**Author responses to Editor comments for the manuscript:**
**"Acidification, deoxygenation, nutrient and biomasses decline in a warming Mediterranean Sea"**
**May, 2022**

We thank Dr. Abed El Rahman Hassoun and the Anonymous Reviewer#2 for their positive feedback and for providing detailed comments and suggestions that helped us to further improve the manuscript. Reviewer's comments are in bold, authors' responses are in normal font, italicized where they quote the changes in the manuscript.

**Reply to Reviewer#1 (Dr. Abed El Rahman Hassoun)**

**1-For the new table of projections, it would be very helpful to also add the projected anomalies.**
We thank the Reviewer for his comment in the previous revision related to the need for a table in the manuscript. However, the anomalies are already discussed in the manuscript and we think that adding these anomalies to the table SP1 where the absolute values are already shown would make this information just redundant. In any case, in order to handle the request of the other Reviewer the table was further extended by reporting the temporal standard deviation values associated with each variable.

**2-For the comment of "P8, L263-266", although it is adopted in other published studies, I do not agree to remove the Adriatic and Aegean Sub-basins, since they both, with the remaining sub-basins, give to the Eastern Mediterranean basin its peculiarity. Also, the main water masses are circulating in all Eastern Med. Sub-basins and it is not logical to separate them as if they are not connected. For example, high alkalinity waters coming from the Black Sea, through the Aegean, towards the Levantine Sub-basin, are the reason why there is high AT/buffering capacity in the latter sub-basin compared to other Mediterranean areas, etc. BUT, I will not request to change this in the current manuscript, just wanted to reflect my point of view.**

We thank the Reviewer for this comment. We think that including/excluding Adriatic and Aegean Seas into/from the Eastern Mediterranean Sea should be decided/justified on the basis of the scope of the analysis. In our specific case, we decided to exclude them for sake of consistency and for allowing a quick comparison of the results of our numerical simulations with the previous works discussing the biogeochemical dynamical of the Mediterranean Sea (Lazzari et al., 2012; 2016; Di

Biagio et al., 2019; Reale et al., 2020 a,b; Cossarini et al, 2021). In any case, the peculiarity of the Adriatic and Aegean Sea is shown in the maps and tables of the manuscript.

**3- For the comment of "P11, L326", thanks for adding a reference at the end of the new sentence.**

On our side, we thank the Reviewer for this suggestion.

**4- In lines 332-334: please add 'spatio-temporal' instead of 'spatial-temporal'.**

Done

**5- For references in lines 917-920, the reference "Hassoun et al., 2019" is not correct. I think you mean here "Hassoun et al., 2015". Hassoun, A.E.R., Gemayel, E., Krasakopoulou, E., Goyet, C., Abboud-Abi Saab, M., Guglielmi, V., Touratier, F. and Falco, C., 2015. Acidification of the Mediterranean Sea from anthropogenic carbon penetration. Deep Sea Research Part I: Oceanographic Research Papers, 102, pp.1-15.**

Yes, we were mistaken. The citation has been changed accordingly.

**Reply to Reviewer#2**

**Minor remarks:**

**Line 83: "CO2" abbreviation hasn't been defined before**

Done

**Line 214: You introduce ALK and you don't use it on line 215 or line 227, be careful to be consistent with the abbreviations.**

Agreed. The text has been modified accordingly

**Line 341: "the resolution to 1/24 degree"; Change "degree" for the symbol to be consistent with the lines above.**

Agreed. The text has been modified accordingly

**Line 346: "chlorophyll-a (Chl-a)"; You could introduce this before and remove the chlorophyll-a, it would be more consistent. See line 943 as well.**

We thank the Reviewer for the suggestion. The text has been modified accordingly

**Bibliography: Some references end with a dot "xxx 2019." and others end with the date without a dot, see for example line 1122, 1141.**

We thank the Reviewer for spotting this inconsistency in the references. The text has been modified accordingly adding a dot at the end of each reference.

**Figures:**

**The figures need to be carefully checked. I will list here figure by figure what needs to be corrected. A general remark is that the font size between all the figures needs to be coherent.**

**Fig.2: h) the unit is false for pH**

**g&i ) space between mu and mol**

**Fig.15: space between mu and mol for DIC unit**

**Fig.16: c & d) you use d-1 here, but usually you use year-1 so use day-1**

**Fig.17: a) end bracket is missing for concentration**

We thank the Reviewer for spotting the errors in the figures that have been corrected accordingly

**Fig.S4: Yaxis title "MLD year [m]" why year?**

Unfortunately, there was a typo in the uploaded figure, which has been modified by removing the word "year" in the Y-axis title.

**Fig S5: you use Mmol but if I am not mistaken in the manuscript you use mmol please correct this (as well in the other figures)**

The values reported in Fig.S5-S6-S7 represents the mass balance of phosphate and nitrate through the selected straits and it is measured in Megamoles year$^{-1}$(Mmol year$^{-1}$). In the manuscript we reported the absolute concentration of nitrate and phosphate in millimole/m$^{-3}$ (mmol/m$^{-3}$).

**Sp1: I like this table that is a great improvement, the caption however could be clearer. The values are averaged spatially and between 0-100 m and 200-600 m? Adding the std could be nice.**

Agreed. Moreover, we thank the Reviewer for suggesting the addition of the standard deviation to the table. The table has been modified including the temporal standard deviation of the "unbiased scenario" values. Both table and caption have been modified as follows:

| | | RCP4.5 | | | RCP8.5 | | |
|---|---|---|---|---|---|---|---|
| | | **PRESENT** | **MID-FUTURE** | **FAR-FUTURE** | **PRESENT** | **MID-FUTURE** | **FAR-FUTURE** |
| **Seawater Temperature (°C)** | | | | | | | |
| WMED | 0-100 | 16.3±0.3 | **16.8±0.3** | **17.5±0.2** | 16.4±0.3 | **17.2±0.4** | **19.0±0.3** |
| | 200-600 | 13.9±0.1 | **14.9±0.1** | **15.6±0.1** | 14.0±0.1 | **15.2±0.1** | **16.6±0.2** |
| EMED | 0-100 | 18.2±0.2 | **18.9±0.3** | **19.8±0.2** | 18.4± 0.2 | **19.5±0.5** | **21.7±0.4** |
| | 200-600 | 14.5±0.1 | **15.0±0.1** | **15.8±0.0** | 14.6±0.1 | **15.3±0.1** | **16.8±0.2** |
| **Seawater Salinity (-)** | | | | | | | |
| WMED | 0-100 | 37.4±0.1 | **36.9±0.1** | **37.0±0.1** | 37.4±0.1 | **36.9±0.1** | **37.0±0.1** |
| | 200-600 | 38.6±0.0 | **38.8±0.0** | **38.7±0.0** | 38.6±0.0 | 38.9±0.0 | **39.0±0.0** |
| EMED | 0-100 | 38.6±0.1 | **38.3±0.1** | **38.5±0.1** | 38.6±0.1 | **38.4±0.1** | **38.8±0.1** |
| | 200-600 | 38.9±0.0 | 38.9±0.0 | **38.9±0.0** | 38.9±0.0 | **39.0±0.0** | **39.1±0.1** |
| **$PO_4$ (mmol $m^{-3}$)** | | | | | | | |
| WMED | 0-100 | 0.14±0.01 | **0.13±0.00** | 0.14±0.01 | 0.14±0.00 | **0.13±0.00** | **0.13±0.00** |
| | 200-600 | 0.29±0.00 | **0.30±0.01** | **0.28±0.00** | 0.30±0.00 | **0.29±0.01** | **0.29±0.00** |
| EMED | 0-100 | 0.03±0.00 | **0.03±0.00** | **0.03±0.00** | 0.03±0.00 | **0.03±0.00** | **0.02±0.00** |
| | 200-600 | 0.18±0.00 | **0.18±0.00** | **0.17±0.00** | 0.17±0.00 | 0.17±0.00 | 0.17±0.00 |
| **$NO_3$ (mmol $m^{-3}$)** | | | | | | | |
| WMED | 0-100 | 1.0±0.1 | 1.0±0.1 | 1.0±0.1 | 1.0±0.1 | **0.9±0.0** | **0.9±0.0** |
| | 200-600 | 4.6±0.0 | **4.7±0.1** | **4.5±0.0** | 4.7±0.0 | **4.7±0.1** | **4.6±0.0** |
| EMED | 0-100 | 0.2±0.0 | **0.1±0.0** | **0.1±0.0** | 0.2±0.0 | **0.1±0.0** | **0.1±0.0** |
| | 200-600 | 3.1±0.0 | **3.0±0.0** | **3.0±0.0** | 3.0±0.0 | 3.0±0.0 | 3.0±0.0 |
| **Dissolved Oxygen (mmol $m^{-3}$)** | | | | | | | |
| WMED | 0-100 | 237±1 | **233±1** | **231±1** | 235±1 | **230±2** | **223±1** |
| | 200-600 | 213±1 | **207±1** | **204±1** | 211±0 | **205±0** | **196±2** |
| EMED | 0-100 | 234±1 | **232±1** | **228±1** | 233±1 | **229±2** | **219±1** |
| | 200-600 | 219±1 | **217±0** | **213±0** | 220±1 | **217±1** | **208±2** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Phytoplankton biomass (mg $m^{-3}$)** | | | | | | | |
| WMED | 0-100 | 12.9±0.5 | **11.8±0.6** | **11.9±0.6** | 12.7±0.6 | **11.5±0.6** | **10.4±0.5** |
| EMED | 0-100 | 7.5±0.5 | **6.3±0.5** | **6.2±0.4** | 7.0±0.4 | **5.7±0.5** | **4.8±0.3** |
| **Zooplankton biomass (mg $m^{-3}$)** | | | | | | | |
| WMED | 0-100 | 14.5±0.3 | **14.0±0.4** | **14.2±0.4** | 14.6±0.4 | **14.0±0.4** | **13.7±0.5** |
| EMED | 0-100 | 11.7±0.3 | **10.9±0.3** | **10.9±0.3** | 11.4±0.2 | **10.5±0.4** | **9.8±0.4** |
| **Integrated net primary production (gC $m^{-2}$ $year^{-1}$)** | | | | | | | |
| WMED | 0-200 | 135±6 | 134±3 | **144±4** | 137±5 | **139±3** | **156±8** |
| EMED | 0-200 | 140±5 | **136±3** | **149±4** | 137±4 | **139±3** | **162±6** |
| **Dissolved Inorganic carbon (µmol $kg^{-1}$)** | | | | | | | |
| WMED | 0-100 | 2276±7 | **2297±4** | **2322±4** | 2270±2 | **2301±8** | **2375±12** |
| | 200-600 | 2373±0 | **2404±7** | **2447±4** | 2375±1 | **2404±11** | **2495±14** |
| EMED | 0-100 | 2325±4 | **2363±12** | **2400±4** | 2318±3 | **2372±14** | **2484±15** |
| | 200-600 | 2382±2 | **2410±6** | **2452±3** | 2379±2 | **2412±10** | **2505±15** |
| **pH (-)** | | | | | | | |
| WMED | 0-100 | 8.07±0.00 | **8.03±0.01** | **8.00±0.00** | 8.07±0.01 | **8.01±0.02** | **7.88±0.02** |
| | 200-600 | 8.08±0.00 | **8.05±0.00** | **8.00±0.00** | 8.09±0.00 | **8.04±0.01** | **7.92±0.02** |
| EMED | 0-100 | 8.09±0.00 | **8.03±0.01** | **7.99±0.00** | 8.09±0.00 | **8.00±0.02** | **7.84±0.02** |
| | 200-600 | 8.1±0.00 | **8.06±0.00** | **8.02±0.00** | 8.10±0.01 | **8.05±0.01** | **7.92±0.02** |

*"Table SP1 "Unbiased scenario" values for seawater temperature, salinity, dissolved phosphate, nitrate and oxygen concentrations, Phytoplankton and Zooplankton biomass at surface, vertically integrated net primary production, Dissolved Inorganic Carbon and pH in the PRESENT (2005-2020), MID-FUTURE (2040-2059) and FAR-FUTURE (2080-2099) time windows. Averages and temporal standard deviations are computed considering the timeseries of annual means for the Western (WMED) and Eastern (EMED) Mediterranean Sea for the layers 0-100 m and 200-600 m. Bold format indicates significant differences of the future averages from the values of the PRESENT period according to a Mann-Whitney test with $p<0.05$."*