The CO_2 system and its outgassing effect from the Yarlung Tsangpo River on the Tibetan Plateau

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Rivers, lakes and other inland waters are important agents in the coupling of biogeochemical cycles between land, atmosphere, and oceans. Global-scale assessments of carbon (C) suggest that C discharged to the oceans is only a subordinate fraction, with most of the C influx returned to the atmosphere from inland waters as CO_2). Most research on this topic have collected data from low alkalinity and high nutrient concentration rivers in low altitude regions. Therefore, it remains unclear what role Plateau Rivers play in the current paradigm. Here we report the hydrochemical characteristics and dissolved carbon (DC) fluxes of the upper and middle reaches of the Yarlung Tsangpo River (YTR) on the Tibetan Plateau (TP). The results show that the water chemistry is mainly controlled by carbonate weathering, with Ca^{2+} and HCO_3^- being the dominant ions under weakly alkaline water conditions. The mean partial pressure of CO_2 (pCO_2) and emission flux were 899 atm and 56.1 mmol/m2.d, respectively, which are lower than that of global river waters. Considering the dissolved inorganic carbon (DIC) isotopic signature and the equilibrium-supersaturating state of calcite in water, carbonate precipitation may be the dominant process of producing CO_2, such that pCO_2 would not accumulate in waters under these hydrochemical equilibrium conditions, resulting in lower pCO_2 values. Analysing the watershed C balance estimated that 16.6 % of the C was degassed during fluvial transport, suggesting a weak CO_2 outgassing effect in the plateau river. These findings indicate the significance of chemical weathering, which produces DIC and a carbonate buffering capacity that can modulate pH, carbonate equilibrium, and CO_2 outgassing in rivers on the plateau. Our study suggests that a careful reassessment of CO_2 evasion and C fluxes in river ecosystems of the plateau and global carbon budgets is needed, with full consideration of their sources and characteristics.