We would like to thank the reviewers for their insightful and helpful comments. Set out below are the general changes we have made and then responses to specific requests /points.

General Changes

Following the range of comments made by Reviewer 1, we have changed the title of the paper by deleting "proxy" and specifying BMLD as the mixed layer depth below the pycnocline. Moreover, we set out in the abstract, introduction and discussion that the aim and novelty of the paper is to provide an empirical method for calculating BMLD and provide context and reasoning as to why the BMLD is an ecological important variable and can be used to investigate the variations in the abundance, phenology and vertical distribution of Chl-a caused by deep mixing processes.

Other main changes regard:

1. The name of the mixed depth layers: AMLD was replaced with the well-established MLD as suggested by Reviewer 1, and BMLD was better defined as the *mixed layer depth below the pycnocline*.
2. The more conventional SCM is now used for Subsurface Chl-a Maxima and
3. The more conventional DCM is now used for the Depth of the Chl-a Maxima.
4. The function identifying for MLD and BMLD is now provided in GitHub at https://github.com/azampollo/BMLD, together with some examples and a brief description of its use.
5. We have included the photoacclimation in section *4.2 Vertical distribution of Chl-a and BMLD*

Reviewer 1

General:

Overall the manuscript has improved by shortening the Methods section and making some progress in clarifying what the paper is all about.

We are pleased that Reviewer 1 has liked all improvements so far

The writing can be quite difficult to decipher at times. Sometimes it feels that it is being made to sound more complicated than it needs to be. I would shorten/split a lot of the sentences and aim for concise clarity. Consider every sentence and ask yourself (1) does this say what I think it says, and (2) does this say something that is important for the paper? You need to have a clear view of who you are writing this for. The paper as it stands is probably well targeted at someone with a high level of data analytic/stats skills who will be familiar with some or most of the methods and terminology. It is not targeted at someone with a more practical/observational oceanographic background. But I suspect you do want to reach that 2nd group, in which case the methods still need to be clarified/distilled. For instance, Fig. 3a, b needs to be used better to provide a step-by-step lead through how AMLD and BMLD are arrived at. You could also consider splitting into shorter paragraphs or sub-sections (e.g. sections 2.2, 2.3 and 2.5 have some long, very detailed paragraphs that are difficult to keep track of).

We see there was more to do in providing clarity – as stated below with many good suggestions that have been taken up. The areas of improvement will be specified in the specific response sections 2.2, 2.3 and 2.5.

Specifics:

1. Abstract, line 18: BMLD is introduced here, but appears to be defined as "base of the pycnocline (BMLD)". Presumably BMLD=Bottom Mixed Layer Depth – so that is what you need to define it as when you first mention it. Be clearer about what you mean by determining a "proxy" for the SCM. Do you mean, by looking at a density profile in the absence of any chl data you can say something sensible about where the chl profile would be? Then explain why this might be useful (you say it is essential to investigate the impacts of physical changes, but that sounds rather vague – what examples might help explain your idea here?)

We changed abstract to make it more straight forward. We agreed that "BMLD" was defined differently in the sections of the paper. Hence, we specified in the abstract that "A new algorithm identifying the mixed

layer depths above the pycnocline (AMLD and BMLD) is proposed". BMLD has been then defined together with one of the main aims of the paper: providing the method and the reasons why the BMLD can be used as a good variable to understand the vertical distribution of Chl-a in stratified shelf waters.

2. BMLD, CMd, SCML and probably MLD are poor choices for "keywords". Think of keywords as search terms someone might use that could lead them to your paper. Using acronyms as keywords presumes the searcher already knows exactly what they are looking for.
The keywords were changed to deep mixing, , depth of Chl-a maxima (DCM), subsurface Chl-a maxima (SCM), offshore renewables, primary production

3. Line 31-32: "where the pycnocline acts as a barrier against the mixing of the whole water column and allows cells to buoyance and photosynthesize". I think you mean something like – the pycnocline provides a barrier to mixing between surface and deeper waters, and also a stable habitat for phytoplankton growth in the lower euphotic zone"? I'm not sure what you mean by "buoyance" – you might be invoking some ability of phytoplankton to position themselves within the pycnocline (buoyancy or migration), but such behaviour is not necessary. The key to SCM production is residence time (and acclimation to low light) – buoyancy changes or migration can certainly help that, but they are not critical.
We recognize that the sentence was over-complicated hence we replaced it with "the pycnocline provides a stable habitat for phytoplankton growth in the lower euphotic zone".

4. Line 33: "the modulation of daily and biweekly strong tidal cycles" and also seasonality?
We mentioned only daily and biweekly scales because they are related to the ebb and flood, and spring and neap, while the seasonal variation of M2 is relatively limited (5-10%) (Müller et al. 2014, doi: 10.1007/s10236-013-0679-0). However, indeed seasonal variation is still important to include, and we now included "seasonally" in the sentence.

5. Line 35-36: "which can be altered by climate change and man-made infrastructures (Dorrell et al., 2022)." This is a rather sweeping statement that needs a bit more explanation. What aspects of climate change can alter the mixing? The Dorrell reference is fine for man-made structures (you could be more specific and note the impending development of large-scale floating renewable energy structures), but "climate change" needs drawing out more with other supporting references.
For climate change predictions on mixing we have added the references of Holt et al., 2016 and 2018 in the introduction and pick up this now back up in the discussion

6. Line 58: "source of nutrients intake within the pycnocline" sounds awkward. "source of new nutrient supply to the pycnocline"? Also, I think worth specifying "new" as there will be recycling of nutrients within the SCM.
This sentence has been moved to L. 33-34 to address the comments from Reviewer 2 since there was a repetition in L. 30-35 and L.53-58. We changed "source of nutrients intake within the pycnocline" into "the main source of new nutrient's supply to the pycnocline".

7. Lines 60-65. I am not sure what point you are trying to make here. You seem to be suggesting that shelf SCM productivity has not been studied much, and mixing below the pycnocline has not been considered (much) in SCM productivity. I can think of work by people such as Hickman, Moore, Holligan, Sharples, Weston, Richardson on the NW European shelf, McManus, Franks, Lucas off W USA (and beyond). I think here is where you are making a statement of what aspect(s) of the SCM you will be focusing on that are novel – and the key to me is the link between the shape of the lower pycnocline (which is a tracer of bottom layer mixing) and the location of the SCM?
Thank you very much to point this out and allow us to explain better our intentions. We did not intend to say that SCMs in shelf waters are little studied, which is quite the opposite especially in the North Sea. Reading the literature, I (Arianna Z) have always found that most of the studies were reporting subsurface concentrations of Chl-a very close to the end of the pycnocline-beginning of the low mixed layer depth, although most of the studies investigating the phenology and abundance of primary production have

considered only MLD (upper mixed layer depth) as an indicator of the possible physical factors influencing these variations.

Hence, the paper aims to promote the use of the BMLD (hereafter intended as the mixed layer depth below the pycnocline) to further assess variations in the abundance, phenology and vertical distribution of Chl-a. A first method is provided to extract the BMLD, which can be surely improved in the future, but offers a new point of view on a very well-known system: the subsurface Chl-a distributes very close to the end of the pycnocline, during summer, in temperate shelf waters. To avoid misunderstanding of our aims, the sentence was changed from "However, despite the clear linkage between SCM and tidal mixing in shelf seas, variations on productivity have been mainly conducted at oceanic sites by investigating the mixing processes above the pycnocline (within the upper mixed layer) (Somavilla et al., 2017; Steinacher et al., 2010), omitting the effects of processes close to the seabed, e.g. variations of mixing processes below the pycnocline. On the other hand, studies on shelf waters suggest variations of the water column due to both surface and deep mixing processes, since the interplay of marine components from surface to seabed are more adjacent than in deep oceanic locations (Durski et al., 2004)" into "However, despite the clear linkage between SCM and deep physical processes in shelf seas, surface mixing processes have been used to investigate the global variations of primary production (Somavilla et al., 2017; Steinacher et al., 2010) making the surface mixed layer depth (MLD) an indicator of variations of Chl-a. The use of MLD is motivated in oceanic sites where the deepest limit of the pycnocline is difficult to draw, while the limits of the pycnocline in shelf waters are more evident due to surface and deep mixings confining the pycnocline in a restricted zone".
The novelty (and aim) of this paper is providing a method and a context to BMLD.

8. There is a tendency to overload the paper with citations. The first paragraph of section 1.2 has 28 citations, some of which are in lists of 5 – 8. Be more selective – pick the works that are most pertinent, or represent important initial studies.
We deleted some of the references where the list was unnecessary too long in the whole introduction. Section 1 is still particularly dense and has now 21 citations. We left 5-6 references in the lines 67-71 because we wanted to list all the main papers mentioning the relationship between MLD and Chl-a vertical distribution, bloom events and nutricline depth. Since one of the aims of the paper is proposing BMLD as more informative than MLD, we believe that referring to the main papers that used MLD would set a good background knowledge about MLD and Chl-a relationship.

9. Line 89 (title to 1.3). Again, you appear to define the BMLD as "base of the pycnocline". Then later at line 93 you define it as "below mixed layer depth". I understand what the base of the pycnocline is, but am less sure about how to interpret below the mixed layer depth. I would be very tempted to use MLD and BP: MLD is well-established and does not need redefining to AMLD, and to me BP works better as "base of the pycnocline". That way you are making a clear contrast between the base of the mixed layer and the established concept of the mixed layer depth.
Thank you for being supportive and finding a solution for the acronymous. We agreed to change AMLD to MLD considering its broad use in the literature. On the other hand, we opted to define the BMLD as the *mixed layer depth below the pycnocline*, leaving the order of the letters as the previous version. However, we considered to use BP (base of the pycnocline), but we believe it will deviate it from the concept of being a depth between the pycnocline and a mixed layer. In fact, MLD and BMLD refers to the deepest limit of the upper mixed layer and the first depth of the lower mixed layer (below the pycnocline). The use of BMLD includes in the acronymous the "mixed layer" concept, which is not excluded in BP. Since MLD and BMLD can also be seen as the limits of the pycnocline, the start and end, the top and base of the pycnocline, using BP would associate more with the "top of the pycnocline", which I (Arianna Zampollo) believe should also be defined. Moreover, we believe that defining the base of the pycnocline as the BMLD would increase its exposure. We also considered MLDb, although it appeared too similar to MLD and may lead easily to errors of misspelling.

10. The first paragraph of Methods does not work well. You are trying to summarise things that have yet to be explained, and also repeat/paraphrase the paper's aim which is not necessary here.

We understand why it is not working and we deleted it.

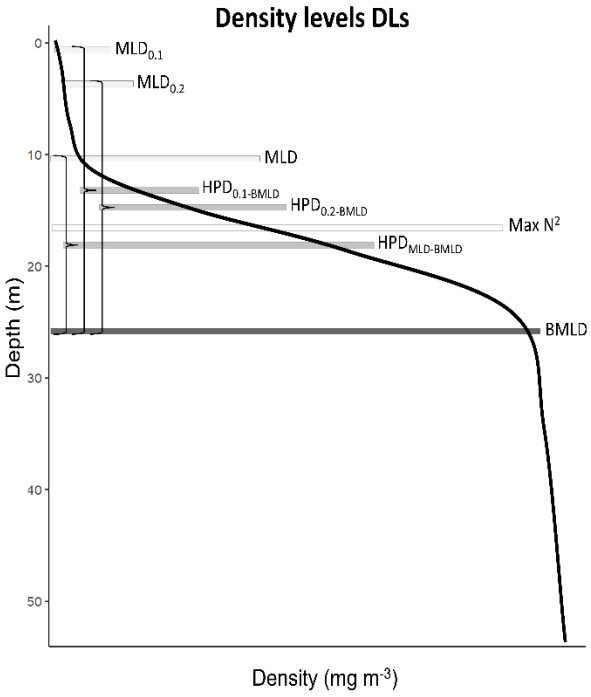
11. Line 143-144: "both transitional layers from a mixed to a stratified vertical region occurring at the beginning and end of the pycnocline." This sounds unclear. Do you mean that they are both the transition regions between mixed waters and the pycnocline?

Yes, we meant that the locations of MLD and BMLD are the transition regions between mixed waters and the pycnocline. The sentence was changed from "The surface mixed layer depth (AMLD) and the mixed layer depth below the pycnocline (BMLD) are both transitional layers from a mixed to a stratified vertical region occurring at the beginning and end of the pycnocline." into "The upper mixed layer depth (MLD) and the mixed layer depth below the pycnocline (BMLD) are both the transition regions between mixed waters and the pycnocline.".

12. Lines 150-158. This is a confusing paragraph, but I think the point you are making is that both the AMLD and BMLD are defined based on a critical value of the density difference between adjacent data points in the profile? And is this critical density different the same for AMLD and BMLD?

The selection of MLD and BMLD is not based on a critical value, as the algorithm works regardless for any *a priori* threshold. The aim of this paragraph was defining how MLD and BMLD are intended in this paper, since using a method without a critical value leads to select a different MLD from those obtained by thresholds' methods ($MLD_{0.1}$ and $MLD_{0.2}$). After having introduced the limitations of other common methods, we listed some of the definitions related to MLD and BMLD. Since the paragraph appeared confusing, we simplified it and changed it into "In the proposed algorithm, the detection of MLD does not assume that the upper mixed layer has a density gradient close to zero up to the top of the pycnocline, and it identifies MLD (and BMLD) regardless any *a priori* threshold (Chu and Fan, 2019, 2011; Holte and Talley, 2009). Two approaches, the angle's method from Chu and Fan (2011) and K-mean statistics, are used to analyse the vertical distribution of density (ρ) by comparing the observations to each other in the same profile instead of applying an absolute threshold to all profiles. The algorithm distinguishes in the water column three layers having similar density values (the upper mixed layer, pycnocline and lower mixed layer) (Fig. 2) using K-mean statistics. The MLD represents the shallowest depth up to which the difference of density between adjacent points $\Delta\rho$ is small and similar from the surface. The BMLD is the first depth below the pycnocline from which $\Delta\rho$ is small and similar down to the seabed. This type of detection based on the density shape allows the identification for unconventional density vertical distribution (Fig. A1 in Appendix A)."

Figure 2 (below) was replaced with the current Figure 2 to support readers visualizing what we intend with upper mixed layer, pycnocline and below mixed layer, and where MLD and BMLD locate.



13. Lines 163-185. I think this is the section where I need to understand how AMLD and BMLD are arrived at. But I cannot understand what is happening.

We acknowledge that the reviewer spent time to understand the method and that this paragraph was quite difficult to decipher. The aim is to summarize and simplify the details reported in the supplementary material, hence this section was extensively re-written and can now be found between lines 143 and 228. Below we gave an overall description of the method and our replies to specific issues for clarity.

The main issue that has been raised is the lack of clarity in the using of V1 (red line) and V2 (blue line). At each measured point (z) in the density profile , V1 is fitted using z and 2 points (2δ) above it, and V2 is fitted using z and 2 points below it. Therefore, a unique V1 and a unique V2 are calculated for each point of the density profile. The angle (φ) resulting from the intersection of the two lines is measured in degrees using equation 1 in Supplementary material. A value of φ is hence associated with each point of the density profile. At this point, following Chu and Fan (2011), the maximum angle is chosen as MLD or BMLD. Since the identifications of MLD and BMLD are both based on a ranking of φ, the selection of either one or the other requires splitting the observations in the water column to avoid their mis-identification. Therefore, to distinguish MLD from BMLD, the density profile must be split in two sections: Split1 and Split2. If the profile is not split, it would be impossible to distinguish both MLD and BMLD.

Therefore, splitting the profile in "surface" and "deep" sections is necessary to select which observations are used to identify MLD and BMLD. The surface layer goes from the bottom of the pycnocline to the sea surface, and the deepest section goes from half of the pycnocline (which is approximated as the middle point between the minimum and maximum density values) to the deepest recorded point. However, since V1 and V2 are calculated using 3 observations, the half of the pycnocline appeared too close to MLD in very thin pycnoclines (< 5 observations), and led to errors. Hence, Split2 was set to start 2 observations below the half of the pycnocline, while Split1 is just measured using all the observations from BMLD to the sea surface. It is noticeable that the limit of Split 1 is depending on the identification of BMLD, which is solved before the MLD in the algorithm. Following this explanation and the issues raised by the Reviewer, we changed several parts in the paragraph and simplified the algorithm's process.

Below some additional explanations referred to specific comments from the reviewer:

"Split1 appears to need knowledge of BMLD before it can be set. I cannot work out how split1 and split2 are used to determine AMLD and BMLD. Is it that split2 is first used to define BMLD, and then BMLD is used to determine split1 which then allows estimation of AMLD?"

Yes, first BMLD is identified using Split2, then BMLD is used to set the limits of Split1 and select the observations used in MLD's identification.

"But I do not understand how the red and blue lines in Fig 3 are decided upon and the role they play in AMLD and BMLD"

The intersection between red (V1) and blue (V2) lines return the angle (φ) which is used to identify MLD and BMLD as reported Chu and Fan (2011). However, our high-resolution profiles required a second level of inspection on the MLD and BMLD, which was made with K-mean statistic applied on several candidates (3 for MLD and 5 for BMLD) to select the truest MLD and BMLD.

"I think I can see how two of the lines are set (for AMLD, the blue line is a linear regression on the surface data? For the BMLD the red line is a linear regression on the bottom layer data? Why not use the same colour for these two?)"

This is partially correct, since the blue line in Fig. 3a refers to the regression made with the MLD and 2 observations above it (hence being part of surface data), and the red line in Fig. 3b is the regression made with BMLD and 2 observations below it (hence being part of deep data). The colours refer to the way they are measured: the red line is the regression made out with the investigated depth (z) and 2 observations above it (z-2), the blue line is the regression of z and z+2 (2 observations below z).

"Then does the blue line in Fig 3b allow determination of BMLD, which then allows split1 to be determined and so the red line in Fig. 3a? But what sets the left end of the red line in 3a?"

The blue line and red line contribute to determine MLD in Split1, and to determine BMLD in split2. BMLD contributes to determine split1, which is used to select the observations used in measuring V1 and V2 for MLD's identification.

Also, does this method only work if the data reach very close to the seabed? Split2 seems to be dependent on this. I am also a bit concerned that there were some profiles with density decreasing below the pycnocline – Fig A1d could show a real, temporary overturn in the density profile, but how does the method overcome this?

The answer to the question "does this method only work if the data reach very close to the seabed?" is no. This method works well with high-resolution data (1 m), pycnoclines defined by at least 4 observations, and enough observations after the pycnocline. We limited Split2 to $0.9\Delta\rho$ (90% of the observations from the sea surface to the deepest observations) because the profiles were exhibiting many points below the pycnocline, slowing down the running time of the profile. Moreover, this set up reflect what has been used by Chu and Fan (2011). However, we decided to allow users to choose if they want to consider the whole profile or just 90% of it. We added some details to the GitHub page (https://github.com/azampollo/BMLD/) to let the user change the setting of the abmld.R function.

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abmld.R is set up to work with the first 90% of the observations from the surface to the seabed (10% of the deepest points are not used). This setting is not ideal if your profiles have BMLD very close to the end (deep portion) of your density profiles. If you want to run the function using all the points of the profile, in abmld.R you have to comment L. 103-104 and uncomment L. 106-107 as shown below:

```
## USE L. 103-104 IF YOU WANT TO SET THE BOTTOM LIMIT OF SPLIT2 TO EXCLUDE 10% OF THE DEEPEST OBSERVATIONS
#per15 <- nrow(dd)-round((dd$pressure[nrow(dd)]*10)/100)
#d <- dd[1:per15,]
# USE L. 106-107 IF YOU WANT TO USE THE WHOLE DENSITY PROFILE
per15 <- nrow(dd)
d <- dd[1:per15,]
```

Moreover, we clarified this point in the paper in the section "method to extract MLD and BMLD" with the sentence "The abmld.R function works well with high-resolution data (1 m), pycnoclines defined by more than 5 observations, and the base of the pycnocline occurring within the 90% of the observations from the surface to the deepest point." and "The bottom limit of Split2 was defined at $z_{0.9\Delta\rho}$ following Chu and Fan (2011) to reduce the number of observations close to the seabed. However, the analyses can be extended up to the end of the profile by following the instructions reported at the website https://github.com/azampollo/BMLD.".

14. Lines 193- : Performance of the algorithm seems to require prior knowledge of AMLD and BMLD to then determine of the algorithm got it right. Is there some automated way of assessing the quality of the calculations? Otherwise, you might as well just select AMLD and BMLD manually.

Thank you for your comment. Since any method can have an error margin, we measured the algorithm's performance by checking the identifications manually. We had to assume some prior knowledge of MLD and BMLD to develop the algorithm and assess its performance. The validation was made with the co-authors and by considering their oceanographic experiences. Obviously, the selection of BMLD, as MLD, can be done manually, but we wanted to provide an automatic method to process large numbers of profiles. Moreover, although many methods are described to identify MLDs, none are reported for BMLD. Hence, the paper aimed to indicate the importance of BMLD and provide a method to extract it easily. Nevertheless, your point is very relevant, and we considered adding the following sentence "The algorithm was validated by manually checking the estimated MLD and BMLD in each profile, which were considered wrongly identified when falling into the pycnocline. Since most of the errors located the mixed layer depths clearly at the centre of the pycnocline having with thin layers of re-stratification (> 4 observations) (Fig. A1 b, c, e, f, Appendix A), the identifications were considered correct when they appeared i) on top of a lower mixed layer (in BMLD) and ii) on top of a large density gradient (pycnocline) separating surface to deep waters (in MLD)". This paragraph clarifies i) that the validation was required to assess the performance of the algorithm, ii) that the validation was manual and iii) what was considered as correct and what was wrong.

15. Section 2.3. It would help if you first explained what you mean by "density levels" and why they might be/are important here.

We agreed that the paragraph missed a description for DLs and the reasons behind their selection. Hence, we added the following sentence: "The depths detailing the density structure in the water column are defined here as density levels (DLs). Among the multiple indicators of mixed layers that associate with Chl-a vertical distribution, the ecological relevance of the MLD, the halfway pycnocline depth and the maximum buoyance depth were compared to the proposed algorithm's identifications.

16. Section 2.4. Not clear how the chl max is determined – you state the same method of angles used in 2.2, but I did not fully grasp that and certainly cannot now see how it is used to determine the chl inflexion point in a way that makes it better then manually doing it.

Here, as we specified in our reply to comment 14, the manual identification of DCM is a valuable option. However, large dataset can take a lot of time. For example, oceanographic variables from 3D models such as Copernicus dataset, are becoming widely used in spatial distributions models of marine species, and the time of processing several years of daily values can discourage users to adopt very informative variables (such as max Chl-a, MLD and BMLD). Hence, we used the adapted Chu and Fan (2011) method identifying for φ angle to automatically pinpoint Max Chl-a (SCM) in the water column. The method is coded into a function named maxChla.R that is available at https://github.com/azampollo/BMLD.

We have re-written this whole section, highlighting that "The angle (φ) were measured at each depth of the Chl-a profile, and the maximum φ with the largest Chl-a concentration was selected as DCM". This should clarify that the maximum angle's method was used to identify which depths have a large variation in Chl-a, and the DCM having a large concentration in Chl-a was selected among them. We decided to not give more details about the maximum angle's method because this is already described in Sect 2.2, Supplementary materials, and the github webpage.

17. Section 2.5. The first sentence works well – I immediately grasped what the aim of this section is. I was less clear one why 3 different linear models were used – I suspect that each method provides different information, but this was all presented in a fairly dense paragraph. Maybe split them out into their own short paragraphs/subsections so that it is easier for the reader to know what they should be focusing on.

We have added 'All three methods differently assess the level of correlation or prediction'. The aim of using each method is explained in table 2, and in the lines between 274-285.

18. Line 346 and Table 4: I do not understand where the units of mg m-1 come from. For a depth-integrated chl I would expect mg m-2.

The correct unit is mg m^{-3} and it has been corrected. We calculated the depth-integrated Chl-a (mg m^{-2}) and divided this value by the number of observations used to measure the depth-integrated Chl-a. Hence, the standardized depth-integrated (total) Chl-a is the amount of Chl-a in the whole water column above and below DL, and weighted by the number of samplings. Therefore, dividing the total Chl-a (mg m^{-2}) by the number of observations (m) returns mg m^{-3}. We clarified what values in Table 4 represent by changing the legend: "Sum of all depth-integrated Chl-a (mg m^{-2}) standardized by the number of observations above and below the four density layers."

19. Fig. 5: I do not know what this is showing me (I confess I've not heard of a "violin plot"). I assume they are sowing me the distribution of chl above and below the depth of the maximum across all data. But I do not know exactly how.

The violin plot is "a hybrid of a box plot and a kernel density plot, which shows peaks in the data" (Joel Carron, Data Scientist at Mode, 2021, link). While the box plot can only show summary statistics, violin plots summarize statistics and the density of the observations. Hence, it returns an idea of how the observations mainly distribute, and (for example) can inform about the ratio of outliers. We decided to use violin plots to represent the amount of Chl-a at each meter depth among all the profiles in order to visualize where most of the Chl-a distribute in the water column. In Figure 5, each violin plot is created with the Chl-a values from all the profiles at any depth. Hence, the violin plot allows visualizing if high concentrations occur at a certain depth beside what is the average value.

General Discussion point – show specifics

Overall the Discussion is very hard to grasp. A lot is said, but I find it difficult to pull out what the really important, novel points are from your work. Your results show that on the shelf the SCM tends to be located in the lower pycnocline – which is not surprising. But is a key point that the correlation with the BMLD means that climate predictions of changes in BMLD can tell us about how the SCM might respond? This needs to be much clearer.

We agreed that the link between MLD, BMLD and DCM or primary production was not well explained in the different sections of the discussion. Hence, we simplified some sentences in section 4.1 (paragraph 1), and changed the structure of section 4.2. We also added the photoacclimation effect on section 4.2.

20. Section 4.1 paragraph 1. So, is your main point here that AMLD probably works better in deep ocean environments where below-pycnocline turbulence is weak?

We agreed that paragraph 1 was not clear, and we added the sentence "Although MLD are linked to the physical processes setting the vertical distribution of DMCs in deep oceanic environments, all the investigated surface mixed layers' indicators ($MLD_{0.01}$, $MLD_{0.02}$ and MLD) weakly predicted DCM in the shelf waters investigated in this study."

21. Lines 403-406. I do not understand what you mean here – particularly, what is meant by "Max N2 would therefore represent a hot spot of nutrients reached by resuspended phytoplankton cells"? Your observations show that the depth of max N2 tends to be above the chl peak, which in every chl peak I have seen in shelf seas will mean that nutrients (nitrate) will be depleted.

We agreed that the sentence was not entirely correct. We wanted to justify the highest co-occurrence between DCM and Max N^2 (13.51%, Table 3) by saying that Max N^2 may pick up the layer where Chl-a cumulate due to the less turbidity. However, including the nutrients in this assumption is not correct because their distribution is not influenced only by physical drivers. Therefore, we changed the sentence into "The Max N^2 would therefore represent a mild turbulent layer where resuspended phytoplankton cells cumulate, while mixing processes above and/or below Max N^2 redistribute phytoplanktonic organisms throughout the water column.".

22. There is potentially a timing issue that needs to be considered. The SCM is a result of weak upward mixing of nutrients, but the slope of the nutricline is also affected by the uptake within the SCM – as summer

progresses the SCM can deepen in the pycnocline, not because the phytoplankton are actively swimming/sinking down but because their uptake of nutrients gradually eats down through the nutricline. All of your data is June/July, so you might not see that – but it is worth considering when comparing with other SCMs.

We are aware of this timing issue and this was the reason behind considering the shape of the vertical distribution of Chl-a in the first version of the paper. We know that subsurface production is strictly related to the nutrients' availability, although data on nutrients are often lacking in large scale analyses. Hence, we want to say in this paper that BMLD can still be an informative variable to understand where phytoplankton distributes in prolonged stratified conditions. We changed the sentences in paragraph 4.3 and added specified that the subsurface production is caused by surface depletion of nutrients after surface blooms: "Prolonged stratified conditions are known to promote subsurface patches of Chl-a (Ross and Sharples 2007; Somavilla et al., 2017) due to the depletion of nutrients at shallow layers after surface blooms. The starvation of nutrients at the surface forces phytoplankton to re-distribute (e.g. Bindoff et al., 2019; Boyd et al., 2015; Schmidt et al., 2020) in deeper nutrient-enriched waters, within the euphotic zone."

23. Lines 435-436. I do not know what you mean by "invalidated". In fact, I am not sure what I am expected to draw out of this entire paragraph. Towards the end you say "Hence, the location of CMds….", but I cannot see the connection between your statement about the FoF data and the earlier examples in the paragraph. What point are you trying to make?

Considering the comment made by the chief editor "*you should revise your manuscript, particularly the Discussion, with the aim to make clear the new mechanistic insights that your analysis provides, so that your work can be of interest to a wide readership of oceanographers"*, we decided to clarify the aims in paragraph 4.3 by adding a general introduction "In this section are introduced some of the potential contexts in which BMLD's use would be advantageous. The linkage between the mixed layer depth below the pycnocline and subsurface Chl-a advocates BMLD as a key variable to address the effects of climate changes and man-made structures (e.g. offshore wind farm foundations) on the food resources, and defines BMLD as a potential proxy of subsurface food patches to investigate the vertical and spatial distribution of grazing and predator species" and splitting the paragraph in two sections referring to the potential uses of BMLD in climate change scenarios and offshore renewable infrastructures.

We changed and partially deleted the sentence containing "invalidated".

We hope the intentions in the paragraph are now clearer.

Reviewer 2

L. 17: "Out of 1237 observations of the water column exhibiting a pycnocline". "Out of 1237 observations of the water column exhibiting a pycnocline in the North Sea".

Sentence is changed.

L. 25: A number of Keywords are acronyms, I suggest to consider more explicit keywords.

See 'Comment 2' response section to view the new keywords

L. 92: Are you meaning "the distance between" instead of "the depth between".

We changed the sentence from "to characterize the depth between the pycnocline and i) the surface mixed layer […]" into "to identify i) the surface mixed layer [..] and ii) the below mixed layer depth (BMLD) intended as the depth at which the pycnocline ends and the deep mixing develops until the seabed."

L. 53-58: These lines discuss concepts that are partially addressed above (L. 29-33). Please consider to:
** remove "The stratification is generally controlled by […] nutrient conditions within the pycnocline."*

Sentence was removed because it repeated L.35-37.

** move the following sentence "In the North Sea […] within the pycnocline" in place of (or integrated with) "The balance between stratification and mixing […]" (L. 31-33).*
Sentence moved to L. 34-35 and integrated to L.31-35. The sentence was changed from "The balance between stratification and mixing in the water column is determinant for phytoplankton, and, in the North Sea, it fluctuates in time and space by the modulation of daily and biweekly strong tidal cycles (Klymak et al., 2008)." to "The balance between stratification and mixing in the water column is determinant for phytoplankton. In the North Sea, the balance between mixing and stratification fluctuates in time and space by the modulation of daily and biweekly strong tidal cycles (Klymak et al., 2008; Loder et al., 1992; Sharples et al., 2006, 2001; Zhao et al., 2019b), which represent the main source of nutrients' input within the pycnocline in prolonged stratified conditions.".

L. 327-330: This sentence could fit at the beginning of the following paragraph (3.2).
We agreed that this was repeating the introduction of paragraph 3.2. Hence we integrated L.327-330 into L.337-341. The section changed from "Since hydrodynamic and biological conditions generating resuspension, passive drift, and mortality (i.e. zooplankton grazing in stratified waters) shape Chl-a differently throughout the water column, the amount of Chl-a was measured above and below each density levels regardless the vertical distribution of DCM. " to "Although DCM generally reflect the region with the highest concentration of Chl-a throughout the water column, large concentration can still accumulate above or below it. Hydrodynamic and biological conditions generating resuspension, passive drift, and mortality (i.e. zooplankton grazing in stratified waters) can shape Chl-a differently throughout the water column, hence the ecological relevance of the density levels has been investigated in comparison with the vertical distribution of Chl-a".

L. 463: OWFs is introduced here but not used elsewhere in the manuscript. Since several acronyms are already used, the use of OWFs could be avoided.
We agreed and deleted "(OWFs)".