

Late Holocene reconstruction of strong El Niño events

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Annually-resolved $\delta^{18}\text{O}$ records were derived from a modern and a 2.3 ky coral acquired in Maydolong, eastern Samar, Philippines to reconstruct past El Niño events. The two records are comparable in length: the modern coral spans the past 82 years (1922 to 2003) whereas the 2.3 ky coral includes 91 years. Replicate measurements of samples milled at annual increments were made until the standard error of the mean fell below 0.05‰. $\delta^{18}\text{O}$ anomalies were then calculated by subtracting the 7-year running mean from the average of each year.

Strong El Niño events in the past 82 years exhibited positive $\delta^{18}\text{O}$ anomalies. The most recent events, which occurred in 1972/3, 1982/3, 1991-3 and 1997/8, registered values from 0.09 to 0.18‰ (Fig. 1). To identify strong El Niño events in the 2.3 ky coral record, we used the threshold value of 0.10‰ as weak to moderate El Niños have an average $\delta^{18}\text{O}$ anomaly of 0.05‰. Eight events occurring at fairly regular intervals (approximately every 10 years) were identified in the late Holocene record (Fig. 1). Relative to modern-day events starting from the 1970s, the frequency as well as the amplitude of strong El Niños is similar to that of the late Holocene. The tendency for more frequent and stronger El Niño events in the late Holocene has been shown in a climate model (Clement et al., 2000) and in coral records from Papua New Guinea (Tudhope et al., 2001; McGregor and Gagan, 2004). However, persistent events (lasting more than 1 year) are more common in the late Holocene record relative to the modern. This corroborates findings of multi-year El Niño events based on coral reconstructions (Tudhope et al., 2001; McGregor and Gagan, 2004) but not captured in models.

Clement, A.C., Seager, R., and Cane, M.A., 2000. Suppression of El Niño during the mid-Holocene by changes in the Earth's orbit. *Paleoceanography*, 15: 731-737.

McGregor, H.V., and Gagan, M.K., 2004. Western Pacific coral $\delta^{18}\text{O}$ records of anomalous Holocene variability in the El Niño-Southern Oscillation. *Geophysical Research Letters*, 31: doi:10.1029/2004GL019972.

Tudhope, A.W., Chilcott, C.P., McCulloch, M.T., Cook, E.R., Chappell, J., Ellam, R.M., Lea, D.W., Lough, J.M., and Shimmield, G.B., 2001. Variability in the El Niño-Southern Oscillation through a glacial-interglacial cycle. *Science*, 291: 1511-1517.

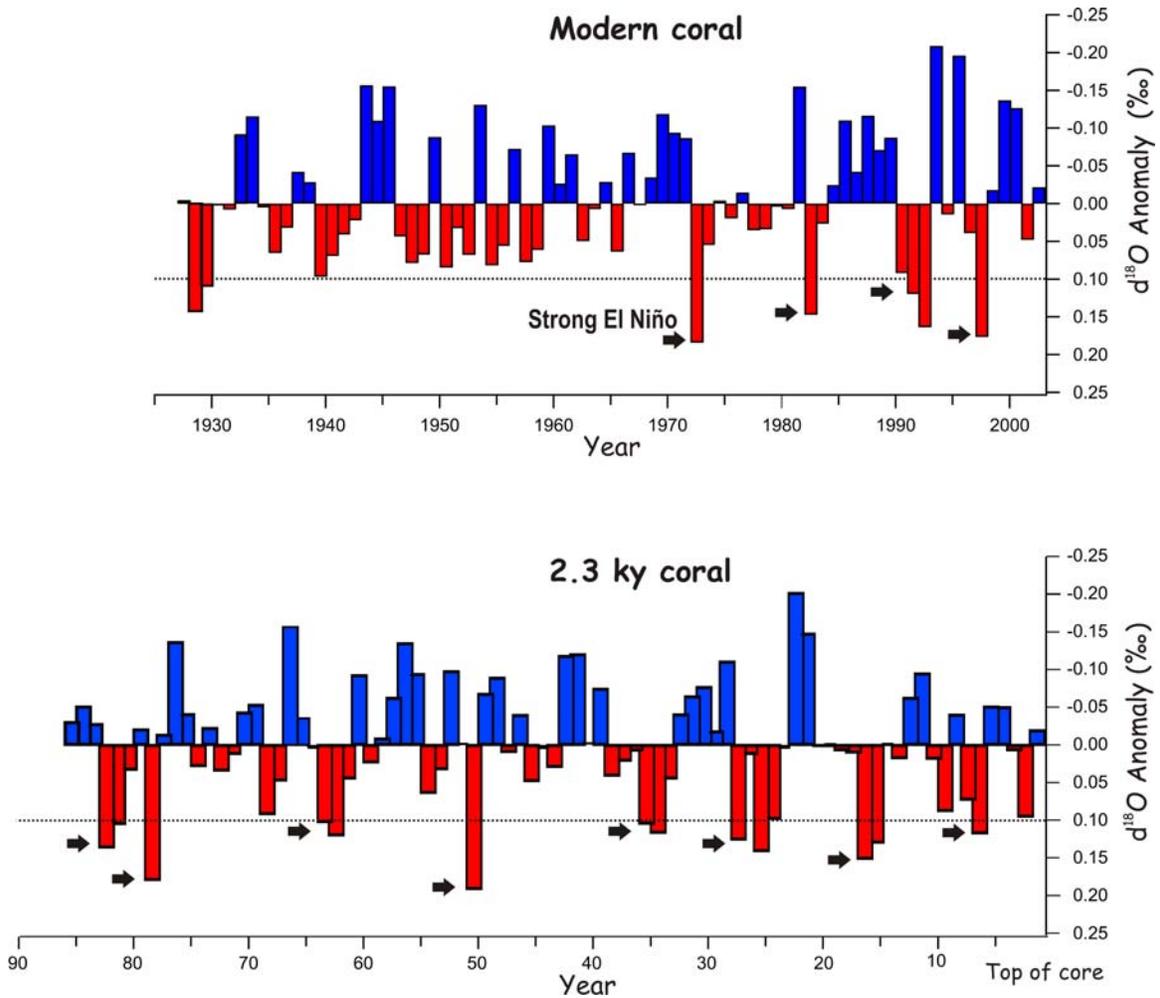


Figure 1. $\delta^{18}\text{O}$ anomalies in the modern (top) and 2.3 ky (bottom) coral records from Maydolong, eastern Samar, Philippines. Black arrows indicate strong El Niño events. The threshold for strong events is marked by the dashed line