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The linkage of dust cycle dynamics and loess during the Last Glacial Maximum in Europe

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In this work, we present different aspects of the mineral dust cycle dynamics and the linkage to loess deposits during the Last Glacial Maximum (LGM) in Europe. To this aim, we simulate the LGM dust cycle at high resolution using a regional climate-dust model. The simulated dust deposition rates are found to be comparable with the mass accumulation rates of the loess deposits determined from Loess sites across Europe. In contrast to the present-day prevailing westerlies, easterly wind directions (36 %) and cyclonic regimes (22 %) were dominant circulation patterns over central Europe during the LGM. This supports the hypothesis that recurring east sector winds, dynamically linked with a high-pressure system over the Eurasian ice sheet (EIS), are an important component for the dust transport from the EIS margins towards the central Europe loess belt. Our simulations reveal the occurrence of highest dust emission rates in Europe during summer and autumn, with the highest emission rates located near the southernmost EIS margins corresponding to the present-day German-Polish border region. Coherent with the persistent easterlies, westwards running dust plumes resulted in high deposition rates in western Poland, northern Czechia, the Netherlands, the southern North Sea region and on the North German Plain including adjacent regions in central Germany. Further, a detailed analysis of the characteristics of LGM cyclones shows that they were associated with higher wind speeds and less precipitation than their present-day counterparts. These findings highlight the importance of rapid and cyclic depositions by cyclones for the LGM dust cycle. The agreement between the simulated deposition rates and the mass accumulation rates of the loess deposits corroborates the proposed LGM dust cycle hypothesis for Europe.