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A 335-year Coral-Based Reconstruction of Sea Surface Temperature along the Route of the Northeast Madagascar Current in the Tropical Southwestern Indian Ocean

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Over the past century, the Indian Ocean stands out as the fastest warming ocean in the world. Yet, the southwestern Indian Ocean (SWIO) faces challenges in acquiring in-situ observational data, both spatially and temporally. The limited availability of long term continuous high-resolution instrumental data in the SWIO hinders a comprehensive understanding of sea surface temperature (SST) variability and its intricate relationship with large-scale atmospheric and oceanic modes. This scarcity further hinders efforts to disentangle natural variability from anthropogenic influences. To address these limitations, we present a 335 yr continuous coral record of monthly SST reconstruction in the Indian Ocean based on proxy Sr/Ca, obtained from Ambodivahibe Bay, northeast of Madagascar.

Sampled from a strategic region under the control of the NW monsoon during austral summer and trade winds for the rest of the year, this unique long record provides insights into coral resilience in a coastal upwelling zone amidst the rapid pace of ocean warming, as well as long-term trade wind variability, which significantly impacts the temperature signature of the South Equatorial Current and the downstream Northeast Madagascar current (NEMC), subsequently influencing moisture delivery to the East African and Asian Monsoon regions.Our SST reconstruction uncovers annual to multidecadal variations in the tropical SWIO spanning from 1672 to 2007, highlighting the dynamic interplay between local and remote climate processes, each dominating at different time scales. Furthermore, this new record extends the existing coral Sr/Ca-SST monthly reconstructions in the SWIO back to the 17th century and underscores the enhanced capacity to reconstruct regional climate variability using proxy records from multiple sites. Particularly noteworthy is its ability to capture SST variations under the alternating influence of monsoon and trade winds. This new coral Sr/Ca record provides valuable initial SST reconstruction along the route of the NEMC, serving as an indicator of the long-term NEMC strength variability.