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Centennial to millennial-scale monsoon changes since the last deglaciation linked to solar activities and North Atlantic cooling

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Rapid monsoon changes since the last deglaciation remain poorly constrained due to the scarcity of geological archives. Here we present a high-resolution scanning X-ray fluorescence (XRF) analysis of a 13.5-m terrace succession on the western Chinese Loess Plateau (CLP) to infer rapid monsoon changes since the last deglaciation. Our results indicate that Rb/Sr and Zr/Rb are sensitive indicators of chemical weathering and wind sorting, respectively, which are further linked to the strength of the East Asia summer monsoon (EASM) and the East Asia winter monsoon (EAWM). During the last deglaciation, two cold intervals of the Heinrich event 1 and Younger Dryas were characterized by intensified winter monsoon and weakened summer monsoon. The EAWM gradually weakened since the beginning of the Holocene, while the EASM remained steady till 9.9 ka and then grew stronger. Both the EASM and EAWM intensity were relatively weak during the middle Holocene, indicate a mid-Holocene climatic optimum. Rb/Sr and Zr/Rb exhibit an anti-phase relationship between the summer and winter monsoon changes on centennial timescale during 16~1 ka BP. Comparison of these monsoon changes with solar activity and North Atlantic cooling events reveals that both factors can lead to abrupt changes on the centennial timescale in the early Holocene. During the late Holocene, North Atlantic cooling became the major forcing of centennial monsoon events.