NSF OCE-1949660 (SUB00002236): Hawaii Aerosol Time-Series (HATS): Quantifying Marine Dust Deposition and Composition in an Oligotrophic Gyre
Award Time Period: 9/1/20-8/31/24
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Atmospheric deposition of dust and the fate of aerosol-derived trace elements in the ocean remain key uncertainties in the effort to understand global biogeochemical cycles. There is a clear need to test and improve estimates of total dust deposition fluxes alongside simultaneous observations of particle composition in the open ocean. This project will consist of a two-year land-based sampling effort and six seasonal cruises to accomplish three tasks.

(1.) Use the deposition flux of ^{7}Be measured from aerosols, precipitation, and the upper ocean inventory to directly estimate dust and aerosol trace element fluxes to Hawaii Ocean Time-series Station ALOHA, a representative and remote oligotrophic site. This region is characterized by a predictable seasonal variability in dust concentrations and precipitation and is an exceptionally applicable region for testing the limits of dust deposition techniques by observing seasonal variability in ocean-atmosphere coupling over a multi-year cycle.

(2.) Explore the extent to which seasonal variations in aerosol trace element flux to the surface of the North Pacific, and mineralogy of that input drive variability in the composition and inventories of marine particles.

(3.) Investigate the extent to which the fractional solubility of aerosol trace elements collected over the North Pacific shows temporal variability and calculate flux rates of soluble aerosol trace elements. Thus, this study will advance understanding of dust and soluble aerosol trace element flux from the atmosphere to the ocean and link that flux to upper ocean particle inventory, mineralogy, and chemical composition.

The combined results of this study will contribute a significant step forward in the application of geochemical tracers for quantifying atmospheric deposition to the remote ocean. Dust flux to the open ocean is a major input of biologically relevant trace elements, such as iron, and plays a vital role in marine biogeochemistry. Thus, the rate of dust flux must be well constrained to accurately model ocean productivity and biogeochemical cycles. The proposed study will advance understanding by producing estimates of dust deposition to the North Pacific, assessing aerosol trace element fractional solubility, and observing the coupling between dust flux and marine particle dynamics. Global and regional deposition models can use the results to ground-truth results and improve model performance.

The Hawaii Ocean Time-series Study Site Station ALOHA is located within the North Pacific subtropical gyre, at 22°45’N 158°00’W, approximately 100 km north of Oahu and in 4740 m of water (Figure 3). The area is characterized by warm (> 23°C) surface waters and a seasonally variable surface mixed layer of 10 – 120 m, above a relatively deep permanent pycnocline and nutricline (Karl & Lukas, 1996). Since 1988 it has been the site of the Hawaii Ocean Time-series (HOT), with approximately monthly research cruises to study core physical and biogeochemical parameters. As a result, the seasonal and interannual variability in water mass structure, biogeochemical processes, and primary and export production are well understood.