Clim. Past Discuss., 9, C30–C35, 2013
www.clim-past-discuss.net/9/C30/2013/

Climate
of the Past
Discussions

Interactive comment on "Excursions to C₄ vegetation recorded in the Upper Pleistocene loess of Surduk (Northern Serbia): an organic isotope geochemistry study" *by* C. Hatté et al.

L. Zoeller (Referee)

ludwig.zoeller@uni-bayreuth.de

Received and published: 14 February 2013

General comments:

Hatté et al. (2013) in their previous studies from Western and Central European loess-palaeosol sequences (LPS) did not find evidence of measurable C4 vegetation during the last glacial-interglacial cycle, based on δ^{13}C measurements from soil organic matter (SOM). For the first time episodes with C4 vegetation are now reconstructed for a LPS of comparable age in Europe. The studied section Surduk (Serbia) is situ-

ated in the Pannonian Basin and characterized by different climate compared to Western and Central European climate north of the Alpine and Carpathian orogenic belt. The present-day climate of Surduk has warmer summers, less positive water balance and stronger influence of Mediterranean air masses. It must be assumed that a similar climatic gradient also existed during glacial times due to both, the regional relief (basin surrounded by high mountain ranges) and the contributions of Atlantic, Mediterranean and continental air masses. The reconstructed palaeovegetation patterns point to palaeovegetation gradients in response to paleoclimate gradients in Europe. Vice versa, climatic patterns which are able to explain the C4 episodes can be proposed as new helpful tools for reconstruction of past atmospheric circulation patterns over Europe. As LPS in the Pannonian Basin and in some other parts of Europe are amongst the most complete and valuable palaeoenvironmental continental archives new and promising perspectives to explore the climate of the past are presented.

Specific comments:

The excellence of the manuscript includes:

- careful description of sampling procedures and methodology
- elaboration of a sound chronology based on different dating methods, and
- profound discussion of results and possible climatic pattern to explain the C4 episodes. (Details concerning IRSL dating were published elsewhere, see Fuchs et al. 2008).

It is noteworthy that the discussion chapter includes results from disciplines which at the first glance may not appear relevant, e.g. reconstruction of LGM atmospheric circulation based on glacial geomorphology (Florineth & Schlüchter 2000; Kühlemann et al. 2009). Further evidence suitable to support the interpretations of Hatté et al. is given in recent publications by Buggle et al. 2008, 2009 and 2010 which deserve to

be mentioned. The publication by Sebe et al. (2011), even if their conclusions about "Mega-Yardangs" in Hungary are still under debate, may also support the proposed model atmospheric pattern explaining C3 and C4 episodes (Fig. 4; note that Figure Captions are confused between Fig. 3 and Fig. 4!).

The consideration on palaeotemperatures during the LGM (page 200, last paragraph) is somewhat speculative because modern analogues are missing. Climate stations in Central Asia with summer temperatures up to 14°C and up to 6 months below 0°C lie much farther north and are not summer dry. Presently summer dry steppe climates in Asia lying at lower latitudes have summer temperatures >20°C and very few or none months below 0°. Nevertheless, the consideration is justified but should be classified as somewhat speculative due to the lack of modern analogues.

Although details in the methodology of the applied biogeochemistry are beyond my personal expertise I like to encourage the authors to include recent papers by Gocke et al. (2010, 2011, 2012) from the Nussloch site into discussion. According to them, the rhizosphere from interglacial or interstadial tree and shrub vegetation may penetrate the loess several m deep.

Technical corrections:

Subsequently I add some suggestions to improve the manuscript:

- page 190, line 2: Do not forget to mention palynology
- page 191, line 25: Is it "the stronger" or "the better adopted"?
- page 192, line 19: "main" appears to be wrong. "are outcropping"? line 20: remove "other"
- page 195, line 17: "copper" instead of "cupper"; line 18: 4 cm diameter (see Fuchs et al. 2008).

- page 197, line 9: Can you give another possible explanation, e.g., IRSL underestimate of sample BT141 for reasons so far unknown?
- page 198, line 17: For this period (ca. 66.1 to 86.8 kyr) no ^{14}C-ages are available, only IRSL ages. Therefore, the notation cal BP is not appropriate. Quote as "kyr old (IRSL)". This concerns also other parts of the text further below.
- Page 199, line 21 and 22: What is meant by "should likely be approximately 200-300 mm/y"? The nearby Belgrade station actually has 690 mm/y!

Nevertheless, in my opinion the manuscript by Hatté et al. fulfils the principal manuscript evaluation criteria. It presents a novel and substantial contribution to the scientific progress to decipher the climate of the past. As the novel methodology using δ^{13}C measurements from SOM is not yet fully approved but still under development different opinions may persist. They need, however, be published and discussed together with the presently available results to ensure scientific progress, even if some published data may be revisited or re-interpreted in the following years. With respect to this state of the art, applied methods are valid and results are discussed in a balanced way if the publications mentioned and comments above will be included. Apart from the mentioned mismatch of Figure Captions and my suggestions to improve the manuscript results and conclusions are presented in a clear, concise and well-structured way.

References:

Buggle, B., Glaser, B., Zöller, L., Hambach, U., Marković, S., Glaser, I., and Gerasimenko, N: Geochemical characterization and origin of Southeastern and Eastern European loesses (Serbia, Romania, Ukraine).- Quaternary Science Reviews 27, 1058-1075, 2008.

Buggle, B., Hambach, U., Glaser, B., Gerasimenko, N., Markovic, S., Glaser, I., and Zöller, L.: Stratigraphy, and spatial and temporal paleoclimatic trends in Southeast-

ern/Eastern European loess–paleosol sequences. Quaternary International 196, 86–106 2009.

Buggle, B., Glaser, B., Hambach, U, Gerasimenko, N.,. and Marković, S.: An evaluation of geochemical weathering indices in loess-paleosol studies, Quaternary International, 2010, doi:10.1016/j.quaint.2010.07.019

Fuchs, M., Rousseau, D.-D., Antoine, P., Hatte´, C., Gauthier, C., Markovic´, S. and Zoeller, L.: Chronology of the Last Climatic Cycle (Upper Pleistocene) of the Surduk loess sequence, Vojvodina, Serbia. Boreas, Vol. 37, pp. 66–73, 2008. 10.1111/j.1502-3885.2007.00012.x.

Hatté, C., Gauthier, C., Rousseau, D.-D., Antoine, P., Fuchs, M., Lagroix, F., Markovich, S. B., Moine, O., and Sima, A.: Excursions to C4 vegetation recorded in the Upper Pleistocene loess of Surduk (Northern Serbia): an organic isotope geochemistry study, Clim. Past Discuss., 9, 187–215, 2013.

Florineth, D. and Schlüchter, C.: Alpine evidence for atmospheric circulation patterns in Europe during the Last Glacial Maximum, Quatern. Res., 54, 295–308, 2000.

Gocke, M., Kuzyakow, Y., and Wiesenberg, G.L.B.: Rhizoliths in loess – evidence for post-sedimentary incorporation of root-derived organic matter in terrestrial sediments as assessed from molecular proxies. Organic Geochemistry 41, 1198–1206, 2010.

Gocke, M., Pustovoytov, K., Kühn, P., Wiesenberg, G.L.B., Löscher, M., and Kuzyakov, Y.: Carbonate rhizoliths in loess and their implications for paleoenvironmental reconstruction revealed by isotopic composition: δ13C, 14C. Chemical Geology 283, 251–260, 2011.

Gocke, M., Perth, S., and Wiesenberg, G.L.B.: Lateral and depth variation of loess organic matter overprint related to rhizoliths — Revealed by lipid molecular proxies and X-ray tomography. Catena (2012), http://dx.doi.org/10.1016/j.catena.2012.11.011

Kühlemann, J., Milivojevic, M., Krumrei, I., and Kubik, P. W.: Last glaciation of the

Sara Range 30 (Balkan Peninsula): Increasing dryness from the LGM to the Holocene, Austrian J. Earth Sci., 102, 146–158, 2009.

Sebe K., Csillag G., , Ruszkiczay-Rüdiger, Z., Fodor, L., Thamó-Bozsó, E., Müller, P., and Braucher, R.: Wind erosion under cold climate: A Pleistocene periglacial mega-yardang system in Central Europe (Western Pannonian Basin, Hungary). Geomorphology 134, 470–482, 2011.

Interactive comment on Clim. Past Discuss., 9, 187, 2013.