Centennial to millennial-scale East Asian monsoon variations during the MIS 19 interglacial

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Millennial to centennial-scale climate variations during interglacials may be linked with solar activity or geomagnetic field variations through galactic cosmic ray. However, the mechanism is still unknown due to insufficient high-resolution climate data. Millennial scale continental climate changes were investigated using magnetic and grain size data, proxies of summer monsoon (SM) (summer precipitation) and winter monsoon (WM) (wind speed), respectively, from loess-paleosol sequences at Xifeng and Lingtai in the Chinese Loess Plateau, focusing on the interglacial period with the last geomagnetic reversal. The SM and WM long-wavelength variations well synchronize with the precession related sea-level variations within the interglacial period, as the SM strengthens and the WM weakens during high sea-level periods, and vice versa during a low sea-level period. This pattern of SM and WM changes is the same with that of glacial-interglacial cycles. Besides the orbital scale variations, six events postdating the geomagnetic reversal show the same pattern as the SM strengthens when the WM weakens, and vice versa. These events spanning 500 to 2300 yr are well correlated with the high sea-level and/or warming events, observed in the mid-latitude North Atlantic, Northwest Pacific and Osaka Bay. Moreover, around the sea-level peak, the WM is intensified during a period from 783–778 ka at Lingtai, and 782–777 ka at Xifeng, being uncorrelated with the SM (sea-level) variations. The intensified WM event coincides with the cooling event observed in Osaka Bay, and also with the period when the Earth’s dipole magnetic field decreases below one-fourth that of the present, and cosmic ray flux increases by more than 50 %. Therefore, the intensification of the WM is probably caused by the strengthened Siberian High resulting from the umbrella effect of the increased low cloud due to the cosmic ray flux increase. The WM intensification event provides the first wind evidence for the link between the geomagnetic field and climate.

Keywords: Chinese loess, Winter monsoon intensification, geomagnetic reversal, galactic cosmic ray, MIS 19

