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The Impact of Ocean Circulation Changes on the Glacial-Interglacial Difference between EASM and ISM Speleothem Records

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The Asian summer monsoon is a highly complex system that comprises two distinct subsystems: the Indian summer monsoon (ISM) and the East Asian summer monsoon (EASM). A thorough understanding of the intricate change processes and inherent differences between these two subsystems is crucial for deciphering the mechanisms driving climate change and, ultimately, predicting future climate patterns. The Indonesian Throughflow (ITF), a critical component of the global thermohaline circulation, serves as the sole low-latitude channel transporting warm seawater from the tropical Pacific to the Indian Ocean. This circulation directly impacts the mass and heat balance of the Indo-Pacific region.

In this study, we utilized stalagmite samples from southwestern China and obtained high-resolution speleothem records dating back to ~18-9 ka BP. Through meticulous comparison and analysis of speleothem records from both the ISM and EASM regions, we observed significant disparities in the δ18O amplitude between glacial and interglacial, particularly around the Younger Dryas interval. Notably, the timing of this amplitude difference aligns with the flooding of the Karimata Strait, suggesting a potential linkage between the ocean circulation change and monsoon dynamics.

This study delves deeper into the potential impact of the Karimata Strait's flooding on $\delta^{18}O$ within ISM and EASM speleothem records. We propose that this flooding redirected freshwater runoff away from the South China Sea, leading to comparatively heavier $\delta^{18}O$ of surface seawater in the SCS. Furthermore, it is likely inhibited the surface flow of the ITF, subsequently curtailing heat transfer from the Pacific to the Indian Ocean, combined with an intensified Agulhas leakage during the deglacial, these factors contributed to relative cooling of the Indian Ocean, in turn, magnified the ISM strength relative to that of the EASM. The position of the Walker circulation's ascending branch was also influenced by these oceanic changes. In the early Holocene, this branch shifted eastward, leading to a reduction in distant moisture sources in the EASM region.

The above changes ultimately caused the $\delta^{18}O$ of stalagmites in the EASM region to be relatively positive in comparison with that in the ISM region during interglacial, indicating the significance of ocean circulation changes for the evolution of climate system, and may help explaining the "missing" 100 ka signals in EASM speleothem records.