Hydrologic forcing of submarine groundwater discharge: Insight from a seasonal study of radium isotopes in a groundwater-dominated salt marsh estuary

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ABSTRACT: A seasonal study of radium-derived submarine groundwater discharge (SGD) and associated nitrogen fluxes was carried out in a salt marsh estuary between 2001 and 2003 (Pamet River Estuary, Massachusetts). Twelvehour time series of salinity and radium at the estuary inlet were used to determine the relative importance of fresh versus saline SGD, respectively. The distinct radium (^{228}Ra : ^{226}Ra) isotopic signature of marsh peat pore water and aquifer-derived brackish groundwater was used to further partition the Ra-derived SGD estimate. Of these three groundwater sources, only the marsh-derived groundwater was constant across time. The ratio of brackish to fresh SGD was inversely correlated with water table elevation in the aquifer, suggesting that Ra-derived SGD was enhanced during dry periods. The various SGD fluxes were responsible for an average annual dissolved inorganic nitrogen (DIN) input of between 1.7 mol m^{-2} yr^{-1} and 7.1 mol m^{-2} yr^{-1} and a soluble reactive phosphate (SRP) flux of 0.13-0.54 mol m^{-2} yr^{-1}. Approximately 30% of the SGD-derived DIN and SRP flux is exported to coastal waters (Cape Cod Bay), whereas 70% is retained by the salt marsh ecosystem.