Reviewer 3.

This paper addresses the impact that climate change and future riverine nutrient inputs will have on the biogeochemistry of the Mediterranean Sea over the period 1980-2100 using a high resolution coupled NEMO/PISCES model. This paper is important for the scientific community as it is the first time a transient simulation on the response of the biogeochemistry of the Mediterranean Sea to climate change has been run. The authors separate the individual effects of the different scenarios to help determine the reasons for the future biogeochemical changes that the model predicts. In addition they looked at both the impact of each scenario to nutrients and the phytoplankton and zooplankton communities. This study concludes that nitrate concentrations in the Mediterranean are likely to increase in the future while there is no change in phosphate concentrations. They further predict a decrease in net primary productivity. In general, the use of English is good although there are some areas which need clarification which I have highlighted below. However I have some concerns regarding the initial conditions of the model and the analysis of model results which need addressing before this can be published. This review will start with more general comments before detailing more minor changes.

My main concern is regarding the initial nutrient conditions in the model. The authors state on line 212 that there is "some underestimation of nutrient concentrations" and again on lines 536-537 that "nutrient concentrations are slightly underestimated" but they do not quantify this. I was surprised when looking at Figure 4 to see deep water nitrate concentrations between 4 and 4.5 µM in the Western Mediterranean Sea. I was expecting to see nitrate concentrations on the order of 8-9µM and hence I do not call this a slight underestimation. Although there is a slight W-E gradient in nutrient concentrations within the model it is not anywhere near as strong as observations suggest. Together with the fact that nitrate in the DW is decreasing in the control scenario suggests to me that the model is not be capturing the biogeochemical cycling of nitrate correctly and raises the question of the validity of future model results. How does this underestimation of nitrate concentrations (and to a lesser extent phosphate concentrations) in the Western basin impact the results of changing circulation such as decreased deep water formation and increased stratification? Would this have a major difference on results? Can the model really predict future changes due to climate change if it can't predict present day conditions correctly?

This point was also outlined by another reviewer. We added in the appendix section vertical profiles of phosphate and nitrate at the DYFAMED station and along the BOUM section. These figures show that nutrient concentrations in the deep Mediterranean are underestimated by the model. However, the nutricline is represented for both nitrate and phosphate, although is it too weak. The model is indeed not representing the correct nutrient concentrations in the deep Mediterranean. However, the main biogeochemical characteristics are represented such as the position of the nutricline, a deep chlorophyll maximum and the west-to-east gradient of productivity. Moreover, we added in figure A1 of the article the chlorophyll profiles for different years at the DYFAMED station in February and in May. This figure shows that the model is able to reproduce a seasonal and an interannual variability in the biogeochemistry of the Mediterranean that generate a surface chlorophyll distribution that is supported by observations (figure 1 and 2).

The decrease of nitrate deep water concentrations in the CTRL may be linked with the unbalanced sources and sinks of nitrate in the Mediterranean. There may be sources of nitrate that we underestimate or fail to include due to a lack of observations (submarine groundwater discharge or sediment remobilization for instance). The same modelling approach, conducted with a higher resolution model (1/12°, Richon et al, 2017), lead also to underestimation of deep nutrients concentration, but with less amplitude. It suggests that changes obtained by increasing the dynamical model resolution improve the dynamics of the model (convections, eddy activities …), but also in consequences biogeochemical variables. Unfortunately, long climate change simulation performed for this study can not be conducted yet with higher resolution.

We believe that the discrepancy between modeled and measured nutrient concentrations are not

impacting qualitatively our conclusions. The results of this study should be looked at qualitatively and the trends should be remembered rather than the absolute numbers. The trends we observe (accumulation of nitrate, decrease of surface productivity) are the result of multiple factors and have the potential to modify nutrient limitation and surface primary and secondary production. Stratification is virtually isolating the surface layer from regenerated nutrients from the deep and the increase in riverine nitrate discharge (impacting the surface layer) will consequently increase surface nitrate concentration. The trends we observe are explained by the changes in sources and sinks of nutrients and by the circulation changes. Therefore, we believe the trends are robust, but we agree that the absolute values of present and future concentrations may be wrong.
Moreover, it is difficult to assess the robustness of future response of climate models. Models with important bias in the present conditions may not perform worse in future simulations than models with good performances in the present. This is mainly because physical mechanisms driving the response to climate change are not the same than the ones driving model bias in the present. Again, the model and scenario we use in this study are the only ones directly available to us at the moment.

My next concern is in regards to whether the authors include dissolved organic matter inputs though the Strait of Gibraltar and from rivers into the model? On line 291-293 the authors say that
"The Mediterranean is a remineralization basin that has net negative fluxes of inorganic nutrients (i.e. organic nutrients enter the basin through the Gibraltar Strait surface waters and inorganic nutrient leave the Mediterranean through the deep waters of the Gibraltar Strait"

However there is no mention of dissolved organic nutrients anywhere in this paper. Do the authors include them in the inputs through the Strait of Gibraltar (or in the riverine input)? If yes this needs to be explicitly stated and if no then they are missing a major source of phosphorus and nitrogen in their model (see Powley et al., 2017; 2018). In addition the paper tries to present a nutrient budget based solely on nitrate and phosphate and then use the imbalanced budget to explain the decrease in nitrate in the CTRL model (Line 540). However dissolved organic matter inputs need to be included in the budget so that total N and P inputs and therefore a complete budget can be calculated (see Powley et al., 2017; 2018) In addition I suggest creating a Table summarizing the budget as currently it is difficult to interpret from the graphs. Finally Lazzari et al. (2014) conclude that dissolved organic matter is increasing in their model in response to climate change. Do your results agree? (I know this is not a key result but a sentence regarding this could be added to the discussion)
Organic forms of phosphorus and nitrate are not included in the version of PISCES we used. They can only be calculated by multiplying the DOC by the Redfiled ratio. However, organic forms of nutrients are not available to phytoplankton. The only forms of organic matter are dissolved organic carbon (DOC) and particulate organic carbon. DOC from river and Gibraltar inputs is included. It can be remineralised to inorganic nutrients and therefore acts as an indirect source of nutrients. However, it is impossible to quantify this remineralization in our simulations. In the HIS/A2 simulation, the DOC riverine inputs are kept constant to the 2000 value over the 21st century. The evolution of DOC incoming and outgoing at Gibraltar is shown below. The three graphs represent respectively total incoming, outgoing and net DOC fluxes through the Strait of Gibraltar in the HIS/A2 simulation (Red) and in CTRL (blue). Numbers in the top right boxes represent respectively the total fluxes for the periods 1980-1999, 2080-2099 and 2040-2059. These figures show that the net DOC flux is increasing throughout the 21st century.

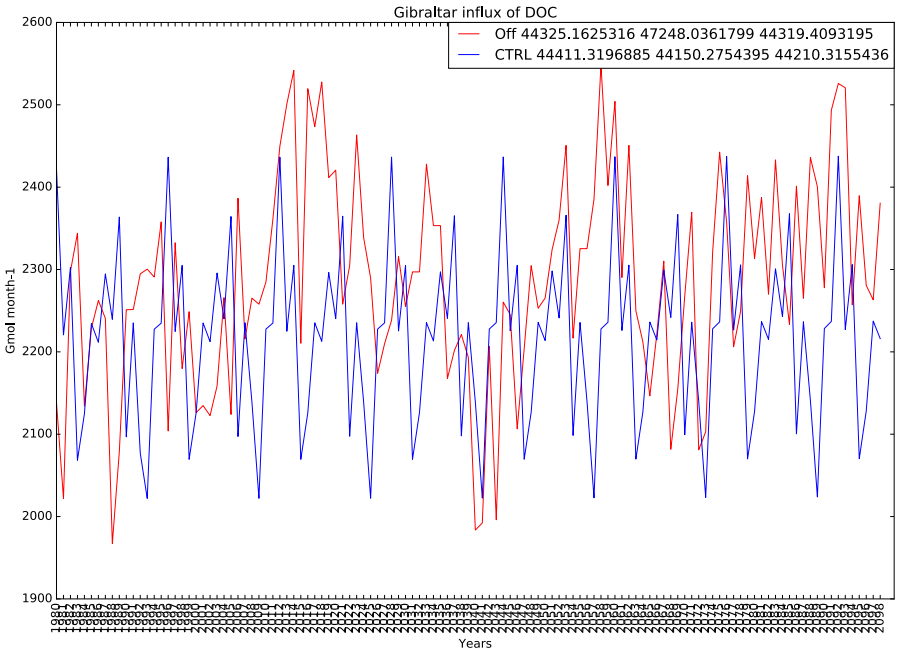

Figure 1 Influx of DOC through the Strait of Gibraltar

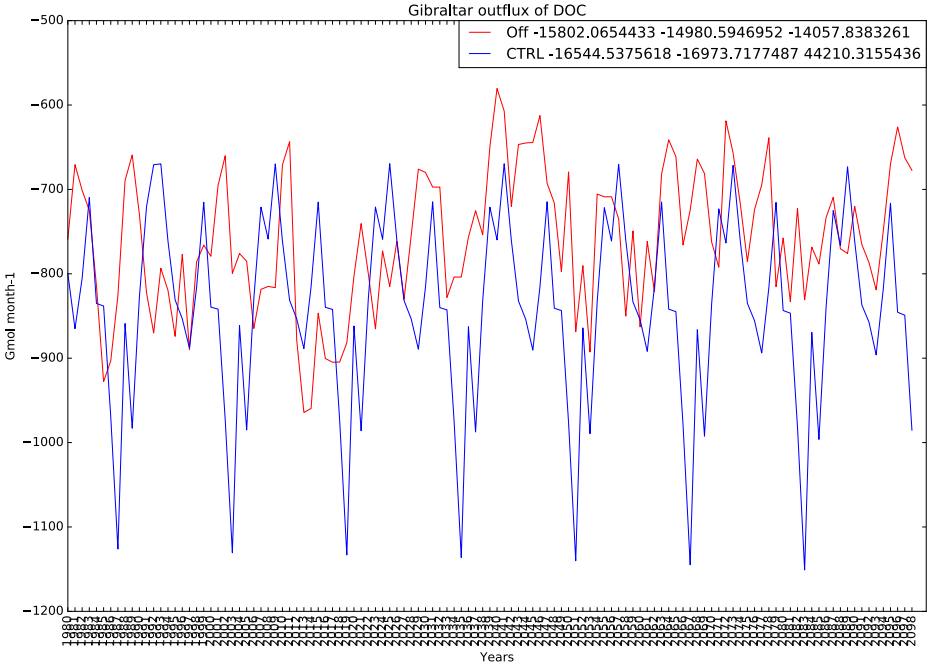

Figure 2 Outflux of DOC through the Strait of Gibraltar

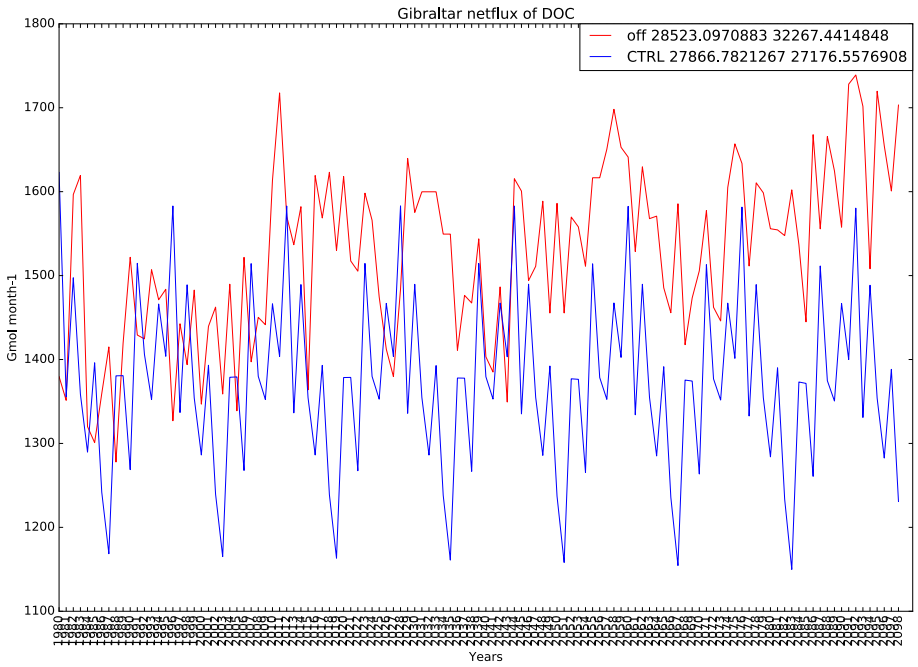

Figure 3 Net flux of DOC through the Strait of Gibraltar

In spite of this increase in DOC flux, the concentrations seems to be decreasing in the basin in our simulations (see the following figures). DOC concentrations in the surface layer are increasing in HIS/A2, but the important decrease in the intermediate and deep layers is probably linked with a decrease in vertical water flux.

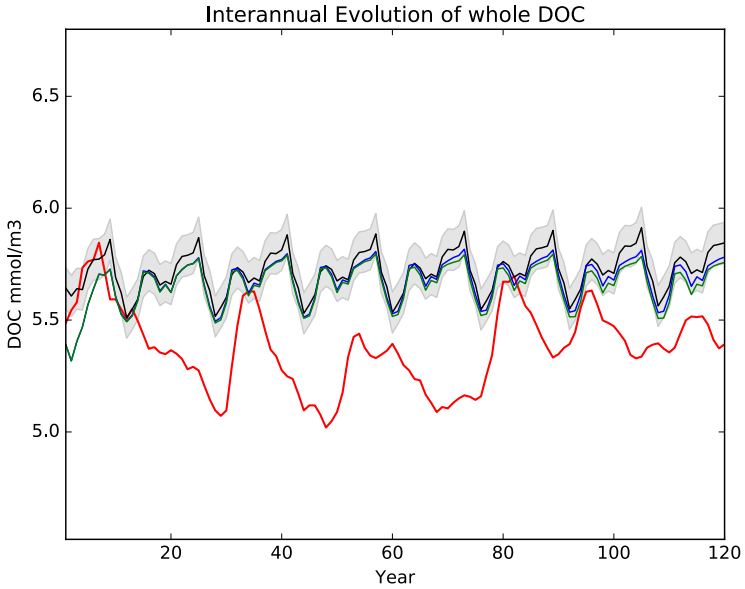

Figure 4 Interannual water column concentration of DOC in the eastern basin for all simulations (HIS/A2 in red, CTRL in black, CTRL_R in blue and CTRL_RG in green)

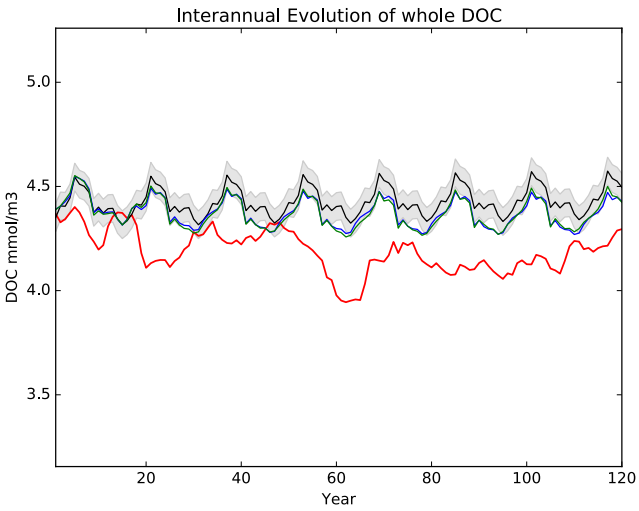

Figure 5 Interannual water column concentration of DOC in the western basin for all simulations (HIS/A2 in red, CTRL in black, CTRL_R in blue and CTRL_RG in green)

Reviewer is right to point out that in the absence of organic nutrient forms, our N and P budget is unbalanced. We add this point in the discussion (section 4.3).

The results section is very qualitative with little quantitative analysis. Phrases such as slightly increase and significantly increase are common with no data to back them up. In addition I feel that section 3 and especially section 3.3 can be condensed as there is a lot of repetition and is hard to follow in places. This would make the main conclusions and outputs of the paper clearer to the reader. I suggest re-organizing section 3.3 to start with the nutrient budget first, analysing the different inputs and outputs from rivers, Straits of Gibraltar and sediment before going on to look at the effect of the different scenarios to nutrient concentrations. This way you can bring in the analyse from the budgets to explain the concentration trends rather than having to repeat yourself analysing and explaining the trends in nutrient concentrations before you have analysed the causes. I would also in general try and keep the same structure within each section in regards to the analysis i.e compare phosphate first, then nitrate, etc.

We thank the reviewer for this suggestion. We followed the advice and reorganised the section. Also, as suggested by another reviewer as well, we tried to provide more quantitative analyses of the results.

General minor comments

While I appreciate that you are limited by both data and computational power in your model runs I suggest refraining from using 'external inputs' and instead be specific and use 'fluxes through the Straits of Gibraltar and riverine inputs'. As far as I understand you are not including atmospheric inputs, direct wastewater discharges or submarine groundwater discharges in your model which can all be considered external nutrient inputs.

Use Strait of Gibraltar or Gibraltar Strait throughout the paper rather than Gibraltar as Gibraltar is a body of land!

We thank the reviewer for these remarks and tried to correct the sentences wherever possible

Detailed minor comments

Line 8: Change "coastal nutrients" to riverine nutrients. Coastal nutrient inputs could mean coastal runoff, direct wastewater discharges submarine groundwater discharge.
Changed

Line 9: Do you just mean from riverine inputs rather than external sources.
Sentence changed to "These contrasted variations result from an unbalanced nitrogen--to--phosphorus input from fluxes through the Strait of Gibraltar and riverine discharge and lead an expansion of phosphorus--limited regions across the Mediterranean. "

Line 27: I thought the last deposited Sapropel was 10,000 years ago not that they have been deposited for the last 10,000 years
We added precisions in this sentence :"In particular, high stratification events, characterized by the preservation of organic matter in the sediment, known as sapropels, have been recorded through several over geological times, the most recent was recorded 10~000 years ago and lasted about 3~000 years."

Line 36: Please quantify the short residence time (i.e 100 year timescale) and add reference.
Precision added. The residence time is around 100 years (Robinson et al. 2001).
Robinson, A. R., Leslie, W. G., Theocharis, A., & Lascaratos, A. (2001). Mediterranean sea circulation. *Ocean currents: a derivative of the Encyclopedia of Ocean Sciences*, 1689-1705

Line 40-41: Please re-phrase. The word transport in this sentence doesn't make sense.
We removed this sentence that was out of the scope of the paragraph

Line 48: I am confused by the Adloff reference at the end. Do they also show this enhanced vertical stratification?
We rephrased : "In all A2 runs, Adloff et al (2015) show an increase in the stratification index at the end of the 21st century."

Line 49: remove "lead to"
Done

Line 70: Add Heurtas et al. (2012) to the Gibraltar references. Add more references for atmospheric deposition or say 'and references therein'. There have been a lot of studies on atmospheric deposition in the Mediterranean region. What about direct wastewater discharges (Powley et al., 2016) and submarine groundwater discharges (Rodellas et al. 2015). Note also Powley et al., (2017;2018) have calculated a complete nutrient budget for the Mediterranean and these should be referenced somewhere in this paper.
We thank the reviewer for these suggestions and added more references in this part.

Line 100: define the SST acronym rather than on line 222
Done

Line 111: define the SSS rather than on line 222 Done
Line 112: remove 'that'
Done

Section 2.3 Please add a bit more detail regarding the biogeochemical model and the compartments so the reader has an idea of what is included without having to go to the references (i.e Are there compartments for bacteria, DOM etc?).
There is no explicit bacterial compartment but bacterial biomass is calculated using zooplankton biomass (see Aumont et al (2006) for details). Organic matter is divided in 2 forms: dissolved organic carbon (DOC) and particulate organic carbon. Other organic nutrients such as phosphorus and nitrogen are not explicitly represented in this version of PISCES but can be derived from the Redfield ratio.

These precisions have been added to the section.

Section 2.3 Include a sentence regarding why you did not use atmospheric deposition, and other external inputs in this section.
We added the following sentence in section 2.4:
“We did not include atmospheric deposition as there is currently no scenario for its future evolution. Similarly, we did not include submarine groundwater discharge and direct wastewater discharge as there is to date no climatology for these sources.” (lines 152-154).

Lines 150-155: Please be specific in which MEA scenario you use. None of the four scenarios are called business as usual. Also how did you combine values from the two Ludwig papers together as Ludwig et al. (2010) states that they are not directly compatible with one another.

The scenario we use is the Order from Strength (OS) from Ludwig et al 2010. PO4 and NO3 flux are from Ludwig et al. 2010 for both HIS and A2 only DIC and Si are based on Ludwig et al. 2009. There is no incompatibility issue.

Line 175: Why are 1966-1981 conditions used when the model results are from 1980 onwards? Please specify in the text.
The 1966-1981 period was chosen to avoid years with too much warming, which are observed as of 1980. During the CTRL, these years are looped over the simulation time (120 years). We present the results on the 1980-2099 time scale. Precisions are added in lines 187-190.

Line 184: Write minus rather than using the minus sign as it wasn’t clear to me what you meant initially.
Changed

Line 203 satellite not satellites
Changed. Note that we added new figures and data in this section to evaluate the model performances.

Line 212-213: Quantify the error. Compare model results with measurements. (See my main concern)
We added a value of the underestimation (approximately 50%)

Line 224: When you say global I assume you mean across the entire Mediterranean. Please clarify
We changed the word “global” to “basin-wide” for more clarity.

Line 229-235: I suggest moving this section to where you discuss the budget as no results are given and it confuses the reader
This paragraph is intended as an introduction to the long section of results following. In these line we present the vocabulary we use afterwards. This is why we consider this paragraph important at this stage.

Line 230: Add references after “nutrient budgets are highly dependent on external sources”.
References added to Ludwig et al 2009, 2010, Christodoulaki et al 2013, Huertas et al 2012

Line 244-246: State this later on when you are talking about limiting nutrients.
We removed the words 'limiting nutrients' from this sentence.

Line 252: How much does the phosphate concentration decrease by? From what to what?
Phosphate decreases by about 0.015 mmol/m3 in the surface layer and 0.017 mmol/m3 in the intermediate layer in the first half of the simulation period. It increases in the second half to reach concentrations close to the 1980 value in the surface layer and higher concentrations in the

intermediate layer (by about 0.01 mmol/m3). These precisions were added.

Line 253: Only use significantly if it is statistically significant. If yes then the state the statistics.
We removed the word “significantly” from the sentence.

Line 254: Add “in the surface water in the Western Mediterranean Sea” after phosphate concentrations. The reader shouldn’t have to look at the figures to know which water body you are talking about.
Added

Line 254-255: What about the comparison between CTRL_RG and CTRL R?
We added the following sentences: “Figure 7a shows that the difference in phosphate concentrations in the surface layer of the western Mediterranean in the CTRL_RG and CTRL_R simulations is important only at the end of the 21st century (approximately from 2070). Therefore, the similar evolutions of phosphate concentration in HIS/A2 and of incoming fluxes of phosphate through the Strait of Gibraltar throughout the simulation period must be linked with changes in physical conditions. In this very dynamic part of the Mediterranean, changes in physical conditions linked with climate change are preconditioning the western basin to become more sensitive to nutrient fluxes thought the Strait of Gibraltar.”

Line 263: “The eastern part of the basin contains approximately 50 % less phosphate than the western part.” Where have you got this data from? Table 3 shows greater phosphate content in Western Mediterranean than Eastern Mediterranean. If you mean concentrations then I would still argue that your model is not showing 50% less.
Reviewer is right, this sentence is confusing. The eastern basin naturally contains more nutrients as its volume is greater. We mean that the concentrations are approximately 50% less in the eastern basin. We changed the sentence to “Nutrient concentrations in the eastern part of the basin are lower than in the western part (50 % lower phosphate concentration in the surface layer, about 30 % lower concentration in the intermediate layer and about 15 to 20 % lower concentration in the deep layer).”

Line 265-267: Give quantitative values.
We modified this paragraph to add quantitative values in the text:”In the surface layer, phosphate concentration decreases in the beginning of the simulation and remains low during the 21st century (from 0.022 mmol/m3 in 1980 to less that 0.015mmol/m3 in 2000, Figure 4d). There is, however, a large annual variability in surface phosphate concentration with peaks up to 0.025mmol/m3 in 2060. But the HIS/A2 simulation values are consistently below the CTRL concentrations showing an important effect of climate change on surface phosphate reduction. We observe in Figures 4e and 4f an accumulation of phosphate in the intermediate and deep layers (17 and 13 % respectively), with large decennial variability of phosphate concentration in the deep eastern basin. In both of these layers, HIS/A2 concentrations are higher than the CTRL concentrations. "

Line 268: State which scenario you are talking about.
We modified this paragraph to add precisions and quantitative values.

Line 272. Reference Figure 5 after Atlantic
The paragraph was modified and references to figures added

Line 278-281: Consider consolidating with previous paragraph as there is a lot of repetition (especially concerning impact of rivers of nitrate concentrations).
We thank the reviewer for the suggestion and merged the paragraph with the previous one.

Line 293: Reference needs brackets around it. Changed, reference to Gomez et al 2003 included as well.

Line 295-298: Put quantitative results.
This paragraph was modified to include more quantitative values.

Line 305-307: What about statistics for nitrate?
The Pearson correlation coefficient is 0.80 (p-value < 1%). We also recalculated the statistic for phosphate because we noticed the previous result was for the entire water column.

Line 308: I suggest adding a figure showing the net fluxes through the Strait of Gibraltar to show imbalance. Again, I also suggest the authors look at total nitrogen fluxes to be able to determine whether there is an imbalance at the Strait of Gibraltar not just nitrate.
In order to keep the number of figures, we did not include the net fluxes in the article. However, the Figures are shown below and we added discussion about the net fluxes in the paragraph (see lines 334 to 339).

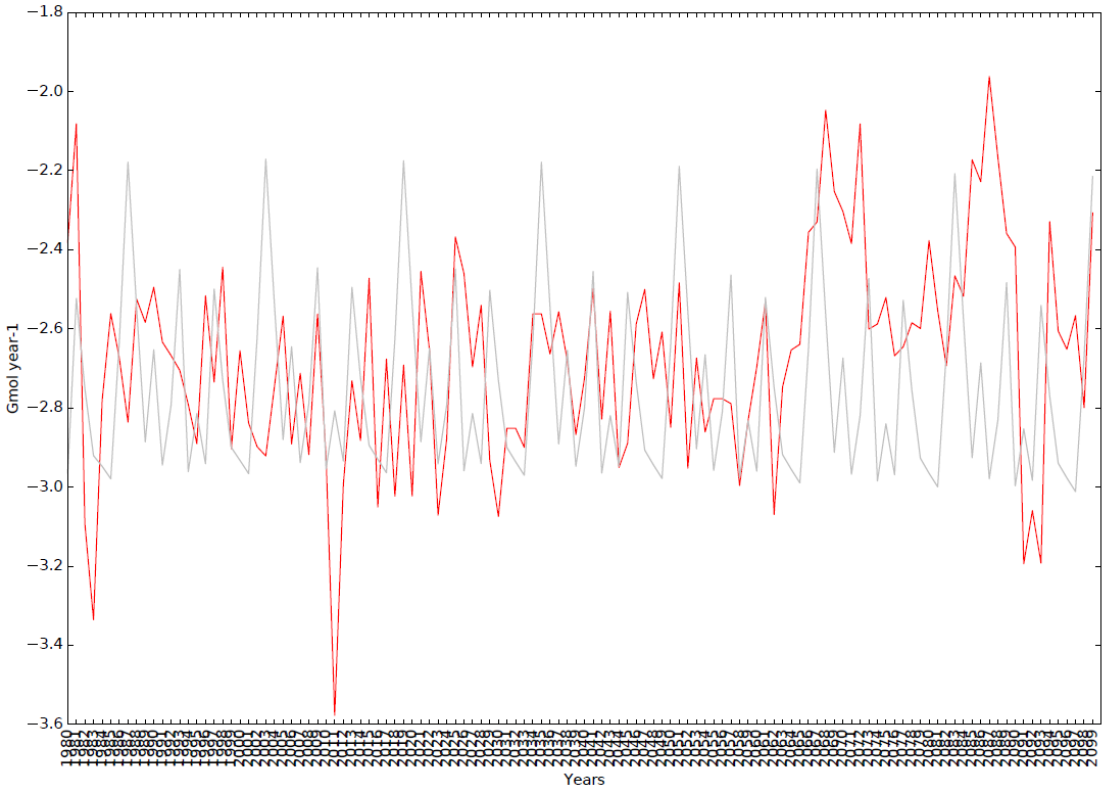

Figure 1: Net flux of phosphate throught the Strait of Gibraltar in HIS/A2 (red) and in CTRL (grey)

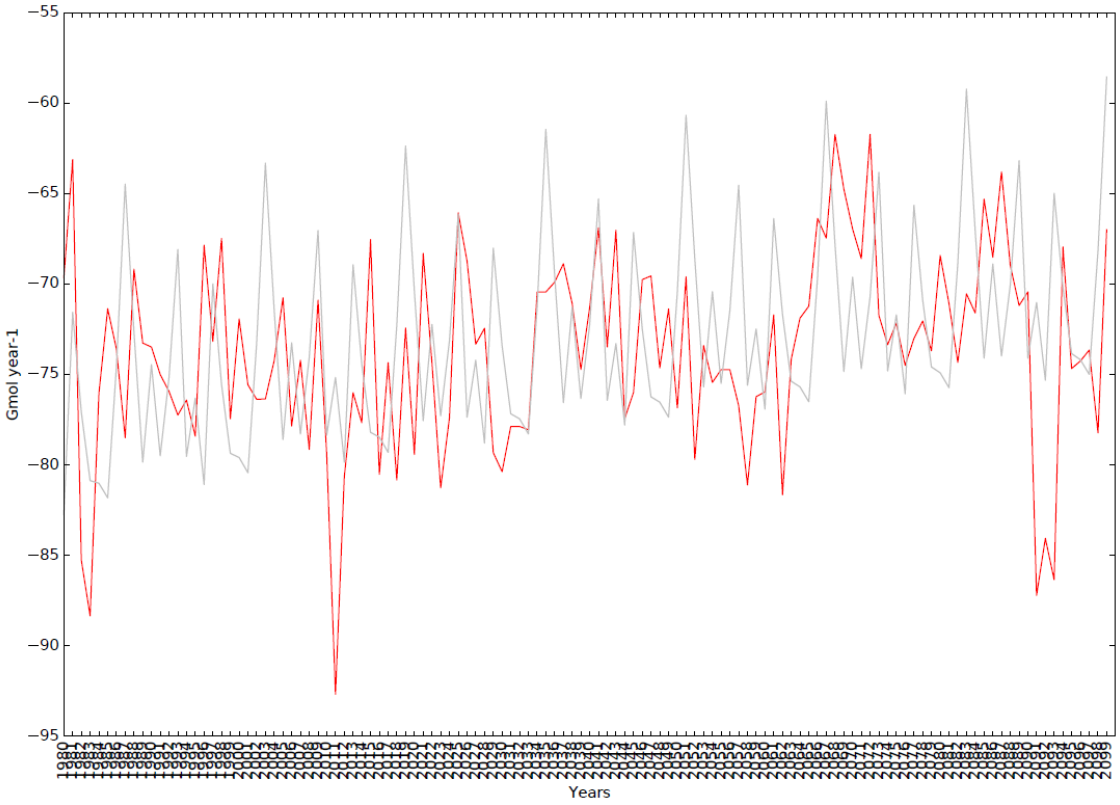

Figure 2: Net flux of nitrate through the Strait of Gibraltar in HIS/A2 (red) and CTRL (grey)

Line 315 Capitalise N in nitrate after full stop.
Done

Lines 315-320: Is there a difference in the evolution of riverine discharge of nutrients between Western and Eastern basins? Combining everything into one flux makes this impossible to see, but if it differs it would have a large impact on results and may explain the differences to the riverine scenario seen in the two basins.
We do not have a figure for the riverine discharge of the western and eastern basins separated. However, the figures below show nitrate and phosphate flux from 3 of the major rivers of the Mediterranean: the Po, the Nile and the Rhone. The nutrient outflow from these rivers have important impact on the local productivity.

Figure 3 below shows that the nutrient discharge from these important rivers evolves differently. In particular, phosphate flux from the Nile increases abruptly between 2000 and 2050 while nitrate flux remains low. This important phosphate source in the P-limited Levantine basin explains the high productivity observed at the end of the century in our HIS/A2 simulation.

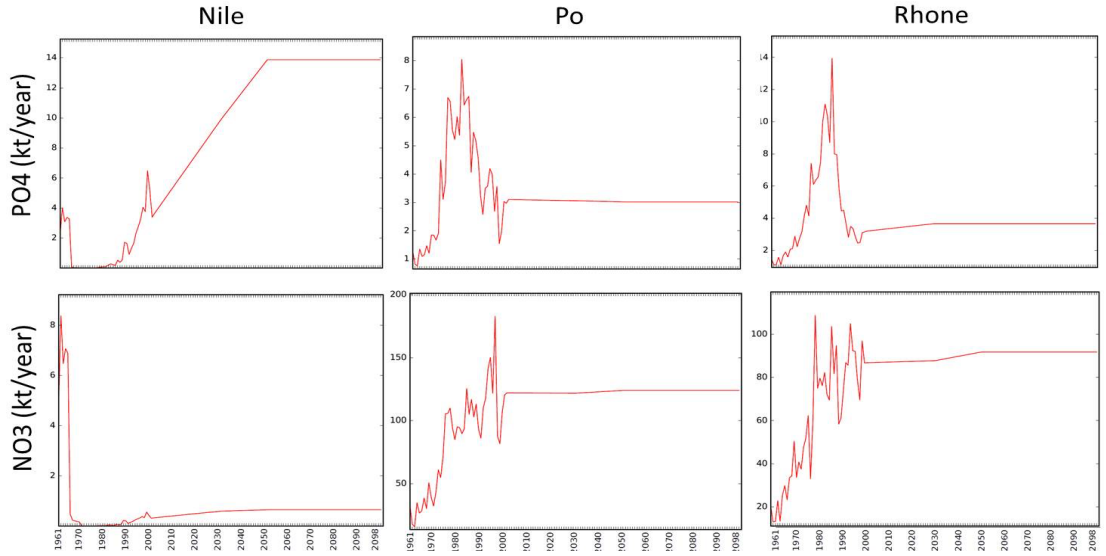

Figure 3: Phosphate (top) and nitrate (bottom) fluxes from the Nile (left), the Po (middle) and the Rhone (right) rivers during the simulation period. From Ludwig et al 2010.

Line 328: Replace "This" with "The"
This was corrected, but the sentence was moved to section 3.3.5, line 335.

Line 329-330: put comma after occurs and flux
Done, this sentence was also moved to section 3.3.5.

Lines 328-332: What happens to sedimentation in the CTRL-R and CTRLRG scenario? This

will make the argument stronger whether sedimentation is linked to decrease in vertical fluxes. Also please be more explicit about the process that would increase phosphate and nitrate in the deep water. A lower particulate matter flux to the deep water would lead to lower remineralisation fluxes and therefore lower phosphate and nitrate. Alternatively, higher water temperatures could lead to higher remineralisation and therefore a lower sedimentation flux despite the same flux of particulate matter exiting the surface water. How do the authors know it is not higher temperatures rather than changes in the water flux that alters the sedimentation flux?

We did not calculate the sedimentation fluxes in CTRL_R and CTRL_RG.
Temperature does not affect remineralization rates in the PISCES model. Therefore, the changes in export fluxes between CTRL and CTRL_R or CTRL and CTRL_RG are only linked with the changes in surface nutrient concentrations and vertical water fluxes.
We looked at the POC export fluxes at 1000m in the different simulations in order to explore the changes in sinking material. Our results show that POC export at 1000m in the HIS/A2 simulation is reduced more than twofold in the 2080-2099 period in comparison to the 1980-1999 period. In the CTRL_R and CTRL_RG simulations, the change in POC export is lower (up to -30%) and in the same order of magnitude than in the CTRL simulation. These observations are in favour of the hypothesis of lower vertical water fluxes explaining the decrease in sedimentation rates. Lower sedimentation coupled with a constant remineralization rate (because remineralization is invariant with temperature in PISCES) leads to the accumulation of nitrate and phosphate in the deep Mediterranean.

Line 334: A new section heading Is needed before line 334.
We moved this paragraph in the discussion section 4.4

Line 334: Into rather than in?
Changed

Line 334-335. Compared to when? The start of the model run? When you say the sum do you mean the balance between inputs through the Gibraltar Strait, riverine inputs and sedimentation? Be specific. Also, as mentioned before, I suggest including dissolved organic matter in your calculations and to produce a table to show the balance of the different inputs and outputs of phosphorus and nitrogen.
We mean in comparison to the beginning of the simulation (1980). “Sum” means indeed balance between inputs and outputs, we modified the sentence to be more specific.
We do not have organic nutrients explicitely represent in the model. However, we added Figure 18 in discussion section 4.4 to summarize the fluxes of nutrients to the basin and the evolution of nutrient budgets.

Line 350-351: The authors state “changes in Gibraltar exchange fluxes of phosphate seem to have limited effect on Mediterranean phosphate content” but on lines 305-306 they also state “evolution of phosphate concentration in the Western basin is linked with Gibraltar inputs”. Which one is it?
This sentence is confusing. We mean that the fluxes through the Strait of Gibraltar are having an important impact on the western basin, but do not seem to have large impact on the nutrient budget of the entire Mediterranean. We added “global” in the sentence to make it clearer.

Line 353-356: What about increase in temperature effecting results? Luna et al., (2012) hypothesise increasing deep water temperatures will increase prokaryotic metabolism, thus potentially increasing nitrate and phosphate concentrations. Lazzari et al., (2014) also predict that increasing temperatures increase metabolic rates.
We thank the reviewer for the reference to Luna et al that we were not aware of. Prokaryotes are not explicitly modeled in PISCES, and nutrient recycling is not a function of temperature in the model. Therefore, temperature increase in our simulations may have effects on planktonic production, but not on remineralization.

We added the following lines in the discussion : “Moreover, Luna et al 2012 hypothesise that the

warm temperature of the deep Mediterranean may be a cause for important nutrient recycling via prokaryotic metabolism. In the version of PISCES used in this study, nutrient recycling is dependant on oxygen, depth, plankton biomass and bacterial activity. Therefore, we could not observe the effects of temperature on nutrient recycling."

Line 378: Replace "and shows" with "showing"
Done

Line 380: Delete as this is repeated and explained in the next paragraph.
Done

Line 384" surface phosphate what? Concentrations? Masses?
Concentration. This was added in the sentence

Line 386-387: The decrease does not look that clear to me and it certainly doesn't become entirely depleted in phosphate.
We removed the word 'largely', but phosphate concentration is reduced in all the eastern basin.

Line 409: Remove would
Done

Line 410-414: Why would the phosphate become the major limiting nutrient in areas where primary productivity is reduced?
Based on the results shown in Figure 11 and 12, the P-limited areas at the end of the simulation period match areas where the most important primary productivity decrease is observed. Our hypothesis is therefore that the imbalance in nitrate and phosphate budgets leading to decrease in the surface phosphate budget drives the surface eastern Mediterranean to a P-limitation. This hypothesis is confirmed by the nutrient budgets in Tables 2 and 3, even though we do not have the budgets of organic nutrients.

429-430: Reduced by how much?
We corrected the figure that was using the wrong units and find that the surface concentration in the 2080-2099 period is actually increased by about 25 ng/L in comparison to 1980-1999. This shows that local variability in circulation and biogeochemitry is an important feature of the Mediterranean biogeochemistry.

Line 433: Are we still talking about chlorophyll or primary productivity?
Chlorophyll, we changed this confusing term.

Line 434: What is "it"?
We replaced by "subsurface chlorophyll concentration"

Line 441: Remove Adloff reference?
This reference was formatted wrongly. ***It is "Figure 2 from Adloff et al"***

Line 452? Do you mean riverine nitrate inputs or total nitrate inputs?
Yes, we added the precision in the sentence.

Line 460-463: Which scenario are you talking about?
We rephrased this sentence: "In HIS/A2, we observe lower biomass for both phytoplankton classes across the Mediterranean Sea at the end of the century than at the beginning. "

Line 463: Add Western Mediterranean Sea after diatom concentrations.
Done

Line 465: Add diatoms after concentration
Done

Line 478: Add references if other studies have concluded this.
We are not aware of any studies focusing in zooplankton using NEMO/PISCES. This sentence is an hypothesis based on the authors' experience with the model.

Line 483: "After all" doesn't make sense in English. I suggest you use "Altogether".
We thank the reviewer for this suggestion and modified the sentence accordingly.

Lines 494-497: Add references to this sentence
References have been added to Ludwig et al (2009), Krom et al (2010) and Santinelli et al (2012).
Line 514 and 515: When talking about "coastal nutrient inputs" and "coastal runoff" are you only talking about riverine inputs? Be specific.
We refer to riverine inputs. We tried to harmonize this paragraph to make it more specific.

Line 518: 'developing' not 'developping' Corrected

Line 540: I don't think you can say there's an imbalance in sources and sinks without looking at the organic nitrogen aswell (unless you count nitrate sourced from DOM). There will always be an imbalance of nitrate in the Mediterranean if you only look at external sources as you mention yourself it is a remineralization basin.
We do not have organic nitrogen in the model. However, nitrate can be recycled from DOC in PISCES and is therefore included in the budget.
We added a sentence on this matter: "Organic forms of nutrients are not included in this version of PISCES. Powley et al (2017) show that organic forms of nutrient are an important part of the Mediterranean elemental budgets. Therefore, we may be missing a part of the N and P budgets in our calculations."

Line 591-592: Please re-phrase the sentence and be specific to what you are talking about. What inputs?
We rephrased: "Our results also illustrate how climate change and nutrient inputs from riverine sources and fluxes through the Strait of Gibraltar have contrasted influences on the Mediterranean Sea productivity."

Line 598: I disagree with this statement. There are lots of nutrients inputs that you haven't considered such as direct wastewater discharges, diffuse runoff, submarine groundwater discharge.
We changed this part to: "Finally, this study accounts for the changes in fluxes through the Strait of Gibraltar and riverine inputs, but some potentially important sources are missing such as direct wastewater discharge, submarine groundwater and atmospheric deposition. Measurements and models are still missing in order to include comprehensive datasets for past and future evolution of these nutrient sources."

Line620: Shown rather than showed
Corrected

Table 2: It would be more informative to present the numbers per m2 surface area and then comparisons between basins can happen as the Eastern Mediterranean is almost twice the size of the Western Mediterranean. The reader can still calculate the total mass if the surface area is given. Also taking the difference from the control rather than total values might make it easier to spot trends.
We added in the tables 2, 3 and 4 percentages. These correspond to the relative difference between each period and the 1980-1999 period and help see the trends. We also added on Figures 7,8, 14

and 15 the average concentrations of tracer for each simulation for the periods 1980-1999, 2030-2049 and 2080-2099.

Figures 3 and 4: Please create a greater contrast between the CTRL R and CTRL RG. These are difficult to see at present.
These figures were changed

Figure 5: it would be nice if the net flux of nitrate and phosphate across the Strait of Gibraltar could be added aswell.
For the sake of the number of figures, we chose not to include the net flux in the figures. However, we discuss it in the text.

Figures 8,9,10 and 12. I struggled to see the differences between the two time periods which were mentioned in the text. I suggest to produce a figure of the anomaly between 2080-2099 and 1980-1999 rather than having the 2080-2099 figure as it currently is. The changes with time will then be more evident to the reader.
We produced the anomaly maps and changed the figures

Figure 10. Units in caption do not match units in figure Changed
Figure 12: Why is the HIS/A2 scenario figures not presented aswell?
The CTRL is not presented. We chose not to show it as we are not discussing it and it is almost the same partition as in the HIS/A2 during the 1980-1999 period.

Figure 13: Units in caption are different than on figure Changed
Figures 14 and15: What are the units? mmol m-3 of what? Carbon? Yes, corrected
Figure A1: When were the data points collected? Would the HIS/A2 scenario be a better comparison than CTRL as it actually uses 1980-2000 data?
We changed the figure to include the comparison of HIS/A2 for the corresponding years
Figure A.2 Change P4 to PO4 in the label. Done