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Quantifying the magnitude and spatiotemporal variation of aquatic CO_2 fluxes in a sub-tropical karst catchment, Southwest China

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The role played by rivers in regional and global C budgets is receiving increasing attention. A large portion of the carbon transported via inland waters is returned to the atmosphere by carbon dioxide evasion from rivers and lakes. Karst landscapes represent an important C store on land, and are also considered to play an important role in climate regulation by consuming atmospheric CO_2 during chemical weathering. However, we cannot be certain how effective this sink is if we do not know how efficiently the rivers draining karst landscapes remobilise weathered C to the atmosphere as CO_2. pCO_2 in karst waters is generally greater than atmospheric equilibrium, indicating that there can be a net CO_2 efflux to the atmosphere. However, measurement confirming this and quantifying flux rates has been rarely conducted.

Using a floating chamber method, in 2016 we directly measured CO_2 fluxes from spatially distributed freshwaters (springs, sinkholes, streams and reservoirs/ponds) in the Houzhai Catchment, a karst region in SW China. Fluxes ranged from -0.5 to +267.4 μmol CO_2 $m^{-2}s^{-1}$, and most sites showed seasonal variations with higher CO_2 efflux rates in the wet (April - September) than dry season (October - March). There was a significant positive relationship between CO_2 efflux and flow velocity, indicating that hydraulic controls on CO_2 efflux from flowing water are important, while for water with little movement (sinkholes and reservoirs/ponds), pCO_2 appears a more important control on efflux rates.

Conditions similar to this study area may exist in many sub-tropical rivers that drain karst landscapes in South China. These waters are rich in DIC which can be an order of magnitude greater than some non-karst catchments. The large DIC pool has the potential to be a considerable source of free CO_2 to the atmosphere. Considering that carbonate lithology covers a significant part of the Earth's surface, CO_2 evasion in fluvial water from these regions is expected to contribute notably to the annual carbon dioxide release from global freshwater systems, thus must be better represented in global spatial analyses of CO_2 evasion. This research advances this need.