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El Niño dynamics in the warm Pliocene climate

A. S. von der Heydt and H. A. Dijkstra

Utrecht University, Institute for Marine and Atmospheric Research Utrecht, Department of Physics and Astronomy, Utrecht, Netherlands (a.s.vonderheydt@uu.nl)

A 'permanent' El Niño climate state has been suggested for the warm Pliocene interval, the most recent period similar to what is expected for the twenty-first century. Main piece of evidence of such conditions is the small east-west sea surface temperature (SST) difference that is found in proxy temperature records of the equatorial Pacific Ocean. Using a version of the Zebiak-Cane model for which the tropical Pacific background state is part of the solution, we study the sensitivity of the Pacific background climate and El Niño/Southern Oscillation (ENSO) variability to Pliocene climate changes. The parameters varied in this sensitivity study include changes in the trade wind strength due to a reduced equator-to-pole temperature gradient, higher global mean temperatures and an open Panama gateway. All these changes lead to a westward shift of the position of the cold tongue along the equator by up to 2000 km. This result is consistent with data from the PRISM3D Pliocene SST reconstruction. The associated changes in thermocline tilt across the equatorial Pacific are, however, not uniform and depend on the relative strength of the processes involved. Our model further suggests that ENSO variability is present and similar to today in the Pliocene climate. A background climate that would resemble a 'permanent' El Niño with weak to no east-west temperature difference along the equator is only found for a very weak equator-pole temperature gradient, which seems unrealistic for the Pliocene climate.