Oxygen Isotope Analysis of Corals from the Gulf of California and the Gulf of Panama: Application and Implications for Coral-Based Paleoclimate Reconstructions

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Abstract

Coral-based reconstruction of past variability of sea surface conditions is improving our understanding of the tropical ocean-atmosphere system. We present oxygen isotope records from corals collected near the tip of Baja California (Baja) and the Gulf of Panama (Saboga). The Gulf of California experiences a large annual range in temperature related to seasonal upwelling and the influence of the California Current. The Gulf of Panama experiences a large range of temperature and salinity related to the seasonal migration of the intertropical Convergence Zone that produces wind-induced upwelling early in the year and a pronounced wet season from May to December. The isotope records are calibrated with COADS, GEDEX, interpolated Reynolds, AVHRR, and site observations of sea surface temperature. Salinity and proxy salinity data developed from rainfall and river discharge records are used to calibrate the Saboga coral. Seasonal and monthly calibration of the Baja coral attests to the presence of a strong annual temperature cycle, but annually averaged data exhibit limited correlation with temperature. Poor constraint of annual and inter-annual variability of the isotopic content of the Gulf of California water contributes to the weak annual correlation. The bimonthly Saboga record correlates strongly with salinity (r^2=0.72) and proxy salinity (r^2=0.66) and moderately with annual salinity (r^2=0.45). Temperature is not significant at $p<0.05$ in calibrations using both salinity and temperature as dependent variables but is weakly correlated (r^2=0.2) with temperature as the only dependent variable after applying a water correction term. Most, but not all, ENSOs appear in both records as a depletion in the annual maximum isotopic values. The catastrophic 1982-83 event is absent from the Saboga record. A strong coherence between records from the Gulf of Chiriqui (>300 kilometers away) and Uraba Island, Gulf of Panama (>60 kilometers) indicates that the corals are recording regional signals in addition to local reef conditions. The Saboga coral exhibits a strong coherence to the interannual Panama rainfall measured at Barro Colorado Island. Each record shows a trend toward drier conditions since the early 1950s. A 20-year isotope record from a Pleistocene coral taken from a marine terrace near the Baja coral exhibits similar annual variability as the modern coral and the possible occurrence of two ENSO events. There is evidence in both records of a step (*eg*, Ebbesmeyer 1991) toward more positive isotope values occurring in the mid-1970s, but we do not argue for interpretation as a climatic "state" shift.

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