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The contemporary Amazon Forest carbon budget

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The Amazon is the largest continuous tropical forest in the world and plays a key role in the global carbon cycle. Human-induced disturbances (e.g., deforestation and wildfires) in combination with climate change have impacted its carbon cycling. However, uncertainties remain on the magnitude of carbon fluxes associated with human-induced disturbances and the old-growth forest sink, and thus the net land carbon balance of the Amazon. Here we synthesize state-of-the-art estimates of the land carbon flux components in the Amazon. To quantify the human-disturbance fluxes from deforestation, land use and land cover changes and degradation, we use a set of bookkeeping models. The annual intact sink was quantified using a set of 16 Dynamic Global Vegetation Models (DGVMs). We then combine the carbon flux estimates from disturbances with the intact sink estimates to provide a bottom-up estimate of the net land carbon flux and compare them alongside top-down estimates from atmospheric model inversions. Between 2010 and 2018, the net land carbon flux in the Brazilian Amazon estimated with the bottom-up approach was $-59 (\pm 160) \text{ Tg C yr}^{-1}$ and $+36 (\pm 125) \text{ Tg C yr}^{-1}$ with the top-down approach. Despite disagreeing on the sign of the flux, this analysis suggests that the Brazilian Amazon was on average near carbon neutral over the 2010-2018 period, given the large uncertainties underlying both methods. The net land carbon fluxes for the years 2019 and 2020 based on the bottom-up approach were larger than for 2010-2018. This is likely primarily due to direct emissions related to an increase in deforestation although it may possibly be partly caused by a weakening of the forest carbon sink, both in response to deforestation and a warming climate. Spatially, both methodologies agree that the south-eastern Amazon was a net carbon source over the whole study period. These results have important implications for the mitigation potential of Brazilian ecosystems within the goals of the Paris Agreement.

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