

## ***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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Reply to the interactive comment "RC1: 'Improper compensation between nitrogen cycle and management module', by Anonymous Referee 1, 09 Jun 2016" by Dóra HIDY and Zoltán BARCZA

We thank the Anonymous Referee for the valuable comments on our manuscript (gmd-2016-93). The notes of the Referee are inserted below in between quotation marks in *italic*. Our detailed response to the comments and suggestions are presented below.

C1

*"A major problem is that the authors left the issue of negative nitrogen pool unresolved, in favor of the management module (P27 L3-12). This is a red flag in ecosystem modelling! If the authors are anticipated to employ the MuSo as a part of ESM in near future (P3 L2-13), this issue definitely need to be resolved with a more proper approach. Otherwise, the future projection of nitrogen cycle will be biased by non-equilibrium state."*

We believe that this is a misunderstanding. In Biome-BGCMuSo v4.0, and also during the development of earlier Biome-BGCMuSo versions, **we have fixed the issue of negative nitrogen (N) pool**. In other words, the negative nitrogen pool issue is completely resolved in the model version that we describe in the manuscript. Negative nitrogen pool **was** an issue in earlier model versions in some cases during land use change simulations (LUC; when normal phase represent a different plant functional type than the spinup phase) that we mention in the original manuscript (P27 L3-12). We realized that the original text could be misunderstood, as we wrote the following: "One problem that is associated with LUC is the frequent crash of the model with the error 'negative nitrogen pool' during the beginning of the normal phase." It would have been better to write it as "....One problem that was associated with LUC in earlier model versions was the frequent...". In the revised manuscript we will rephrase this sentence to avoid misunderstanding.

Below we provide a brief description of the logic that is used in the LUC simulations for clarity. This implementation can be traced by checking the model code which is available at the model's website at

[http://nimbus.elte.hu/bbgc/files/biome-bgc-muso\\_4.0\\_2016\\_03\\_03\\_Linux\\_src.tar](http://nimbus.elte.hu/bbgc/files/biome-bgc-muso_4.0_2016_03_03_Linux_src.tar)

The core logic of all Biome-BGC versions is that the N flux calculations of the plant compartments are based on the carbon fluxes of the corresponding plant compartments and the C:N ratios of the plant compartments. The logic for the carbon fluxes is different because they are based on the content of the carbon pools and the environmental drivers. If the C:N ratio of a given plant compartment in the normal phase

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is lower than in the spinup phase, it can happen that the N flux calculated from the C flux using the new C:N ratio is higher than the content of the N pool. In earlier model versions this caused negative N pool thus crashing of the simulation. In order to avoid this error we have implemented an automatic procedure (in the source code this is implemented in `restart_io.c`): in the normal phase, instead of using the result of the spinup phase, the nitrogen content of the plant compartments are calculated internally by the model code based on the final (equilibrium) carbon pools and the new C:N ratios of the plant compartments, so that the resulting N pools of the plant compartments are harmonized with the C:N ratio of the plant compartments presented in the ecophysiological parameterization.

It is important to note that soil and litter pools (litter labile, unshielded cellulose, shielded cellulose and lignin C and N) are not affected by this LUC handler, only the actual, transfer and storage pools of leaf, fine root, soft stem, fruit, liveroot, deadroot, livestem and deadstem. It means that equilibrium C and N soil pools (which are the most important elements for the initial conditions of the normal run) remain intact. In the manuscript we stated that the equilibrium N pools are adjusted, but the word "plant" was missing, thus it was ambiguous. In the revised manuscript we will correct this problem ("equilibrium carbon pools" in P27 L8 will be replaced with "equilibrium plant carbon pools", and the same for nitrogen).

In case of the Mead simulation (presented in our manuscript) where the spinup phase used C3grass parameterization and the normal phase used maize parameterization this modification resulted 0.49 g N m<sup>-2</sup> N-surplus in transfer N pool of fine root (because the fine root C:N ratio of maize was lower than the fine root C:N ratio of C3grass). The magnitude of the change is similar in case of other LUC types such as forest-herbaceous, herbaceous-forest, and herbaceous-herbaceous. But most importantly **in all possible LUC cases the plant N pools that are adjusted are not important anymore, since they are replaced by new vegetation in the normal phase with new C:N stoichiometry.** We added a new sentence to the revised manuscript to

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explain this logic: "This modification means that equilibrium plant nitrogen pools are not passed to the normal phase, but in fact this is not needed because LUC means change in the existing plant functional type, so new plant C:N ratios will inevitably be realized."

All in all, the equilibrium soil carbon and nitrogen pools are not changed during LUC, only the plant compartments that are in fact replaced by a new plant functional type during the first year of the normal run. Most importantly, this handler resolves the negative nitrogen pool issue that was possible in earlier model versions. We truly believe that this is a remarkable improvement as previous, published and widely used Biome-BGC model versions frequently crashed in such situations.

*"Most importantly, with the current version of MuSo, the authors cannot claim legitimacy of carbon cycle as well. Biome-BGC is a carbon/nitrogen coupled model. Therefore, distorted nitrogen cycle affects carbon cycle, especially in long-term simulations. The manuscript provided many good pieces of information about the validation of the modified model, but they are rather meaningless without a proper treatment of carbon/nitrogen cycles. So I don't comment on them at this stage."*

We kindly ask the Referee to comment on the validation of the model (if he/she accepts our explanation on the negative nitrogen pool). We appreciate any comments about the case studies and about the rest of the manuscript.

*"The full modification of the model would take time, so I recommend to withdraw the current manuscript and resubmit a new one later."*

We hope that the Referee agrees that it is not necessary to withdraw the manuscript as the negative nitrogen pool issue does not exist in Biome-BGCMuSo v4.0.