

## **General comment**

The manuscript presents a well-structured and comprehensive analysis of the spatial and temporal variability of primary production in the Mediterranean Sea over the past 25 years, based on an impressive satellite dataset. The study provides a valuable contribution to our understanding of the coupling between physical forcing and phytoplankton dynamics in this complex basin. The results are coherent and highlight the key role of physical drivers such as mixing, circulation, and nutrient inputs in shaping phytoplankton biomass, diversity, and productivity at both seasonal and interannual scales.

The paper is clearly written, well organized, and offers novel insights through the use of empirical orthogonal function (EOF) decomposition to identify dominant modes of variability. The analysis successfully integrates multiple parameters (SST, MLD, chlorophyll) to characterize the relationships governing primary production. However, some aspects could be further strengthened. In particular, the absence of an explicit analysis of light availability and its variability deserves justification, given its potential influence on phytoplankton dynamics and primary production. Similarly, while the discussion of surface primary production (PP<sub>fo</sub>) is interesting as a complementary product, it partly duplicates the conclusions derived from surface chlorophyll patterns and could be streamlined to focus on the most relevant findings.

Overall, this is an interesting and well-conducted study that significantly contributes to the long-term understanding of Mediterranean primary production. The figures and data presentation are clear and effectively support the conclusions. I recommend publication after minor technical revisions, mainly aimed at clarifying the introduction and improving the description of the applied methodology (e.g., briefly summarizing Volpe et al., 2012, to ensure full reproducibility). Adding a few additional references could also help strengthen the contextual framework.

## **Technical comments:**

Line 28:

Both “color” and “colour” are used in the manuscript. Please harmonize the spelling throughout the text for consistency and improved readability.

Line 63:

Although the <sup>14</sup>C method for estimating primary production is widely used, some uncertainties remain regarding its accuracy (e.g., Baltar and Herndl, 2019). This point could be briefly acknowledged in the text.

Line 125:

A period appears to be missing after the closing parenthesis.

Line 190:

In Figure 1, would it be possible to include the Mixed Layer Depth in the sensitivity analysis of primary production? This could help illustrate its influence more clearly.

Line 206:

For improved readability, consider adding a short definition of “Case-2 waters.”

Line 230:

A brief description of the method developed by Volpe et al. (2012) would be helpful here to ensure reproducibility.

Line 250:

Please provide a reference to support the statement on the “well-known longitudinal gradient.”

Line 255:

Could the absence of a longitudinal P<sub>Peu</sub> gradient be related to an excessively deep integration range?

Line 267:

Might the apparently high productivity in the Gulf of Gabès be influenced by bottom reflectance affecting satellite observations?

Line 274:

In Figure 2, if possible, please consider using a color-blind-friendly palette to enhance accessibility.

Line 370:

As a complement to this analysis, relevant results can also be found in Toseland et al. (2013).

Line 375:

Please refer to Marañón et al. (2021) for discussion of the relationship between light and the Deep Chlorophyll Maximum.

Line 404:

It is unclear what “these two” refers to. Please clarify.

Line 440:

It may be useful to discuss the PSC (phytoplankton size class) distribution in light of how it is derived (i.e., directly from chlorophyll concentration).

Line 468:

How confident are you that this pattern results from long-term warming rather than from an increased frequency of marine heatwaves?