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Modeling dust emission variations in Eastern Europe related to North-Atlantic abrupt climate changes of the last glacial period

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The European loess sequences of the last glacial period (approx. 100-15 kyr BP) show periods of strong dust accumulation alternating with episodes of reduced (or no) sedimentation, allowing soil development. For the main loess sedimentation period (approx. 40 - 15 kyr BP), data indicate a correlation between these variations and the North Atlantic rapid climate changes: the Dansgaard-Oeschger (DO) and Heinrich (H) events. We use numerical modeling to investigate the relationship between the North-Atlantic abrupt changes and the sedimentation variations in Europe. A first study (Sima et al, QSR, 2009) focused on western Europe, and addressed the impact on dust emission of North-Atlantic SST changes as those associated to DO and H events. It proposed that vegetation played a key role in modulating dust emission variations in western European source areas. Here we focus on eastern Europe, especially on the areas north and north-east of the Carpathian Mountains, where loess deposits have recorded DO and H events (Rousseau et al., Clim. Past. 2010). We use the same set of simulations and dust calculations as in Sima et al. (2009) study. The simulations, made with the LMDZ AGCM and the SECHIBA land-surface models; are: a reference glacial state ("stadial" GS), a cold ("HE") and a warm ("DO, or Greenland interstadial", GIS) perturbation, all corresponding to Marine Isotope Stage 3 conditions. Our reference loess site is Stayky, in Ukraine. We define our area of study by taking into account the fact that western winds are predominant, and that most of the dust deposited at Stayky must have been brought from up to 1000 km far from the site (Rousseau et al., Clim. Past. 2010). The simulated most active potential dust sources for Stayky correspond to the observed loess deposits. The simulated dusty season generally lasts from Feb to May, with differences from a climate state to another. Averages on this interval are analyzed for the meteorological variables and surface parameters relevant for dust emission. For the identified source areas, HE wind and precipitation anomalies are small, so that the differences HE-GS of emission flux and frequency are also small (below 20%) without vegetation effect; they are even smaller with it. In the case of GIS, the wind is weaker than for GS, but the dry soil fraction is higher. Thus, without vegetation effect, GIS would be only up to 20% less dusty than GS in the main source areas. Vegetation increases the difference by approx. 20%, so its key role in stadial-interstadial dust emission variations is confirmed.