Investigating the sources and drivers of inorganic carbon to Australian streams using isotopic approaches

Abstract

The export of terrestrial carbon through aquatic ecosystems is a key component of the global carbon cycle. Riverine carbon (i.e. the carbon that is transported by rivers) can originate from terrestrial ecosystems ('biogenic' carbon) or the weathering of rock material ('geogenic' carbon), yet the relative contributions of these two sources to riverine carbon export remain poorly understood. To assess these contributions, we collected samples from 161 rivers across tropical and temperate rivers in Australia. Riverine DIC and CO2 concentrations spanned from 46.7 to 9773.4 mmol/L and 15.7 to 1711.7 mmol/L, respectively. δ13C-DIC and δ13C-CO2 ranged from -28.4‰ to -5.8‰ and from -12.1‰ to -28.9‰, respectively. Hydrochemistry and isotope data indicate a minimal influence of rock weathering processes, with biogenic carbon being the predominant source of riverine carbon at >80% of the sites. DIC and CO2 concentrations were driven by climatic factors, catchment areas, and river network connectivity, with higher concentrations observed in the tropics compared to the temperate region. The hydrological shift between wet and dry seasons played an important role in carbon distribution, with higher DIC and CO2 concentrations in the dry season compared to the wet season. Moreover, we found that degassing was a key driver of CO2 concentrations and isotopic composition. This research represents the first step towards constructing a national-scale framework for identifying and understanding the sources and dynamics of carbon in Australian rivers. Ultimately, our work will contribute to improving the Australian carbon budget and assessments of the amount of carbon stored on land.