Comment on bg-2021-94
Anonymous Referee #1

Referee comment on "Phosphorus cycling in the upper waters of the Mediterranean Sea (Peacetime cruise): relative contribution of external and internal sources" by Elvira Pulido-Villena et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-94-RC1, 2021

General comments:

The authors report phosphorus (P) dynamics on the zonal transect in the Mediterranean Sea using a sensitive analytical technique for determining nanomolar P. The technique enabled to represent not only spatial variations in nanomolar P but also their upward flux in the oligotrophic upper water. The authors found a west-east gradient of P dynamics from data on nanomolar P distribution/flux and DOP hydrolysis. Based on these data as well as atmospheric P deposition data, they analyzed P budgets in the mixed layer and found a large external supply of atmospheric deposition relative to upward supply and an importance of internal DOP hydrolysis for sustaining primary production. The budgetary analysis includes some assumptions, but this approach using nanomolar P data is new and is necessary for understating P dynamics in oligotrophic oceans. Overall, the manuscript is well structured and is scientifically implicated. Thus, I consider that this study is suitable for publishing in Biogeosciences after addressing specific comments below.

Specific comments:

L24, 25, 27: "L-1 or kg-1"

"-1" should be superscript.

L45: “physical structuration of the water column”

What is “physical structuration”? Is it physical phenomenon such as mixing and/or diffusion? Please clarify.

L72: "North Pacific (Duhamel et al., 2011)"

In addition to Duhamel et al., Sato et al. (2013 BG, doi:10.5194/bg-10-7677-2013) is citable as a representative AP study in the North and South Pacific Ocean.

L119: “4.5% (n=10)”
What is the concentration level of sample for determining the precision? Please specify the concentration with 4.5%.

L123: “two 100 nM solutions of glycerol-phosphate and glucose-phosphate”

These compounds are analogs of labile phosphate ester. Did you try to examine the digestion efficiency using a refractory P analog such as phosphonate with C-P bond?

L167-168: “The mixed layer depth.....the profile (1 m)”

Could you please cite the reference for this statement?

L198: “unpublished measurements in the study area”

This measurement for determining the fraction of AP-DOP to total DOP is very important, because the result of the AP-DOP fraction significantly influences on in site AP hydrolysis rate. Could you please describe how to measure the AP-DOP here?

L247-251: “Using measured density gradient.....14.4 μmol m⁻² d⁻¹.”

While this paragraph for phosphate upward flux is informative, I am thinking that the authors can also calculate upward flux of DOP as well as phosphate. If DOP upward supply is significant, it may contribute new production in the mixed layer as well as phosphate upward supply. I am glad the authors consider this point.

L291: “PO₄”

“₄” should be subscript.

L306: “nM m⁻¹”

In the Results section, vertical gradient of phosphate is expressed as a unit of μmol kg⁻¹. Why do the authors use “nM m⁻¹” here? I think it is better to use same unit throughout the manuscript.

L309-313: “Similar vertical gradients.....South China Sea”

The authors need to cite the reference here.

L309-313: “Similar vertical gradients.....(Van Wambeke et al. 2020)”

Why do the authors describe vertical gradient of nitrate here? Since this subsection is for vertical variations in phosphate as indicated by its title, the description of nitrate is likely off-topic.

L339: “analytical locks”

What is it?

L345: “oligotrophic South China Sea (0.21-0.44 μmol P m⁻² d⁻¹)”

Hydrographic condition is likely different between the Mediterranean Sea and South China Sea. Can you simply compare vertical P fluxes between these different areas?

L352-353: “However.....horizontal gradients”
The authors need to show the evidence for little horizontal gradient of surface phosphate here. In addition to the west-east gradient, the north-south gradient is likely important for lateral nutrient supply.

L354: “lateral advection to be negligible”

This is a contradiction with the paragraph in L394-405. Please revise.

L400: “Seawater”

“S” should not be italic.

L428: “P demand”

P demand of what?

L442-443: “In the eastern.....exceeded 100%.”

The >100% INT/TPR is likely due to preferential recycling of P relative to C as reported in a range of biogeochemical studies (Clark et al. 1998 Nature, doi.org/10.1038/30881; Loh and Bauer 2000 DSR-I, doi:10.1016/S0967-0637(00)00027-3; Paytan et al. 2003 Mar. Chem., doi:10.1016/S0304-4203(03)00052-5; Duhamel et al. 2007 BG, doi:10.5194/bg-4-941-2007; Letscher and Moore 2015 GBC, doi:10.1002/2014GB004904). I recommend the authors use these references to explain the results of >100% INT/TPR.

L458-460: “the proportion of AP-DOP to DOP.....(Hashihama et al. 2013).”

In addition to Djaoudi et al. (2018b) and Hashihama et al. (2013), Yamaguchi et al. (2021 Front. Microb., doi: 10.3389/fmicb.2020.570081) recently reported a review of the proportion of AP-DOP to DOP. Table 1 in Yamaguchi et al. is useful for this study, and the multiple comparison of AP-DOP/DOP ratios in different regions would strengthen the discussion here.

L461-462: “Accurate determinations.....P-deficient oceanic regions”

I think the authors generally consider phosphate ester as AP-DOP. However, phosphonate is also utilized by marine diazotroph Trichodesmium (Dyhrman et al. 2006 Nature, doi:10.1038/nature04203) and eukaryotic phytoplankton (Whitney and Lomas 2019 Limnol. Oceanogr. Lett., doi: 10.1002/lol2.10100). Therefore, we now should consider both phosphate ester and phosphonate as bioavailable DOP. Could you please discuss phosphonate as well as phosphate ester?

L505-510: “CC and KD.....and VT”

In the Author contribution, authors’ initials KD and KDJ are vague. From the author list in L4-6, I can identify two KD but not KDJ. Please correct.

References:

Reference style is not consistent. Please check throughout all references.

Figure 3:

“FA, TYR and ION” in the legend should be “FA (panel A), TYR (panel B), and ION (panel C)”.
Tables:

In general, the legends of tables should be appeared just above the tables.

Table 3:

The authors should define significant level such as \( p<0.05 \).

Table 4:

Please indicate how to derive the correlation matrix in the text or table legend. Did you use Spearman correlation test or Pearson correlation test?

Table S1:

“Sustained PP” may be wrong. I think “Sustained NP” is correct because this is based on external P flux that corresponds to new production (NP) rather than primary production (PP). Also, “Maranon et al.” in the legend should be “Marañón et al.”.

Table S2:

For “\( TPR_{moy} \)”, please explain the meaning of “\( moy \)”. 