EGU2020-13928, updated on 30 Oct 2020
https://doi.org/10.5194/egusphere-egu2020-13928
EGU General Assembly 2020

Reconstruction of regional humidity variations during the Younger Dryas - Holocene transition in NW Iberia using lipid biomarker stable isotope ratios

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The impact of global temperature changes on hydroclimate, especially on regional spatial scales, is difficult to predict with global climate models. These models are generally too coarse in resolution and do not fully constrain complex atmospheric processes. We can study past climatic changes to understand the evolution of hydroclimate and identify its mechanisms on regional scales. The Younger Dryas (YD) cold period ca. 12.000 years ago was the last major abrupt climate change in Earth history and as such provides us with a natural laboratory to better understand impacts of such change on both global and regional scales. Increasingly, high resolution datasets from terrestrial archives throughout Europe are being developed which suggest atmospheric controls on abrupt changes in local ecosystems, such as the southward movement of the jet stream during the YD period. Therefore, regions located at the boundary between major moisture sources are particularly interesting, such as NW Iberia, which is situated between Atlantic and Mediterranean moisture sources and their effects. Here we present terrestrial lipid biomarker (n-alkane) stable hydrogen (δ^2H_{wax}) and carbon ($\delta^{13}C_{wax}$) isotope records from lake Laguna de la Roya (LR) (NW Iberia), covering the YD. In combination with pollen and chironomid reconstructed temperature data, we aim to identify the evolution of atmospheric conditions during the YD in NW Iberia. Since LR is located close to the Atlantic Ocean and the reconstructed maximum YD sea-ice extent, we are specifically interested in amplitude and variability of local hydroclimatic changes compared to more continental sites during the YD-Holocene transition. During the YD, La Roya δ^2H_{wax} values were characterized by ~6‰ more negative values compared to the preceding Allerød, indicative of colder and drier conditions, which is supported by local temperature reconstruction and pollen analysis. More continental records from western Europe such as Lake Meerfelder Maar (MFM) showed ~12‰ more negative values during YD. This doubling in depletion of MFM samples compared to LR could be, in part, attributed to the stronger temperature drop in continental Europe of about 4-6°C. For the same time at LR, the chironomid data show a drop of only 2.5°C. In general, δ^2H_{wax} from LR were more positive, on average, compared to MFM, by ~27‰ in the Allerød and ~33‰ during the YD. However, in the Holocene both records converge to an average difference of 15‰, which is close to the modern measured 10‰ difference in $\delta^2H_{precipition}$ (source

water for δ^2H_{wax}) and consistent with a shared Atlantic moisture origin and subsequent Rayleigh rainout towards the East. Considering possible temperature related depletions in the LR δ^2H_{wax} record during YD, the 27‰ difference in the Allerød implies additional influences on the recorded signal. A different moisture source area (Mediterranean) for LR during Allerød/YD period, and/or increased air mass transport distances from LR to MFM compared to Holocene conditions can explain the δ^2H_{wax} differences. These findings suggest significant changes in the atmospheric circulation at the YD-Holocene transition when the jet stream shifted northward due to lower seasonal sea-ice expansions and intensification of the Atlantic Meridional Overturning Circulation.