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Interactive comment on "Explicit silicate cycling in the Kiel Marine Biogeochemistry Model, version 3 (KMBM3) embedded in the UVic ESCM version 2.9" *by* Karin Kvale et al.

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This paper describes a set of new processes in the KMBM3 model embedded in the UVIC Earth System model. I must apologise in advance that I have concentrated my review on the model presentation due to my time constraints and where my comments are likely to be most helpful.

The biogeochemical model, and the silica components in particular, are interesting, and simulations suggest they are an improvement on earlier versions. The interesting components of the silica model would be better presented if the model description was more cleanly separated from the model configuration, so that people wishing to apply

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your silica equation could more easily work off your paper. For example, lines 254 – 258 and 270 – 278 should be separated out into a new subsection, titled something like 'Silica inputs in the UVic model configuration '. Look for other instances.

Comments for improved clarity / rigor:

1. The manuscript would benefit from a table of state variables, which could also define the many subscripts used in the manuscript.

2. The use of term 'mass conservation' in the model might be unclear to readers. Please distinguish between the model equations, and the model domain, conserving mass. An input or export of silica to the model domain should not be confused with a failure to account for a term in the equations. Do all case of non-conservative behaviour relate to inputs and exports?

3. On point 2, line 79, why do you balance export to the sediments with inputs to the surface ocean? Isn't the point that the pool of oceanic silica is changing over time. The artificial nature of this assumption is more limiting than any benefit in domain wide mass conservation and potentially obscures problems with the formulation.

4. Line 98. Description is loose. The symbols m, JX and μ* are a rate coefficients, μ* X is the term.

5. The use of T in Eq. 3 and elsewhere is awkward because it relies on use the Celsius scale. If you swapped to Kelvin, 20/15 $\neq$ (20 + 273)/(15 + 273). Looking at Eq. 3, 'a' is a growth rate parameter (not a maximum growth rate as described in Table 2). Infact, it is not even an exponential growth rate parameter, since the exponential component is in the term e(T/Tb).

6. Eq. 4. It would be preferable that you use Fe for the Chemical Symbol, and [Fe] for the concentration of iron. Also for other elements. Reasons are highlighted in later comments.

7. Eq. 8 looks odd but behaves okay. In any case, there are three constants in the

equation which should be parameters.

8. Line 144. Mortality from ‘old-age’ is a misleading description since you do not track age distribution of the population. How about simply non-grazing mortality.

9. Interesting that you have self-grazing in the zooplankton!

10. Line 157. Should state that the sum of the food preference parameters must be 1. This would make it clear that it is a ‘relative food preference’. While this grazing form meets a local mass conservation criteria, it is, nonetheless, awkward.

For example, if you had one phytoplankton species, its preference would be 1, and G1 would be mu Z X / (X + k). If you split this into two identical classes with 0.5 preference, then G12 = mu Z [0.5 X/2 / (0.5 X/2 + 0.5 X/2 +k) + 0.5 X/2 / (0.5 X/2 + 0.5 X/2 +k)] = mu Z X/2 / [X/2 + k] $\neq$ mu Z X / (X + k). To test this, try running your model with two identical LP cases, starting with half the concentration. Thus it is not only relative preference, but also specific to the predators and prey you have in this configuration.

11. Eq. 20, 39 Brackets around max function are different than Eq. 15 and others.

12. L163 – what does ‘sox’ mean? I suspect it should be ro2sox. Think about how you have used subscripts to identify cases (i.e. phytoplankton type, element type) and superscripts to define its application (i.e. max). Eqs. 10 and 11 also appear to have the super- and sub-scripts the wrong way around.

13. Eq 30. Rethink subscript. If 0 is meant to identify an example of a ratio of Opal to POC, then it should be written as ROpal:POC,0. Lots of places subscripts would benefit from commas.

14. For example CaCO3liv would be better as [CaCO3]liv as proposed above. Eq. 25, Feorgads also mixes chemical symbolism with mathematical notation.

15. I don’t understand Eq. 32. If it is a local rate of change why does it have units of m-1. [Reading later it looks like it is a benthic term – needs clarification].

16. There is inconsistent us of the (x) symbol. Equations in latex format work better without them. Only use where it improves clarity.

17. Instances of SCaCO3 should be S(CaCO3) (Eq. 29, 41, 42 etc.)

18. Eq. 43 is simplistic as the units don't work. I presume Pr(Opal) is a 3D flux, I am not sure what Di(Opal) is (see comment 15), and Si(Dust) is probably a 2D flux, and Siriv is probably multiple point sources. But Si in equation 8 and elsewhere is a concentration. Another reason to represent concentration of an element as [Si]. Eq. 40 has similar problems.

19. Line 230. Why does sinking increase with depth? I would have thought the increasing density with depth would result in a reduced negative buoyancy, and dissolution would reduce particle size slowing the Stokes' sinking rate? Coagulation might go the other way. Discuss more.

20. L266. M-M uptake rate? I prefer the line 102 description of iron availability. Perhaps a table of 'derived variables' with definitions of mathematical symbols that are in the equations, but not state variables or parameters would help in tightening up these descriptions.

21. Eq. 36. bsi would be better as bSi.

22. Eq 36 Exp is potentially confusing with the exponential function.

23. Eq. 21. Would it be better to use oxygen concentration of % saturation. I am not sure which it is that affects animal metabolism.

Other minor comments.

Line 13 'migrate' – poor word choice. Perhaps 'bloom further south'

Line 94 – what does a virtual flux mean in this context.

L276 replace 'before the biology' with 'faster than the biological processes'

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