Interactive comments on "Excursions to C_4 vegetation recorded in the Upper Pleistocene loess of Surduk (Northern Serbia): an organic isotope geochemistry study" by C. Hatté, C. Gauthier, D.-D. Rousseau, P. Antoine, M. Fuchs, F. Lagroix, S. B. Markovich, O. Moine, and A. Sima

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Hatté et al. (2013) presented $\delta^{13}C$ evidence of soil organic matter (SOM) to demonstrate four measurable excursions of C_4 vegetation during periods of 26.0 to 28.0, 30.0 to 31.4, 44.5 to 53.4, and 66.1 to 86.8 cal. ka (thousand years ago) in Surduk (Serbia) loess sequences. These excursions correlate with low soil organic carbon and high carbonate carbon contents and high concentrations of aeolian sand trapped in loess sediments. Their multiproxy analyses strongly suggest that expansions of C_4 vegetation occurred in phase with active aeolian activity along with intensified Northern Hemisphere cooling, whereas a C_3 ecosystem prevailed during interglacial and interstadial intervals. The authors then proposed that large-scale atmospheric evolution associated with intensified North Atlantic and European ice advances played an important role in these C_4 plant expansions at 45° north latitude in Europe. In their model, large-scale atmospheric evolution occurred in two ways: (1) the Azores High expanded northward and the Siberian High expanded westward, blocking the wet westerly wind and allowing the dry Arctic air mass (northerly wind) to penetrate deep into the Mediterranean region; and (2) a reorganization of deepwater circulation in the Mediterranean Sea reduced the evaporation and heat/moisture meridional transport to higher latitudes. These atmospheric circulation changes introduced a prolonged drought during growing seasons, and without precipitation for two or more months, the C_3 photosynthetic pathway was largely inhibited and the local ecosystem gave way to an expansion of C_4 plants.

Discussion

1. Wynn and Bird (2007) reported that the decomposition rate of C_4 plants is twice as fast as the total biomass and that the $\delta^{13}C_{SOM}$ derived from C_4 plants reflects only half of its contribution to the ecosystem. Cerling et al. (2010) argued that the $\delta^{13}C_{SOM}$ significantly underestimates the C_4 biomass from soils worldwide. Our loess study in the Mississippi River Valley of the United States (Wang et al., 2000) revealed that the $\delta^{13}C_{SOM}$ varies in 2.5‰ bands but the coexisting $\delta^{13}C_{Rhizoliths}$ vary in 5‰ bands. It is becoming clearer that even a small, measurable excursion of $\delta^{13}C_{SOM}$ (1–2‰), as Hatté et al. (2013) reported in the Surduk loess sequence, can provide important information to better understand loess environments during the last glaciation.

2. About 7,600 angiosperm species use C_4 carbon fixation, which is more common in monocots than in dicots. In monocots, the grass species (*Poaceae*) predominantly use the C_4 photosynthetic pathway, although it is also used by the sedge family (*Cyperaceae*) and the daisy (*Asteraceae*), cabbage (*Brassicaceae*), and spurge (*Euphorbiaceae*) families. In dicots, the chenopod (*Chenopodiaceae*) predominantly uses C_4 carbon fixation. Unlike C_3 dicots, there are no woody C_4 dicots to form biomass worldwide, which also explains why its decomposition rate is much faster. As stable isotope paleoecologists, we are all interested in a discussion about the potential C_4 plants that could adapt to very cold and dry conditions at high latitudes during the glacial phases. Pyankov et al. (2010) explicitly described the C_4 taxonomic distribution in Europe and its relation to climatic parameters. They summarized their discussion by stating that "the abundance of total C_4 dicots and C_4 *Chenopodiaceae* is correlated with precipitation and aridity but not temperature, whereas the abundance of total C_4 monocots, C_4 *Poaceae* and C_4 *Cyperaceae* is correlated with temperature and aridity but not precipitation." (page 283). In addition, annual C_4 plants contribute more to the ecosystem than do perennial C_4 plants in Europe. It seems that annual C_4 dicots, especially chenopods, could potentially have prevailed in the Surduk loess environment under cold and dry climatic conditions.

3. Hatté et al. (2013) proposed a simple, elegant model to explain how millennial-scale climate changes played an important role in C_4 biomass expansion at 45° north latitude in Southeast Europe. The other intriguing topic is that we know an intensified North Hemisphere ice advance stopped the Atlantic meridional overturning circulation and shifted the Intertropical Convergence Zone southward, which certainly pushed the polar jet stream (PJS) southward as well. By definition, the PJS separates the moist air mass to its south from the dry air mass to its north. If future investigations in loess sites south of the Surduk, Serbia, can demonstrate a predominant C_3 ecosystem associated with relatively wet summer regimes on similar time scales, the paleo-PJS position changes could be reconstructed somewhere in between locations. If so, we may be able to constrain PJS position changes using a new concept—stable isotope geochemistry studies on SOM in European loess sediments to study the last glacial-interglacial atmospheric evolution.

4. Margins: Figure captions are confused between Figures 3 and 4. In addition, it would be appreciated if keys for stratigraphic units were displayed in either Figure 2 or Figure 4, or both.

Table 1. For age reporting, a comma "," rather than a period "." should be used. It would be appreciated if equivalent dose "De" (Gy), chemistry concentrations derived from ICP-MS or

activity ratios for U, Th, and ^{40}K derived from gamma spectrometry, dose rate (Gy/ka), and water contents are included for IRSL age report.

On page 196, line 6, Hatté at al.'s (2001c) should be (2001a)?

On page 200, line 23, the citation of Lézine et al., 2010 is missing from the References.

On page 203, line 24, assuming it is the typo that "by Krichak and Jaspert (2005). It should be Krichak and Alpert (2005).

References

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