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Interactive Comment

Interactive comment on "Earth System Models that simulate crops underestimate CO_2 emissions from land use by neglecting soil disturbance due to cultivation" *by* S. Levis et al.

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This analysis incorporates the soil carbon dynamics from DayCent (a biogeochemical ecosystem model) into an Earth System Model (the Community Land Model (CLM)) to simulate more accurately the loss of soil organic carbon resulting from cultivation of native soils, a well documented phenomenon. The authors claim that other Earth System Models underestimate the emissions of carbon from land use because they do not account for the enhanced decomposition of soil organic matter that results from cultivation. Their claim seems reasonable as long as other Earth System Models are like the CLM and "compute an instantaneous C flux to the atmosphere from the conversion

of unmanaged to managed (and vice versa) land; they do not include cumulative C effects of land cover change in the calculated flux for the years following the change. . ..” This reviewer does not know whether/how other ESMs calculate a loss of soil C from cultivation.

There are other reasons, besides accounting for soil carbon, why estimates of the emissions of carbon from land use and land management (LULM) as calculated by a bookkeeping model are different from those calculated by land biogeochemistry models (LBMs), and why estimates differ among LBMs (see Gasser and Ciais, 2013; Houghton, 2013; Pongratz et al., in review).

An issue not clear in the paper, that deserves attention, is the initial carbon stocks in the soils of the simulation experiments. The model experiments simulate the years 1973 to 2004 and assume that cultivation begins in 1973. Does the model start with estimates of soil carbon for 1973, for native soils (before any cultivation), or for current stocks? The initial content matters because existing agricultural soils in North America will have been cultivated for a century or more by 1973 and will already have reached a carbon equilibrium. They might not be expected to lose more carbon. The loss of carbon from soils in the bookkeeping analyses starts with native soils. Are there parameters in the model that account for the quality of organic matter? Presumably native soils have more carbon to lose than old agricultural soils. The issue would not change the main point of the paper, but it does deserve some discussion.

References

Gasser T, Ciais P (2013) A theoretical framework for the net land-to-atmosphere CO2 flux and its implication in the definition of “emissions from land-use change”. Earth Systems Dynamics Discussions,4, 179-217.

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Interactive comment on Geosci. Model Dev. Discuss., 6, 6639, 2013.