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The Maldivian archipelago: Past, present and future climatic and oceanographic insights using foraminiferal proxies

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This research uses planktonic and benthic foraminiferal geochemical measurements (n = 5067) to better understand past South Asian Monsoon (SAM) processes and its influence on the physicochemical and thermocline properties of the Maldives Inner Sea. Particular emphasis is given to the interval encompassing the warmer Marine isotope stage (MIS)11, a recognised analogue for the Holocene, as it allows insight into possible future scenarios in a world with rapidly increasing sea surface temperatures (SSTs). To facilitate regional paleo-reconstructions, the modern apparent calcification depths and ecological affinities are inferred for 14 planktonic foraminiferal species. Past SAM dynamics are then assessed using high-resolution geochemical records ($\delta^{18}O$, $\delta^{13}C$, Mg/Ca) for multiple foraminiferal species (n = 16) for the last ~1800 kyrs. The diagenetic biases on the whole-test geochemistry are found to be prolific, particularly due to authigenic overgrowths with elevated Mg/Ca and $\delta^{18}O$ compositions. Notwithstanding these diagenetic influences, absolute reconstructions of seawater temperatures, salinity and $\delta^{18}O_{sw}$ are still deemed viable for at least the top ~627.4 - 790.0 kyr of the records. Subsequently, the multi-species data across the MIS10-13 interval (~340-500 kyr) all confirm discrete glacial-interglacial thermocline and SAM dynamics. Based on the assumption that future conditions could present with similarities to the warmer MIS11 maximum (+0.30 - 0.41 °C from modern SSTs), it is shown that in comparison to the present, there was a stronger summer SAM control with a more prominent Arabian Sea Oxygen Minimum Zone extent in the Maldives region. During MIS11 there was also a deeper, warmer surface mixed layer together with a stronger thermocline and more stratified water column. Furthermore, both coral and *Amphistegina* bleaching thresholds were exceeded more frequently during MIS11. Given the current global warming trends, increased stress in the Maldivian coral reef ecosystems, in response to the 2016 El Niño climatic perturbation, is further confirmed through the application and verification of the *Amphistegina* Bleaching Index (ABI). In addition to exploring SAM dynamics and its impact on the Maldives coral reef ecosystems, a new planktonic morphospecies, *Globigerinoides eoconglobatus*, is described within this research and contributes to on-going foraminiferal biostratigraphy efforts. Overall, this research thus confirms the strength of an integrated multi-species foraminiferal geochemical study to link both present and past oceanographic and SAM processes. A future increase in SSTs, as well as more frequent and extreme warm events together with a stronger summer SAM control and more prominent low oxygen/high nutrient intermediate waters might push the tropical Maldivian coral and benthic shoal ecosystems closer to or even beyond their ecological and thermal limits.

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