



Mid to late Holocene Leeuwin Current variability offshore southern Australia linked to ENSO state changes

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The El Niño-Southern Oscillation (ENSO), a key aspect of the Earth's climate, drives regional to global oceanic and climate changes on various time-scales. Differences in the temporal coverage of Holocene records for the more general state in El Niño frequency, however, restrict a comprehensive overview. Oceanic variability offshore southern Australia is linked to the Leeuwin Current (LC), an eastern boundary current, transporting tropical waters from the Indo Pacific Warm Pool region towards higher latitudes. Instrumental data, spanning the last few decades, document that ENSO modulates LC variability.

Here we present new, well-dated time series from two marine sediment cores (MD03-2611 and SS0206-GC 15) of past LC variability, based on alkenone-derived sea-surface temperatures (SST) and planktonic foraminifera offshore southern Australia, an area affected by recent El Niño and La Niña events. Our reconstructions of ENSO-state changes cover the last 7,400 years. With transition into the mid Holocene [dates], we find clear evidence that oceanic conditions prevailed under the dominant influence of a persistent La Niña mode. A strong LC produces a stratified water column and establishes a permanent thermocline as seen in the high abundance of the 'tropical fauna' (*Globoturborotalita rubescens*, *Globoturborotalita tenella* and *Globigerinella sacculifer* (including *G. trilobus*)) and maximum SST offshore southern Australia. During this La Niña-state dominated period, we record at c. 5000 years BP the first short period of a strong El Niño-like-state, by a pronounced drop in abundance of the subtropical species *Globigerinoides ruber* and a reduced SST gradient between the two core sites. The Late Holocene (from 3,500 years BP onwards) period is characterized by centennial to millennial scale variability in the LC strength, which is accompanied by an overall decrease of SSTs offshore southern Australia. We link this LC variability to Late Holocene centennial-millennial scale El Niño/La Niña-state swings. Phases of El Niño dominance occur from 3,000 to 2,400 years BP, from 1,800 to 1,400 years BP and from c. 1,000 years BP onwards, while the brief periods of a predominant La Niña-state occurred from 2,400 to 1,800 years BP and 1,400 to 1,000 years BP. Our high-resolution ENSO-state reconstructions parallel terrestrial reconstruction from Laguna Pallcacocha (South America) and highlight the strong influence of ENSO on the palaeoceanographic development offshore southern Australia via teleconnections.