

EGU24-5380, updated on 20 May 2024

<https://doi.org/10.5194/egusphere-egu24-5380>

EGU General Assembly 2024

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Indian Ocean variability changes in the Paleoclimate Modelling Intercomparison Project

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The Indian Ocean exhibits multiple modes of interannual climate variability, whose future behaviour is uncertain. Recent analysis of glacial climates has uncovered an additional El Niño-like equatorial mode in the Indian Ocean, which could also emerge in future warm states. Here we explore changes in the tropical Indian Ocean simulated by the Paleoclimate Model Intercomparison Project (PMIP4). These simulations are performed by an ensemble of models contributing to the Coupled Model Intercomparison Project 6 and over five coordinated experiments: four past periods (midHolocene, lgm, lig127k and midPliocene-eoi400) and an idealized forcing scenario to examine the impact of greenhouse forcing. The two interglacial experiments are used to characterize the role of orbital variations in the seasonal cycle, whilst the others are focused on responses to large changes in global temperature. The Indian Ocean Basin Mode (IOBM) is damped in both the mid-Holocene and last interglacial, with the amount related to the damping of the El Niño–Southern Oscillation in the Pacific. No coherent changes in the strength of the IOBM are seen with global temperature changes; neither are changes in the Indian Ocean Dipole (IOD) nor the Niño-like mode. Under orbital forcing, the IOD robustly weakens during the mid-Holocene experiment, with only minor reductions in amplitude during the last interglacial. Orbital changes do impact the SST pattern of the Indian Ocean Dipole, with the cold pole reaching up to the Equator and extending along it. Induced changes in the regional seasonality are hypothesized to be an important control on changes in the Indian Ocean variability.