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Stable carbon isotope evidence for large terrestrial carbon inputs to the global ocean

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The transport of carbon from land to ocean, via rivers, groundwater, and aerosols, is an important component of the global carbon cycle that must be known to assess anthropogenic CO_2 storage on land and ocean. Thus far, global carbon cycle budgets have adopted terrestrial carbon inputs to the ocean ranging from 0.5 to 0.9 GtC/yr, derived mainly from estimates of riverine fluxes. However, these budgets ignore the terrestrial carbon input from coastal ecosystems and through submarine groundwater discharge due to difficulties in making global assessments. Here we use a numerical model and globally distributed ocean observations of stable carbon isotopes to estimate the preindustrial and present-day rates of terrestrial carbon inputs to the ocean as 1.2-1.8 GtC/yr, with the largest fluxes occurring in the Pacific and Indian Oceans. This terrestrial carbon flux is balanced by the carbonate burial of 0.2 GtC/yr in marine sediments and the efflux to the atmosphere of 1.0-1.6 GtC/yr, 40% of which occurs in the coastal ocean that has not been included in the observation-based global estimate. Our study suggests that the net carbon flux between the land, ocean, and atmosphere is greater than previously assumed and that rivers are not the dominant pathway for terrestrial carbon to the ocean.