Geosci. Model Dev. Discuss., 7, C1160–C1163, 2014
www.geosci-model-dev-discuss.net/7/C1160/2014/

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

R. Q. Thomas and M. Williams

rqthomas@vt.edu

Received and published: 16 July 2014

We thank the anonymous referee for comments that have improved the manuscript.

Comment: This paper tried to propose a new C/N model that based on the carbon return with nitrogen investment. The C/N coupling is an active research area and this paper fills a nice gap by provide an advanced optimization approach that well predicted the C:N ratio. While the paper is well written, I do have a few important concerns. First, the author seems omitted an important earlier publication on this area [Fisher, J. B., S.

Sitch, Y. Malhi, et al(2010), Carbon cost of plant nitrogen acquisition: A mechanistic, globally applicable model of plant nitrogen uptake, retranslocation, and fixation, Global Biogeochem. Cycles, 24, GB1014]. What is difference between author's research compared to Fisher's research is not clear to me.

Response: We agree that not including discussion of Fisher et al. 2010 was an important oversight.

The primary difference between the FUN model in Fisher et al. 2010 is two-fold: 1) ACONITE is a full ecosystem model that mechanistically calculates NPP, along with LAI and foliar C:N, while FUN uses a specified potential NPP (i.e., NPP without nitrogen limitation) and calculates how this NPP is allocated to additional respiration for the uptake of nitrogen, 2) ACONITE only allocates excess respiration (i.e., respiration beyond growth and maintenance respiration) to N fixation while FUN uses the costs of N acquisition to determine the allocation of respiration to the retranslocation of foliar N, active N uptake, and N fixation. ACONITE and FUN are complementary and can help inform each other. For example, ACONITE demonstrates how to calculate the N return on allocation to root construction. FUN demonstrates how to calculate N return on allocation to root respiration. Future research could potentially combine the two approaches to build a model that mechanistically predicts LAI and leaf C:N based on ACONITE and the allocation of respiration to N uptake based on FUN.

We have now added the following paragraph to the discussion:

"In the current version of ACONITE, the respiration of excess labile C is used for N fixation when N is limiting. Future model extensions can more mechanistically allocate this respired C to different forms of N, based on the uptake cost of each form. For example, the Fixation and Uptake of Nitrogen (FUN) model provides an example how to allocate C respiration to N uptake based on the comparison costs of N of fixation, active N uptake from inorganic forms in the soil, and retranslocation (Fisher et al., 2010). The FUN model could be further expanded to include marginal returns N on C

allocation to soil microbes (soil priming) or mycorrhizal allocation. Combining elements of ACONITE and FUN would allow for more mechanistic predictions of both LAI and leaf C:N from ACONITE and the allocation of respiration to N uptake from FUN."

Comment: Second, for the methodology section, it is very dense with equations. Because most of the equation comes from ACM model, it will be difficult for the readers to identify what is the new components proposed by this paper. I would suggest that the author move the description of ACM model into appendix and derive a general description of the ACONITE. This will help the reader easier to follow and also make it easier to implemented ACONITE in other models.

Response: We appreciate the need to improve the readability of the model description section and have included edits throughout in response to this comment and the comments provided by reviewer 1.

We included the ACM model in the main text for two reasons: 1) our goal was to include all equations in the text so that a model user could find all equations in a single location and 2) there was a modification to the ACM model in ACONITE that is important to clearly describe. We believe this rationale warrants the inclusion of ACM in the main text.

Comment: Finally, it is not clearly to me how the authors designed their numerical experiment for model evaluation. One paragraph describing that will be helpful.

Response: We modified the description of the model simulations to more clearly define the numerical experiment. The paragraphs now state:

"Next, using the full ACONITE model, we performed three numerical experiments to analyse the qualitative functioning of the model using two different sets of climate forcing, one tropical and one temperate. For the temperate forcing, two separate simulations were performed using a deciduous forest (leaf lifespan <1 year) and evergreen forest (leaf life span > 1 year). The model was run to steady state using a 2000 year

simulation that cycled through climate data from Harvard Forest (Munger and Wofsy, 1999), at 42.5°N, 72.0°W. Steady state was evaluated by testing the stationarity of Csoil, the longest residence time pool. The tropical simulation paralleled the temperate simulation with tropical tree parameters and climate data from Manaus (Kruijt et al., 2004) at 2.6°N, 60.2 °W.

The three simulations evaluated the model capacity to resolve seasonality in climate and phenology. We examined the annual GPP, annual carbon use efficiency (CUE; ratio of NPP to GPP), foliar C:N, maximum annual LAI and compared to representative ecosystem data. Intra-annual patterns in LAI, GPP, net primary production (NPP), leaf C allocation, wood C allocation, and root C allocation at steady-state for the temperate deciduous and tropical forests are described in the supplemental material (Figure S2)."

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