Supplementary Material

Paleoecological methods

The modern vegetation of the sampled peat bogs include *Caricetum carpetanae* communities dominated by *Carex nigra*, *C. echinata* and *Parnassia palustris* (Sánchez-Mata 1989). The forests of the area include Maritime pine (*Pinus pinaster*), and *Pinus nigra* subsp. *salzmannii* and *Pinus sylvestris* woodlands with *Genista cinerascens* and *Festuca elegans* subsp. *merinoi* (López-Sáez *et al*. 2016). Overall, the high-supramediterranean belt, above the treeline, is dominated by grasslands and shrublands (*Juniperus communis*, *Cytisus oromediterraneus*, *Echinospartum ibericum*).

A 50-cm sediment core was extracted from the peat bog in October 2000 using a Russian corer with a diameter of 50 mm. Peat sections were individually sealed and stored at 4°C prior to laboratory sub-sampling at 1 cm intervals. Five peat samples were ^{14}C dated using AMS technique (Table S1). at the Centro Nacional de Aceleradores (Sevilla, Spain). Radiocarbon dates were calibrated in years cal AD with the CALIB 7.10 software using the calibration curve IntCal13 (Reimer *et al.* 2013). Dates are expressed as intercepts with 2σ ranges. An age-depth model was produced using Clam 2.2 software (Blaauw 2010). The best fit was obtained applying a smoothing spline to the available radiocarbon dates.

Pollen analysis was carried out on 50 sub-samples of 1 cm^3 along the core. Standard pollen extraction techniques were used (Faegri and Iversen 1989). Pollen counts of up to 400 grains total land pollen (TLP) per sample were identified and counted. Percentages were calculated based on TLP sum excluding wetland taxa and non-pollen palynomorphs (NPPs). Pollen diagrams were produced using Tilia and Tilia-Graph v. 2.0.b.5 software (Grimm 1992, 2004). Pollen grains, spores and NPPs were identified using palynological keys and photo atlases (Moore *et al*. 1991; Reille 1999; Cugny *et al*. 2010). Local pollen assemblage zones (LPAZs) were defined on the basis of agglomerative cluster analysis of incremental sum of squares (Coniss) with square root transformed percentage data (Grimm 1987). The number of statistically significant zones was determined using the broken-stick model (Bennett 1996).

Contiguous 1 cm^3 sub-samples were retrieved at 1 cm intervals for macroscopic charcoal analysis. Samples were soaked in a 10% NaOH solution for 24 h to disaggregate organic silts, then in a 6% H_2O_2 solution (24 h) to bleach the remaining non-charcoal organic material and thus make charcoal identification easier (Carcaillet et al., 2001). Samples were sieved through a 150 µm mesh. The total number of macrocharcoal particles was counted using a stereomicroscope in order to estimate past changes in fire activity at a local scale (Whitlock and Larsen 2001, Higuera *et al*. 2007, Brown *et al*. 2013). Charcoal accumulation rate (CHAR) was calculated by sedimentation rate (cm $year^{-1}$) and is expressed in particles cm^{-2} $year^{-1}$ (Long and Whitlock 2002).

Table S1. Accelerator Mass Spectrometry radiocarbon (AMS-^{14}C) data with 2σ range of calibration from "Arroyo de Aguas Frías" peat bog.

Laboratory code	Depth (cm)	AMS ^{14}C age BP (yrs.)	Age cal AD	Mean Age cal AD
CNA-111	50	230 ± 30	1532-1950	1737
CNA-112	37	143 ± 20	1669-1944	1802

CNA-113	33	75 ± 30	1691-1923	1847
CNA-114	25	67 ± 20	1696-1919	1868
CNA-115	19	10 ± 30	1690-1960	1900

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