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Impacts of extremely asymmetrical polar ice sheets on the East Asian summer monsoon during the MIS-13 interglacial

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Marine Isotope Stage (MIS) 13 is a relatively weak interglacial in benthic δ18O and Antarctica ice core records. However, many proxy records from the northern hemisphere (NH) indicate that MIS-13 is at least as warm as or even warmer than the recent interglacials, with extremely strong summer monsoon and a possible melting of Greenland ice sheet. In this study, following a hypothesis of asymmetric hemisphere climate, we test the response of the East Asian summer monsoon to different scenarios regarding the size of the Greenland and Antarctic ice sheets by using the HadCM3 model as well as factor separation analysis. The results show that, in response to the individual effects of the disappearance of Greenland ice sheet and of a large Antarctica one, there is a more summer precipitation in the East Asian monsoon region, in line with proxy reconstructions from China. This is associated with stronger land-ocean contrast, more water vapor transport over the East Asian region and a northward shift of the Inter Tropical Convergence Zone (ITCZ). Regarding the Greenland ice sheet, the mechanism is related to its thermodynamic and topographical effects that influence the East Asian monsoon through an orographically induced wave train. Regarding the Antarctica ice sheet, the mechanisms involve stronger meridional overturning circulation in North Atlantic that results from stronger upwelling of the circumpolar deep water in the Southern Ocean due to larger Antarctica ice sheet.