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A comprehensive evaluation of the U-Salinity relationship in the Arctic Ocean and implications for the ^{238}U-^{234}Th method

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The ^{238}U-^{234}Th disequilibrium method is a key tool for constraining the export of carbon and the fluxes of other key elements out of the surface ocean. Uranium is thought to be conservative with respect to salinity in the oxygenated open-ocean and is often not measured directly in ^{234}Th -based studies. Because the difference in the activities of the parent ^{238}U and daughter ^{234}Th (t ½ ~ 24 days) is needed to determine the export of elements like carbon, it is important to understand the conditions that can create deviations in ^{238}U from the canonical U-Salinity relationship, and how these deviations could impact ^{234}Th-based estimates. The Arctic Ocean has the potential for ^{238}U deviations due to its expansive coastal shelves, which can act as a significant sink of uranium from the ocean, and the disproportionate contribution of fresh water from rivers, as uranium is primarily transported to the ocean by rivers. As productivity changes have already been observed throughout the basin, measurements of carbon export utilizing the ^{238}U-^{234}Th method are vital for monitoring the rapidly changing Arctic system.

To assess whether significant ^{238}U-salinity deviations could be present in the Arctic Ocean, we measured seawater ^{238}U activities using High Resolution Inductively Coupled Mass Spectrometry (HR ICP-MS) from samples collected across the Western Arctic during the GN01 U.S. GEOTRACES campaign in late summer-fall 2015. Samples were collected from a total of 35 locations spanning from the shallow Chukchi waters (~5 m surface samples) to the Amerasian Basin (sampling depth ~ 2100 m). Preliminary data analysis shows that most of the data with salinity 30-35 fall within the known uncertainties of the canonical U-salinity relationship, and ^{238}U at lower salinities (24-30) shows deviations. Replicate analyses from the Arctic seawater samples, archive samples from the central Pacific (US. GEOTRACES GP16), and standard water from the central Atlantic Ocean (BATS) will be used to constrain analytical uncertainties. Here, we will discuss the possible reasons for the observed divergence at low salinity and the effect of ^{238}U variability on ^{234}Th-based export estimates in the Arctic Ocean to make recommendations for future sampling efforts.