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A calibration study of Sr/Ca ratios and δ18O to sea surface temperature and salinity in the West Pacific Warm Pool

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This study focuses on using Sr/Ca and δ^{18}O measurements on a coral skeleton drill core from Kosrae Island, Federal States of Micronesia, as proxies for local variations in sea surface temperature (SST) and sea surface salinity (SSS). The coral proxy records are calibrated to instrumental datasets between 1982 and 2012, to establish the equations quantifying their correspondence. From 1996 to 2012, we find very strong correlations between Sr/Ca and SST at monthly (r^2=0.62) and interannual (mean summer r^2=0.63, mean winter r^2=0.51, mean annual r^2=0.70) timescales. Relationships for each of these timescales become weaker when the entire calibration interval back to 1982 is used. This could be a result of limited SST variability at the site (1-1.5º seasonal cycle), which may amplify relatively small differences not due to temperature. Another explanation may be artifacts from large spatial averaging in the satellite SST data, which results in overly-strong cooling in the satellite data during some winters, especially in 1991-1992. Discrepancies due to spatial averaging of instrumental data are supported by the fact that stronger correlations are obtained when comparing Sr/Ca to a 1x1º resolution SST dataset, rather than 2x2º resolution (monthly r^2=0.62 and 0.55, respectively). For both monthly and interannual timescales, the correlations show similarly steep slopes (-0.08 to -0.12), steeper than most reported values and similar to slopes from abiotic precipitation experiments. The steep monthly Sr/Ca-SST slopes indicate that the coral is not greatly affected by "bio-smoothing", possibly due to extremely high growth rates (averaging 2cm/year). Over the top 15 cm of the core (2005-2012), the range of δ^{18}O variability is mostly accounted for by changes in SSS variability. Strong relationships between δ^{18}O and SSS are found at monthly (r^2=0.54) and interannual (summer wet season r^2=0.69, winter dry season r^2=0.36, mean annual r^2=0.56) timescales, with consistent slopes (0.25 and 0.40) in agreement with the range of estimates for this area. The winter dry season shows the weakest correlation, which may be explained by the previously-discussed spatial averaging of the instrumental datasets. SSS can be quantitatively reconstructed using Sr/Ca and δ^{18}O together, with a good correlation between instrumental and proxy SSS (monthly r^2=0.43). We conclude that Sr/Ca and δ^{18}O in this coral core are robust proxies for reconstructing SST and SSS variability in the region. The Sr/Ca-SST calibration is influenced by the resolution of SST data, and the δ^{18}O-SSS relationship may be similarly affected. Future calibration work will include measuring δ^{18}O back to 1982 and investigating the nature and source of any divergence between proxy and instrumental data back through time. The overall future project will include generating the full SST and SSS records to investigate West Pacific Warm Pool and ENSO variability over the past 250 years.