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Using long-lived radium isotopes as water-mass tracers in the North Sea and investigating their use for tracking artificial ocean alkalinization

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The North Sea's location has made it an object of oceanographic study for over 150 years. But within the more recent past, this shelf sea with its strong continental shelf pump system has captivated science's attention for a different reason: artificial ocean alkalinization (AOA). Through the enhancement of metabolic pathways or the addition of dissolved alkaline minerals into the ocean to draw down atmospheric CO_2, AOA seems to offer a compelling option to mitigate climate change. But without judicious thought, human interaction could come at great cost. Alkalinity plays an integral role within a system's biogeochemistry, and disruptions may result in large scale changes to small scale environments. But, within the North Sea, an extremely effective tracer of total alkalinity has been found, ^{228}Ra. This isotope along with ^{226}Ra, comprise the two long-lived isotopes of the Radium Quartet with half-lives of 1600yrs and 5.8yrs, respectively. As naturally occurring, sediment-derived radioisotopes, ^{228}Ra and ^{226}Ra have the potential to map the water-mass composition, the distribution patterns, and the associated timescales from shelf-sediment interaction to the open ocean. Furthermore, providing a possible method to shed light on the North Sea's water-mass distributions, changing alkalinity patterns, and the potential effects of AOA. Over the course of this study, we will identify the basin's key water-mass patterns and end members through the use of ^{226}Ra and ^{228}Ra, complemented by hydrological and carbonate parameters collected from the North Sea during the summers of 2018 and 2019 aboard the German research vessel Heincke. By employing inverse modelling techniques, we will investigate how AOA can cause changes on both a local and potentially global scale.