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8,000 years of El Niño: Towards data-model integration

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Past changes in El Niño-Southern Oscillation (ENSO) provide an opportunity to learn more about ENSO dynamics. To study the changes in ENSO over the past 8,000 years, a low-resolution climate system model is used to simulate the evolution of the global climate over this period. The simulations are then compared with the coral record from two sites in the tropical Pacific Ocean.

The model is able to reproduce the trends in the coral data. The simulations show a gradual strengthening of ENSO, with an increase in both the frequency and magnitude of El Niño events. This strongly suggests that the changes in ENSO variability over the past 8,000 years represent a response to external forcing – and particularly orbital forcing – over this period, rather than merely representing low-frequency internal stochastic variability.

Examination of the model simulations reveals that the changes in ENSO variability are driven by decreasing summer insolation over the Asian landmass. This results in a weakening of the easterly trade winds in the western Pacific, creating conditions more favourable for the development of El Niño events. As the trade winds weaken, there is also a change in the nature of the simulated ENSO, with an eastward shift in the location of greatest sea surface temperature variability.

The coral data shows strong variability on decadal timescales, accompanied by rapid switches between ENSO modes. This model simulations exhibit similar behaviour, although the model appears to exaggerate the magnitude of the decadal-scale variability. The combination of strong low-frequency variability and rapid transitions between modes has considerable implications for simulations of future changes in ENSO behaviour.