

## Review of MS “Analyses of sea surface Chlorophyll-a trends and variability in a period of rapid Climate change, German Bight, North Sea ”, from Felipe de Luca Lopes de Amorim et al.

### General remarks

- The study is relevant and important wrt marine ecosystems in the context of the climate trends, and the method is adequate to explore the questions.
- Yet, I have problems to identify the take-home message. The paper is very long and contains 18+ graphs, which somehow blurs the message.
- The Authors may want to provide clearer explanations about some statistical methods (e.g., combined EOFs and PCs results are not always straightforward to interpret). Clearly, these statistical approaches are rich and provide good insights, but they remain somewhat cryptic still. Such paper may be the opportunity to share knowledge and familiarize the community on the used methods. This is a non-mandatory suggestion.
- The language of the whole manuscript should be screened by an English-speaking colleague before publication (and, ideally, even before submission). I pinpointed some disturbing examples but did not underline all instances.

### Abstract

This section describes with too many details the results, and could probably be shortened with a better summary of the results. What is the take-home message?

There are some unclear sentences that should be corrected. For instance:

- L27. “The monthly chlorophyll-a concentration anomalies covaried 45% with sea surface temperature anomalies” should better be “Monthly chlorophyll-a concentration anomalies covaried by 45% with sea surface temperature anomalies”
- L28-29. “This study demonstrated that the [...] product can assess mostly of the known processes” should be “This study demonstrated that the [...] product can evaluate most known processes”

### Introduction

1. L57 ‘dimension’ instead of ‘domain’?
2. L59 ‘enabling the assessment of Chl-a spatiotemporal variability.’ ... but only at the surface.
3. L69-73 exhibit an argument that is between a discussion and an introduction. Having read it as it is written now, I am not sufficiently convinced that the approach is without flaws, as more questions are raised than answered. For instance, you mention a remote sensing (RS) sampling at depths comprised within 1-12 m (depending on turbidity). However, considering the total depth at the Helgoland sampling site (~6-10 m) and its surroundings sampled by satellite (~30-40 m in the Elbe Glacial Valley), we see that these are different depths. Is there a difference wrt the interpretation of the RS signal of Chl? I mean, if the satellite Chl is calibrated at

Helgoland sampling site, is it valid at deeper sites? And what do you do when the water column is stratified in summer (is it?)? When it is not stratified, it is well-mixed for dissolved substances, but not for particles (you even suggest this idea when you rightfully mention that turbulent mixing may enhance resuspension). What about that when it comes to analyze RS Chl signal? Do changes in turbulence only generate a small variability in Chl wrt the seasonal variability? Perhaps the Authors might want to be more affirmative in the Introduction (i.e., suggest less questions), and then discuss the details about RS signal, depth, stratification, resuspension, etc. in the Discussion? As far as I can see, it seems to be just a matter of presenting the argument.

4. L75 'Chlorophyll-a (Chl-a)' This acronym was already defined above. Please, double check the whole manuscript for overall consistency.

## Methods

1. L136 '60 km of the German coast' Do you mean '60 km **off** the German coast'?
2. L138 'The samples are representative for the whole water column due to the well-mixed conditions'. Indeed, Wiltshire et al. say it in their paper of 2009 based on an earlier reference. Yet, isn't there a vertical gradient of particles (Chl and SPM) in spite of the vertical mixed conditions? Is it negligible for the purpose of this study?
3. L167 'As a pre-analysis, we calculated temporal mean and standard deviation (std) of the Chl-a anomalies.' When writing 'temporal mean' (or std) do you mean 'yearly mean' (or std)? Please, specify here.
4. If you see Fig.3b, would you consider that Chla anomalies are normally distributed, or skewed? Is it important when calculating the mean and std?
5. L175 '1 time step lagged' Is the lag one month, or is it another time length?

## Results

1. L190 'Both time series showed significant negative trends, evaluated by the Mann Kendall trend test.' Difficult to see how this statement relates to Fig.2. It seems better linked to Fig.10...
2. Fig.3b Is the green colour the superimposition of both in situ and RS Chl? Please, clarify or improve the plot.
3. Fig.4d There is an increasing trend of Chla at the coast and a decreasing trend offshore. While any potential eutrophication/de-eutrophication trend may affect Chla, it would do it at the coast mainly. This is a very interesting result as it suggests that the (de-)eutrophication trend is not the only (or even the main) controlling factor of the Chl trend. This result motivates the study.
4. Fig.4 & 5 In this approach, attention is given to the spatial variability of Chl. It raises the question of whether the observed increasing trend in SST is also variable in space, or if it is homogenous in the G. Bight...
5. Fig.6 caption. The last sentence of the caption should be in the text, not in the caption.
6. L256 'bellow' => 'below' Please, check the MS for this kind of misprint.
7. L260-261 'although the spatial averaged Chl-a remote sensing was overestimated during winter months, and the second bloom peak was delayed in offshore areas.' Dubious interpretation. It seems the Authors were expecting the same results for

mean coastal RS Chl and Helgoland in situ Chl profiles. I do not see an 'overestimate' or a 'delay'. Profiles are just different.

8. Fig.8 caption. Once again, clarify please. Understanding what is on a graph should be made easy by the Authors for the reader, especially in a paper showing 18+ graphs. An effort should definitely be provided on that aspect.
9. Fig.8 Maybe I did not fully understand the EOF approach, but it is unclear to me why PC2 was averaged over the entire area and not over the two different areas (red and blue) identified with EOF2. As a side remark, PC2 shows a seasonal profile that reminds me the profile of SPM concentration in most coastal zones of the southern North Sea (high winter values, and low summer values due to TEP-enhanced flocculation of SPM).
10. L316 'The peak in Chl-a anomalies in 2008 was related with a positive peak of North Atlantic Oscillation index winter mean (NAO)' (and sentences next to it). This is not a convincing demonstration. I would be convinced if Chl anomalies in April were in general more correlated with winter NAOi. But I do not think it is the case. Therefore this statement seems very dubious to me. This being said, I have nothing against dividing the period into two segments around 2010, as the Authors did. These two periods seem indeed different wrt their mean April Chl, for instance. Some impartial statistical tests might even be conducted to justify this separation.
11. L329 'These results could be the response of earlier spring blooms in the period 2010-2020 compared to the years before.' Indeed, the results from March to May might indicate a forward shift of the spring bloom to earlier days in recent years. Did the Authors also have a look at the February distributions?
12. L347-361 Interesting results! Yet, I find it odd that the Authors offer an interpretation of why coastal Chl anomalies tend to increase in recent years without even mentioning a possible trend in coastal nutrients (or adjacent river loads, at least the Elbe)...
13. Fig.16 caption. Now, we know that the lag is one month... It should have been said in Methods (or perhaps I missed it?)
14. Fig 17 & 18. Improve caption please.
15. L492-3 is a direct repetition of L480-1
16. L494-5 The information about nutrients comes much too late in this manuscript about Chla variability. I wonder if it shouldn't even take place in the introduction as it is not a proper result of the study and nevertheless an important element of the story.
17. L499 'decreasing trends and slight increase of Chl-a' Unclear sentence.
18. The discussion does not discuss the validity of the approach. It is not always mandatory but in this case it may be more convincing (see, e.g, my comment in the Introduction section).
19. The conclusion seems a repetition of the Discussion with more numbers and less references. Where is the core message? When I see the results, I see a potential story. However, I do not find that story in the text.