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Ice sheet induced North Atlantic Oscillation mode during an interglacial 500,000 years ago and its impact on East Asian Summer Monsoon

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Abstract

Monsoon systems affect large regions of the globe. Among them, the best known is the Asian monsoon which with its Indian and East Asian branches can have vital impacts on large populations. Current modeling studies indicate that global warming can lead to the intensification of the Asian monsoon and related precipitation by the end of 21st century but uncertainties still remains. A way to get a better insight to this future is to understand the past climates with particularly well developed monsoons. This is the case for the interglacial climate of MIS-13, an interglacial about 500,000 years ago, during which different proxy records indicate an unusual strong East Asian Summer Monsoon (EASM) despite the possible global cooling as shown by the marine δ18O records and also low greenhouse gas concentrations. We attempt to find a possible explanation for such a strong EASM during the relatively cool MIS-13. Our first simulations with an Earth System model shows that in the presence of ice sheets over North America and Eurasia, MIS-13 climate exhibits a positive phase of the winter North Atlantic Oscillation (NAO) like feature. The simulated oceanic anomalies associated with NAO persisted till summer and the signals of NAO are transmitted to East Asia through the stationary waves excited at the Asian Jet entrance. The wave train anomaly in geopotential height clearly shows dual blocking highs over the Ural Mountains and Okhotsk Sea and a low in between them over the Lake Baikal. Such a feature reinforces the Meiyu front and enhances the precipitation over East Asia. Further simulations with a more sophisticated general circulation model confirm such results. Hence we suggest that one of the possible reasons for the enhanced EASM during MIS-13 can be the presence of the ice sheet induced winter NAO and its delayed impact on the EASM.