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Geoscientific Model Development Discussions

Interactive comment on "A model using marginal efficiency of investment to analyse carbon and nitrogen interactions in terrestrial ecosystems (ACONITE Version 1)" *by* R. Q. Thomas and M. Williams

Anonymous Referee #1

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Review of the manuscript entitled "a model using marginal efficiency of investment to analyse carbon and nitrogen interactions in terrestrial ecosystems (ACONITE Version 1)" by R. Thomas and M. Williams.

Major comments:

In this manuscript the authors present a new model (ACONITE) to analyse terrestrial carbon and nitrogen interactions, that uses theory on plant economy and optimisation. The paper is generally well-written, includes a full code description in the supplement, and stands out with its novel approach. I really appreciate the use of a simple model,

which requires a relatively small number of parameters and inputs. This combination makes ACONITE easy to apply, and of great benefit to the modelling community.

Developing a new model is always a tremendous amount of work, especially when building on novel concepts, as is the case here. The latter requires a careful introduction and description of the involved processes, in which I think the authors are successful. But high information density plus complex sentence structures, in combination with the enormous amount of equations and tables, makes the first half of the paper a bit of a 'tough read'. Contrastingly, the results and discussion are presented in a clear and concise manner.

I think the manuscript could be improved in readability by breaking down the larger and complex sentences into shorter ones (examples in specific comments). Also, many difficult words are used that could easily be replaced by more common ones. With these changes the authors may be able to better reach the wide audience of non-native English speakers of this journal. The model description covers a substantial part of the paper and is broken down into smaller components for clarity, which I appreciate. But section 2.1 of the manuscript suffers from (many!) missing parameter descriptions and appropriate references to tables and equations. I suggest a careful check of all parameters, equations, in-text references and corresponding tables (see specific and technical comments for details).

I am confident the authors will be able to address above shortcomings. The manuscript is very suitable for publication when 1) the use overly complex language is avoided in the introduction and model description; and 2) the methodology section (2.1) is carefully revised and checked for any inconsistencies.

Specific comments:

p. 2526, l. 8-13: This is a very long and complex sentence explaining the theory behind ACONITE. I strongly suggest breaking this up in smaller fragments to improve readability. The final part of the sentence is complex, with terms as "emergent con-

straints" and "marginal returns". Why not use a description more like based on the text in the introduction (p. 2528, l. 6-20) which I find much more comprehensive.

p. 2526, l. 24: The non-linear relationship performed better how, did it perform better in describing leaf C:N, and compared to what?

p. 2527, l. 1: what sort of challenges do we face in ecosystem earth system models, and how do the constrained LAI and variable leaf C:N ratios in ACONITE help to address these challenges?

p. 2528, l. 15-18: And a recent addition by Smith et al. (2014). doi:10.5194/bg-11-2027-2014

p. 2532, eq. 1: parameter store_propC is set to 1%, what is the rationale/reference for this value? E.g. Zaehle and Friend (2010) have set the maximum size of the storage pool to be almost ten times larger and made this term PFT-specific, based on Friend et al 1997. In their approach, the maximum pool sizes are based on data, with evergreen PFTs having a lower maximum storage pool size than deciduous trees because the fraction of live sapwood is smaller.

p. 2532, l. 8: Is this leaf or atmospheric temperature? In the latter case, I do not agree with this statement. Plants - needleleaf evergreens in particular - are known to continue photosynthesis at atmospheric temperatures up to -10 (-7) °C in temperate (boreal) regions, e.g. see Linder and Troeng (1980); Suni et al (2003); Sevanto et al. (2006). Photosynthesis shuts down only after a prolonged period of freezing temperatures.

p. 2532, l. 11-15: Please be clear on the definition of photosynthesis. It is first defined as GPP (previous page, line 6), and set as a values between 0 and G*Xc (eq 2) which is fine. Then, photosynthesis is said to be "G" in eq. 4, which is ok when one is familiar with the Farquhar type of models, but might confuse other readers.

p. 2533, l. 2: to which temperature is ltemp related: soil, atmospheric? Also please refer to equation 19, because I went looking for a definition in Table 4.

p. 2536, l. 1: Why is the maximum daily growth potential set to 0.07? I wonder what the rationale is for using only 7% of the labile C for growth each day, can you provide a reference? In case this is a 'tuning parameter', this should be made clear to the reader.

p. 2537, l. 23: Only here the authors mention that Cstore is a variable in itself and refer to eq. 42. Why not do so when the parameter is first introduced, in section 2.1.2? Also, qeuation 1 equals equation 42? Please explain the difference, or remove one of the two.

p. 2539, l. 9: what scalar is applied here? It is not directly clear from equation 33 below.

p. 2539, eq. 34 and 35: Again, which temperature is used? This is unclear throughout the whole manuscript (g(T) functions for soil processes in section 2.1.10.

p.2543, l. 24/25 – line 1-5 on the next page: What is shown where? It is unclear what is meant with "below" and "above". Instead, refer to the appropriate equations.

p. 2550, l. 9: CUE is used without explaining the acronym and its meaning. A full description is not provided until late in the discussion.

Parameter acm11 is discussed in quite some depth in the results and discussion. therefore, a description of this parameter and the shape of the LAI-Nleaf relatoinship in section 2.1 would be extremely useful for interpretation of the results.

Fig. 1: Autotrophic respiration flux Rax is not explicitly defined in either the figure caption or model description. Presumably it represents increased respiration after the maximum labile pool size is exceeded (Raexcess, Table 2)?

Fig 1: Is any excess C allocated to mycorrhiza? This would influence the uptake of N. If this is not handled within the model, the authors should briefly adress this topic in the discussion.

Table 8: bold values are hardly visible in any printed version of this document. Shading

might be more appropriate.

Technical corrections:

p. 2533, l. 2: alpha is also not listed in table 4, so please refer to equation 14.

p. 2533, l. 3: Z is not specified in any Table or the text, yet it is used as a linear scalar in equation 12. What is its value and/or reference?

p. 2536, l. 16: Insert a reference to parameter ReturnleafCNInstant in line 16.

Raexcess and RaexcessC are used intermittently in the document. For example, compare equation 37 and Table 1+2.

Textual comments:

- p. 2526, l. 6: replace “However” with “However,” - p. 2531, l. 1: replace “describes” with “describe” - p. 2531, l. 22: replace “Therefore” with “Therefore,” - p. 2531, l. 24/25: replace “... sub-model listed in” with “... sub-model are listed in” - p. 2531, l. 26: remove “the” before maximum and actual photosynthesis - p. 2533, l. 13: overly complex language, replace “extant” with “existing”

References:

Linder, S., Troeng, E., 1980. Photosynthesis and Transpiration of 20-Year-Old Scots Pine. Ecological Bulletins, 165-181.

Sevanto, S., Suni, T., Pumpanen, J., Grönholm, T., Kolari, P., Nikinmaa, E., Hari, P., Vesala, T., 2006. Wintertime photosynthesis and water uptake in a boreal forest. Tree Physiology 26, 749-757.

Suni, T., Berninger, F., Vesala, T., Markkanen, T., Hari, P., Mäkelä, A., Ilvesniemi, H., Hänninen, H., Nikinmaa, E., Huttula, T., Laurila, T., Aurela, M., Grelle, A., Lindroth, A., Arneth, A., Shibistova, O., Lloyd, J., 2003. Air temperature triggers the recovery of evergreen boreal forest photosynthesis in spring. Global Change Biology 9, 1410-

1426.

Zaehle, S., Friend, A.D., 2010. Carbon and nitrogen cycle dynamics in the O-CN land surface model: 1. Model description, site-scale evaluation, and sensitivity to parameter estimates. Global Biogeochemical Cycles 24, GB1005.

Interactive comment on Geosci. Model Dev. Discuss., 7, 2525, 2014.