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Tropical heat-stress and heat-induced dead zones during the PETM?

Joost Frieling (1), Holger Gebhardt (2), Matthew Huber (3), Olabisi Adekeye (4), Samuel Akande (4), Gert-Jan Reichart (8), Jack Middelburg (1), Steven Bohaty (5), Dan Lunt (6), Ursula Rohl (7), Thomas Westerhold (7), Jaap Sinninghe Damste (8), Stefan Schouten (8), and Appy Sluijs (1)

(1) Department of Earth Sciences, Utrecht University, Utrecht, Netherlands (j.frieling1@uu.nl), (2) Geologische Bundesanstalt, Wien, Austria, (3) Department of Earth, Atmospheric, and Planetary Sciences, Purdue University, West Lafayette, USA, (4) Department of Geology and Mineral Sciences, University of Ilorin, Kwara State, Nigeria, (8) NIOZ Royal Netherlands Institute for Sea Research, Den Burg, Texel, the Netherlands, (5) Ocean and Earth Science, National Oceanography Centre Southampton, University of Southampton, Southampton, UK, (6) School of Geographical Sciences, University of Bristol, Bristol, United Kingdom, (7) MARUM – Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany

The Paleocene – Eocene Thermal Maximum (PETM) is marked by approximately 5 °C of global surface and deep ocean warming, superimposed on already warm latest Paleocene climates. The PETM is characterized by a negative stable carbon isotope excursion (CIE) in the global exogenic carbon pool, poleward migration of thermophilic biota, ocean acidification, increased weathering, photic zone euxinia and intensified hydrological cycle. Reconstructed temperatures for the PETM in mid and high-latitudes regularly exceed modern open marine tropical temperatures. However, constraints on absolute tropical temperatures and the biotic response during the PETM were lacking.

Recently, 3 new localities from the equatorial Atlantic yielded constraints on sea surface temperature. These records revealed warming of 3-4ºC of already warm sea water (33-34 ºC) to extremely warm sea surface temperatures (∼37ºC) during the PETM. This indicates persistent polar amplification and refutes tropical thermostat theory even at extremely high temperatures. Similar to the biotic response at higher latitude localities, early stages of the PETM are marked by acme events of thermophilic dinoflagellate cysts (dinocysts) in these equatorial records. We also record widespread deoxygenation, expressed as photic zone euxinia on the shelf and expanding oxygen minimum zones further offshore. However, in stark contrast to the flourishing plankton communities at mid and high latitudes, we observe a nearly complete absence of planktic eukaryote microfossil groups during peak warmth. Surprisingly, this absence cannot be explained by anoxia, acidification, preservation biases or sediment dilution. Based on multi-proxy evidence, we find the absence is best explained by heat-stress. We re-examined published data in other oceanic basins and argue heat-stress may have been more widespread in tropical oceans than previously considered. We will discuss the latest insights and implications in the context of other transient rapid warming events and subsequent recovery.