Groundwater-derived dissolved inorganic and organic carbon exports from a mangrove tidal creek: The missing mangrove carbon sink?

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ABSTRACT: A majority of the global net primary production of mangroves is unaccounted for by current carbon budgets. It has been hypothesized that this "missing carbon" is exported as dissolved inorganic carbon (DIC) from subsurface respiration and groundwater (or pore-water) exchange driven by tidal pumping. We tested this hypothesis by measuring concentrations and $\delta^{13}C$ values of DIC, dissolved organic carbon (DOC), and particulate organic carbon (POC), along with radon (^{222}Rn, a natural submarine groundwater discharge tracer), in a tidal creek in Moreton Bay, Australia. Concentrations and $\delta^{13}C$ values displayed consistent tidal variations, and mirrored the trend in ^{222}Rn in summer and winter. DIC and DOC were exported from, and POC was imported to, the mangroves during all tidal cycles. The exported DOC had a similar $\delta^{13}C$ value in summer and winter (~ −30‰). The exported $\delta^{13}C$-DIC showed no difference between summer and winter and had a $\delta^{13}C$ value slightly more enriched (~ −22.5‰) than the exported DOC. The imported POC had differing values in summer (~ −16‰) and winter (~ −22‰), reflecting a combination of seagrass and estuarine particulate organic matter (POM) in summer and most likely a dominance of estuarine POM in winter. A coupled ^{222}Rn and carbon model showed that 93 ± 99% of the DIC and 89 ± 92% of the DOC exports were driven by groundwater advection. DIC export averaged 3 g C m^{-2} d^{-1} and was an order of magnitude higher than DOC export, and similar to global estimates of the mangrove missing carbon (i.e., ~ 1.9 ± 2.7 g C m^{-2} d^{-1}).