

Interactive comment on “Terrestrial Ecosystem Process Model Biome-BGCMuSo: Summary of improvements and new modeling possibilities” by Dóra Hidy et al.

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Received and published: 18 June 2016

Reply to the interactive comment "RC2: 'Valuable step and contribution weakened by no repository', by Ben Bond-Lamberty (Referee 2), 09 Jun 2016" by Zoltán BARCZA and Dóra HIDY

First of all, we thank Ben Bond-Lamberty for reviewing the manuscript (gmd-2016-93), we are grateful for the positive and valuable notes. The comments of the Referee are shown below in between quotation marks in italic. Our detailed response to the comments and suggestions are presented below. We attached the revised manuscript to this interactive comment. The revised manuscript also contains modifications to fix

the issues raised by the Anonymous Referee #1.

"There are a few weaknesses, only one of which I consider critical. First, the processes that have been implemented or improved come across as something of a laundry list, and a bit random; it would be good to describe any common themes that unite them, and better talk about remaining areas of weakness the authors see in the model."

We agree with the Referee that the improvements might seem a bit random. In fact we are working on the developments for quite a long time, and during the years we faced different problems with the model, and we tried to fix them using our best knowledge. Three common themes emerge (two larger groups plus a group of heterogeneous fixes): soil processes (from different aspects), management (now it covers the majority of typical human interventions), and a number of additional fixes and adjustments to create a state-of-the-art Biome-BGC (we can mention here acclimation, representation of the CO₂ mixing ratio dependence of stomatal conductance, and estimation of other greenhouse gas fluxes). We truly hope that this is not a serious problem as the modeling community might find these diverse developments useful in many cases. Publication of partial adjustments is an option, but we decided to disseminate the developments as part of this major work for easier accessibility and reference.

Nevertheless, we added a few sentences to the revised manuscript (P9 L24-38) where we mention the main motivations for the adjustments: "The developments were motivated by multiple factors. Poor agreement of the modified Biome-BGC with available eddy covariance measurements made in Hungary over two grassland sites (see Hidy et al., 2012) clearly revealed the need for more sophisticated representation of soil hydrology, especially at the drought-prone, sandy Bugac site. Implementation and benchmarking of the multilayer soil module resulted in several additional developments related e.g. to the N balance, soil temperature, root profile, soil water deficit effect on plant functioning and decomposition of soil organic matter. Lack of management descriptor within the original Biome-BGC motivated the development of a broad array of possible management techniques covering typical grassland, cropland and forest

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management practices. Modeling exercises within international projects revealed additional problems that needed a solution related e.g. to stomatal conductance (Sándor et al., 2016). Recently published findings (e.g. simulation of temperature acclimation of respiration; Smith and Dukes, 2012) also motivated our work on model development. Addressing the known issues with the Biome-BGC model required diverse directions but this was necessary due to the complex nature of the biogeochemical cycles of the soil-plant system. Our overarching aim was to provide a state-of-the-art biogeochemical model that is in the same league as currently available models, such as LPJmL, ORCHIDEE, CLM, JULES, CASA and others."

In the 'Discussion and conclusions' section we mention a few remaining areas where developments are needed in the future:

"Representation of photosynthesis acclimation (Medlyn et al., 2002) is needed in future modifications as another major development." (P32 L29-31 in the revised MS)

"Developments are clearly needed in terms of soil water balance and ecosystem scale hydrology in general. Other developments are still needed to improve simulations with dynamic C and N allocation within the plant compartments (Friedlingstein et al., 1999; Olin et al., 2015). Complete representation of ammonium and nitrate pools with associated nitrification and denitrification is also needed to avoid ill-defined, N balance related parameters (Thomas et al., 2013). Even further model development will require the addition of other nutrient limitations (phosphorus, potassium)." (P33 L3-8 in the revised MS)

"Clearly, extensive testing is required at multiple EC sites to evaluate the performance of the model and to make adjustments if needed." (P33 L10-11 in the revised MS)

"Second, there's no validation or testing of the individual changes. This isn't a show-stopper, but it would have been really useful to run many more simulations with and without each of the new changes. That would have let you quantitatively assess their

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individual value."

We presented several additional simulation results in the Supplementary material (S2-S9): <http://www.geosci-model-dev-discuss.net/gmd-2016-93/gmd-2016-93-supplement.pdf>

In the Supplementary material we illustrate the effect of different model features such as senescence, management, and groundwater effects on the simulated results in a fashion that is mentioned by the Referee (switching on and off individual features to see its result on the simulated fluxes and pools). We hope that this is what the Referee proposed.

"Finally, and most seriously, I'm mystified that the authors are choosing to host the code on their own webserver. GitHub has become the standard for scientific software repositories, but even if you don't use it, for permanence and reproducibility you HAVE to use version control (so, for example, people can send you pull requests or see commit histories) in an established repository. This would massively increase the utility of the new model, and enable it to become a true community-driven model (or, at least, a much more transparent one). I applaud all the work you've done here, including on this website, but really, really urge you to make use of GitHub or another web-based repository hosting service. Note that I have posted the Biome-BGC source code in such a repository (<https://github.com/bpbond/Biome-BGC>) and would be happy to make this available, and/or turn it over to you."

Thank you very much for this proposal. We did not use GitHub (or other source code repository) or other version control software previously. We have submitted the source code to GitHub, which is available online at https://github.com/bpbond/Biome-BGC/tree/Biome-BGCMuSo_v4.0

We have inserted a sentence into the manuscript into Code availability section about this possibility (P34 L5-6 in the revised manuscript).

Specific comments

"1. Page 3, line 4: probably 'often is no longer' (concentration-driven runs remain very common in ESM simulations)"

We have modified the sentence according to the Referee's comment (P3 L3 in the revised manuscript).

"2. P. 3, l. 8-9: perhaps cite one of the Friedlingstein et al. papers (e.g. 10.1175/JCLI-D-12-00579.1)"

We have inserted the Friedlingstein et al. citation.

"3. P. 3, l. 30: perhaps cite Thornton et al. (2013) 10.1029/2006GB002868"

We have inserted the Thornton et al. citation.

"4. P. 4: wow, great summary of Biome-BGC history! One addition might be in line 12: '. . . and decomposition, and then simulated wildfire effects across a western Canadian forest landscape (Bond-Lamberty et al. 2007, 10.1038/nature06272).' (Completely optional though.)"

Thank you for mentioning this paper. Somehow we overlooked this important paper. We have inserted the text and the citation that the Referee suggested into the revised manuscript.

"5. P. 5, l. 11-12: I think this is true, but would add that Biome-BGC also strikes a great balance between process fidelity and tractability: it's relatively easy to use and run, even for non-specialists, but still yields interesting insights. If you agree, perhaps note this"

We have inserted this note to the manuscript. In the revised MS (P5 L11-14) the sentence reads as: "The success and widespread application of Biome-BGC can be

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attributed to the fact that Biome-BGC strikes a great balance between process fidelity and tractability: it is relatively easy to use and run, even for non-specialists, but still yields interesting insights. The success can also be attributed to the open source nature of the model code."

"6. P. 10, l. 21-22: More dials and knobs aren't always better. How do you know this is an improvement? Are four layers known to be too few?"

The motivation for the implementation of 7 soil layers can be summarized with the followings: - Using 7 layers the soil profile can be better described, which means that change of texture and bulk density with depth can be described in a more realistic fashion. Soil profile effect on soil hydrology was demonstrated in many cases (this feature is also used for the Jastrebarsko case study within the paper), and it can be important in many cases. - Implementation of thin soil layers close to the surface can support drying out the upper layers (due to surface evaporation and root water uptake which is strong close to the surface), so the resulting soil water content profile is closer to observations. Consequently, drought effect on plant functioning and soil microbial activity is better captured. - Usage of multiple layers (with thinner layers close to the soil surface) might be important for herbaceous vegetation due to the small rooting depth. - Cropland related developments have priority in the future within Hungarian research projects, and experience from crop models (e.g. from DSSAT) shows the necessity of a larger number of simulated soil layers.

In summary, we think that 4 soil layers are too few (even 7 layers might turn out to be too few) especially in case of herbaceous vegetation. Benchmarking and further development of the model is needed to find the optimal distribution of soil layers.

We have extended the manuscript summarizing the above reasoning (P10 L22-28 in the revised MS): "Higher number of soil layers might be useful to better represent the soil profile in terms of soil texture and bulk density. This should be beneficial for sites with complex hydrology (see e.g. the Jastrebarsko case study in section 5.3).

Additional layers also improve the representation of soil water content profile as the upper, thinner soil layers typically dry out more than the deeper layers, which affects soil and plant processes. As rooting depth can be quite variable, additional layers might support the proper representation of soil water stress on plant functioning. Seven layers provide an optimal compromise between simulation accuracy and computational cost."

"7. P. 12, l. 36-37: a thought for the future: an adaptive-timestep algorithm that shrinks the timestep only when necessary"

Thank you for the note. In fact we implemented such solution that is suggested by the Referee. P13 L1-15 in the original manuscript described this feature.

"9. P. 31, l. 19: 'he probable'"

Thank you for the language corrections. We modified the sentence.

"10. P. 31, l. 35: 'The original'"

We have corrected this.

"11. P. 32, l. 32: 'The role'"

We made the correction.

"12. P. 33, l. 34-: consider mentioning/discussing PEcAn ' see Dietze et al. (2014) 10.1002/2013JG002392"

Thank you for mentioning PEcAn, this workflow based system is indeed similar to the one we implemented. We have inserted a sentence to the revised manuscript (P33 L24-26) mentioning PEcAn and the ED model: "The infrastructure is similar to PEcAn (Dietze et al., 2014) which is a collection of modules in a workflow that uses the Ecosystem Demography (ED v2.2) model."

Please also note the supplement to this comment:

<http://www.geosci-model-dev-discuss.net/gmd-2016-93/gmd-2016-93-AC1->

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