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Geoscientific Model Development Discussions

Interactive comment on "A generic biogeochemical module for earth system models" *by* Y. Fang et al.

Anonymous Referee #2

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General Comments

Fang et al. present an approach which allows the user to automatically and consistently set up large biogeochemical reaction models containing known and novel processes, which can be used in the Community Land Model (CLM). Technical correctness is shown by re-implementing an existing process model (CLM-CN).

With more details on biogeochemical processes becoming available, corresponding models become more complex and larger in size, so that their set-up and expansion becomes more and more difficult. Hence, the presented approach is welcome and surely of interest to the readers of Geoscientific Model Development.

The presentation and structure of the work, however, needs improvement, as detailed

below.

Major Issues

* The promise of a "generic biogeochemical module" is in contrast to the "reaction database consist[ing] of processes of nutrient flow" (P. 3212, l. 17-18). Also, the importance of microbial communities is discussed at some length (P. 3214, l. 13-15), but it is later not shown how their dynamics can be reflected in the proposed approach. Also, it is not obvious whether the module can be linked to other earth system models besides CLM. This would significantly improve it's value.

* The general concept remains a little bit vague, and the description of the various components is scattered throughout the manuscript. What exactly compromises the "new biogeochemical module", what is the "generic algorithm"? The description of the PERL script is not clear, either. Please clearly state what it is used for, and describe the different functionalities separately. "dynamic variable stoichiometries" are mentioned here for the first time (P. 3221, l. 18), please describe in detail, what is meant by these, and how they fit into the previous description of the module. Also, the method for numerically solving the system is not clearly described. A conceptual figure could be helpful to make the operational structure of the approach clear, and also indicating the relationship between database, PERL script, and model, including the inputs and outputs of the different steps in setting up a reaction network model.

* Three current major challenges in earth system models are correctly identified in the abstract, however, how the approach helps on the second (computational cost) is not obvious. Are fast and slow reactions automatically separated? How are algebraic equations defined in the approach? The third challenge (different mathematical representations for different processes) sounds a little bit vague, and should be sharpened.

* The stated challenges are not new, and a discussion and comparison to other approaches tackling these issues is missing (e.g., Aguilera et al., Geochemistry, Geophysics, Geosystems, 6 (7), and others).

* For readers not familiar with CLM, a short description of this model, including purpose, considered processes and numerical implementation would be very helpful.

* While the stoichiometries in Equation (2) are automatically retrieved, how are the rates R defined? Can they be set by the user? It is mentioned that they might depend on moisture, temperature, etc., but details on how this can be implemented are missing. Are arbitrary mathematical expressions possible? See also next point.

* P. 3222, l. 1,2: How exactly are rate expressions incorporated in the module? This is an important point for modelling. Can they have arbitrary form?

* P. 3216, l. 17 - P. 3217, l. 2 is introductorial / motivational material and should be moved to the introduction.

* P. 3219, l. 4-14, l 24-27: is introductorial material and should be moved to the introduction.

* It seems that processes are derived from the source code of CLM-CN (P. 3217, l. 19-20). Note that this is an unusual step; for a well-documented model, this information should be unambigously retrievable from the documentation of the code.

Minor Issues / Language

P. 3212, l. 22: What is "CLM-CN"?

P. 2312, l. 4: "CLM" -> "CLMs"

P. 3212, l. 18: "litter" -> "litter,"

P. 3213, l. 9: "energy" -> "energy,"

P. 3213, l. 10: "e.g." -> "e.g.,"

P. 3213, l. 16: "contribution" -> "contributions"

P. 3213, l. 17: "in literature" -> "in the literature"

P. 3213, l. 24: "is not in" -> "is not included in"

P. 3214, l. 2: remove comma

P. 3214, l. 5-6: remove "(" and ")"

P. 3214, l. 15: "of the microbial" -> "of microbial"

P. 3215, l. 17: "in which," -> "in which"

P. 3216, Equation 2: remove "[l]"

P. 3216, l. 11-15: avoid the same reference in consecutive sentences

P. 3218, l. 1-2: Make clear that only an example is given.

P. 3222, l. 13: "refer our" -> "refer to our"

P. 3223, l. 5: "land model" -> "land models"

P. 3223, l. 8: "pools follow" -> "pools to follow"

P. 3223, l. 9: "N and P" -> "N, and P"

Unclear sentences or unusual wording:

P. 3213, l. 20: "raises a difficulty"

P. 2315, l. 9-10: "P included model", "P effect"

P. 3217, l. 22: "reaction-based decomposition cascade processes"

P. 3217, l. 24: "inverse of C:N ratio" -> "N:C ratios"

P. 3220, l. 2: What is meant by "column averaged type by (p) and (c)"?

P. 3221, l. 11: "a tool written with the PERL script"

P. 3221, l. 15: "that point the reaction names"

P. 3222, l. 22: "The database was used to pick the reactions"

P. 3223, l. 6-7: "assume the allocation of P to live aboveground and belowground"

P. 3223, l. 16: "inverse of the C:P ratio" -> "P:C ratios"

P. 3225, l. 5: "were inputted"

P. 3225, l. 20-21 "two years of simulation time" -> "two years of simulated time"

Interactive comment on Geosci. Model Dev. Discuss., 6, 3211, 2013.