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Sub-seasonally resolved coral records of Caribbean sea surface conditions during the demise of the Maya civilization (∼AD 800-1050)

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We present a unique collection of annually banded fossil Montastraea coral colonies from Bonaire (Netherlands Antilles) in the southern Caribbean Sea that reveals growth between ∼AD 800-1050. Coincidentally, this time interval was known for the demise of the classic Maya civilization in the lowlands of the Yucatán Peninsula termed the Terminal Classic Period (roughly AD 750-1050). Explanations for the downfall ranged from foreign invasion to social turmoil, but paleoclimatic evidence suggests severe climate change such as prolonged dry cycles as the primary influence. The Bonaire corals provide the first sub-seasonally resolved proxy records of surface ocean conditions in the Caribbean region during the Terminal Classic Period, and are completely different than the terrestrial-driven and summer-influenced precipitation proxy records from locations in the Yucatán and the Cariaco Basin.

The corals display uninterrupted growth patterns ranging ∼30-60 years and overlap each other at various time periods during the Terminal Classic Period. Our preliminary coral radiocarbon ages will be refined by precise U-series dating. The aragonitic skeletons of modern and fossil Montastraea colonies have been analyzed for Sr/Ca and δ18O at sub-seasonal resolution as proxies of sea surface temperature (SST), sea surface salinity (SSS), and hydrological changes. Evaluation of the modern coral record provides a modern baseline condition as basis of comparison to track the changing SST and SSS in the southern Caribbean during the Terminal Classic Period. The modern record indicates that seasonal to interannual variability in southern Caribbean Sea coral δ18O is predominantly driven by SST where Sr/Ca and δ18O records are tightly coupled and in-phase reflecting a similar source of influence. However, the fossil coral records display distinct interannual variability and longer-term decadal variability (8-15 years) in both Sr/Ca and δ18O that are decoupled from each other indicating deviations in SSS and differences in primary drivers of proxy variability between past and modern conditions. In addition, interannual variability of the annual amplitude in δ18O were consistently higher in the fossil records than the modern coral while interannual variability of annual Sr/Ca amplitudes remained relatively uniform possibly indicating changes in the intensity of the seasonal SSS cycle. These differences were likely related to corresponding changes in the seasonal cycle of hydrologic balance during the Terminal Classic Period. Annually averaged Sr/Ca and δ18O records corroborate our findings and are also in agreement on the differing conditions between modern and Terminal Classic Period climate. Using the coral Sr/Ca and δ18O records, we were also able to reconstruct relative δ18O of seawater (proxy of SSS) and demonstrate significant positive anomalies of multiple 2-5 year periods representing high SSS events in the surface waters of the southern Caribbean Sea during the Terminal Classic Period. Finally, we expect to generate a total of about 250 years of sub-seasonally resolved proxy records of SST and SSS from fossil Bonaire corals.