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Corals Do Not Lie About Their Temperature

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The Sr/Ca of Porites corals is probably the most quantitative proxy for paleo-climate research. However, there are still lingering doubts on how faithfully they record the SST when they grew their skeleton (Alibert, and McCulloch 1997; de Villiers et al., 1995). In order to test the reliability of the coral Sr/Ca as an SST proxy and to aid the selection of samples for the reconstruction of the SST in the Taiwan area for the past 100 years, we have conducted a detailed test at Lutao. This 4 km x 4 km islet is 30 km south east of Taiwan and in the path of Kuroshio, the western boundary current of the Pacific carrying heat from the tropics to the Arctics. We have drilled three 100 plus year cores from large living heads of Porites: one from the west side (W) and two from the north sides (N-I and N-II). Using our micro-sampling techniques (Shen et al. 1996), we have reconstructed the monthly mean SST from coral Sr/Ca for the periods of 1980-96 (W), 1981-95 (N-I), and 1971-84 (N-II). To establish modern instrumental SST, we used shipboard CTD to survey transects west and north of Lutao in September, 1998. We also measured SST using recording thermometers several times in 1996-2000. The west coast of Lutao is open to the deep (>1000 m) channel where a branch of Kuroshio flows through whereas the north shore is a shallow ridge in the shadow of the islet hence not directly exposed to the warm current from the south. Data for the transects clearly showed that the hydrography for these two coastal waters were different. The SST of the west was 30ºC and uniform down to 25 m. In contrast, the north side showed a SST of 28.5ºC and had a 1ºC gradient down to 25 m. The recording thermometers detected daily invasion of cold bottom water at N-1 site but not at W site, suggesting that the cooler SST for the north side might be caused by upwelling. Moreover, the SST for the west coast agree with those compiled in IGOSS to represent the large (100 km x 100 km) area average centered on Lutao. On the other hand, the cooler SST on the north side seemed to be an anomaly caused by local conditions (surface wind, shadow effect of the islet, etc.). Surprisingly, the N-II site, which is only 1.5 km away from N-I, showed no upwelling and the same SST as the west side. The SST reconstructed from coral Sr/Ca are fully consistent with these subtle differences from large area average (W) to local regional anomaly (N-I) to small scale heterogeneity (N-II). These faithful recording demonstrated beyond any doubt the reliability of coral Sr/Ca as an SST proxy. It also accentuates the need to carefully examine detailed local conditions around a sampling site before interpreting the SST reconstructed from coral Sr/Ca. Although the corals do not lie about their SST, the local hydrography in the past could be quite different from the present due to changes in bottom topography, sea level, and sea water circulation pattern. We should not rush to claim large scale climatic changes before demonstrating that the changes in the reconstructed SST can not be attributed to the more mundane changes in local conditions. Another implication is that the selection of sampling site depends on the scientific goal for the study. For instance, core W is well suited to represent the large area average SST as part of the input for a global modeling effort. On the other hand, the N-I core seems to be more sensitive to variations in monsoon strength that may be of more interest to the climate of East Asia then merely providing a grid point in a global model.

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