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PALAEO
Palaeogeography, Palaeoclimatology, Palaeoecology 248 (2007) 190–201
www.elsevier.com/locate/palaeo

Interdecadal climate variability in the Coral Sea since 1708 A.D.

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Received 25 May 2006; received in revised form 1 December 2006; accepted 6 December 2006

Abstract

Low resolution (5-year) Sr/Ca and δ^{18}O samples, extending back to 1708 A.D., were analysed from a *Porites* coral core collected from Flinders Reef, an offshore reef on the Queensland Plateau in the western Coral Sea (17.5° S, 148.3° E). Using the Sr/Ca ratio as a proxy for sea surface temperature (SST), we deconvolved a salinity record by subtracting the SST signal from the δ^{18}O record. Decadal variability in the reconstructed salinity record is closely paralleled by changes in SST, with cooler (warmer) temperatures recorded during wetter (drier) periods. This relationship differs from the conventional view often described for tropical areas, where warm temperatures are associated with wet periods and cool temperatures with dry periods. The anti-correlation between reconstructed SST and salinity observed at Flinders Reef, however, matches the climatic effects expected from variations in the Interdecadal Pacific Oscillation (IPO), a recurrent pattern of SST variability over the Pacific Ocean which is known to modulate Australia's climate, in particular the impact of ENSO events on decadal time scales. On longer timescales, salinity seems to have remained almost constant for the last two centuries after a progressive freshening of surface waters that culminated around 1800 A.D. Conversely, SSTs show a warming trend towards the late 20th century.

Keywords: Coral proxies; Interdecadal variability; Salinity; South Pacific; Coral Sea; Interdecadal Pacific Oscillation

1. Introduction

El Niño-Southern Oscillation (ENSO) variability dominates the climate of the Pacific Ocean on interannual time scales. On longer time scales, there is increasing evidence of the Interdecadal Pacific Oscillation (IPO) driving sea surface temperature (SST) and circulation anomalies over the Pacific region with spatial patterns and climatic conditions similar to those developed during individual ENSO events (Zhang et al., 1997; Folland et al., 1999; Power et al., 1999). The IPO changes phase every 15 to 30 years and is equivalent to the Pacific Decadal Oscillation previously described for the North Pacific (Mantua et al., 1997). This oscillation has been shown to modulate the strength and frequency of ENSO events (Salinger et al., 2001; Mantua and Hare, 2002) and, more importantly, the magnitude of the impact of individual ENSO events (Gershunov and Barnett, 1998; McCabe and Dettinger, 1999; Power

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doi:10.1016/j.palaeo.2006.12.003

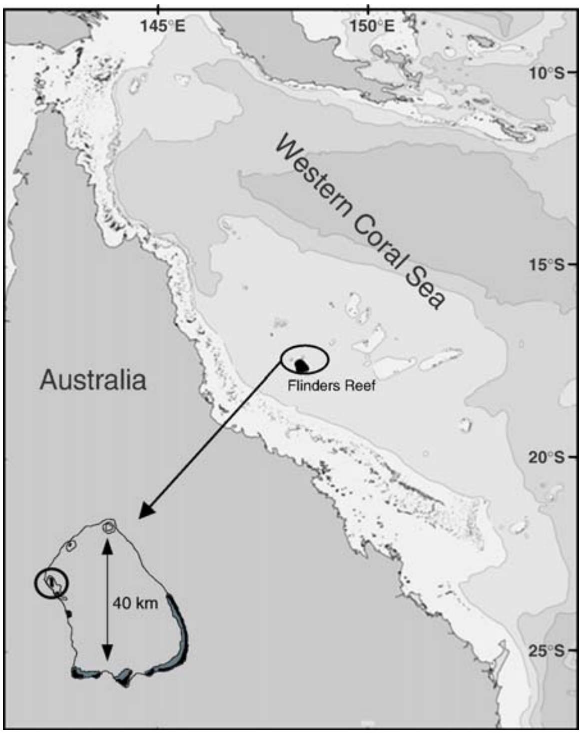

Fig. 1. Map of the western Coral Sea showing the location of Flinders Reef, an offshore reef on the Queensland Plateau (17.5° S, 148.3° E). Sketch shows the location of the coral core and dimensions of Flinders Reef. The coral core was drilled on the northwestern side of the reef (black circle).

et al., 1999). Power et al. (1999), for example, showed a strong IPO modulation of ENSO impacts on Australia's climate. These authors found that during a negative IPO phase, when the tropical Pacific is cooler than average (La Niña-like state), teleconnections between ENSO events and Australia's rainfall are strong, which translates into increased precipitation variability over eastern Australia. Conversely, during warm IPO phases such as those developed during 1924–43 and 1979–97, ENSO teleconnections were weak and Australia experienced reduced interannual rainfall variability (Lough, 1991; Allan et al., 1996; Latif et al., 1997; Power et al., 1999; Hendy et al., 2003). Such interdecadal modulation of the impact of ENSO on Australia's climate has important implications for management policies focused on flood and drought risk (Kiem et al., 2003; Kiem and Franks, 2004).

In this study, we present Sr/Ca and δ^{18}O measurements from a long coral core from Flinders Reef, off northeast Australia. Parallel Sr/Ca and δ^{18}O measurements allow reconstruction of past changes in both SST and salinity over the last 280 years and provide new insights into the influence and dynamics of decadal and longer-term trends of Pacific climate variability. Since the main priority of this study was decadal and longer-term climate variability, we chose a low-resolution sampling, bulk 5-year intervals, instead of the more common annual or sub-annual resolution often presented for coral records. This sampling approach was successfully applied in a compilation of eight coral records from several reefs in the central inshore to midshelf Great Barrier Reef (GBR: Hendy et al., 2002). The location of Flinders Reef, an offshore

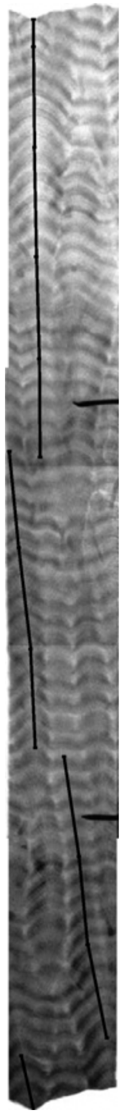

Fig. 2. X-radiograph positive image of annual density banding in Flinders Reef coral core. Couplets of high skeletal density (dark bands) and low skeletal density (light bands) represent one annual growth increment. Black lines indicate positions of 5 year-increment sampling transects which started and finished in the annual low density bands.