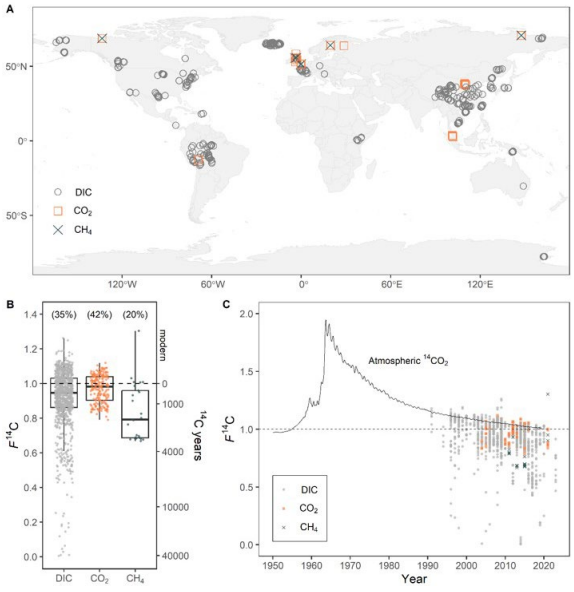
Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28550

Old carbon routed from land to the atmosphere by global river systems

JOSHUA DEAN[1], GEMMA COXON[1], YANCHEN ZHENG[1], JACK BISHOP[1], MARK H GARNETT[2], DAVID BASTVIKEN[3], VALIER GALY[4], ROBERT SPENCER[5], SUZANNE TANK[6], EDWARD T. TIPPER[7], JORIEN VONK[8], MARCUS WALLIN[9], LIWEI ZHANG[10], CHRIS EVANS[11] AND ROBERT HILTON[12]

[1]University of Bristol
[2]NEIF
[3]Department of Thematic Studies - Environmental Studies
[4]Woods Hole Oceanographic Institution
[5]Florida State University
[6]University of Alberta
[7]University of Cambridge
[8]Vrije Universiteit Amsterdam
[9]Swedish University of Agricultural Sciences
[10]East China Normal University
[11]UK Centre for Ecology & Hydrology
[12]University of Oxford



Rivers and streams are an important pathway in the global carbon cycle, releasing carbon dioxide (CO_2) and methane (CH_4) from water surfaces to the atmosphere. Until now, CO_2 and CH_4 emitted from rivers were thought to be predominantly derived from recent (sub-decadal) biomass production, and thus part of ecosystem respiration. Here we combine new and published measurements to create a global database of the radiocarbon content of river dissolved inorganic carbon, CO_2 and CH_4. Isotopic mass balance of our database suggests that 59 ± 17 % of global river CO_2 emissions are derived from old carbon (millennial or older), the release of which is linked to river catchment lithology and biome. This previously unrecognised release of pre-industrial aged carbon to the atmosphere from long-term soil, sediment and geologic carbon stores via lateral hydrological routing equates to 1.2 ± 0.3 Pg C yr^{-1}, similar in magnitude to terrestrial net ecosystem production. A consequence of this flux is a greater than expected net loss of carbon from aged organic matter stores on land. This requires a reassessment of the fate of anthropogenic carbon in terrestrial systems, and in global carbon cycle budgets and models.