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Reconciling global land model estimates and country reporting of anthropogenic land CO2 sources and sinks with the CMIP6 LUMIP NOAA/GFDL LM4.1 simulations

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Global land models, which often served as components Earth system models, and national GHG inventories rely on different methods and produce different estimates of anthropogenic CO_2 emissions and uptakes from land use land cover changes throughout historical period. For example, for 2005 -2014, the sum of the national GHG inventories net emission estimates is 0.1 ± 1.0 GtCO2 yr^{-1} while the bookkeeping models is 5.2 ± 2.6 GtCO2 yr^{-1} (IPCC SPM 2019). Previous estimates with the 16 global stand-alone land models produced an estimate of the net land sink of 11.2 ± 2.6 GtCO2 yr^{-1} during 2007– 2016 for the natural response of land to human-induced environmental changes such as increasing atmospheric CO_2 concentration, nitrogen deposition, and climate change (IPCC SPM 2019). However, these 16 models do not provide separate estimates for the managed and unmanaged lands.

Here we use results from simulations with the NOAA/GFDL new land model LM4.1 from the CMIP6 Land Use Model Inercomparison Project (LUMIP) to demonstrate how to reconcile the discrepancy between the inventories and land models estimates of the anthropogenic CO_2 land emissions by using bookkeeping accounting approach applied to the model results. In addition, we separate estimates of land fluxes on managed and unmanaged lands. Key features of this model include advanced, second generation dynamic vegetation representation and canopy competition, fire, and land use representation driven by full set of gross transitions from the CMIP6 land use scenarios. We demonstrate how bookkeeping accounting combined with the LUMIP experiments can enhance understanding of land sector net emission estimates and their applications.