Biogeosciences Discuss., 11, C3601–C3603, 2014
www.biogeosciences-discuss.net/11/C3601/2014/

Biogeosciences
Discussions
Open Access

Interactive comment on "Nitrogen feedbacks increase future terrestrial ecosystem carbon uptake in an individual-based dynamic vegetation model" *by* D. Wårlind et al.

D. Wårlind et al.

david.warlind@csiro.au

Received and published: 20 July 2014

We would like to thank the reviewers for their constructive and positive comments, which we have taken into consideration and have improved the manuscript.

Answers to comments from Chris Jones

Question 1: ...But I had a question that arose from the very interesting dynamics of N limitation acting to reduce carbon uptake by present day, but enhancing it by 2100 under RCP8.5 presumably, therefore there is a level of climate change, or some state, where the two effects balance. So, under RCP2.6 for example the impact of N-cycle may be still to reduce carbon uptake - can you specify where/when this transition hap-

pens? In your results it happens globally when the curves in figure 1 cross - around 2030? but is this either rate or state dependent? and presumably it varies regionally too.

Answer: First, thanks a lot for the overall positive and encouraging words on the manuscript. Regarding the different RCPs, as we were interested here mainly on C-N interactions in a high CO2 world, we have not yet performed the same analysis for the RCP 2.6 scenario, nor the 4.5 or 6.0 scenarios, so cannot say exactly what their outcomes would be like. One critical feature that emerged, however, is that the different responses in the RCP 8.5 scenario are very local. When comparing Figure 1B and Figure 2, the mid-high latitudes stand out as the area which differs most from earlier studies, with higher C sequestration with C-N interaction than without. The main reasons for this result are the initial condition. Strong initial N limitation, limiting present standing biomass, together with large storage of SOM in the soil, gives the possibility of higher increase in standing biomass with increased atmospheric CO2 concentration and enhanced N mineralisation with warming soils. How these synergetic would behave in the other scenarios is hard to say, but an initial guess would be that the C sequestration curves would cross at a later stage, if at all. We have included the aspects of initial condition in the first paragraph of the discussions of our results (page 8) and also added a comment on different scenarios on page 12: "Even though two versions of the same model are compared here, with respect to their interactions with a changing environment, a direct comparison between the C-only and C-N version of the model is difficult, due to a number of ecosystem-scale feedbacks that are introduced in the C-N version, causing differences in the equilibrium state after the spin-up in the C-pool sizes (Table A2) and the PFT distribution (Thornton et al. 2009). Large differences in C-pool sizes originate from the equilibrium condition with climate and CO2, both in vegetation and soils. For the N version, the initial state is also in equilibrium with a pre-industrial N-deposition. Since this is not included in the C-only version, the initial states naturally are different. These differences arising from the spin-up procedure are important also for the transient model experiments: If both versions of the

model were to start from the same initial condition, the sudden addition of nitrogen to the C-N version when the transient experiment commences would create an artificial offset and/or trend to the simulations. Such a response would render it impossible to separate what is driving the shift in vegetation structure and C sequestration. Either it could be the model converting to equilibrium for the present environmental conditions, or it could be the change in environmental conditions over time." "Whether or not a similar ecosystem response would emerge also in different climate and CO2 scenarios has not yet been investigated, possibly the intersection of the C-sequestration curves of the two model version would happen at a later point in time."

Question 2: It occurred to me it would be nice to map out a phase space of delta-T and delta-CO2 perhaps within which you can see how the balance of N varies - see attached very simple schematic. Could you produce this for different regions? or maybe a variant of this figure with delta-T vs latitude, so some regions show up as reduction to-enhancement at different levels. This could be done for other models too where presumably they don't cross this threshold - but perhaps they would at higher levels that just aren't sampled in the studies to date.

Answer: Setting up a delta-T and delta-CO2 experiment for different location and examine where the synergetic effect would result in higher C sequestration with C-N interaction would be an interesting experiment and could be a future analysis. Especially, as noted by Chris Jones, the regional interactions would be interesting to study. Addressing this in the required detail (including vegetation and soil aspects, and perhaps also looking at effects of different time-lags) we felt would make the current manuscript too long (and lose focus). Hence we would prefer to leave it out for the moment.

Interactive comment on Biogeosciences Discuss., 11, 151, 2014.