The porewater carbon pump

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The coastal carbon cycle is often thought to be driven primarily by a combination of allochthonous river inputs and internal cycling. Porewater and groundwater flows driven by a number of physical processes are ubiquitous in coastal environments. These advective flows significantly increase the surface area of substrates available for biogeochemical cycling. A common transformation is the conversion of particulate organic carbon into dissolved organic (DOC) and inorganic (DIC) carbon. As a result, porewater and groundwater often have high loads of carbon dioxide, methane, alkalinity, DIC and DOC that may eventually be released to surface waters. We have investigated whether submarine groundwater discharge and/or porewater exchange represent sources of dissolved carbon species to the coastal ocean. Experimental work has been performed in coastal wetlands, mangroves, coral reefs, embayments, estuaries, tidal rivers, and intertidal flats. By combining high resolution observations of carbon parameters and their stable isotopes to natural tracers (i.e., radon and radium isotopes), we revealed that groundwater and porewater were major drivers of carbon cycling in most of the coastal systems investigated. Groundwater and porewater functioned as allochthonous and/or autochthonous facilitators of carbon cycling. In some cases, carbon fluxes and transformation within porewater were the single most important driver of carbon cycling, accounting for nearly 100% of carbon dioxide and methane outgassing to the atmosphere. We suggest that groundwater and porewater exchange are key components of coastal carbon budgets as important as river inputs and internal cycling processes.