Biogeosciences Discuss., 10, C2418–C2420, 2013
www.biogeosciences-discuss.net/10/C2418/2013/

Biogeosciences
Discussions
Open Access

Interactive comment on "The effect of vertically-resolved soil biogeochemistry and alternate soil C and N models on C dynamics of CLM4" *by* C. D. Koven et al.

Anonymous Referee #2

Received and published: 31 May 2013

Review of "the effect of vertically-resolved soil biogeochemistry and alternate soil C and N models on C dynamics of CLM4" by Koven et al.

This is a clearly written paper. It documents the new soil biogeochemical models as implemented in one of leading global land surface models, CLM. The authors clearly explained what the new models can do, and cannot do. This work is a significant contribution. I recommend it for publication after some minor revisions. P3. On L13-15. It is not always true that single-layer approach has an implicit assumption about the depth (30 cm) of soil C the model represents. In theory, the single-layer model simulates all C in the rooting zone. Many single-layer models underestimates soil C because they overestimate the soil C turnover rates, as limitations from oxygen and other factors are

not accounted for. P9. Eqn (7). In the field, it is difficult to distinguish between the effect of rz and other effects, such as the effect of oxygen supply. If the effect of oxygen has been accounted for by ro, why the effect of microsite anoxia is also included in rz. Does this account for the effect of oxygen twice? Should ro be dependent on the anaerobic fraction (see your eqn 12)? Much of the work by Arah and his colleague is related to soil aggregates. P13. Eqn (12). In theory, ïĄč increases with a decrease in soil temperature. Is that dependence significant? particularly for soil at high latitudes? P13. Eqn (13). As explained by Houlton et al. (2008, Nature) and Wang and Houlton (2009, GRL), equation (13) would predict higher N fixation rate in evergreen tropical forest than in tropical savannah, which is contradictory to observations. Does BNF in eqn (13) include both symbiotic and asymbiotic N fixation? A better way to capture the seasonal variation of BNF is to use the variation of canopy LAI and mean temperature. This may be future work for CLM, but needs to be discussed. The dependence of N fixation on temperature has been provided by Houlton et al. (2008). Wang et al. (2007, GBC) developed the first model of N fixation, and Wang and Houlton (2009) provided the first estimates of global BNF. P14, L 15. See my comments above. Houlton et al. (2008), Wang et al. (2007, GBC) and Wang and Houlton (2009) should be cited here, as they provided the first explanation of global N fixation variation. P14, L25-26. It remains controversial whether plants prefer NH4 to NO3. This should be noted here. P17. L1-3. The recent work on accelerated spinup by Xia et al. (GMD 2012) should be cited here. P17, section 2.6. It should be stated more explicitly whether variation of vegetation type in each land cell from land use and fire is accounted for, because this has implications on your simulated global carbon budget (Figure 12). P25, L18. Also cite the work by Aerts and Chapin (2000, Adv. Ecol. Res). P25, L26. Galloway et al. (2004)'s estimate BNF of 120 Tg N yr-1 does not include asymbiotic N fixation. More recent estimate of N export to river has been provided by Dumont et al (2005, GBC), and more recent estimate of denitrification loss by Bai, Houlton and Wang (2012, biogeoscience) using 15N data. Figure 11. Your estimate of denitrification loss is much higher than the estimate by Bai et al. (2012). This needs to be discussed. Figure 12.

If land use change is included, your simulated global land carbon change by all three versions of CLM agree with the other estimates, given the uncertainty of CO2 emission from land sue change. If land use change is not included, you should simulate a net land carbon sink about 80 150 Pg C from 1955 to 2005. Please clarify.

Interactive comment on Biogeosciences Discuss., 10, 7201, 2013.