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Reconstruction of precipitation variability in the Strait of Yucatan associated with latitudinal shifts in the position of the Intertropical Convergence Zone since the Last Glacial Maximum

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The elemental composition of sediments from gravity core HOLOVAR11-03 provides a ca. 40 ka record of past climate variability in the Strait of Yucatan, between the Caribbean Sea and the Gulf of Mexico, a region where precipitation variability is determined by the seasonal position of the Intertropical Convergence Zone (ITCZ). Within this region, sea level pressure decreases and rainfall increases as the ITCZ moves north of the equator in response to increased solar insolation in the Northern Hemisphere during boreal summer. In contrast, as the ITCZ retracts southward towards the equator during boreal winter, rainfall diminishes and the regional sea level pressure gradient strengthens. On interannual, multidecadal and millennial timescales, fluctuations in the average latitudinal position of the ITCZ in response to insolation forcing modulate the intensity and duration of the seasonal regimens, determining average regional precipitation and, ultimately, the elemental composition of the marine sedimentary record. Regionally, higher titanium and iron content in marine sediments reflect greater terrigenous input from inland runoff, indicating greater precipitation, hence a more northerly position of the ITCZ. Correspondingly, Ti and Fe concentration data were used to reconstruct regional rainfall variability since the Last Glacial Maxima (LGM $\sim$24 cal ka BP). HOLOVAR11-03 age model (based on 4 AMS 14C dates obtained from multi-specific samples of planktic foraminifera) shows stable sedimentation rates in the area throughout the cored period. Nonetheless, higher terrestrial mineral input is observed since the LGM and all through the last glacial termination (24 to 12 cal ka BP), indicating a period of increased precipitation. In contrast, lower Ti and Fe values are typical for the period between 12 and 8 cal ka BP, indicating reduced precipitation. A positive trend characterizes the following interval, showing a return to wetter conditions lasting until 5 cal ka BP. Notably, records of sea-surface temperature from the Caribbean indicate similar variability, with among others, colder than present conditions in the early Holocene indicating a more northerly mean ITCZ position, followed by warmer surface waters and a weaker tradewind associated with a southward displacement of the ITCZ, further illustrating the strong link between precipitation variability and oceanographic conditions in the region. After 5 cal ka BP, Ti and Fe values remain fairly stable at an intermediate level until shortly after 2 cal ka BP, when a sudden increase in Fe content is observed. At this time, a significant increase in precipitation has also been inferred from the δ18O signal of ostracods and gastropods in lake sediments from the Yucatan Peninsula and a stalagmite δ18O monsoon reconstruction from mainland Mexico. The drastic increment in Fe content also marks the beginning of a shift towards rapidly decreasing Ti and Fe values, suggesting an increasingly drier climate. Decrease inland runoff/precipitation during the late Holocene has also been observed in stalagmite and lacustrine δ18O signals from nearby locations, altogether indicating a southward displacement of the ITCZ.