Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2017-258-RC1, 2017

Geoscientific Model Development Discussions

Interactive comment on "EcoGEnIE 0.1: Plankton Ecology in the cGENIE Earth system model" *by* Ben A. Ward et al.

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Received and published: 13 December 2017

This manuscript is a generally clear description of an extended ocean biogeochemical model in the GENIE EMIC. However, a number of equations are wrong, so I recommend correcting these, rerunning the model, updating the figures, and if needed the text and conclusions. While this amounts to major revisions, I am hopeful that a revised manuscript would be acceptable.

Major comments: Line 244: "Finally organic matter (D) is made up of K size classes of organic matter, each containing i d organic nutrient element pools. (Note that strictly speaking, detrital organic matter is not explicitly resolved as a state variable in ECOGEM as we currently only resolve the production of organic matter, which is passed to

BIO- GEM and held there as a state variable. As a consequence, there is no grazing on detrital organic matter in the current configuration of EcoGENIE. We include a description of D and its relationships here for completeness and for convenience of notation." This is in fact a really inconvenient notation, because it obscures what happens in the model. See Line 452 below.

Line 294: "The size of the quota increases with [. . .] the loss of carbon." First, this statement is not true, because in Section 3.2.7 it is pointed out that grazing loss does not affect stoichiometry, which is the correct thing to do. Secondly, Ikeda et al. (2001, DOI 10.1007/s002270100608) show that the stoichiometry of respiration is undistinguishable from the stoichiometry of biomass as well. This incorrect representation would lead to quota that are sometimes in excess of Qmax, which would give unrealistic artefacts in the nutrient cycling and potentially a violation of mass balance, and should therefore be corrected.

Line 301: This incorrect equation also appears in Geider et al. (1998, Limnol. Oceanogr. 43:679), although it is given here without attribution. Please use the correct equation from Morel (1987, J. Phycol. 23:137) max = himax – (himax – lomax)*(Q-Qmin)/(Qmax-Qmin)

Line 303: The appearance of γFe in the denominator of this equation is incorrect. It would make Chl synthesis increase as cells run out of iron, when in fact Chl:C decreases at low iron (Sunda and Huntsman 1997, Nature 390:389). A photosynthesis model that reproduces this iron limitation effect is given in Buitenhuis and Geider (2010, Limnol. Oceanogr. 55:714)

Section 3.2.6 uses several words that have physiological meanings (limitation term, half saturation, inhibition) in a section describing light attenuation. If these sentences in fact deal with α (it would help to rename this to αChl), then it should be moved to Section 3.4.3. If it deals with light attenuation, it should be made clear how kChl is derived.

Line 343 : “length scale of 20 m” Is this used to calculate kw or the average value of ktot?

Line 345: “At the ocean surface” This would be a logical sentence to start the section.

Between Line 452 and 455 D changes from 6 state variables in ECOGEM to 2 (C contents) in BIOGEM. Please explain what happens to the organic nutrient concentrations.

Line 533: It would make more sense to change e.g. the range between Qmin and Qmax, the partitioning between POM and DOM and the decay of POM with depth, which have much more uncertainty than the unrealistic choice noted in Line 294.

Section 3.2.9: See comment on Line 294.

Figure 5 and Line 595: It is confusing to speak of POC production when there is no state variable for POC, and it leads to confusion with primary production. It would be easier to understand to speak of POC flux. Given the central importance of POC flux for air-sea CO2 flux and nutrient distributions, I suggest comparing it to observations (Schlitzer (2004), J. of Oceanography 60:53-62, https://lred.uea.ac.uk/web/green-ocean/data) and including these in Figures 3 and 19.

Line 605: Rather than change ECOGEM to reproduce an arbitrary result in BIOGEM, it would be much more helpful to compare the CaCO3 export to observations (Lee (2001) Limnol. Oceanogr. 46: 1287–1297) and adjust the model to reproduce that.

Line 617: “total oceanic DIC inventory increased by just under 2% from 0.299 mol C” This makes no sense. The total oceanic DIC inventory is $\sim$3.3 Examol.

Line 652 and Figure 17: “The model predicts higher chlorophyll concentrations in the Southern Ocean” Figure 17 is inadequate to decide whether this is a reasonable comment to make. Please have the y-axis range from 10-2 to 10 (values between 10-5 and 10-2 are insignificant), put the station names inside the panels, so that the panels can be made higher, and include the satellite chl in the figure. If that shows the in situ measurements span the satellite estimates, delete the Dierssen reference and rewrite

this to reflect the findings of Le Quere et al. (2016, doi:10.5194/bg-13-4111-2016), that models underestimate SO chl because they underrepresent macrozooplankton. Also, after correcting the error on line 303, this may improve/decrease SO chl.

Figure 18 needs to be described.

Line 737: “the ecological community conforms to expectations in terms of standing stocks” This has not been shown. Comparison to Buitenhuis et al. (2013, doi:10.5194/essd-5-227-2013) would test this statement. Given the different definition of plankton groups, comparison could be made to Fig. 5a.

Minor comments: Line 85: for the how -> for how Line 143: in terms its -> in terms of its Line 162: modularised -> modular Line 176: a greater intention to explore long timescale -> the intention to explore longer timescale Line 262: the the -> the Line 363: level the -> level of the Line 421: The O2:C ratio is in fact >1. Anderson and Sarmiento (1994) find it’s $\sim$170/117=1.45, so even 138/106 would be quite low, and it would be helpful to justify it. Line 439: used equations -> used in equations Line 592: in tropical -> in the tropical Line 636: Figures 12 and 13 we -> In Figures 12 and 13 we Line 687: Figure 18 -> Figure 17 Line 690: is probably too low -> is too low

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