Organic proxy based temperature reconstructions of the Pacific warm pool and cold tongue since late Miocene (~12 Ma): Implications for ancient El Niño

El Niño – Southern Oscillation (ENSO) is a consequence of tropical Pacific ocean-atmosphere dynamics and exerts control on Earth's interannual climate variability. Sea surface temperatures (SSTs) in the Pacific warm pool and cold tongue have been shown to be diagnostic of ENSO conditions. Ancient SST reconstructions suggest that the temperature of the Pacific warm pool was invariant during the Plio-Pleistocene, whereas the cold tongue was much warmer in the Pliocene. The appearance of a negligible east-west equatorial Pacific Ocean temperature gradient during the Pliocene was used to infer a "permanent" El Niño climate state. However, some recent records show quasi-periodic climate variability (2-7 years) during the late Miocene - Pliocene, challenging the permanent El Niño paradigm.

Here I show a multi-proxy (TEX_{86}, $U_{37}^{k'}$), multi-site reconstruction of SSTs in the Pacific warm pool and cold tongue since late Miocene (~12 Ma). At the warm pool, TEX_{86} temperatures exhibit long-term cooling since late Miocene, in contrast to an invariant temporal character previously assumed. In the cold tongue, temperatures derived from TEX_{86} and $U_{37}^{k'}$ are offset from each other, probably due to the difference of production, transportation and preservation processes of the lipid biomarkers that these proxies are based on. Nevertheless, both proxy-derived results show a similar cooling trend of the cold tongue. When all records are stacked, a ~3°C zonal temperature gradient persists between 12 and 6 Ma in the tropical Pacific, and then increases toward modern-day conditions. Considering sedimentary records that show interannual variability during late Miocene – Pliocene, a ~3˚C mean zonal gradient might be large enough to sustain El Niño – La Niña variability and thus directly challenges the notion of a permanent El Niño state during warmer global conditions.