Biogeosciences Discuss., 12, C3229–C3233, 2015
www.biogeosciences-discuss.net/12/C3229/2015/

Biogeosciences
Discussions
Open Access

Interactive comment on "Evaluating the Community Land Model in a pine stand with $^{13}CO_2$ labeling and shading manipulations" *by* J. Mao et al.

Anonymous Referee #2

Received and published: 30 June 2015

General Comments:

This paper combines a site level manipulation experiment (PiTs) of a young loblolly pine plot in Oak Ridge, Tennessee as a tool to test the model structure of CLM4. The authors use observations from two levels of shading to evaluate ecosystem response, and inject highly enriched 13CO2 into the atmosphere to evaluate model allocation of carbon biomass. The authors find that through calibration of a subset of parameters that the biomass pools, respiration and transpiration are captured fairly well. Based upon differences between del13C concentration in biomass pools and del13C in the soil respiration the authors determine that the existing fixed annual allocation methodology within CLM is insufficient to represent the observed patterns in carbon allocation.

They recommend the inclusion of a non-structural carbohydrate pool to help delay the allocation of carbon to plant tissue. In addition they recommend a dynamic allocation sub-model that is influenced by environmental conditions rather than the existing fixed annual allocation approach.

This reviewer felt it was unclear how the model was initialized from the spinup- phase to the sapling state in 2003. Was a disturbance imposed and/or the biomass characteristics of the sapling simply prescribed into the model? In addition, it was also left unclear which sets and how much of observed data were used in the calibration phase and which were withheld (e.g. the light response data).

Although the authors demonstrate that the existing formulation is deficient in simulating allocation timing, it was less clear whether this formulation was insufficient in simulating multi-year to decadal allocation. I would have welcomed more discussion of model skill in terms of the model simulation of biomass variables from 2003-2010 against observations (Figure 3) to help contribute to this discussion. The data is already there in Figure 3, it just needs to be evaluated, and perhaps shown more clearly than in a log plot.

Finally, C13 labeling, as demonstrated here, is used as a means to an end in order to evaluate simulated allocation and timing. To that effect, C13, isotopes and isotopic fractionation are not the focus of the paper, however, the author gives the impression that the model itself is a passive placeholder for C13. In reality, the model is imposing its own mechanistic representation of C13/C12 photosynthetic fractionation upon the canopy air and is actively partitioning against the heavier C13 isotope during the photosynthetic process. The degree of fractionation is dependent upon stomatal conductance, assimilation rate and nitrogen limitation, which in turn are dependent upon environmental variables. Although this fractionation mechanism may be relatively minor as compared to the overwhelming signal of the injection of enriched 13CO2, this reviewer would have benefitted from a more careful discussion of the simulated behavior in biomass pool del13C behavior in Figure 6. How much did the modeled fractionation processes contribute to the model-data mismatch both in terms of bias and trend, if at all?

In general, this paper represents a valuable fusion between manipulated site level experiment to test and improve CLM skill, and recommends acceptance with revisions based upon the suggestions mentioned above.

Specific Comments:

How was the model initalized after the spinup? Was a harvest or planting initiated at 2003 or were the sapling biomass variables prescribed into the model? Only in the results section does it become clear that the simulation was started from near bare ground in 2003 and then run forward. This should be described more carefully in the methods.

Although there were many measurements taken at the site, it was unclear what were actually used for the calibration, how many data points, and at what temporal resolution.

Page 6979, Line 19: Should read 13CO2.

Page 6981 Line 26: I would say standard 'parameter' CLM version, instead of just standard CLM because this is confusing whether you mean parameter or structure.

Page 6985: Lines 3-6: An increase in soil respiration suggests increase in root respiration? How do you not know it isn't increased soil carbon respiration?

Page 6986: lines 5-10, The fact that the model overestimates the del13C could be a function of allocation turnover time or the fractionation process itself. Did you demonstrate what the pre-treatment fractionation process is...? Could have taken pretreatment del13C leaf samples and gotten a baseline for the fractionation process itself. It could be useful to account for the influence of fractionation on model output, and help distinguish issues with the fractionation vs. pool turnover and allocation.

Page 6987 Line 11 The leaf level light response data was not used in calibration, but I

am not completely clear what was included.

Page 6987 Line 17 You found that the seedling biomass was important for the simulation, so did you use that as a calibration tool? You only show in table 1, the parameters that were being optimized, but if state variables are also optimized this needs to be included in table 1.

Page 6989, line 23: "The simulation does not show any difference in respiration between LS and HS plots prior to the shading". But that's the same for all variables, shown in Figures 4,5 and 6. Why would it not be this way? Aren't these simulated exactly the same way between plots, or did you calibrate individually? It was my impression that the only thing that would make a simulation difference would be imposing different meteorological conditions at the point of shading. Nothing was different before this between the state of the LS and HS plots as far as the model was concerned. This is not the model's fault, and you would have to optimize or initialize the model based on subplot characteristics to get different pre-treatment simulations.

Page 6990 Lines 12-25: "It is clear from this study that additional work is needed to improve allocations schemes in CLM." I would tend to agree with this statement if we are concerned with diurnal scale variation (as show in this paper, and even then it doesn't seems quite so much an allocation problem, but a timing, or staging problem, i.e. assimilated carbon is too quickly allocated to biomass and respired), perhaps seasonal allocation variation (not specifically addressed in this paper). Has this been demonstrated for decadal time scale allocation and growth? Isn't a better indicator of model skill how well the biomass variables were estimated from start (2003) to treatment (2010) (Figure 3a). The log scale makes it hard to see, but it would appear that the calibrated simulation provides biomass variables consistent with observations, and isn't this the time scale more relevant for climate, perhaps the simple allocation scheme isn't bad for longer time frame..?

Page 6992, Line 15. ....'[the model]' is not able to reproduce the observed patterns of allocation as revealed by the 13C labeling experiment."

I thought this was too strong a statement: certainly the labeling experiment demonstrated deficiencies in model timing of the allocation, but ultimately this statement is based upon the growth patterns based upon DBH in Figure 5, which in itself was a proxy for biomass based on allometric assumptions and highly variable based on water status. It does seem like the model overestimates stem growth on this short time scale, but again is this consistent with longer term allocation as shown in Figure 3a? This might make for an interesting comparison if this short time scale overestimation in growth translates to 7 year allocation. The stem biomass seems to be captured quite well.

Figure 1: Labeling of relative humidity should be consistent. Hr and RH should be same thing. Choose one.

Figure 3a: Log scale, although convenient in order to apply all biomass simulations on one plot, makes it very difficult to assess the simulated vs. observed biomass variables. Do they agree within error. . ..hard to say.

Interactive comment on Biogeosciences Discuss., 12, 6971, 2015.