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Interactive comment on "Characterisation of extreme events waves in marine ecosystems: the case of Mediterranean Sea" *by* Valeria Di Biagio et al.

Anonymous Referee #1

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== Overall Comments

In this Study, Valeria Di Baggio et al. use an extreme event identification method to track the late winter-early spring blooms in the Mediterranean sea. Their method enable to identify and follow day by day the bloom propagation, and characterize the event with different indexes.

Although the method is shown to be powerful and useful, I have some questions/concern with the application done here with the Mediterranean surface chlorophyll, as I am not sure what we are looking for, and getting in the end... Are we looking for extremes ? blooms ? strong blooms ? blooms maxima ? maxima of surface chl

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Discussion paper

maximum ? we are not sure, and the way it is done probably allow all of those. But then... Are blooms considered as extreme events ? Apart from this main and i think important concern, the study is nice and relevant. the way the authors manage to track and characterize these events is shown to be useful, with lots of relevant information, and could be exported for all kind of extreme event study.

I really appreciate this study, but it has to make clear what we are looking at: extreme? or surface chlorophyll maximum ? depending on the answer, the amount of work needed to correct the paper will be different, corresponding to a major review if you want to make it an extreme event analysis; or a minor review if it rather is a surface chl maximum analysis using an extreme event tool (what i think the authors are doing here).

== Extreme, Bloom, or Surface Chlorophyll Maximum ?

Although the method is shown to be powerful and useful, I have some questions/concern with the application done with the Mediterranean surface chlorophyll, as I am not sure what we are looking for extremes ? blooms ? strong blooms ? blooms maxima ? maxima of surface chl maximum ? it seems you see all of those including extremes, like the one you have selected for the example. But then... Are blooms considered as extreme events ? From the definition you give (Page 2, line 35) "a large deviation from a reference state", but i think the reference state should include the annual cycle... if you are looking for extreme. If your targets are extremes of surface Chl, you still could use the 99th percentile threshold, and only keep those going above the local annual cycle + STD (or 1.5 * STD) for example, or instead of a 2D threshold make it 3D, including an annual cycle, that could also show extreme in summertime (maybe due to dust events for example),... The choice of a 2D 99th percentile on the whole period is somehow too broad if you look for extremes, and of course you will get completely different results in the different area of the Mediterranean sea. In the North-Western part with strong and spiky blooms,you will overshoot the threshold at least once a year, because of this spiky bloom configuration (but that's not extreme... it

is the every year bloom), whereas in the oligotrophic region, where the chl phenology is smooth, a relatively stronger event can cover the whole 99th percentile.

So, if you were looking for extreme, you should change that, adapt the threshold which seems to be the key of the method. But i am not even sure you are looking for extreme. The text and the title are confusing. If you are characterizing blooms (or maxima in chl maximum) using an extreme event method, it is great, but present it like this. Please, don't try to oversell it. A title like "Tracking the Mediterranean blooms using Extreme event waves method" or something like that. Of course the current title is more punchy, but personally, when i read it i've imagined dozens of possible things.

Also, make it clear in the text :

-p1 l14: identify the maxima of chlorophyll as exceptionally high and prolonged "blooms"

-p2 l54: This allowed to identify maxima of phytoplankton blooms (Desmit et al., 2018), but also positive anomalies with values too low to be actually considered "bloom""

-p6 l172 : (i.e., exceptionally high and prolonged "blooms", as clarified in Introduction)

-p9 l272 : probably the clearer explanation : "we propose a new method to tackle extreme events in the marine ecosystems on the basin scale. The method is then applied to the surface chlorophyll in Mediterranean open-sea areas to investigate maxima in the winter-spring blooms".

So sometimes it is "exceptionally high and prolonged", some other time it is "maxima in the winter-spring" blooms. The second (which includes the first) sounds more accurate, but read both is confusing. please make it clearer.

What struggles me is the lack of definition for bloom and for bloom maxima, Or at least what you consider "blooms" and "bloom maxima" in this study. what gives me the impression of not being sure of what we are looking for, and results with places where a bloom maxima appears every year, and other places where it happens once or twice

in 18 years and last 90 days. In the oligotrophic region, where there is no blooms, an EEW is found by construction (as said p6,l181 : "Considering the temporal extension of the simulation (approximately equal to 7000 days), the number of POTs in each grid point is by construction equal to 70.") the long EEW might well be an eddy with higher surface chl concentration inside. It cannot be considered a bloom.

A solution could be to:

– Stop talking about blooms for the whole Mediterranean sea. It would make more sense if you were talking of "(...) investigate maxima in the winter-spring surface chlorophyll maximum". That would be more correct, the maxima being not necessarily extreme, and not saying the word "bloom" don't mislead the attention on something specific that does not occur everywhere in the Mediterranean sea.

– And stop talking about extremes everywhere. The method you use is a method that is first made to find extreme events, but the way you use it, you don't only find extremes. an extreme event that comes back at least once a year is not an extreme, it is part of the normal annual cycle.

– Something else that could help to better visualise how extreme the EEW are. You could try to plot the surface Chl annual cycle (with STD in dashed line) for each Mediterranean regions (Fig 3), with the averaged 99th percentile threshold represented on top. that way we can appreciate how "extreme" an EEW is for each area (Maybe you want to adapt the area so it looks more like the fig 6 ? might be more relevant).

Unless you want to talk about extremes and only extremes. Then you have to adapt the threshold by taking into account the surface chlorophyll annual cycle as suggested above.

Apart from this (important) semantic question, the method is nice and prove to be able to identify, characterize and track the EEW beautifully.

– Also, talking about extremes, i wanted to rise a question, just for discussion. I un-

derstand the choice of surface Chl maxima is mainly to test the method and show how it works. But thinking about Mediterranean sea, climate change and extreme events, i wonder if tracking maxima of surface chlorophyll maximum is what i would do. I don't think we can get hypoxia or eutrophication with 12th degree model, this is rather a coastal and river mouth problem. We know that a climate impact could be to lower the deep water formation and hence the bloom. We could use your method (adapting the threshold, considering the Annual cycle) to track years with little or no bloom, and understand why, and see the trends. Or in summertime if your model include dust deposition on high frequency, see if the model shows EEWs linked to dust deposition events,... There is lots of other application of your methods that could make lots of sense (Lots of nice study in perspective).

== Text remarks

– I think there are few places where the English could be corrected, but not being a native English myself, i am not the right person to do that. Maybe you could ask a native English around you to double check your manuscript.

– from p5.l134 and all units following : double check the units the -2 and -1 should be up, if you write with latex, you should write kg km^{-2} day^{-1}

– p6 l73 : " chlorophyll as a proxy for the phytoplankton biomass" Surface chlorophyll is representative of the surface biomass (probably why one of your idea in the discussion is to check the event in 3D)

– p6 l82 to 85: "Mapping the 99th percentile threshold values computed at each grid point on the whole basin (Fig. 3), it can be noticed that grid points that are near in space exhibit small differences in their threshold values and also that different patterns are recognisable in the basin. Hereafter, we use the abbreviations indicated in Fig. 3 to refer to different Mediterranean regions" – So the 99th percentile is fixed in time. This means that you compare toward an ∼annual 99th percentile threshold of Chl. basically you will only have EEW during the bloom period. A summer with exceptional

summertime Chl will not appear with this method as it will never exceed bloom period values. can't you do a time varying 99th percentile threshold to be able to see non-bloom period EEW ? otherwise you will probably miss the most interesting events... probably needs a longer run to get enough data to keep it statistically feasible.

– p7 l191 : " The model-derived chlorophyll patterns (Fig. 4, second column) are in good agreement with the remote sensing data (first column) in the same temporal interval of the EEW" – Hard to tell, seems the sat Chl has a more extended bloom than the model, and starts slightly later (and probably ends later as well). But both model and sat presents an EEW on the same period, what is already a nice model performance ! And you have a nice bloom in the Ligurian sub-basin, that's impressive! Talking about e Ligurian bloom, it does not appear in the EEW area. it is considered as a separated EEW ?

– p8 l235 : " are around half of the ones of ALB or NWM." needs to be rephrase.

– p8 l239 : "with a similar chlorophyll EEWs phenomenology."

– p10 l288 : "pointed out the heterogeneity of the blooms intensity in the Mediterranean Sea" - back to my main comment, you don't see blooms everywhere...

– p10 l310 : Furthermore ?

– p10 l310 : you could have shown the "spatio-temporal persistence", it looks like a nice index. Why not show it ?

– p12 l360 to 374 : Good idea!

– p12 l375 : "A critical parameter of our method is the choice of the local percentile threshold" - I agree looks like one of the key of the method. but why this choice of a simple percentile threshold, and not include the local annual cycle (maybe + a*STD) in the threshold (As i mentioned above depending what you want to analyse, it can be justified, it can be the right choice) ?

– p13 l 197 : "Of the clusters with the highest content of all the indexes has been generally maintained both in case of higher and lower thresholds" - rephrasing : of the clusters with the highest index values,...,

– p13 l396 : "A key issue" - not issue, it is one of the strength of this method, not issue i think, and from all what you could do in your study because of that.

– p13 l400 : "The time series in the grid point" - rephrase : Each grid point's time serie

– p13 l400 : " allowed to maintain a definition of "extreme" relative to the local ecosystem properties." This i do not agree. in some places like the most oligotrophic regions, you probably find extremes, but in the bloom regions, it is not.

– P23 - Fig 4 – You talk about the MLD in the text, but you don't show it on the plot. Of course, we can guess the Mixed layer is very deep where the NO3 is high and Chl low, but, it might be good to add iso-contour with depth values on the Chl plot for example. That would help both the writer and the reader. – very nice bloom in the Legurian sub-basin! You must have a very high res atm model with high freq coupling. you should add these details in the model description. It help understand the results.

– P24 - Fig 5a – Difficult to interpret.... and the color-scale does not help. how many EEW occur per year ? how many on the hole period ? I don't understand what you mean here.

– P27 - Fig A.2, A.3, A.4 – I cannot do the difference between the climatological line end the 2005 one. Please, try with different dashed or doted line to find one that we really can see.

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