



EGUsphere, referee comment RC1  
<https://doi.org/10.5194/egusphere-2022-1041-RC1>, 2022  
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## **Comment on egusphere-2022-1041**

Anonymous Referee #1

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Referee comment on "The representation of alkalinity and the carbonate pump from CMIP5 to CMIP6 Earth system models and implications for the carbon cycle" by Alban Planchat et al., EGU Sphere, <https://doi.org/10.5194/egusphere-2022-1041-RC1>, 2022

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### ***Review of The representation of alkalinity and the carbonate pump from CMIP5 to CMIP6 EMSs and implications for the ocean carbon cycle by Planchat et al.***

In this manuscript, Planchat et al. compare the representation of ocean alkalinity within a set of 15 marine biogeochemical models, across two generations, from CMIP5 to CMIP6. Besides alkalinity they also compare seawater dissolved inorganic carbon (DIC), as well as sinking fluxes of CaCO<sub>3</sub> and particulate organic carbon. They note an increased global export of CaCO<sub>3</sub>, closer to observations, and a strengthened vertical alkalinity gradient.

This is a long and dense manuscript, but remarkably clearly written and structured given the number of results presented. Overall, this is likely going to be a key paper that will be useful to anyone using or interpreting results from CMIP5/6 models, and will pave the way to the next generation of ocean biogeochemical models. I enjoyed reading and reviewing it and praise the authors for putting such an important piece of work together.

One main comment I have after reading this piece is that what has changed within models between both generations is clearly presented in the main text, and as a result, we are left wondering what exactly needs to be done for models to better reproduce observed alkalinity patterns. I reckon that there are many models included in this analysis and that all had unique improvements that were not necessarily well described in the original publications/technical notes, so it is very challenging to attribute the improvement to any process. Section 3.1 does a great job synthesizing the different ways to represent various processes across different model groups; it would be useful to do the same synthesis effort but focusing on changes between CMIP5 and CMIP6. Section 4.1 touches this issue, but is very short, and seems to be summarized by the fact that no major trend emerges with regards to the modelling schemes. Could the authors develop this section further? What could be the main processes behind the improved, stronger alkalinity gradient? Inclusion of aragonite or of better diagenesis modules? Could the authors express their opinions on which processes need to be implemented in priority in the next generation of models?

Minor comments:

Abstract:

L31: avoid use of significant for non-statistical meaning

Introduction:

L87: remove extra "Fig. 1"

Methods:

L170: define "piControl" and "Historical" experiments

L180-181: just to make sure I understand: export at 100m from the 3D fields is in theory the exact same thing than export at 100m from the 2D fields?

L182-183: why using MIROC models then? Can you precise whether there is no export in those models, or those quantities exist but were not saved and/or made available to you?

L194: what are those constants?

L196-197: are those two models the only ones that include exchanges at the seafloor? Discarding the lower layer would appear justified if the goal was to compare water-column processes amongst models and if only the lower layer was affected by non-water-column (i.e. seafloor). However, seafloor processes, e.g., dissolution or respiration, should also affect water-column chemistry far away from the seafloor. I would like further discussion regarding the role of seafloor processes in the current model intercomparison (see main comment).

L203: define SSP and explain the difference with RCP

L230-231: I believe that the Sulpis and Battaglia references are mixed up in this sentence

L257: what is  $\tau^{5m}$ ? the concentration of a given tracer  $\tau$  at 5 m-depth?

## Results

Section 3.1.1.: An explicit integration of calcification in models would look like a series of equations used to compute calcification for individual groups, as a function of variables such as light, saturation state, etc. If I understand correctly the implicit integration used by all models skip the production step and computes the PIC export directly, as a function of the same variables (light, saturation, etc.). Because this implicit calcification scheme misses "gut dissolution", as explained in this section, models using it should all miss the shallow (in the couple hundred meters below the euphotic layer) but strong alkalinity production observed in the ocean, see Feely et al. (2004, DOI: [10.1126/science.1097329](https://doi.org/10.1126/science.1097329)), Subhas et al. (2022, <https://doi.org/10.1029/2022GB007388>), Sulpis et al. (2021, <https://doi.org/10.1038/s41561-021-00743-y>). Could you show and/or discuss that somewhere?

Section 3.1.4.: the term "sedimentation" sounds simply like physical accumulation or burial, whereas in this context it should include other sediment transport processes and chemical reactions. Perhaps replace with "diagenesis"?

L445: please add a reference for an observational estimate of the rain ratio

Tables:

Table 1 define "MBG"

Figures:

Fig. 1 the arrow associated with (3) dissolution should be colored in green because, as for the arrow associated with sediment mobilization, it represents a flux impacting seawater alkalinity

Figure 2 why are the 6<sup>th</sup> and 8<sup>th</sup> rows for the MPI models not colored instead of being colored in grey (N/A)?

Figures 2 and 6: all CaCO<sub>3</sub> in ACCESS-ESM1-5 is aragonite? Can you please elaborate on that?