

Interactive comment on “North Atlantic abrupt climatic events of the Last Glacial period recorded in Ukrainian loess deposits” by D.-D. Rousseau et al.

D.-D. Rousseau et al.

denis.rousseau@lmd.ens.fr

Received and published: 23 December 2010

We acknowledge comments of reviewer 2 which implied us to reorganize the text by adding a new figure

1. Inclusion of model simulation (Figure 8) p. 1969 line 28 “The numerical simulations by Sima et al. (2009) also suggest a correlation between West- and East-European sequences, reflecting the impact of the North Atlantic millennial timescale climate changes over the continent.” And p.1975 line 15: “North Atlantic events extending their impact as far as the east of Europe is supported by general circulation model simulations of the impact of North Atlantic abrupt climate changes in Europe (Fig. 8), showing

C1216

predominant western winds over the entire continent for three types of glacial climate conditions; a Greenland interstadial, a Greenland stadials and a Heinrich event.” I do not understand how these simulations support the conclusions. The winds are westerly, that is true, but how does this mean that the impact of North Atlantic abrupt climate changes in Europe extend a certain distance? I would think you would need to differences two simulations to show that there is a significant response to abrupt climate change in the north Atlantic in this region? For your study, it would appear that you would want to look at changes in temperature and precipitation, and how far east they extend in the different simulations. I like the idea of including evidences from simulations, but I do not think the way they are included now to be very effective.

R. We will rephrase the fragment at p. 1969 and add, as suggested, a figure showing temperature and precipitation anomalies from the numerical simulations we talk about, as well as a few words about other relevant modeling studies. The fragment at p.1975 line 15 becomes redundant and will be eliminated.

In more detail: The paragraph p.1969 lines 19 – 27, where we first speak of numerical simulations (showing predominant western winds over Europe), is related to the paragraph above (lines 7-18), discussing the origin of the dust deposited at Stayky. To make it clearer, we slightly modify the last phrase as follows:

“Furthermore, while coarse silt and sand are largely available in the braided plain of the Dnieper river, only approximately 100m east of the site, the coarse grain content in the main part of the sequence is low. Thus, easterly winds do not seem to have been the main winds transporting eolian material to the site. All these suggest that the main dust sources for the Stayky loess sediments must have been located generally west of Stayky.”

The paragraph at p.1969, line 28 will be modified, and the new figure included (NB: figure numbering will be corrected in the final form of the manuscript):

In addition to predominantly western winds, the numerical simulations described in

C1217

Sima et al. (2009) show temperature anomalies associated with the North-Atlantic millennial timescale changes extending from west to east over Europe (Fig. 9). Significant precipitation anomalies are also simulated for the interstadial state GIS with respect to the reference stadial state GS. If the North Atlantic events impacted the entire continent (at least at our latitudes of interest, around 50°N), as also suggested for example by previous numerical experiments at coarser resolution (Ganopolski and Rahmstorf, 2001; Claussen et al., 2003; Jin et al., 2007), then a correlation should exist between loess sedimentation variations in the west and the east of Europe. The existence of such a correlation is investigated in the following, by comparing in detail the Stayky sequence, taken as reference for eastern Europe, to the Nussloch sequence. We remind that Nussloch is most the detailed loess sequence of western Europe, and is correlated to the North Atlantic records (Rousseau et al., 2007).

See fig.

New Fig. Surface air temperature (a - c), and precipitation (d - f): absolute annual mean values for the reference GS state (left column) and annual mean anomalies HE – GS (middle column) and GIS – GS (right column). (modified from Sima et al., 2009). In white, areas where the differences are not significant to the 95% confidence level (Student's t-test).

New references : Claussen, M., Ganopolski, A., Brovkin, V., Gerstengarbe, F. W., and Werner, P. (2003). Simulated global-scale response of the climate system to Dansgaard/Oeschger and Heinrich events. *Climate Dynamics* 21, 361-370.

Ganopolski, A., and Rahmstorf, S.: Rapid changes of glacial climate simulated in a coupled climate model, *Nature*, 409, 153-158, 2001. Jin, L., Chen, F. H., Ganopolski, A., and Claussen, M. (2007). Response of East Asian climate to Dansgaard/Oeschger and Heinrich events in a couple model of intermediate complexity. *Journal of Atmospheric Sciences* 112, D06117.

2. size in the cores is a reflection only of winds “Considering all the material as
C1218

wind-blown, the increasing fraction of coarser material upwards might be interpreted as reflecting a gradual intensification of the wind dynamics, with a possible increase in the frequency of strong wind episodes.” “The variations with time (depth) of the loess grain-size composition are mainly related to a combination of changes in the wind and precipitation regimes, from local to much larger spatial scales (Duce, 1995).” A switch to coarser grain materials could also be due to a shift in the source material or location, or due to weaker winds in the source regions, decreasing the kinetic energy picking up and breaking apart the materials, and thus increasing the size of the entrained material. While it maybe more likely that a switch to coarse material means higher winds, there are alternative explanations, and these should also be mentioned, perhaps in the discussion or results section, just to be clear what can definitely be concluded, and what assumptions you are making.

R. According to the available literature, the source of the transported material is likely to be located to the North-North West of the studied area and be of the same origin. We do agree with R2's indication that alternative explanations could be possible, however in loess deposits this has not yet been demonstrated that coarser material is not related to higher winds. However we will follow R2's suggestion and include this point in the description of the grain size results.

Details: “This grain-size gradient is related to the relative position of the corresponding dust sources: the English Channel and Southern North Sea basins, exposed to deflation due to sea level lowering in glacial times.” How do we know the sources? Is this from geochemical data?

R. NO but through heavy mineral studies of Northwestern loess sequences as indicated in Sima et al (2009) to which we are referring

“The sand fraction remains low and does not show any particular variations. “ I can't find the sand fraction on this figure (I think you can reconstruct this as the remaining percentages from the total, but of course, this isn't so easy to do in one's head): I

assume this is 'not shown?' so maybe you should say that?

R. We don't understand as the fine sand fraction is clearly indicated on the figure, see at the bottom of the second curve to the right.

"The sand fraction reproduces this pattern inversely, but at much lower values." Again, the sand fraction is not shown.

R. We don't understand as the fine sand fraction is clearly indicated on the figure, see at the bottom of the second curve to the right.

In the top 1 m, the sand fraction increases at the expense of the fine and silts." Again, not shown.

R. We don't understand as the fine sand fraction is clearly indicated on the figure, see at the bottom of the second curve to the right.

"With respect to the four analyzed size fractions, the embryonic soils identified in the stratigraphy are characterized by a decrease in coarse silt and sand, and an increase in the fine silt components (Fig. 4)." I cannot see this in the coarse silt or fine silt (and of course, not in the sand, since that is not shown). Maybe you want to show a statistical relationship or some way to pull this out easier?

R. We do understand R2's confusion. This is rather a general trend that an exact statistical relationship. Therefore we rephrased the text accordingly

"Geochemical analyses of eolian deposits in Southern Ukraine, correlated with the presence of sand units south of Stayky (Bugge et al., 2009), have been interpreted as indicating a predominant northern wind direction." I like your discussion later, where you call the deposition direction the 'effective direction' instead of assuming that mean wind speeds are equivalent to the deposition direction downwind.

R. Thank you. By making this comment we wanted to warn the reader about some interpretation that appear too simplistic to be correctly sound. This is the interest of

C1220

combining observation and modeling which prevents misinterpretations.

"The coarse material (coarse silts and sand) comes from sources relatively close to the site, while the fine material (clays and fine silts) has probably been brought also from more distant areas, via the high-altitude atmospheric transport (Duce, 1995; Pye, 1995)." What you consider fine silts here, are actually considered coarse aerosols (>2µm) and don't have a very long lifetime in the atmosphere, so they would also tend to have a 'local' source and not be carried too far. However, it depends a bit on what we would consider far : 100-1000km could be done.

R. Yes you are right and this is also the problem in modeling dust transport responsible of building loess sequences. Present dust models are not at all adapted to the observed grain sizes observed in loess series. Furthermore while in low latitude regions or in China, you still can refer to desert material, concerning European loess sequences, no present environmental conditions prevail nowadays. However, once more referring to our previous modeling experiment, 100-1000 km is a reasonable distance for "paleo-dust" transport contributing to loess deposition

"Taking into account the available dates and the stratigraphic similarities, a correlation between the two sequences can be proposed." Can you discuss how much we should trust this temporal correlation, given the uncertainties in the dating of the two cores?.

R. Nussloch loess sequence is the most dated loess sequence so far and the key reference in Europe. The stratigraphical succession is robust and also representative of loess deposition during the studied interval. We agree that the available dates cannot allow a very precise correlation with North Atlantic abrupt events. However, considering the broad frame of the available chronology, the similar stratigraphy, and also the fact that the pattern observed in Stayky was described in 22 other sequences around, makes us confident that beside TL uncertainties, we are proposing a reliable correlation. Now following R2's comment, we did change the title of the paper by adding "MAY BE", rephrasing the title as follows: "North Atlantic abrupt climatic events of the

C1221

last glacial period may be recorded in Ukrainian loess deposits”

Interactive comment on Clim. Past Discuss., 6, 1959, 2010.

C1222

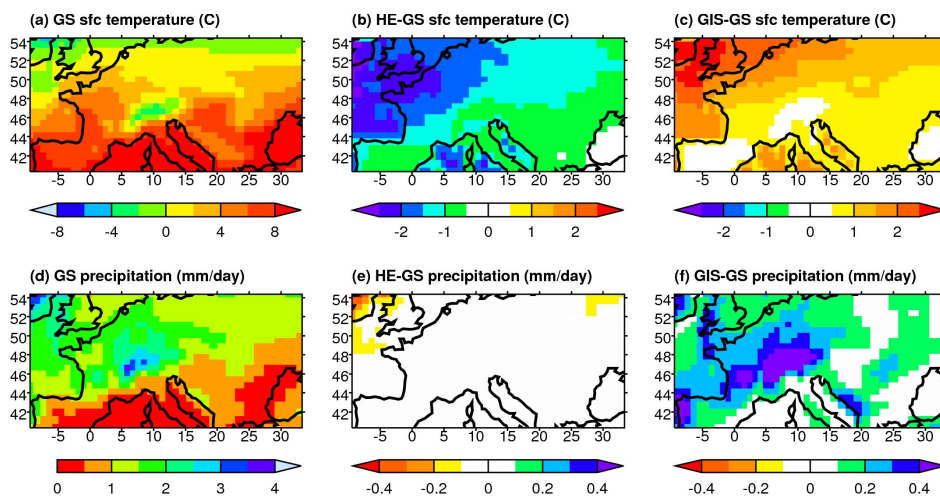


Fig. 1. new figure mentioned in the comment and included in the revised text

C1223