

Reconstruction of the Kuroshio Current Characteristics and Variability during the 20th Century Based on Coral Records from the Ryukyu Islands.

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The Kuroshio region is a critical area for monitoring global warming as it has been noted for a rapid rise in sea surface temperature (SST) at approximately twice the global average, and a potential decrease in salinity associated with alterations in the hydrological cycle under global warming (Wu et al., 2012. *Nature Climate Change*; IPCC AR6, 2021). Oceanographic variability around the Ryukyu Islands, situated in the main path of the Kuroshio, is closely linked to global climate phenomena such as typhoon intensification and the Pacific Decadal Oscillation (PDO) (Andres et al., 2009. *Geophys. Res. Lett.*; 2011. *J. Geophys. Res.*). In recent years, it has been shown that the large meander of the Kuroshio can induce (Sugimoto et al., 2025. *J. Oceanogr.*), and knowledge regarding the characteristics and short-term variability of the current has steadily expanded. However, the mechanisms underlying long-term variability of the Kuroshio remain poorly understood. This is partly because high-quality, continuous oceanographic observations are largely limited to the period after 1950, making it difficult to capture long-term trends and oscillations, including global warming and the PDO.

Pre-instrumental environmental records have been reconstructed using proxy records. One of the useful proxies for reconstructing oceanographic records is hermatypic corals. The coral skeleton is composed of aragonite, which records environmental information during their formation. Due to its rapid skeletal growth and longevity, it enables the reconstruction of long-term, high-resolution records, and its skeletal annual bands allow precise dating. Coupled determinations of oxygen-isotope and Sr/Ca records from coral skeletons can generate the separate SST and salinity datasets; thus, these proxies are widely used to reconstruct past oceanographic variability in coral habitats. Although long coral proxy records have been reported mainly from the South Pacific, Atlantic, and Indian Oceans, such records remain scarce in the Kuroshio region, the northern limit of global coral reef distribution.

In this study, we analyzed monthly resolved oxygen isotope ratios and Sr/Ca ratios in coral skeletons collected from Kume Island, Okinawa, located along the main path of the Kuroshio Current. From these records, we extracted monthly time series of SST and salinity over a 124-year period from 1900 to 2023. Time series analysis was conducted to examine the relationship between SST and salinity in Kume Is., Kuroshio variability, and long-term climate oscillations. The results revealed a long-term decrease in both oxygen isotope ratio and Sr/Ca ratio. Over the 20th century, SST showed warming trend of approximately 1.4°C, while salinity showed no significant long-term trend. Furthermore, we demonstrate that the relationship between SST and salinity in Kume Is. and the Kuroshio volume transport varies seasonally between the positive and negative phases of the PDO.

Keywords: coral, oxygen isotope, seawater temperature, salinity, Kuroshio Current, Pacific Decadal Oscillation