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Distinct response of Asian summer precipitation and monsoon circulation to orbital forcing during Heinrich events

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Climatic fingerprint of Heinrich (H) events was characterized by widespread megadroughts over the Asian monsoon region, accompanied by a systemic weakening of Asian summer monsoon. However, recent hydroclimate proxies suggest that South China experienced increased precipitation contrasting with the prevalent megadrought conditions during the Heinrich events. Our simulations performed with the HadCM3 model show that changes in insolation alone can induce spatiotemporal discrepancies in precipitation over the Asian summer monsoon region. During the H1, 3, 4, 5, 6 events, the amplification of the land-sea pressure contrast in response to a positive solar insolation gradient during boreal summer intensifies moisture transport from the ocean to the Asian monsoon region. The ensuing moisture divergence, combined with anomalous downdrafts, results in decreased precipitation in the South Asian Summer Monsoon (SASM) region, but converse situation for the East Asian Summer Monsoon (EASM) region. During the H2 event, the increased precipitation across the Yangtze River Valley sharply contrasts with the widespread drought over the ASM region. This is attributed to an enhancement of a southerly warm-moist vapor transport along the western edge of the subtropical Western North Pacific anticyclone and an enhancement of a northerly cold-dry vapor transport along the western edge of the Aleutian cyclone, which converge over the Yangtze River Valley. Our results further show an in-phase relationship between the SASM and EASM circulation strengths in response to orbital forcing. This is driven by the combined influence of the land-sea thermal contrast and the migration of the Intertropical Convergence Zone, supporting Kutzbach's hypothesis.