

## ***Interactive comment on “Coupling physics and biogeochemistry thanks to high resolution observations of the phytoplankton community structure in the North-Western Mediterranean Sea” by Pierre Marrec et al.***

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Anonymous Referee #1 (AR1)

Referee Comment (RC): This manuscript provides a valuable contribution to the study of the relationships between the fine scale distribution of physico-chemical variables and of flow cytometry-derived phytoplankton groups in open waters of the NW Mediterranean. The methodology is up to date and the measurements appear to have been carefully carried out.

C1

Authors Comment (AC): We really appreciate the positive and constructive comments addressed by anonymous referee #1. We would like to sincerely apologize for our relatively late responses regarding the reactive comments addressed by anonymous referee #1. This delayed response impeded a really interactive discussion between us, which is an important aspect of publishing in Biogeosciences. Your comments have allowed us to improve the overall quality of our manuscript. We have addressed all the comments relative to your recommendations below.

RC: The conclusions are plausible, but it should be noted that there is more taxonomic richness in “phytoplankton community structure” than that measured in flow cytometric groups; it can be argued that some samples for microscopic examination (to name a classical technique) would have added interesting information to the work.

AC: We acknowledge that there is more taxonomic richness in the phytoplankton community structure than that determined by the flow cytometric groups as optical properties measured by flow cytometry are ataxonomic (except for some specific genus such as *Synechococcus* and *Prochlorococcus*) and pictures taken in flow are adapted to microphytoplankton only. We will argue in the conclusion of the revised manuscript that optical microscope examination of samples might add interesting information but we will mention that according to the weak abundance of microphytoplankton ( $\text{MicroE} \approx 20 \text{ cells.cm}^{-3}$  and  $\text{MicroHighFLO} < 5 \text{ cells.cm}^{-3}$ , with  $10 \mu\text{m} < \text{MicroE ESD} < 20 \mu\text{m}$  and  $\text{MicroHighFLO ESD} > 20 \mu\text{m}$ ) and the small size of nanoeukaryote cells observed ( $\text{ESD} = 4.1 \pm 0.5 \mu\text{m}$ ) a microscopic examination would also have been limited in resolution and quantification. Within our dataset, size classes between pico and nanophytoplankton (including pico and nanoeukaryotes cells and genus between *Prochlorococcus* and *Synechococcus*) present the main differences observed in the two contrasted areas with a high spatial resolution. Based on the literature, we briefly discuss the taxonomic richness in discussion section 4.3.1 from studies performed in the Mediterranean Sea in order to provide an overview of the main species that could have been found in the flow cytometric groups.

C2

RC: The following comments refer mainly to the “communication” aspect of the text, which is rather prolix and difficult to follow in several places.

RC: Methods Some parts of section 2.7 would benefit from more detailed and clearer explanations (e. g., lines 31 of page 8 to 3 of page 9). Some of the mathematical symbols used may not be obvious for a number of readers (e. g., eq. 5, eq. 9).

AC: We acknowledge that some parts of Section 2.7 would benefit from more detailed and clearer explanation. In the revised manuscript we have addressed the requested modifications. We have also further described the meaning of the different mathematical symbols used in order to make this Section more accessible for some readers.

RC: Results Several parts of section 3.2 (Phytoplankton group definition) could be transferred to the Material and methods. (in particular, lines 1-20 of page 11).

AC: We agree that some parts of Section 3.2. could be transferred to the M&M Section. In the revised manuscript, lines 7-12 of page 14 have been included in the M&M Section. As this is the first deployment of this new model of AFCM, we considered that a technical description of the deployment and analysis of the AFCM could be included in the Result Section 3.2.

RC: Lines 1-8 of page 13. There should be a previous explanation of what are warm boundary type 1 and type 2 waters (now in lines 34-39 of page 15).

AC: We acknowledge that the explanation of what are warm boundary type 1 and 2 waters appears relatively late in the manuscript. The characterization of the warm boundary type 2 waters was supported by the study of the relative contribution to total red fluorescence which arrived later in the manuscript, and differentiating these 2 types of warm boundary waters only from the TS graph was kind of tricky. But we have introduced in the modified version these warm boundary type 1 and 2 waters from the 2nd paragraph of the Result Section 3.1.

RC: Section 3-5. Perhaps some of the details could be moved to material and Methods,

C3

so that the main findings would be easier to follow.

AC: We agree that some details could be moved to M&M Section. We choose to move lines 15-17 of page 17 in Section 2.6.

RC: Discussion Section 4.3. Part of the text is repetitive of methods or results and distracts from the main aim of the discussion. Please, try to streamline all the subsections.

AC: We have reduced such repetitive parts in this section in the revised manuscript and we have streamlined all the subsections.

RC: Other comments

RC: Page 1, line 29. “nanoeukaryotes”. AC: Done

RC: Page 2, line 5. “rise2. AC: Done.

RC: Page 5, line 9. The convenience of the phaeopigment “correction” is doubtful (e. g., Stich and Brinker 2995, Arch. Hydrobiol. 162 1 111–120). AC: We have modified this part of the Material and Methods Section and now we do not mention anymore the phaeopigment “correction” as it appears that the method used in our study is not exactly the one mentioned in our manuscript. We apologize for this misleading and thank you for your comment which allowed us to rectify this part of our manuscript.

RC: Line 39. SSS data every minute? Or what?? AC: Done

RC: Page 6, lines 4-5. Rewrite the sentence. As it stands, it seems to say that 177 samples were collected every 20 minutes & e. g. “surface samples were collected every 20 minutes; in total, 177 were obtained” or similar). AC: Thank you for your recommendation, we now mention that “surface samples were collected every 20 minutes. In total, up to 177 samples were obtained”.

RC: Line 14-15. “phytoplankton size wide range”??? or “a wide range of phytoplankton sizes”?. AC: We meant “a wide range of phytoplankton sizes”. Done

C4

RC: Line 36. Explain the meaning of “a.u.” (arbitrary units?). AC: Indeed, a.u. refers to arbitrary units.

RC: Page 8, line 23. “cell removal processes”. AC: Done

RC: Page 10, lines 21-23. How exactly were these correlations carried out? AC: We apologize but we cannot find what this comment refers to due to some discrepancies between page and line numbers from your version of the manuscript and our version. Does your comment refer to the correlation between in-situ Chl-a and satellite values? Or between FLRtotal and Chl-a concentration? If it is about the in-situ vs. satellite Chl-a correlation, to compare in-situ observations with remote sensing products we extracted for each in-situ observation the closest one in time and space from the respective remote sensing product. We could add further details in the revised manuscript for this correlation. And if it is about the FLRtotal vs Chl-a correlation, we thought we have already provided enough details in our manuscript, but if needed we could eventually further describe the correlation.

RC: Page 14, lines 8- 10. “although the sampling frequency spanned 20 min” ??? Explain better. AC: We have modified this sentence in the revised manuscript by mentioning: “even if the sampling frequency spanned 20 min”.

RC: Line 25. “derive growth rate”. AC: Done

RC: Page 15, line 24. “low salinity subsurface water”. AC: Done

RC: Lines 34-38. As mentioned before, this explanation should appear earlier. AC: The explanation of what are warm boundary type 1 and type 2 waters appears now earlier in the revised version of our manuscript, in the 2nd paragraph of Result Section 3.1.

RC: Page 16, line 8. “either limited”? Improve the sentence. AC: We now mention that: “This later was characterized by lower Chl-a values in the warm boundary, which was limited by both the nutrient availability and the amount of light availability for phytoplankton cells.”

C5

RC: Line 24. “resolve”. AC: Done

RC: Page 17, line 5. “ecotypes in surface waters”. AC: Done

RC: Line 17. “that the picoeukaryote”. AC: Done

RC: Page 17. Lines 17-21. Please, revise sentence carefully; concerning radiolarians and dinoflagellates, Not et al. (2009) state (page 4) that : “As the smallest eukaryotic organism known so far has a cell diameter of 0.8  $\mu\text{m}$  [27], some of the 18S rDNA signatures observed in the 0.8  $\mu\text{m}$  fraction might indeed derive from very small eukaryotes (like the prasinophytes that appeared mostly in this small fraction, Table S4), but many sequences most likely derive from cell debris or extracellular DNA from larger cells. This is likely the case for radiolarians, dinoflagellates, and ciliates, groups known to contain relatively large nano- and microplanktonic cells, and for which sequences were prominent in the 0.8  $\mu\text{m}$  fraction and nearly absent from the 0.8–3  $\mu\text{m}$  fraction.” (Thus, these groups were not part of the picoplankton). Not et al. (2009) also mention the importance of prasinophytes in the picoeukaryote fraction. AC: We thank you for this useful comment and apologize for our misinterpretation of this reference. We took notice of your recommendation and we have modified as requested this part of our discussion.

RC: Page 17. Line 25: “cryptophycean taxa”. AC: Done

RC: Line 29: “Gephyrocapsa”. AC: Done

RC: Line 30: “Prymnesiophyceae”. AC: Done

RC: Page 18, line 5. Specify what is dominated by diatoms and dinoflagellates. AC: Microphytoplankton. Done

RC: Line 11 (and other parts of the text): “Marañón et al., 2003” as cited in the reference list (not “Maranon”). AC: Done

RC: Line 19. “where nitrate was not limiting”. AC: Done

C6

RC: Line 36. Italics for generic names. AC: DoneáĀĀ

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