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Changes in terrestrial carbon fluxes, stocks, and residence times over recent decades using TRENDY DGVMs

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Net terrestrial carbon uptake is primarily driven by increases in net primary productivity (NPP) and by the residence time of carbon in vegetation and soil. As such, it is of critical importance to accurately quantify spatio-temporal variation in both terms and determine their drivers. Both NPP and residence times are modulated by changing environmental conditions, including climate change and variability, atmospheric CO_2, and Land Use and Land Cover Changes (LULCC). For the historical period, 1901-2017, outputs from a suite of Dynamic Global Vegetation Models (DGVMs) from the TRENDY consortium, driven with observed changes in climate, CO_2, and LULCC are analysed. Changes in global and regional carbon fluxes, stocks, and residence times are quantified, as well as an attribution to the underlying drivers. Using 16 models allows to quantify uncertainty and gives an indication to the level of confidence in these results. We find that over the historical period the majority of models simulate an increase in NPP, predominantly driven by enhanced atmospheric CO_2 concentrations. This generally leads to increased carbon storage in both vegetation and soils. However, this increase acts to reduce soil carbon residence times due to a relative increase in carbon allocated in the faster decomposing soil pools. LULCC over this period has acted to reduce carbon inputs to the system and reduce vegetation carbon residence times due to conversion of forests to shorter vegetation. Further, we evaluate the ability of the DGVMs to simulate these carbon cycle processes, by using the International Land Model Benchmarking (ILAMB) system. Our initial model evaluation indicates models under-predict soil carbon residence times and stocks. Further, there is a large variation in simulated global and regional fluxes, stocks, and residence times, implying there are considerable uncertainties in current DGVMs.