

Interactive comment on “Phosphorus burial in the ocean over glacial-interglacial time scales” by F. Tamburini and K. B. Föllmi

Anonymous Referee #1

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This paper focuses on the quantification of phosphorus burial in the ocean over glacial-interglacial time scales. The topic is an important one given that changes in phosphorus availability in the ocean may modulate the marine carbon cycle and ultimately affect climate. While this has been demonstrated in various modeling studies, the actual reconstruction of marine phosphorus cycling for different periods in earth's past is hampered by the limited availability of sediment core records. This paper expands the available data by providing a compilation of sediment phosphorus records for 8 sites over the last glacial-interglacial cycle. The most important conclusion is the reported decrease of ca. 8% in total global P burial in the oceans during glacials. This result alone merits publication.

The paper also nicely complements the core records for the Southern Ocean recently

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published by Filippelli et al. (2007) and the recent modeling paper of Tsandev et al. (2008; Global Biogeochemical Cycles) on glacial-interglacial variations in marine phosphorus cycling. While the work of Filippelli is included in the introduction and discussion, the authors apparently overlooked the Tsandev et al. paper, which in fact shows model predicted trends in sediment P burial that are not unlike the changes reported here. Note also that Tsandev et al. predict trends in dissolved phosphate in ocean waters and show that changes in the marine P cycle are unlikely to drive enhanced primary production and CO₂ drawdown during glaciations. Given that the authors also present a reconstruction of dissolved phosphate concentrations in the ocean during this time, it would be appropriate to incorporate these complementary results in their introduction and discussion. This is particularly important since Tsandev et al. show that the response of the marine P cycle to multiple glacial-interglacial cycles and a single glacial-interglacial cycle is not the same; thus modeling just one of these cycles will not provide representative results for the last glacial-interglacial cycle. Thus, the ultimate usefulness of the modeling presented here is limited - as acknowledged by the authors.

An additional major point relates to the calculation of the average MAR of P for the glacial and interglacial periods. It is not specified in the paper how this calculation was performed. The supplementary material suggests that the authors distinguished between glacial stages (stage 2, 4, 6) and interglacial stages (1,3 5) thus implying multiple glacial and interglacial periods over the past 120 kyr and averaging of results for these stages to obtain the average values for G and IG; in Table 1. In the modeling of runs 1 and 2, however, a full 120 kyr glacial-interglacial cycle is assumed with the average glacial burial being used for ca. 20 kyr BP and interglacial burial being assumed for the initial model state (120 kyr BP) and the final results (present). This issue should be clarified.

Specific comments:

P5134. line 5: The most recent work does not suggest that changes in the glacial

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ocean inventory of P were small: see e.g. Filippelli (2007) and Tsandev et al. I would rephrase this part of the abstract.

P5134. line 23. The elevated dissolved P concentrations at the end of a glacial do not necessarily make phosphorus an important player in climate change during glacial-interglacial cycles, see Tsandev et al. paper.

P5135. line 15. The estimates for total P burial in the ocean cited here are based on relatively small data sets and certainly cannot be classified as detailed and accurate as is done here. I would suggest to remove these terms.

P5135. line 21. Note that Tsandev et al. also reconstruct the dissolved PO₄ in the ocean using a model.

P5136. lines 23-27. I would remove the statement: Although the sedimentary phases recognized are operationally defined, the comparison of the P phases with mineralogical and geochemical proxies indicates that the differentiation made during the extraction is reflecting the real distribution in the sediments (Tamburini et al., 2002). This may differ from environment to environment; see work of Ruttenberg and others. Thus, more often than we would like P speciation results do not reflect the real distribution of P phases in the sediments.

P5137. lines 17 and onwards and Table 1. See general comments. Please provide details in the text and table captions on how the average P MAR were calculated for glacial and interglacial periods. This is particularly relevant when using these data in the modeling. The most appropriate approach here would be to compare the glacial maximum to the present and past interglacial state. Given that in the text, the authors refer to glacial terminations (i.e. using the plural), this makes me very concerned that they may have actually used the marine isotope stages in the calculation of the burial fluxes instead.

P5139. lines 1-4. Please clarify what is meant by 'the loss in organic P is not enough to

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explain the changes observed in the other reactive phases';. What changes are meant here exactly? Please specify.

P5139. line 29. The P burial fluxes during the glacial are stated to be 8% lower in table 2 and the text, but 7-10% lower in the abstract. What explains this difference?

P5140. line 8. Here, it says that the data suggest a decrease in detrital fluxes from the continent during glacial periods, whereas on page 5139, line 13-14 the authors write that 'detrital P concentrations are higher during glacial periods';. How can this be reconciled? Please clarify.

P5141. Based on figure 3, line 1, I think it very difficult to conclude that Fe-bound P was lower during glacial periods. In fact, when looking at this figure there is no real difference visible for most sites.

P5145.-5146 -5147. Here, it would be appropriate to include the results of Tsandev et al., who show that, while the marine P inventory likely changed, the effects on glacial CO₂ were likely unimportant.

Technical comments

P5134. line 4: It is not clear to me how P can be a cornerstone of a process in the ocean. I suggest to rephrase this.

P5135. line 2. Suggestion for alternative formulation: 'this property closely couples the phosphorus cycle to that of carbon'

P5135. line 10. I would suggest to rephrase here, since now the text suggests that the P cycle is released to pore and bottom waters, whereas dissolved P is meant.

P5136. line 22. Change to 'the analytical approach used';.

P5139. line 19. Change to 'Redfield ratio'

P5144. line 2. Change to 'inventories'

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P5144. line 10 'with the present oceanic.'

P5145. line 11. change to 'residence time' Reference list: please complete all author details, e.g. the initials of many authors are incomplete, e.g. K.C. Ruttenberg, F.B. Follmi, R.A. Berner and others.

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