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A climate model study of an intense Asian Monsoon in a La Niña-like climate of MIS-13

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Studying the paleo-monsoon during past interglacials is a valuable approach to improve our understanding of the monsoon system in present-day and future climates. We focus on Marine Isotopic stage 13 (MIS-13; $\sim$0.5 Ma) which was a relatively cool interglacial, but with a paradoxically intense monsoonal precipitation over eastern and southern Asia. Our main goal is to understand the physics–based mechanism driving the intense monsoon, specifically the East Asian Summer Monsoon (EASM), during MIS-13.

We applied both an intermediate complexity model (LOVECLIM) as well as fully coupled general circulation models (HadCM3 and CCSM3) to simulate pre-industrial and MIS-13 climates. The boundary conditions for MIS-13 were chosen for 506 ka with Northern-Hemisphere (NH) summer at perihelion and a CO_2 concentration of 240 ppm. For pre-industrial, NH-winter occurring at perihelion and a CO_2 concentration of 280 ppm were prescribed.

Preliminary analysis of the model results shows different atmospheric and oceanic features in MIS-13 compared to the pre-industrial which could affect the EASM. The Northern Pacific Subtropical High (NPSH), which is an important factor in controlling the EASM, strengthened and extended to the northwest in MIS-13 partially due to cooling of the central Pacific Ocean. This in turn brought more moisture from the Central Pacific to the EASM-region and caused a northwestward shift and bending of the low-level jet along East Asia. The change in the low-level jet subsequently increased the meridional wind velocity at 850 mbar in the EASM-region providing more moisture from the tropical Pacific and Indian Oceans. In addition, higher sea-surface temperature in the Indian Ocean during MIS-13 further increased the source of moisture for the EASM. The Asian low, which is another component of the EASM-system, also shifted eastward moving the rain band northward.
Moreover, it was found that MIS-13 had a dominant La Niña condition in the tropical Pacific. La Niña-type climate is normally expected to favor increases in precipitation in the EASM through the NPSH as can be seen in MIS-13. Whether there was ENSO variability around the La Niña-like background climatic state of MIS-13 or not is under further investigation. The correlation between the sea-surface temperature variability in the tropical Pacific and the EASM precipitation was found to increase in MIS-13 compared to the pre-industrial which is another factor explaining the intensified EASM in MIS13.

Although our model results show high precipitation for MIS-13 qualitatively consistent with data, we are still interested in other factors that could increase the precipitation even further.

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