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Sources and fate of dissolved inorganic carbon in rivers of Switzerland

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Each year, rivers export more than one teragram of carbon out of Switzerland as dissolved inorganic carbon (DIC), integrating diverse atmospheric, terrestrial, and aquatic carbon sources over their catchments. However, the contributions of the different carbon sources to riverine DIC – and thus the implications of DIC dynamics for the global carbon balance and climate – remain uncertain. Building upon the 50-year dataset from the national long-term river monitoring network of Switzerland (NADUF), we attempt to predict the vertical CO₂ fluxes between rivers and the atmosphere, and to quantify catchment-scale DIC production through rock weathering, leaching of soil-respired CO₂, and mineralization of organic carbon during fluvial transport. Supported by the national network of groundwater monitoring sites (NAQUA) and soil sampling sites covering Switzerland, a Bayesian mixing model disentangles the sources of riverine DIC using measured data of carbon and water isotopes (¹⁴C, ¹³C, ²H, ¹⁸O), as well as ion concentrations. The exchanges between river DIC and atmospheric CO₂ across the air–water interface are predicted with a diffusion model, validated with measurements of the CO₂ flux and isotopes from in situ floating-chamber experiments. Our predictions of the DIC source contributions and the net CO₂ flux from rivers help to elucidate the role of DIC in the carbon balance of alpine and perialpine river catchments, and contribute towards closing the national carbon budget of Switzerland.