘600 meters? And why not the mixing layer horizon, or export depth? We could understand the importance of 600m after reading the entire manuscript, but it sounds inappropriate in the introduction.

Line 82: What is the main question behind this work? What is the Hypothesis? It could be a great help to guide the reader.

Material and Methods

Line 88: ‘SO283 cruise’ which research vessel?

Lines 89-90: ‘The float remained within the eddy for about 5 months (Baudena et al. 2023, preprint), I would expect more detail of about the eddy’s dynamics during the 5 months (maybe show maps of altimetry anomaly with the float location).

Fig. 1: It is not very clear: If the present map corresponds to the surface altimetry anomaly (ADT) by the date of 18-09-2022 and the black line representing the float trajectory from 04-2021 to 09-2022, it means that the float trajectory could not be directly associated to ADT. This map can be split: one map with the float trajectory (with color scale representing the drifting time). Maybe 2 another one with ADT situation at different date

Did you check if the eddies were stable for this period? You mentioned Line 90 that the eddy disappeared from satellite altimetry. I would expect much more detail of the eddy’s dynamic during the float deployment period.

What you display in Fig. 7 (‘Snapshot of ADT field with the float trajectory (thick black line) during each export feature (A, B and C).’) is very interesting, I think you could put these highlights in figure 1, to give an idea of the actual float trajectory regarding the eddies dipole structure evolution (ADT).

Another map with a smaller zoom could be added to this figure (bigger scale area), to have a better idea of the sampling location in the Atlantic Ocean (African East coast).

Finally, what does the red and black (solid and dotted line) represent? I suppose they represent cyclonic/anticyclonic eddies. It should be mentioned in the figure caption.

Line 126: ‘taxonomic identification of macrozooplankton and large particle classification could be conducted.’ How? Random forest algorithm? Neural network? Ecotaxa application. Maybe add a short sentence explaining the pre-classification

Line 135: ‘The 0.5 mm threshold was used as detrital aggregates > 0.5 mm are considered marine snow (i.e., aggregates, Alldredge and Gotschalk, 1988).’ What about the living organisms smaller than 0.5mm (microzooplankton, small copepods)?

Lines 156-157: ‘Subsequently, for each group, the first quartile distance was computed, and only individuals with a distance smaller than the first quartile were included in the selection’ does it mean that particle images (‘exclusive members’) out of the first quartile distance were not computed?

Line 158: ‘were then used as indicators to see potential differences in the distribution pattern of each morphotype’ it is not very clearly explained like this.

Line 182: ‘masses—a critical’, must be rephrased

1.4 Lagrangian diagnostics: This paragraph is very hard to get into.

Lines 207-209: ‘A front is defined as a physical barrier that separates two adjacent water masses that have been widely separated in the preceding days and are likely to have different hydrographic properties.’ What hydrographic properties? Sea Surface Salinity? Sea Surface

temperature? Sea surface current? Altimetry? FTLEs? It's quite confusing. Such physical barrier must be defined here.

Results

Lines 218-219: 'mesoscale activity', what mesoscale activity, FTLE distribution? Or hydrological variables?

Fig. 2: To improve the readability, the date in x-axis (bottom of C and F) should be bigger. The blue dots (FTLE, top of A and D) could also be bigger.

Would it be possible to add extra text on this figure, describing the relative position regarding the eddies? (e.g. cyclonic eddy, frontal area and anticyclonic eddy)

Lines 231-232: 'with very different hydrographic characteristics compared with the Benguela upwelling cyclones', what are these very different hydrographic characteristics?

Lines 259-260: 'There was also an observable increase in the concentration of small, labile, and refractory particles in the surface, as reflected by the *bbsr* coefficient (Fig. 2.E)' how can the *bbsr* coefficient could be associated with small, labile, and refractory particles?

Fig. 3: Same comment as for Fig. 2

The **Fig. 4** is described nowhere in the text.

Fig. 5: The particles images on the panel C are very small and 'un-contrasted', I know that UVP images are like that (and the contrast is a critical parameter for any classification), but to 'illustrate' the clustering, could you increase the size and the contrast in this panel?

In panel D, 3 columns (stack plot) are displayed (corresponding to the three export features) could you maybe add subtitles with the date of these features?

Fig. 6: Same comment as for Fig. 2.

You mentioned the 'White dashed lines' in the caption, because these white dashed lines are not displayed, and would overlap the distribution, please remove it from the caption.

Line 294: 'except perhaps in the case of column 2.' Avoid the term 'perhaps', the column 2 clearly evidences that 'Bright' particles increase below 300m depth.

Fig. 7: I would expect to see this figure sooner in the manuscript. This figure better explains the float trajectory and record considering the eddies distribution.

Line 297: 'During the second feature (Fig. 8)', I think it's still on Fig. 7 (Fig. 7B)

Line 302: 'the southern edge of a large anticyclone (Fig. 9)'. I think it's still on Fig. 7 (Fig. 7C)

Line 308: You mentioned 'POC', how can you be sure it's only POC (and not PIC or other dust deposition). Did you compare the vertical fluctuation of *bbsr* and Chl *a*?

Discussion

Line 328: there is no figure 10.1. Do meant Fig. 8?

Lines 331-333: Is it possible that these elongated particles are fecal pellet (stick shaped fecal pellet)?

Lines 334-335: 'Coagulation is responsible for the production of large particles when particle concentrations become important in the water column (Jackson et al.1990)', The coagulation is indeed driven by high particles concentration but mostly by the particle's stickiness and size spectra heterogeneity. You might add an appropriate reference here.

Line 339: Re-check the figures number.

Line 342-343: 'However, typical mesozooplankton fecal pellets (a few hundred μm) were not observed in abundance in any of the four morphological categories.' Is it not the case for elongated aggregates?

Line 343-344: '...zooplankton abundance increases during the three particle distribution events (see Figure S6).' Fig. S6 does not correspond to this statement. Inside the eddy, the copepods abundance seems to be higher (at least for 2 events). Moreover, have you also considered the other zooplankton groups based on the UVP6? (Even If I assume that copepods are the main represented group).

Lines 344-345: 'In our case, it is more likely that physical coagulation had a greater influence on aggregate formation than trophic biological aggregation', please reconsider the higher copepods abundance in the eddy.

Lines 395-396: 'types that we hypothesized to be large phytoplankton', what are approximately the length/width of these elongated particles? What chain forming diatoms groups could be represented?

Conclusion

Line 429: Fig.8? (no figure 10)

Fig. 8: Why the MLD (red solid line) is equal everywhere (cyclonic eddy, front and anticyclonic eddy)? According to the Figure 2, it is evident that the MLD vary between these different physical features

Why the 'particles' (colored dots) are characterized by different colors (4 colors) in the ML but only 2 colors below the MLD? Does it mean something? If yes precise

Explain the green circle is displayed only in the cyclonic eddy

What represent the 2 green shapes around both eddy structures?