EGU21-680
https://doi.org/10.5194/egusphere-egu21-680
EGU General Assembly 2021

Decoupled changes in upwelling and acidity in the eastern equatorial Pacific during the Pliocene

Madison Shankle[1], Natalie Burls[2], Alexey Fedorov[1], Matthew Thomas[3], Donald Penman[1], Heather Ford[4], Peter Jacobs[5], Noah Planavsky[1], and Pincelli Hull[1]

[1]Department of Earth and Planetary Sciences, Yale University, New Haven, CT, USA (pincelli.hull@yale.edu)
[2]Department of Atmospheric, Oceanic & Earth Sciences, George Mason University, Fairfax, VA, USA (nburls@gmu.edu)
[3]UCAR Geophysical Fluid Dynamics Laboratory, Princeton, NJ, USA (matthewt@ucar.edu)
[4]School of Geography, Queen Mary University of London, London, UK (h.ford@qmul.ac.uk)
[5]Department of Environmental Science and Policy, George Mason University, Fairfax, VA USA (pjacobs4@masonlive.gmu.edu)

The Pliocene epoch (5.3-2.6 million years ago) is the last time Earth experienced atmospheric carbon dioxide levels comparable to present day anthropogenic levels. As such, this time interval is a potential analogue for future, warmer Earth system states. One enigmatic feature of Pliocene climate is a reduced east-west sea surface temperature gradient in the equatorial Pacific (indicative of reduced equatorial upwelling) coinciding with enhanced biological productivity in the eastern equatorial Pacific (indicative of enhanced equatorial upwelling). Here we use boron isotopes to investigate these dynamics and to reconstruct the zonal surface pH gradient across the Pliocene equatorial Pacific. We find a strengthened pH gradient relative to modern (with more acidic conditions in the east than the west) despite a reduced temperature gradient at this time. These findings are in contrast to modern-day dynamics in which temperature and acidity co-vary, such that the reduction of the zonal temperature gradient during an El Niño event is accompanied by reduced acidity (as well as reduced upwelling and productivity) in the eastern equatorial Pacific. We show that this decoupling between changes in the pH and temperature gradients is consistent with biogeochemically enabled model simulations of Pliocene climate containing an active Pacific meridional overturning circulation and a weakly stratified equatorial thermocline. This reorganization of Pacific circulation and the onset of north Pacific deep water formation allows old, acidic, more nutrient-rich waters to reach the eastern equatorial Pacific despite weak wind-driven upwelling rates, accounting for the low pH values we observe there as well as previous evidence of enhanced productivity.