

ENSO Variability during the Little Ice Age from the Perspective of a Long Coral Record from the Western Pacific Warm Pool

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The Little Ice Age (LIA, ~1400-1700 CE) is a period of cool temperatures generally best expressed in records from Northern Hemisphere high latitudes, but which is variably expressed in the tropics. In particular, the nature of short-term tropical variability, such as the El Niño-Southern Oscillation (ENSO), is obscured by contradictory evidence. Although central Pacific corals and some South American sedimentary records indicate an increase in ENSO activity during the LIA, tree ring records from ENSO teleconnected regions are highly variable, and lake records from the Galápagos Islands and Ecuador show reduced ENSO activity in the LIA. However, the differing resolutions, physical means for recording ENSO events, and dynamical connections to the ENSO system complicate efforts to form a coherent interpretation of these conflicting proxy records. This study addresses the need for additional LIA proxy records that resolve individual ENSO events, record climate parameters directly impacted by ENSO, and are located in core ENSO-affected regions.

We investigate the nature of ENSO during the LIA by generating high-resolution climate time series from corals from Misima Island, Papua New Guinea (10.6°S, 152.8°E). Misima Island is located at the southern edge of the Western Pacific Warm Pool (WPWP), an important heat and moisture source for the climate system that is highly sensitive to ENSO events. Our monthly resolved fossil coral record of $\delta^{18}\text{O}$ and Sr/Ca variations spans the interval from ~1414-1645 CE, which we compare with similar variations in a near modern coral record (~1915-1945 CE) from this location. The fossil Misima coral $\delta^{18}\text{O}$ record, bandpass filtered to highlight ENSO frequencies, contains multidecadal variations in ENSO amplitude, consistent with what is observed in the modern instrumental record of ENSO variability. However, the standard deviation of the fossil $\delta^{18}\text{O}$ record is significantly reduced relative to that observed in the modern Misima coral $\delta^{18}\text{O}$ record, as well as that observed in century-scale records in modern corals from elsewhere in Papua New Guinea, despite a limited change in mean state. We also observe that the magnitude of the 1941/42 El Niño event, as captured in the near modern coral record, is larger than any El Niño event in 230+ years of fossil record. Taken together, our results imply that ENSO variability in the LIA is reduced relative to the twentieth century.

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