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Input-driven versus turnover-driven controls of simulated changes in soil carbon due to land-use change

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Modelling studies estimate a global loss in soil carbon caused by land-use changes (LUCs) over the last century. Although it is known that this loss stems from the changes in quantity of litter inputs from the vegetation to the soil (input-driven) and the changes in turnover of carbon in the soil (turnover-driven) associated with LUC, the individual contribution of these two controls to the total changes have not been assessed. Using the dynamic global vegetation model JSBACH, we apply a factor separation approach to isolate the contribution of the input-driven and turnover-driven changes, as well as their synergies, to the total changes in soil carbon from LUC. To assess how land management through crop and wood harvest influences the controls, we compare our results for simulations with and without land management.

Our results reveal that for the afforested regions both the input-driven and turnover-driven changes generally result in soil carbon gain, whereas deforested regions exhibit a loss. However, for regions where croplands have increased at the expense of grasslands and pastures, the input-driven changes result in a loss that is partly offset by a gain via the turnover-driven changes. This gain stems from a decrease in the fire-related carbon losses when grasslands or pastures are replaced with croplands. Omitting land management reduces the carbon losses in regions where natural vegetation has been converted to croplands and enhances the gain in afforested regions. The global simulated losses are substantially reduced from 54.0 Pg C to 22.0 Pg C, with the input-driven losses reducing from 54.7 Pg C to 24.9 Pg C. Our study shows that the dominating control of soil carbon losses is through the input-driven changes, which are more directly influenced by human management than the turnover-driven ones.