**Comment on egusphere-2022-649 titled as: How subsurface and double-core anticyclones intensify the winter mixed layer deepening in the Mediterranean Sea" by Barboni, Coadou-Chaventon et al.,**

The temporal evolution of MLD in the Mediterranean Sea is investigated in this ms. It is shown that the MLD restratification delay and connection with preexisting subsurface anomalies appear to be determinant in MLD modulation by mesoscale eddy and highlights the importance of interaction with eddy vertical structure. The study is novel and will advance our understanding of the impact of mesoscale eddies on the dynamics of seawater properties. The manuscript is well structured and discussed in detail. I recommend publication, after minor modification and changes. The general and specific comments are given below.

**Abstract**

1. In general, the quality of abstract is not keeping with the entire ms and requires couple of modifications. It is recommended to review the abstract and re-written it, specifically from line 1 to 12.
   Some few examples are given below:
2. Line 2: ….., shoaling very: check the grammatic of the sentence, and replace the comma with an and.
3. Line 2-6, I suggest to focus on your achievements rather than what is done previously (this is more in the introduction section), if it is really important to mention, put it in a way that shows what you have improved in comparison to previous works.
4. Line 13: cooling of MLD, does not make much sense, do you mean reducing the strength of that? please be more specific:
5. Line 13-14: how often it is reaching to more than 2 months.
6. Line 10: at a fine temporal scale on the order of week, you could directly mention how many week(s) ?
7. Line 16: it is not in the opposite of the former sentence, rather an additional information.

The upper comments have been taken into account and the abstract have been re-written in that sense. Particular attention has been put in underlining what are the main results from this study. More quantitative details regarding our results were added (eg. temporal scale of 10 days, 3 cases out of 16 where the MLD restratification delay is more than 2 months)

**Introduction:**

8. Line 40-50: He et al., 2018 show that eddy amplitude is related to surface T anomalies with different behavior for AE and CE, how does their finding cooperate to Gaube et al., 2019?

We greatly thank the reviewer for getting to our knowledge this interesting article. He et al (*A New Assessment of Mesoscale Eddies in the South China Sea: Surface Features, Three-Dimensional Structures, and Thermohaline Transports*, 2018) showed that

eddy amplitude is related to the temperature **subsurface** anomaly (based on their Fig.16). They still observed slightly warmer SST inside anticyclone, a vision maybe blurred by the eddy stirring in surface, then making the inside-eddy SST signature more similar to a dipole. This result is different to the one of Gaube et al (2019) and especially Haussmann and Czaja (2012), however not contradictory : the composite method provides an average shape and vertical structure that is scaled with the eddy amplitude.

Very interesting is the fact that they indeed found eddy-induced MLD anomalies for anticyclones predominantly in subsurface, but somehow small and did not provide a trend. This limit is probably due to their method of an 'annual' MLD anomaly by removing the MLD seasonal cycle from a monthly climatology.

From our work in the Mediterranean sea, we think that much greater MLD anomalies could be observed in a region with subsurface eddies such as the South China sea attempting a Lagrangian tracking of eddies. In particular one could interestingly notice a higher PDF for anticyclone MLD around 120m in their Fig.11b, that could be some strong but brief winter MLD smoothed in the annual average.

9. The ms is focused on the subsurface mesoscale eddies, therefore, it is suggested to briefly explain the subsurface eddies and their differences with other typical type of dominant eddies in the Mediterranean Sea.
10. line 70: I was looking to read the reasons why the MS is an interesting region to study eddy influence on MLD. The text is very scatter and does not clearly explain why MS is an interesting region.

    Pt 9-10 : A clearer definition of subsurface anticyclone was added and following paragraph about the reasons to study Mediterranean anticyclone was rewritten. Two main arguments can be listed :

    - A high-density of in situ observation allowing to follow in time inside-eddy evolution for particular structures, and then beyond a composite vision
    - Wide variety of eddy dynamical behaviors

11. Line 77: remove the sentence here: -All these structures should have a different impact on the mixed layer. You are seeking to find this in the ms.

**Data:**

12. Are the 157053 profiles unique data or some data are repeated in your data bank?

    We added a sentence (in addition to the Appendix) to clarify this : duplicates are checked between CORA-DT and Copernicus-NRT. In case a duplicate is detected, it is retrieved from the delayed-time repository.

    There are : 113486 profiles in CORA-DT from 2000 to 2019 ; 20746 profiles in Copernicus-NRT from 2000 to 2019 and 22821 profiles in Copernicus-NRT from 2020 to 2021

13. Line 112: why 2 set of different data sets are used?

    Delayed-time dataset (CORA-DT) is supposed to be more reliable with more quality controls. However if delayed-time profiles are supposed to be published 6 months after the cast date, some data are often released 1 or 2 years later. Collecting profiles from the second dataset Copernicus-NRT allows accurate data sampling in 2020 and 2021, enabling to measure for instance the Mersa-Matruh-6 event.

    Additionally, we realized that CORA-DT quality controls removed profiles with bad salinity data (QC flag '4') even though the temperature is good and exploitable. This occurred for instance for Argo float 6903204 released in the Ierapetra anticyclone in September 2017. Winter deepening event Ierapetra-2 would then not have been measured retrieving data from CORA-DT only.

14. Line 110-125: please name couple of successful application of using AMEDA on detecting/analyzing eddies in the other regions apart from MS (and preferably not from the co-author of this ms).

    AMEDA is an open source eddy tracking algorithm (https://github.com/briaclevu/AMEDA) . It has been successfully applied in both altimetric data and numerical simulation outputs, and in various regions, such as the Arabian sea (de Marez et al. 2019), the Mediterranean sea (Barboni et al. 2021) or the Northern-Eastern Atlantic Ocean (de Marez et al. 2021 : The influence of merger and convection on an anticyclonic eddy trapped in a bowl).

    The main different with other commonly used eddy detection algorithms (Chelton et al (2008), Chaigneau et al (2009), Mason et al (2014)) is that AMEDA does not consider sea surface height but velocity contours. If a geostrophic approximation is considered, velocity contours are equivalent to SSH isolines, but AMEDA is then applicable in other experiments, such as particle image velocimetry (PIV).

15. Figure 2: D--->D0
16. Line 190-195: why did you choose the background of an eddy by time/spatial averaging with the given time and radius, rather than climatological averaging at the location of the eddy by removing the eddy events following previous studies such as Gaube et al., 2019.

    We didn't built the background with climatological averaging in order to avoid as much as possible the time-averaging and keep the interannual variability. Since we compare the temporal evolution of MLD within eddies with respect to that of the surrounding background sea state, a smoothing of the background state will result in an erroneous MLD modulation by eddies estimate, in particular for years where the interannual variability is strong

**Results and discussions**

17. Figures 2,4 and 5: It is suggested to change the colorbar specially from 0 to -5000 m, as it may get confused with the eddy contours or alternatively change the eddy contours line colors.
18. Figure 4-5: Keep the unit in the figures and text consistent, either °C/m (it is suggested as the profile depths does not cover a km) or °C/km.
19. Does the red region quality in figure 4-5 between 0 and 100 m depth improve, if the colorbar covers a larger number for example to - 30 instead of -20?

    Pt 17 to 19 : Figures were improved in this sense. A mistake was also corrected in Fig.5e, with accurate profiles in April 2010. Position of background profiles also slightly changed because of a code mistake in background selection parameters, but this does not alter the analysis.

20. Would it be possible to add an extra column to table 1 with the eddy lifetime since the generation day ?

    The corresponding column was added in the revised manuscript. The shortest one lived for 345 days, the oldest for 1229. Please also note that eddy tracking for Mersa-Matruh-6 stopped only because the dataset ends in December 2021

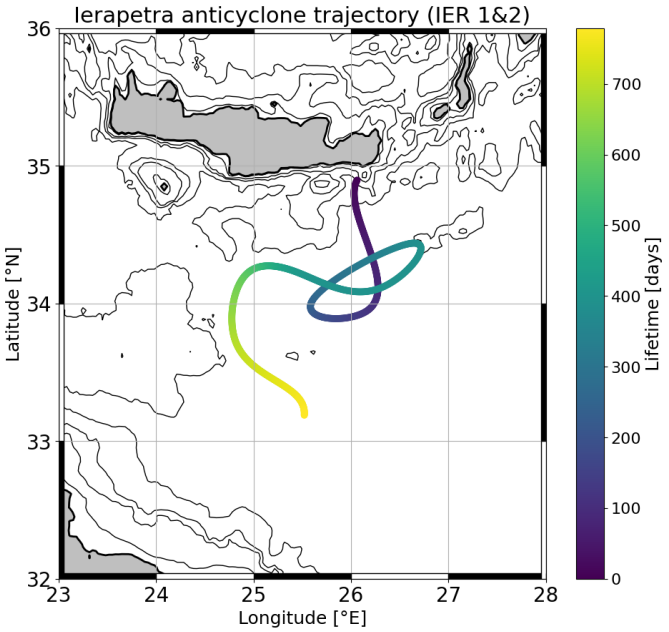
21. Please pay more attention in using abbreviations in the entire text. An example of inconsistency: PEL is first introduced in Fig3 and line 231 without explaining! Then in line 318.

    Abbreviations were indeed not accurately introduced and used more carefully in the revised manuscript, in particular Fig.3.

22. Figure 6: would it be possible to add the eddy path trajectory for the indicated eddies in this figure?

    We can provide below an example of an eddy trajectory for one Ierapetra anticyclone (IER1 &2, shown in Fig.10). However this will add extra information to figures already dense. It is important to emphasize that Mediterranean eddies to not significantly drift, the Beta effect being very weak due to small Rossby radius. Algerian anticyclones could be an exception to this statement but not concerned by our study. Eratostenes and Mersa-Matruh anticyclones are cases of anticyclonic attractors, staying always close to a preferred position (see in particular Barboni et al, 2021, in figures 6a and 10 ). Ierapetra anticyclones also rarely drift significantly far from their formation region, as studied by Ioannou et al (2017).

23. The section 5.5 is suggested to be removed from the ms as i) it is not well discussed ii) out of the focus of the ms.




Section 5.5 was improved to better link with previous discussion. However we would argue it is quite important to keep it. This manuscript focuses indeed on eddy-induced MLD only from a physical point of view, although MLD has a great impact on biological activity. An opening paragraph on the expected biological impact of such eddy modulation then seems very appropriate. Reviewer 1 actually proposed to extent it on Oxygen which is also related to biology.

Besides, it allows to link the findings of this research with previous studies in the Eratosthenes (or Cyprus) anticyclone with more biological focus, in particular Krom et al (1992) and Moutin et Prieur (2012). The later discussed the possibility of winter mixed layer depth not reaching the main nitracline, which is very likely the case in a 'non-connecting' event, while they did not observe it. As our study indeed found this hypothetical event it seems very interesting to keep this paragraph.

**Appendix:**

How does the quality control algorithm work? How does it remove bad quality data? How to you define bad data/spikes in T/S profiles?

Bad quality data (QC flag =1,2 or 5) are removed in the sense they are not kept for interpolation. Profiles filtered from bad data are linearly interpolated on the same vertical vector ( 5m step from 5m to 300m deep, then 10m step from 300m to 2000m deep). After this interpolation, remaining spikes on temperature are removed (replaced by NaN) if there is a jump higher than +6°C or lower than -2°C between 2 points (then dz=5 or 10m). Spikes are corrected only for temperature as this issue almost exclusively concerns noisy XBT.