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Bottom-up and top-down constraints on the greenhouse gases budget in the terrestrial biosphere

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The atmospheric concentrations of the three major well-mixed greenhouse gases (GHG), including carbon dioxide (CO_2), methane (CH4) and nitrous oxide (N2O) continue to increase. Together, they contribute to 87% of anthropogenic climate warming due to long-lived GHG since 1750. Although global terrestrial CO_2 uptake partially mitigates climate warming, its contribution may be offset or even overturned by the increasing biogenic emissions of methane (CH4) and nitrous oxide (N2O). Of particular importance to climate change mitigation policies is the ability to evaluate the net balance of three GHGs in the terrestrial biosphere. Here we synthesized multiple estimates of CO_2, CH4 and N2O from various studies to investigate the net biogenic GHG budget (NBGB) on global and regional scales. Based on 22 bottom-up studies using terrestrial biosphere models, empirical and inventory-based approaches and 7 top-down studies using atmospheric inversion models, we conclude that terrestrial ecosystems globally were a contributor to the increased atmospheric radiative forcing over the past three decades. Biogenic CH4 and N2O emissions have overwhelmed the global land CO_2 sink, contributing to global warming. While there has been increasing attention to mitigating climate change through afforestation, reforestation and deforestation avoidance, our result indicates that effective agricultural management strategies are greatly needed to alleviate biogenic GHG emissions, mitigate climate warming, while sustaining food and bioenergy production.