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Geoscientific Model Development Discussions

Interactive comment on "Global Transition Rules for Translating Land-use Change (LUH2) To Land-cover Change for CMIP6 using GLM2" *by* Lei Ma et al.

Anonymous Referee #1

Received and published: 21 August 2019

Review of gmd-2019-146: Global transition rules for translating land-use change (LUH2) to land-cover change for CMIP6 using GLM2

Summary

The authors present an analysis of how various land conversion rules affect forest area and biomass carbon over the historical period, when applied to the LUH2 land use data. The results are compared with several available data sets, and they find that while a few different rules may be reasonable, the rule corresponding to definitions of source land use data appears to be the most reasonable one to use. They conclude by recommending full clearing of vegetation for cropland, urban, and managed pasture

and clearing only for rangeland, when applying LUH2 data to ESMs and DGVMs.

Overall response

I, and I think many others, will be happy to see these results published. This is a necessary step toward improving estimates of LULCC effects on the earth system. The paper is relatively clear, but some additional clarification and discussion are needed. Please see the details following these main concerns:

1) The methods describing how vegetation fraction and land-use fraction are tracked (section 2.3) are not complete.

2) While there is some discussion of "forest area" vs "forest/tree cover," it is still unclear which metric is being used and discussed in the comparisons.

3) Please include discussion of the analytical rule results. You present the numbers, but do not tell us what they mean in terms of how particular transitions affect forest area and carbon dynamics.

4) It would be useful to see regional comparisons for carbon.

Specific suggestions and comments:

Abstract

page 1, line 23: "optimal" is a strong word here for a global transition rule. "most reasonable global transition rule. . ." may be more appropriate

Introduction

page 2, lines 9-10: this is a misleading statement not supported by the inappropriate reference (which is also quite old). it isn't necessarily the case that recovering or planted or re-planted forest has lower potential biomass many plantations or managed forests have higher growth rates than unmanaged forest, and in time could easily match or outgrow unmanaged biomass levels furthermore, the reference is about avail-

able land for afforestation, and does not compare afforested stands with corresponding primary stands. there are several recent papers that estimate carbon sequestration potential of forests. here is one example: griscom et al 2017: natural climate solutions in PNAS, oct 31 2017 vol 114 no 44 11645-11650

page 2, lines 18-22: awkward sentence that is difficult to read. split it up and bring the examples out of the parentheses

Methodology

page 5, lines 22-23: are there other factors not taken into consideration? is the climatology constant or does it vary with time? be specific here - state exactly what factors are or are not included

page 5, lines 26-29: what tree density or how much tree canopy cover will give 2 KgC/mˆ2? what defines potential forest area in the two comparison studies?

page 6, lines 5-28:

These equations are incomplete, and therefore confusing. Transitions from types 5-8 to 5-8 are not included for f-gained. As such we do not see that these types of gains account for the f/l ratios of the losing types 5-8. Transitions from types 1-4 to 1-4 are not included for losses or gains. Doesn't harvest move primary to secondary land? Are there any gamma factors for these transitions? Also, wouldn't abandoned ag land move to secondary first, then from secondary to primary? For this path from ag to secondary to primary, how is the abandoned ag vegetation fraction tracked over time?

Furthermore, there are corresponding equations for l(i,t+1), correct? But they are different because they track the land use transitions upon which the vegetation changes (without the gamma parameter that alters vegetation cover). This distinction and relationship between the two needs to be made clear.

page 6, lines 20-21: f(i,t) could also be equal to l(i,t)

page 6, lines 22-23: "these" is confusing. maybe delete "these" and make "land-use" at the end plural.

page 7, line 21: considering annual creation and discard of wood products and decay in landfills, these emissions can grow to be quite large over time.

page 7, lines 22-32: This does not appear to account for different areas of secondary land within a grid cell with different ages. Similarly to my comment above, if cropland is abandoned and has half natural secondary veg and half crop veg, there can be at least three different ages of secondary land in the cell. The number of different ages will grow with each transition. How is this dealt with? When does secondary become primary land again? Does primary land always have biomass density of B0?

page 8, line 25: do you expect a 30% tree cover threshold to correspond with GLM's 2 KgC.mˆ2 threshold? Also, are the >30% pixel areas used for the values in table 2, or are the values in table 2 pre-threshold tree cover fractions that were calculated?

page 10, lines 4-28: What numbers are you comparing here and in figures 3-4 and table 4? Are the six-dataset numbers the tree cover or the forest with cover >30%? What does GLM's biomass threshold represent in relation to these metrics? Also, there are a couple of other tree cover estimates that are much lower: see meiyappan and jain 2012 frontiers in earth science 6(2):122 and Li et al 2018 earth system science data, 10:219.

page 11: Can you make regional comparisons of LULCC emissions with info from the sources in table 3?

page 11, lines16-25: It would be helpful to see regional comparisons of carbon stock here.

page 12, lines 11-13: up to this point you report that rules 1-3 have the same forest area dynamics, which makes sense because forest is always cleared in all three rules. but here you state that there are differences between rules 1 and 2 for forest area.

please clarify why this is the case, and if they are different it needs to be noted early on, even if the differences are negligible.

page 12, lines18-30: This is repetitive of your methods. It would be more useful to have discussion of the alternative rules, which you include in your figures/tables, but do not comment on at all.

Figures and Tables

Figure 2 Only the results for rules 1-4 are shown, not all 9 as in the caption

Table 5 Do you mean compared with studies from table 3?

Figures 5 and 6 I don't see the black dashed line. is it hidden?

Figure 8 I suggest plotting them in rule # order - rules 1 and 2 appear to be switched

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