Geophysical Research Abstracts,
Vol. 11, EGU2009-5757, 2009
EGU General Assembly 2009

Modeling study of North-Atlantic millennial-timescale variability imprint on Western European loess deposits

A. Sima (1), D.-D. Rousseau (2,3), M. Kageyama (1), G. Ramstein (1), M. Schultz (1), Y. Balkanski (1), P. Antoine (4), F. Dulac (1), and C. Hatté ()

(1) CNRS-CEA, Laboratoire des Sciences du Climat et de lÉnvironnement, Gif-sur-Yvette, France (adriana.sima@gmail.com, Masa.Kageyama@lsce.ipsl.fr, Gilles.Ramstein@lsce.ipsl.fr, Michael.Schulz@lsce.ipsl.fr, Yves.Balkanski@lsce.ipsl.fr, francois.dulac@cea.fr, christine.hatte@lsce.ipsl.fr), (2) CNRS-ENS, Laboratoire de Météorologie dynamique, Paris cedex 5, France (denis.rousseau@lmd.ens.fr), (3) Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964 USA, (4) CNRS, Laboratoire de Géographie physique, Meudon, France (Pierre.Antoine@cnrs-bellevue.fr)

Studies on loess sequences of Western Europe have shown (i) that the loess sedimentation pattern over the last glaciation (approximately 100 to 15 thousand years before present (kyr BP)) has been very similar throughout the European loess belt, indicating a common climate control, and (ii) that the rapid environmental changes on the continent are correlated with the North-Atlantic millennial-timescale variations, the so-called Dansgaard-Oeschger (DO) and Heinrich (H) events. Here we test, by means of numerical modelling, if, and by which mechanisms, the dust cycle response to the environmental changes induced by the DO and H events could have led to the recording of these events in the loess deposits of the Western Europe. The LMDZ atmosphere general circulation model, in a version with a stretched grid enhancing the resolution over Western Europe to 60km, is used to simulate (a) a reference glacial state, assimilated to a DO stadial (DOS), (b) a cold perturbation over the North Atlantic, resembling a H event, and (c) a warm perturbation, assimilated to a DO interstadial (DOI). The reference state corresponds to the 40-kyr BP context, in the middle of the typical glacial period (approximately 75 to 15 kyr BP). The subsequent perturbations are obtained by applying cold or warm anomalies of up to 2°C in absolute value to the North-Atlantic sea-surface temperatures in the latitudinal band 30° - 63°N. The three simulated climate states are compared from the point of view of the initial driver of the dust cycle, the dust emission. A detailed analysis is provided for the English Channel and the south of the North Sea (ECSNS), important deflation areas in glacial times, and a source for the Western European loess deposits. In our experiments, the impact of altering the North-Atlantic surface conditions is weak over the ECSNS and loess areas (roughly, the latitudinal band 48° - 53°N) with respect to wind and precipitation. When only considering these factors, and the related land-surface conditions (soil moisture, snow cover), in our main area of interest the DOI dust emission flux differs by +/-30% from the DOS and HE values. This result cannot be reconciled with the strong stadial-interstadial loess sedimentation rate variations, which must have involved important changes not only in the dust transport and deposition, but also in emission. However, when the vegetation effect of inhibiting the aeolian erosion is included, the three climates are clearly differentiated with respect to dust entrainment: the DOS is the dustiest, the HE state comes on the second place, with up to 80% of the DOS mean dust flux, and the DOI is the least dusty, with generally less than 50% of the stadial values. Thus, we suggest that (i) North-Atlantic millennial-timescale variability is the cause for the environmental variations revealed by Western European loess profiles, and (ii) vegetation changes are essential in explaining the stadial-interstadial dust cycle variations. We also find that, in our area of interest, dust emission seasonality is not controlled by the wind speed, as in the modern large deserts, but by the surface conditions, consisting in a combination of soil moisture, snow and vegetation covers. Consequently, the dusty season generally lasts from late winter to early summer, with maximum activity in April-May, and is shifted towards summer when the climate is colder (by 2 months for HE compared to DOI).