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Biogeosciences Discussions

Interactive comment on "Bio-optical characterization of subsurface chlorophyll maxima in the Mediterranean Sea from a Biogeochemical-Argo float database" *by* Marie Barbieux et al.

Anonymous Referee #1

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Overview:

The paper presents novel dataset of Bio-Argo data collected in the Mediterranean Sea and assesses the occurrence of 'subsurface chlorophyll maxima' (SCM) in different regions and over time. In the more eutrophic regions the SCM, bbp maximum, nitracline and euphotic zone depth are generally well coupled, with the favourable nutrient and light availability at the SCM likely sustaining a phytoplankton biomass maximum. Conversely, in more oligotrophic conditions the SCM is often deeper than the backscatter maximum and the nitracline and euphotic zone depth are also decoupled, with the less

favourable light and nutrient availability at the SCM leading to SCM that are principally the result of photoacclimation. Phytoplankton within SCM are known to be ecologically and biogeochemically important and so understanding how these features vary is important and of interest to the readership of Biogeosciences. The paper also demonstrates the use of novel information provided by Bio-Argo, which is topical and timely. Although focussed on the Mediterranean Sea, the results inform on processes controlling SCM globally as well. Overall, I found the paper well written with clear aims and novel, informative results. I have only one general comment and provide specific comments below. Note that I was not able to judge the statistical methods used to classify the profiles (Appendix A), as this is outside my expertise.

General Comment:

Although SCMs have been assessed before in different regimes, a key strength of the paper is that a gradient across contrasting regimes is presented. The use of schematic diagram Fig 12 was very helpful to illustrate how the vertical profiles vary across this gradient. However, of key importance to driving the SCM dynamics across the different regimes is the physical forcing, and thus physical structure of the water column, and I felt the physical context was somewhat neglected in the data analysis and interpretations. Some comment is included in the later discussion (Fig 10) but I would urge the authors to consider adding a few sentences or short paragraph on the underlying physical controls in the different regimes and, in particular, consider adding the thermocline (or MLD?) to the schematic (Fig 12). It could also be useful to add to Fig 7 and/or 9 as well. Placing the observations into the physical context would provide a more complete explanation of the data presented and would help apply what is learnt to other regions globally.

Specific Comments:

- Line 29: suggest change "to understand which parameter controls the SCMs" to "to understand the main controls on the SCMs".

- Line 62: “their contributions to the depth integrated-production. . .... remains largely unknown. . .”. The use of the Arctic example here is a bit of an odd choice, other examples could be added, for example the contribution is >40% in the oligotrophic Atlantic (Perez et al. 2006 Deep Sea Res 53:1616), 40-50% in the Celtic Sea (Hickman et al. 2012 MEPS 463:39); 58% in the North Sea (Weston et al. 2005 JPR 27:909). (The paper by Perez et al. is shows nicely the decoupling of Chl -a maxima, carbon maxima (.:. idea of Chl:C), thermocline, nitracline and 1% light depth in oligotrophic regimes that could be relevant to other statements about oligotrophic conditions as well).

- Lines 73-81. “. . .. Hence, this “miniature ocean” presents SCMs that may be encountered in both temperate environments and stratified waters of the global ocean”. I found contrasting “temperate” and “oligotrophic” and/or “stratified” a bit confusing (many temperate regions are stratified), as it’s not quite clear which properties of these different regimes are the relevant ones (seasonality? stratification? nutrient status? Maybe all of these?). Using ‘seasonally stratified’ vs ‘permanently stratified’ would be more precise?

- Methods Section: Please describe what (if any) correction for non-photochemical quenching was applied to the Chl-a fluorescence data.

- Line 146. Please give a reference for the quoted regional correction factors, or describe how they were obtained.

- Line 153: “0.03 kg m-3 density criterion”, please describe what the criterion is.

- Section 2.3, 2.5. Im not familiar with the process of calibrating in situ nitrate sensors or the statistical tests applied, so cant make an informed judgements on these aspects. The methods seem reasonable to me.

- Line suggest changing “Occidental” and “Oriental” to a description more geo/oceanographic.

- Line 375: Suggest change “and presents an actual increase in phytoplankton biomass” to “that we propose supports an actual increase in phytoplankton biomass”.

- Line 384: Suggest change “suggesting no accumulation of carbon at the SCM”. It’s unclear what you mean by accumulation here (implies sinking?), also carbon at a subsurface bbp peak isn’t necessarily accumulating. There is likely some generation and turnover of carbon at all depths in the water column, but the standing stock of biomass is maintained at a higher concentration at the depth of the bbp peak than the depth of the SCM. Suggest using more precise wording here.

- Line 393: please change “is, thus, limited by both the availability of light and nutrients” to “is, thus, likely to be limited by both light and nutrients”. No measurements were made to assess whether phytoplankton were light or nutrient limited.

- Line 412-426. I found this section a little jumbled. The section on vertical species distributions and low light ecotypes seemed a bit out of place and it wasn’t clear how it linked to the results presented. I suggest moving Lines 420-425 (which seem to provide the link) further up in this section, and re-consider the wording elsewhere to make the discussion easier to follow. The key points are there: that different phytoplankton species or ecotypes are likely to have different depth and magnitude of C and Chl maxima, different Chl:C, and different bbp properties; gradients in taxa are likely (expected?) in stratified water columns, including through SCMs; and there are vertical gradients in the non-phytoplankton particles that contribute to bbp as well. Consequently, the overall Chl, C, and bbp profiles are the result of all taxa present, their bio-optical properties and their physiology, but it is not possible to tease these apart with the data. This is contained in the existing text, but could be clarified.

- Line 464: I suggest a very short description of what the “light driven hypothesis” is here.

- Line 581: “(1) SCMs arising from an actual increase in carbon biomass at depth (or SBMs) and benefitting from both light and nutrients”. I think you have to be a little

careful here because the data didn't unequivocally show that phytoplankton biomass increased (the bbp max could be due to non-phytoplankton particles). Throughout the rest of the paper great care has been taken not to overinterpret bbp as phytoplankton carbon and to make careful statements about Chl-a:C (photoacclimation) with due consideration of non-phytoplankton particles contributing to the bbp signal. So, I suggest it's worth making sure this summary statement is equally precise. If by 'carbon biomass' you are being more general to include all plankton then say so, and distinguish from 'benefitting from both light and nutrients'.

- Throughout: the use of term "in the SCM layer" is often ambiguous as to whether you mean "at the SCM peak" or "integral within the SCM layer". For example, in the figure caption of Figure 3 and 4 it is not clear whether what's plotted is the Chl-a concentration at the SCM peak or an integrated Chl-a concentration through the SCM layer. The units (mg m-3) indicate the peak magnitude, but the words "in the SCM layer" imply the integral.

- Throughout: check that any abbreviations for Mediterranean Sea are used appropriately (Mediterranean Sea is used at the beginning but after a point "Med Sea" is used, e.g. Line 485).

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