Late Miocene surface ocean properties in the eastern equatorial Indian Ocean: monsoon and global climate drivers


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Palaeoceanography of the equatorial Indian Ocean during the late Miocene

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Rationale

During the late Miocene (~11.5 Ma), \(pCO_2\) may have been 1.5 to 3 x pre-industrial levels, and mean global temperatures were ~5–4°C higher than today, with reduced latitudinal gradients. Major ecosystem changes during this time are consistent with decreasing temperatures and \(pCO_2\), yet proxy evidence for these physical climate changes remains sparse because few continuous, high-resolution palaeoclimate records cover this interval. Major (~9–10°C) late Miocene cooling was previously revealed for the mid- and high-latitudes based on the alkenone SST proxy, however tropical SST records suggest only minor cooling (~1°C).

Benthic Isotope Records

- First orbital-resolution benthic isotope record from the deep Indian Ocean
- Independent astronomically-tuned records show good agreement
- Constant offset in \(\delta^{18}O\) and \(\delta^{13}C\) between deep Indian Ocean and Pacific Ocean records

IODP Site U1443 Records

Here, we present new records of surface ocean variability based on planktic foraminiferal isotope and palaeoceanographic data from IODP Site U1443, spanning 9 to 5 Ma. These records, underpinned by a new orbitally tuned chronology, reveal secular and orbital-scale trends in SST, \(pCO_2\), and export productivity that are influenced by global climate trends and the South Asian monsoon.

Amplitude of late Miocene Global Cooling

Colour scale shows SST anomaly from late Miocene 560ppm simulation minus late Miocene 300 ppm simulation in IPSL-CM6A(LR) amplitude of modelled late Miocene cooling that best fits with proxy-derived SSTs.

- Tropical late Miocene cooling at Site U1443 >3°C
- New model simulations suggest a \(pCO_2\) decrease from 560 to 300 ppm could account for most of this cooling
- No late Miocene intensification of South Asian monsoon winds in the equatorial sector of the Indian Ocean
- Strong eccentricity-modulated precession-band productivity variations throughout
- SST variations become more sensitive to obliquity after the onset of cooling
- Local \(8^\circ\)\(^{18}O\) strongly coupled to SST on long and orbital timescales

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\(\delta^{18}O\) and \(\delta^{13}C\) records.