Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2017-235-RC1, 2017

Biogeosciences Discussions
Open Access
EGU

Interactive comment on "Climate engineering and the ocean: effects on biogeochemistry and primary production" *by* Siv K. Lauvset et al.

Anonymous Referee #1

Received and published: 12 July 2017

General comments

"Climate engineering and the ocean: effects on biogeochemistry and primary production" by Lauvset et al. provides a single-model assessment how three different climate engineering methods (stratospheric aerosol injections, marine sky brightening and cirrus cloud thinning) affect ocean biogeochemistry. This is one of the first studies on the topic and comparing different methods within the same model is a valuable addition to previous works. They concentrate on four key variables in ocean biogeochemistry: sea surface temperature, oxygen, pH and net primary production. For NPP, they complement the interactive Earth System Model simulations with offline calculations that make possible to disentangle different drivers of NPP change. This method adds to the value of the manuscript, although I have some concerns and questions about the

Printer-friendly version

Discussion paper

method (see specific comments).

The manuscript is mostly clearly structured and written, and thus easy to read. However, some more commas when dependent clauses start sentences would enhance readability. For example, I would insert a comma in “When only phytoplankton concentration is allowed to vary temporally in the offline calculation there is a decrease of ∼8% by 2100 in RCP8.5.” (Lines 369-371) and similar sentences. Also, the use of present tense throughout the manuscript differs from the general practice of using past tense to describe the results and methods. Overall, I would recommend this manuscript for publication if my comments below are adequately addressed.

Specific comments

Major comments

The offline model for NPP calculations needs more precise explanation and evaluation. In Lines 139-149, you imply that monthly-mean values are used for nutrients. On the other hand, on Lines 362-364 you write that phytoplankton concentration is used as a proxy for nutrient availability. Moreover, on Line 417, phytoplankton concentration is said to be a proxy for circulation changes. The last two statements are in my understanding consistent with each other (but it would be good to explain explicitly why they are related), but please clarify how the first statement of monthly-mean nutrient fields should be understood.

Also, doesn’t NPP significantly affect phytoplankton concentration? Using phytoplankton concentration to calculate NPP sounds circular reasoning to me and I see a risk that the method overestimates the contribution of circulation changes to NPP changes. For example, if temperature increased phytoplankton in the online simulations and this in turn increases NPP in offline calculations, don’t you attribute this increase to circulation in the offline calculations instead of to temperature?

I think it would also be good to provide some short evaluation of the offline NPP calcu-

Printer-friendly version

Discussion paper

lation method to show whether it provides similar results as the online calculation. The value of offline calculations is to disentangle different drivers of NPP change, but how well does the offline version compare to online version when all drivers are accounted for (both regionally and at global mean level)? Specifically, comparing Fig. 5 to Fig. 7a would be helpful.

Minor comments

Lines 20-22: If the drivers of NPP are “partly” affecting the inhomogeneity of the NPP changes, what is responsible for the rest of the inhomogeneity?

Line 93: Spell out SST as it’s used here for the first time.

Line 118 and throughout the manuscript: You apparently use NPP and primary production interchangeably. I would recommend using NPP (shorter and more precise) everywhere consistently or explain if there is some subtle difference between NPP and primary production in the manuscript.

Line 165: I think it would more precise to say that you scaled AOD to match the level of a 20 TgS/year injection as you don’t explicitly model the aerosol injection here.

Line 172: Maybe good to say here explicitly that the other two methods had -4.0 W m-2 forcing.

Line 193: SST should be defined on Line 93 already. Maybe not necessary to repeat it here.

Lines 207-209: You use a high emission scenario. I would add that RM does not prevent long-term impacts in a scenario where CO2 emissions don’t go to net zero. If they did, the situation would probably look a lot different.

Lines 230-232: Are there many areas where changes are greater with RM than without? If the results in RCP8.5 with RM are spatially highly variable, the changes can’t be attributed to RM.

Printer-friendly version

Discussion paper

Lines 291-292: I'm not sure what this sentence means. What is smaller than in RCP8.5? The exhibited decrease of NPP or the changes in NPP in RM simulations? Please, clarify.

Line 332-334: Isn't the increase in NPP with CCT only present in offline calculations? In Fig. 5, NPP decreases in all simulations, and I think the online calculations are more reliable.

Line 363: As discussed earlier, please explain here or elsewhere what you mean by using phytoplankton as a proxy for nutrient availability.

Line 378: Is this section based on online of offline NPP calculations? If you use only offline calculations, could you provide some evaluation how well the offline results match the online results at regional level?

Line 388-390: What do you exactly mean by being consistent with CMIP5? Consistent with the sign of model ensemble mean or do all CMIP5 models give the same sign for these regions?

Lines 403-409. Why higher NPP would not lead to higher fish catches but lower NPP would decrease fish catches? Is this based on some dynamics of the ecosystem or are you just more careful to predict any increases than to predict decreases?

Lines 411-414: Splitting this to several sentences would make it easier to understand. Also, "do" on Line 413 seems redundant.

Line 422: I don't understand what you mean by "Radiation changes become more important in driving changes with RM".

Line 463: Why is this unusual? Compared to what? Doesn't increased temperature lead to increased NPP in other regions as well?

Line 467: Considering the low number of previous studies on the topic, could you write something about the results of Hardman-Mountford et al (2013) that you mention in the

Printer-friendly version

Discussion paper

introduction? I know that comparing an ESM to single-column model is challenging, but it would be interesting to know how the results compare.

Lines 494-497: I would add here that the potential interaction of SST and the clouds is missing in Partanen et al. (2016). Their forcing is calculated with an AGCM that has a fully interactive aerosol scheme and takes thus into account interactions with clouds and sea salt aerosol, but with prescribed SST, the model might miss some relevant feedbacks.

Lines 497-500: Could you speculate, what are the implications of using a high emission scenario (RCP8.5) instead of a low emission scenario (RCP4.5)? Table 2: I would write that AOD is modified to reflect a sulphur injection not to give an impression that the sulphur injection is calculate online in the current study.

Figure 2 and other maps: Could you move labels a,b,c,. . . outside the plots? They are a bit hard to see and I first thought they were missing altogether. All line plots: The lines are a bit hard to tell apart. I know that with so many overlapping lines it's hard to make them easy to distinguish, but I think there could be some room for improvement using dashed lines or slightly thicker lines or something.

Figure 5. The legend is missing. Also, why is there a gap in the line of CCT around 2100?

Figure 6: Standard deviation of what? Inter-annual variability of annual means of the reference period?

Figure 7. Could the legend be included in sub figure a already?

Technical corrections

Line 34: temperatures -> temperature

Line 39: I think "induced" is redundant here.

Line 235: continue -> continues (if you keep the present tense)

Line 408: decreases -> decrease

Lines 472-473: A verb is missing. (in -> are ?)

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-235, 2017.

Printer-friendly version

Discussion paper