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Plio-Pleistocene Perth Basin water temperatures and Leeuwin Current dynamics (Indian Ocean) derived from oxygen and clumped isotope paleothermometry

David De Vleeschouwer[1,2], Marion Peral[3], Marta Marchegiano[3], Angelina Füllberg[2], Niklas Meinicke[2], Heiko Pälike[2], Gerald Auer[4], Benjamin Petrick[5], Christoph Snoeck[3,6], Steven Goderis[3], and Philippe Claeys[3]

[1]Westfälische Wilhelms Universität Münster, Institute of Geology and Paleontology, Münster, Germany (ddevlees@uni-muenster.de)

[2]MARUM - Center for Marine Environmental Sciences, University of Bremen, Klagenfurterstr. 2-3, 28359 Bremen, Germany

[3]Analytical, Environmental, and Geo-Chemistry, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

[4]Institute of Earth Sciences (Geology and Paleontology), University of Graz, Heinrichstraße 26, 8010 Graz, Austria

[5]Paleontology and Historical Geology, Kiel University, Ludewig-Meyn-Str. 14 R.12, 24118 Kiel, Germany

[6]Maritime Cultures Research Institute, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

The Pliocene sedimentary record provides a window into Earth's climate dynamics under warmer-than-present boundary conditions. However, the Pliocene cannot be considered a stable warm climate that constitutes a solid baseline for middle-road future climate projections. Indeed, the increasing availability of time-continuous sedimentary archives (e.g., marine sediment cores) reveals complex temporal and spatial patterns of Pliocene ocean and climate variability on astronomical timescales. The Perth Basin is particularly interesting in that respect because it remains unclear if and how the Leeuwin Current sustained the comparably wet Pliocene climate in West-Australia, as well as how it influenced Southern Hemisphere paleoclimate variability. To constrain Leeuwin Current dynamics in time and space, this project constructed a new orbitally-resolved planktonic foraminifera (*Trilobatus sacculifer*) stable isotope record ($\delta^{18}O$ and clumped isotopes Δ_{47}) for the Plio-Pleistocene (4–2 Ma) interval of International Ocean Discovery Program (IODP) Site U1459. It complements an existing TEX_{86} record from the same site and similar planktonic isotope records from the Northern Carnarvon Basin (ODP Site 763 and IODP Site U1463). The comparison of TEX_{86} and Δ_{47} paleothermometers reveals that TEX_{86} likely reflects sea surface temperatures (SST, 23.8–28.9 °C), whereas *T. sacculifer* Δ_{47} calcification temperatures probably echo the state of the lower mixed layer and upper thermocline at the studied Site U1459 (18.2–20.8 °C). The isotopic $\delta^{18}O$ gradient along a 19° S–29° S latitudinal transect, between 3.9–2.2 Ma, displays large variability, ranging between 0.5 and 2.0 ‰, whereby a low latitudinal gradient is indicative of a strong Leeuwin Current and vice versa. These results challenge the interpretation that suggested a tectonic event in the Indonesian Throughflow as the cause for the rapid steepening of the isotopic gradient (0.9 to 1.5 ‰) around 3.7 Ma. The tectonic interpretation appears obsolete as it is now clear that the 3.7 Ma steepening of the isotopic gradient is intermittent, with flat latitudinal gradients (~0.5 ‰) restored in the latest Pliocene (2.9–2.6 Ma).

Still, the new analysis affirms that a combination of astronomical forcing of wind patterns and eustatic sea level controlled Leeuwin Current intensity. A period of relatively weak Leeuwin Current between 3.7 and 3.1 Ma is advocated; a time interval also marked by cooler conditions throughout the Southern Hemisphere. In conclusion, the intensity of the Leeuwin Current and the latitudinal position of the subtropical front are rooted in the same forcing: Heat transport through the Indonesian Throughflow (ITF) valve propagated to the temperate zone through Indian Ocean poleward heat transport. The common ITF forcing explains the observed coherence of Southern Hemisphere ocean and climate records.