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Using organic geochemistry proxies to reconstruct sea surface temperature in the eastern Indian Ocean

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The tropics play a crucial role in modulating regional and global climate owing to their large heat and moisture storage capacity. The tropical Indian Ocean forms the major part of the largest warm pool on Earth, and its interaction with the atmosphere triggers important climate variations on both regional and global scales. To date, numerous palaeoclimatic studies have focused on the tropical Pacific zonal sea surface temperature (SST) gradient-related shifts in convection, extending an El Niño-Southern Oscillation (ENSO) framework to interpret millennial-scale climate variability. However, little is known about the past SST changes of the tropical Indian Ocean.

We picked up a sediment core (GeoB10053-7) and sediment trap (Jam2) from the Indonesian continental margin off Java. We performed UK'37 ratio of long-chain unsaturated ketones and TEX86 (tetraether index of GDGTs with 86 carbon atoms) temperature proxies on the collected particles and on the glacial to Holocene sediment, respectively.

Results from the sediment trap show that the alkenone flux was declining from March to May, and rapidly increasing from May to November 2002, similar to the TOC. The average SSTs from December 2001 to April 2002 using TEX86 are 26.8°C, slight warmer than the SSTs from UK'37 , which are 25.7°C . In contrast, the average SSTs from April 2002 to November 2002 derived from TEX86 are 25.9°C , slightly cooler than the SSTs using UK'37, which are 26.6°C. Trap studies show that most of the flux to the sediments occurs during the SE monsoon season, when warm and dry air from Australia induce coastal upwelling in the study area.

The age model of core GeoB10053-7 for the last 22,000 years is based on AMS 14C dates. The TEX86 and UK'37 show core top SSTs of 26.1°C and 27.1°C, respectively (0-3 cm depth representing the last 300 years). Considering the analytical error of 0.1°C and 1.1°C , these results are in line with present-day annual mean SST of 26°C. Holocene average SSTs using TEX86 are 26.3°C, slightly warmer than the SSTs derived from UK'37 ,which are 25.4°C. Glacial average SSTs based on TEX86 are 23.5°C, slightly cooler than the SSTs based on UK'37 are 23.9°C. There is a discrepancy between the two lipid-based SST-reconstructions mainly since 18,000 years. Both proxies are generally assumed to represent annual mean SSTs. Currently discussed hypotheses suggest different seasonality and/or depth habitat of the precursor organisms as explanations for the discrepancy between these trap records. Our trap data, however, do not provide evidence for either of the two for the modern situation. Stronger upwelling during the glacial might have caused a different ecological pattern.