Contrasting rates of thorium and particle cycling in different oceanographic environments along the US GEOTRACES North Atlantic Section

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Thorium is an important tracer for the cycling of marine particles and their associated chemical consituents, including carbon, nutrients, and trace metals. Its use as a tracer of processes in the modern and past oceans derives from its high particle reactivity and its radioactive isotopes characterized by very different half-lives ($t_{1/2}$ = 24.1 days for ^{234}Th, 75,584 yrs for ^{230}Th, and 1.91 yrs for ^{228}Th). We have recently applied a generalized nonlinear least-squares method to fit a Th and particle cycling model to Th isotope and particle data from station GT11-22 of the US GEOTRACES North Atlantic section (GA03). The analysis of the fit residuals indicated that a version of the model with depth-dependent rate parameters (rate constants of Th adsorption, k_1, Th desorption, k_{-1}, and particle remineralization, β_{-1}, as well as particle sinking speed) more accurately describes the data than a version with uniform rate parameters.

In our presentation we will use this method to estimate these important rate parameters in contrasting biogeochemical environments along the GA03 section from data, or observational estimates, of dissolved (<0.45 μm) and particulate (>0.8 μm) ^{228,230,234}Th, ^{230,234}U, ^{228}Ra, and particle concentration. These environments include, e.g., the biologically productive region off the northwestern African coast, the oligotrophic subtropical gyre, and sites influenced by the hydrothermal activity near the Mid-Atlantic Ridge. In particular, we will document the spatial variations of the rate constant ratio, $K = k_1/(k_{-1}+\beta_{-1})$, which describes the relative importance of the attachment of Th to particles by adsorption vs. the release of Th from particles due to desorption and remineralization. In this way, we will elucidate the dominant mechanisms underlying the distribution of Th and particles in different biogeochemical environments in the North Atlantic.