Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2019-152-RC2, 2019

Biogeosciences Discussions

Interactive comment on "Oceanic CO_2 outgassing and biological production hotspots induced by pre-industrial river loads of nutrients and carbon in a global modelling approach" *by* Fabrice Lacroix et al.

Anonymous Referee #2

Received and published: 19 June 2019

The manuscript addresses an important question about material transport across the land-ocean aquatic continuum, and is of particular interest given its global application. I appreciate the substantial amount of work presented here, which includes a synthesis of existing methods to derive a global data set of riverine sources of nutrients and carbonate species to the ocean, long-term simulations of a global ocean-biogeochemical model, and analyses of CO2 outgassing hotspots and the origins and fates of riverine carbon from land/atmosphere to the ocean/atmosphere. I am particularly impressed that the authors were able to run the global model simulations for several thousand

years long (even though the model is relatively coarse). The scope of this study is certainly appropriate for publication in Biogeosciences, however the manuscript in this current format requires clarifications in some places while in others the text needs to be shortened and/or streamlined in order to avoid distraction and help readers better capture the key points of this study.

My major concern about the study is the comparison of carbon (and other) budgets between the standard simulation (RIV, what does it stand for?) and reference simulation (REF), which led to most key conclusions made in the manuscript. The authors described REF as a configuration where no river inputs are added to the ocean but "the burial loss of biogeochemical tracers was compensated by a global homogenous flux to the surface ocean", such that REF is "fully constrained by the loss of the sediment layer" (P13L26-29). This REF configuration seems a bit odd or at least not so clear to me. Is this addition of homogenous flux occurs during the same or next time step? Why choosing to use a homogenous flux instead of a spatially varying flux that directly compensates for the bottom loss at the same location? Wouldn't this framework to some degree arbitrarily homogenize the resource distribution across the ocean? Why adding the flux at the surface instead of evenly distributing it throughout the water column? How about distributing this flux only along the coastline (acting as a riverine source)?... It seems that in this framework carbon (and other materials) is being relocated from the bottom to the surface and from some places to others without any explicit transport processes involved. And this would potentially make a HUGE impact on NPP and CO2 outgassing patterns regardless of riverine inputs. Also, what are other inputs to the REF beside this surface flux? Does REF also include N2 fixation? How is carbon synthesis associated with N2 fixation being handled in the model? These are important details for making the conclusions of the manuscript and should be clearly described.

Depending on these details and whether the comparison between RIV and REF is justifiable, I recommend either a major (which would require a re-configuration and re-

run of the 5000-year REF experiment) or a moderate revision (which would be focused on streamlining and shortening the text plus clarification on some details as suggested below) of the paper before considering it for publication in Biogeosciences.

Minor comments:

P2L13: and also released to the atmosphere

P2L19-P2L6: introductory information in these a few paragraphs needs to be streamlined. I suggest shortening it to 5-8 lines and expand Fig.1 to include more details on the processes to be considered or discussed.

P3L9: without reading the referenced literature, it is not so clear to me why riverine DIC would cause CO2 outgassing. Is it due to solubility change? Would riverine DOC/POC be also, if not more, likely to cause CO2 outgassing as a result of microbial respiration?

P3L20: where does photodegradation most likely occur? In the rivers? Coastal margins? Is this process not reflected in the extremely high C:P ratio (2584:1) considered here?

P3L24: why does POM control the availability of nutrients? By being remineralized?

P4L13: which 10 years? Contemporary?

P5L8: Is there a particular reason to use 250m rather than the more commonly defined 200m?

P7L18: C:P=1000:1 here but 2584:1 in P9L23.

P10 section 2.1.3: why not deriving N:P ratios for different rivers from Global NEWS data set? Or at least to make a comparison with?

P12L7: “river freshwater model” -> is this the MPI-ESM model mentioned in P7L3?

P12L9-18: need some clarification on the biogeochemical model configuration and references for different versions of the model. The original model is described in Ilyina

et al. 2013, and the version being used in this study is the same with Mauritsen et al., 2018? The major changes include cyanobacterial N2 fixation and incorporation of DOM? Was the DOM improvement also made in Mauritsen et al., 2018? What about Paulsen et al., 2017 and Six and Maier-Reimer, 1996? Are these studies relevant to the HAMOCC model development? Also, is the model (e.g. photosynthesis) N or P or C based? Are there different pools for D/POC, D/PON, D/POP, etc? Beside river inputs, are there other inputs from e.g. atmosphere deposition? Is N2 fixation also a carbon input or just N? These important details, particularly on the sinks and sources of N,P,C, need to be provided here.

P13L22: first 0.003 is not just “slightly” slower than 0.008, and second, how did you choose these two values?

Suggestions on shortening the text:

Abstract: focus on the riverine impact on CO2 outgassing and NPP hotspots in the ocean and leave the details of the river export (e.g numbers in P1L8) to the result section. P1L15-19 can be removed or shortened to one sentence.

P2L19-P2L6: can be shortened as suggested above.

P15 Section 3.1 is not a focus of this study and does not seem too necessary to me. P16 Section 3.2 and P18 Section 4.1 can be reasonably shortened to half of its present length. I appreciate the effort made here to validate the results but this is a bit too much details. The readers need to reach P25 Section 5 and P34 Section 6 for the key points before being distracted by these details.

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2019-152, 2019.