What Forced Holocene Millennial-Scale Variability?
A Tale from the Western Tropical Pacific

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1. Motivation

A number of climate archives have documented millennial-scale variability during the Holocene. It is not currently known whether these variations are forced or unforced. A solar hypothesis has been put forward to explain the 1 and 2.5-kyr periodicities based on similarities in spectral peaks. On the other hand, there exists the possibility that the deep ocean drives some of the Holocene variability, especially at the 1.5-kyr timescale. This periodicity is reminiscent of MIS3 cycles.

2. Methods

Holocene Age Model: BCRON1 based on 28 °C dates from planktonic foraminifera. Benthic age obtained by adjusting by 1 ± 3kyr2.3.

3. WEP Millennial-Scale Variability

A number of climate archives have documented millennial-scale variability during the Holocene and MIS3. The offset in the SST series is due to the uncertainty in the pre-exponential constant from the Mg/Ca measurements. The core site is bathed by UCDW, which outcrops in the Southern Ocean.

4. Time Series Analysis

We use the Lomb-Scargle Fourier Transform on each realization of the time series.

5. Solar Forcing Hypothesis

Solar forcing as an explanation for millennial-scale SST variability requires:
1. A large climate sensitivity (10.16°C/Wm²).
2. A highly nonlinear response of tropical SST to TSI changes as highlighted in the bandpass records.
3. A long 300-400-yr delayed response.

6. Deep Ocean Hypothesis

Holocene-MIS3 comparison of the 1,500-year cycle:
1. Similar 0.3°C SST variability.
2. Comparable deep ocean variability (0.10% and 0.15% respectively).

7. Conclusions

A1: Solar forcing is unlikely because there is no coherence between the amplitude of changes in solar forcing and in SSTs. There is also a long phase delay between the peak in forcing and the maximum response.

A2: Deep ocean circulation changes played a role in Holocene and MIS3 cycles resulting in similar periodicities, amplitude changes, and phase relationship in tropical Pacific surface and deep ocean variability.

References