

The impact of global warming on the upwellings and primary productivity at the southern limb of the California Current, Baja California, Mexico

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Abstract:

- Although most of simulation models published have concluded that coastal upwelling will intensify in three of the most productive marine ecosystems of the world, the results seem contradictory for the California Current System (CCS). These contradictory results may be due to the fact that instrumental records are too short to yield reliable predictions. Because of this, we opted to test this hypothesis by studying the sedimentary record of Soledad basin, in Baja California, Mexico, using geochemical proxies to reconstruct at ultra-high resolution the history of productivity and sea surface temperature during the last two millennia, with particular emphasis on the Anthropocene. Our results indicate that SST (alkenones and TEX-86) do not show a cooling trend during the Anthropocene, but rather multidecadal cycles related to PDO. Likewise, primary productivity organic biomarkers (i.e., alkenone concentration (C37 Total) as a proxy for phytoplankton productivity, etc) show an increasing trend that started 2000 years ago with prominent multidecadal cycles, but without any observable trend taking place during the Anthropocene. An interesting feature of the organic matter record is the increasing amplitude of the cycles towards the present, starting 2000 years ago. Primary productivity is probably controlled by large scale mesoscale eddies developing at the southern Baja California margin.

Motivation:

This project investigates changes during the last two millennia in the intensity of the upwelling system in the southwestern margin of the Baja California peninsula, by studying the sedimentary record of Soledad basin.



Figure 1. Study area showing the collection site of the cores in Soledad Basin, Baja California, Mexico (25° 08.00' N, 112° 42. 09' W).

Study Site:

This site is particularly suitable for studying the variability of coastal upwelling because it is one of the most persistent (year-round) upwelling cells in the Pacific Ocean. Two sediment cores were collected in March 2012 from Soledad basin, from a depth of 450 m. One of the cores is a 40 cm long *Multicore* (SD-6-MC). The second core is a 210 cm long gravity core (SD-6-GC). Both cores were radiometrically dated by 210PB and AMS-¹⁴C.

RESULTS:

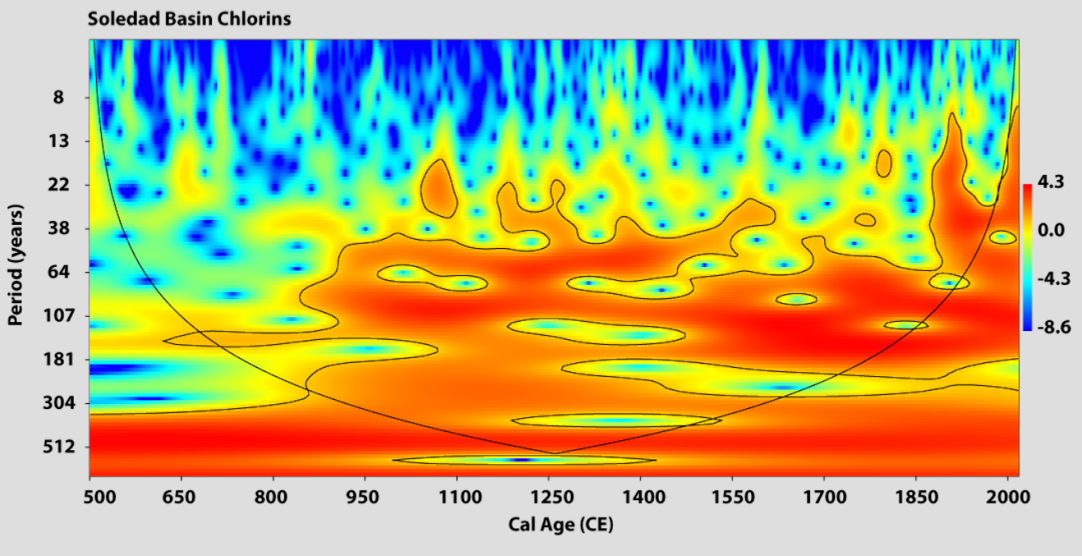


Fig.2

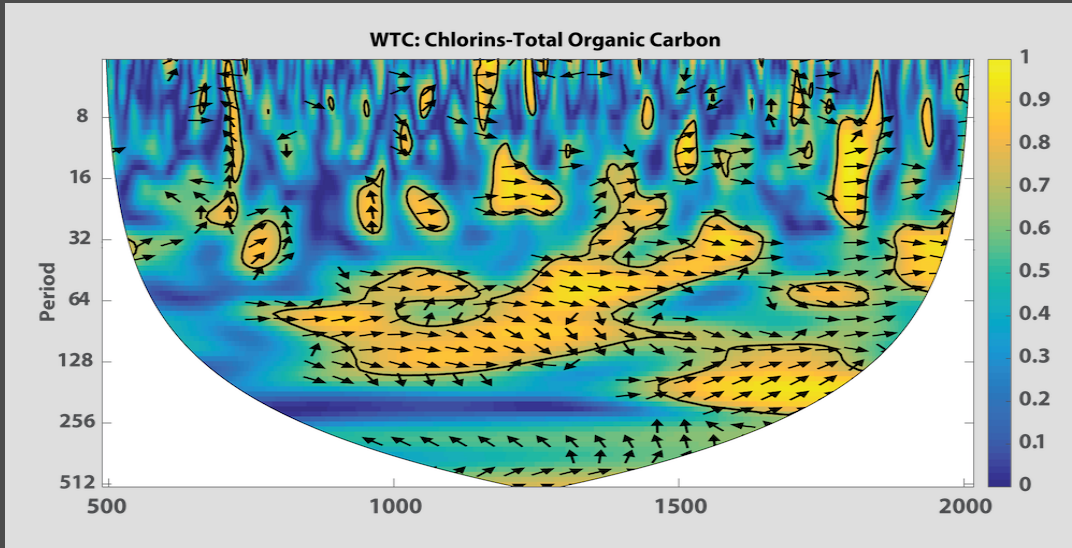


Fig.3

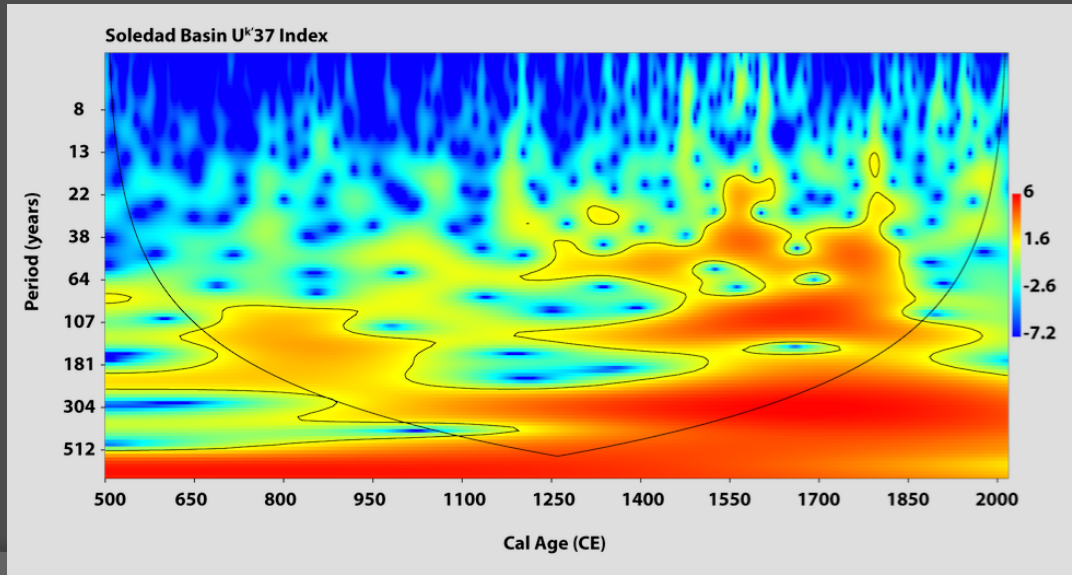


Fig.4

HIGHLIGHTS

- Variability of marine primary productivity is strongly dominated by multidecadal to multicentennial variability (Fig. 2, Chlorins)
- Chlorins concentration in sediments is strongly correlated to Total Organic Carbon (TOC) export. Cross-correlation wavelet between both proxies (Fig. 3) shows great coherence in terms of temporal variability (multidecadal to multicentennial) through time confirming that chlorins is a robust proxy for organic matter export to the seafloor (paleoproductivity tracer).
- SST variability as revealed by the UK'37 index also displays a very coherent variability pattern of multidecadal to multicentennial variability through time (Fig. 4). However, the intensity of the power spectra for both proxies is inverse, indicating its inverse relationship (cooler periods associated with higher primary productivity and organic carbon export).
- Alkenone-derived SST (Fig.4) reveal that decadal to centennial variability strongly dampened almost to a halt during the period between year 1000-1400 CA, corresponding to the Medieval Warming Period (MWP), remaining strong only the multicentennial variability pattern.
- It is interesting to note that, in spite of the warming observed during the MWP (Fig.4), primary productivity was very strong at decadal to multicentennial scales while SST does not significantly vary at the same time scales. The anthropocene does not seem to be characterized by a decadal to multidecadal coupling of SST variability and ocean productivity. Pacific basin-wide variability could be responsible for having a more significant role in controlling primary productivity in this region.
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