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Deciphering the environmental and landscape evolution of Sierra Nevada (S Iberia) from bog archives

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Sierra Nevada is the southernmost mountain range in the Iberian Peninsula and one of the highest in Europe. Its geomorphology was the result of Pleistocene glaciations that carved out depressions, valleys and cirques at high elevations in the metamorphic basement. Depressions gave rise to lakes and wetlands during the Holocene. Geophysical and organic geochemical analyses of biomarkers (n-alkanes) and bulk sediment (C and N ratio and isotopes) from two high elevation bogs (locally called "Borreguiles"): Borreguiles de la Virgen (BdlV) and Borreguiles de la Caldera (BdlC), have allowed us to track the hydrological evolution of the area and its relationship to climatic fluctuations of the western Mediterranean during the Holocene. Most of the bogs of this area resulted from the natural evolution of former small lakes. The records are 56 cm and 169 cm long, respectively. Geophysical data suggest that we recovered the whole sedimentary record from BdlC; however, there are some post-glacial sediments remaining below the BdlV core that we could not recover due to hard-ground conditions. During the early and middle Holocene, aquatic conditions predominated in BdlV compared to the most recent part of the record (low C/N values and high proportion of aquatic plants (Paq) deduced from the n-alkanes) suggesting a lake environment whose water level gradually decreased until ∼5.5 cal ky BP. This aridity trend is also observed in nearby records such as at Laguna de Río Seco (LdRS), a result of the African Humid Period demise. Carbon and nitrogen isotopes were higher during this interval, which might suggest more algae activity, in agreement with the highest concentrations of the algae Pediastrum in the area. There is an important development of terrestrial plants, a real bog stage (C/N higher than 20, high TOC, lower Paq) in both records from ∼5.5 to 3.5-3.0 cal ky BP. Those hydrological changes in the landscape might be related to a possible change in the source of precipitation, detected by n-alkane deuterium data in the nearby LdRS record, and boosted by a dominant NAO positive phase. The record from BdlV shows really low sedimentation rates from 3.5 to ∼0.7 cal ky BP. The same period in BdlC does not show drastic changes in the sedimentation rate or in the geochemical data, suggesting local factors as an explanation for the differences between the records. Important environmental changes are identified during the latest part of both records agreeing with the transition between the Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA). Although the main pattern during the LIA is humid at the beginning ∼600-500 cal yr BP and drier afterwards, surprisingly, the high-resolution BdlC record suggests fluctuating humidity conditions during the LIA. There is an increase in aquatic environments in both bogs during the last decades, which might be related to ice melting during summer time due to the rise of global temperatures.