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Tracing Coastal Carbon Cycling Dynamics with U-Th Isotope Systems in the Gulf of Maine

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Despite constituting less than ~10% of the world's ocean area, coastal regions host ~20% of marine primary production and influence biogeochemical cycles on a global scale. Facing the immediate impacts of heightened anthropogenic activities, uncertainty regarding the cycling of carbon in these highly productive waters remains and limits our understanding of how coastal carbon budgets might change with increased anthropogenic forcing. Here, we combine size-fractionated high-volume pumping, dual Thorium-234 and Thorium-230 isotope systems, a novel resuspension proxy RAp234, and a one-dimensional biogeochemistry model; this combination enables us to unravel the effects of scavenging by surface biological production and sediment resuspension processes, and allows for the quantification of organic carbon export. The Gulf of Maine is a characteristic open-shelf region that exhibits complex coastal dynamics such as river discharge, intense mixing, and sediment resuspension that pose challenges for effectively constraining coastal carbon variability. The few studies to date investigating these coastal carbon fluxes have shown pronounced, full water column deficits of Th-234 relative to its parent U-238, suggesting that export of organic carbon persists at depth below the productive euphotic zone region. To determine the various contributions to these observed fluxes, and explain particle scavenging rates at depth, we utilize the above novel method pairings to consider factors other than biological export, like resuspension of bottom sediment, that could significantly influence these fluxes. In addition, the comparison between our data and the outcomes provided by the particle flux model will help quantify and identify potential factors contributing to the significant deficit that is observed at our site. This research aims to integrate observational data with modeling techniques, deepen our understanding of factors contributing to thorium flux, and help inform future modeling efforts seeking to assess coastal zones on a global scale.