Abrupt climate changes during the last deglaciation and Holocene: Pollen & biomarker analyses from the Portuguese Margin

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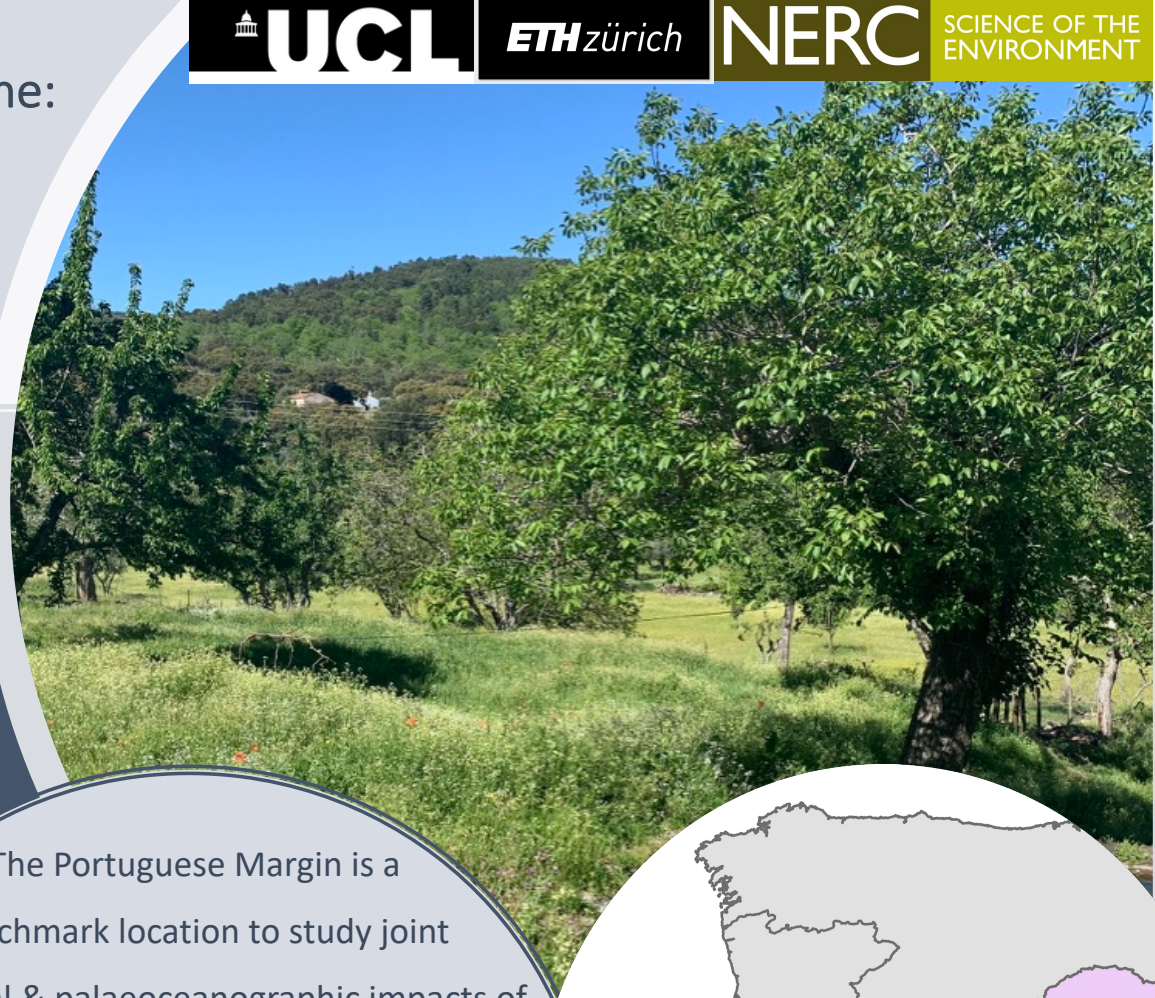
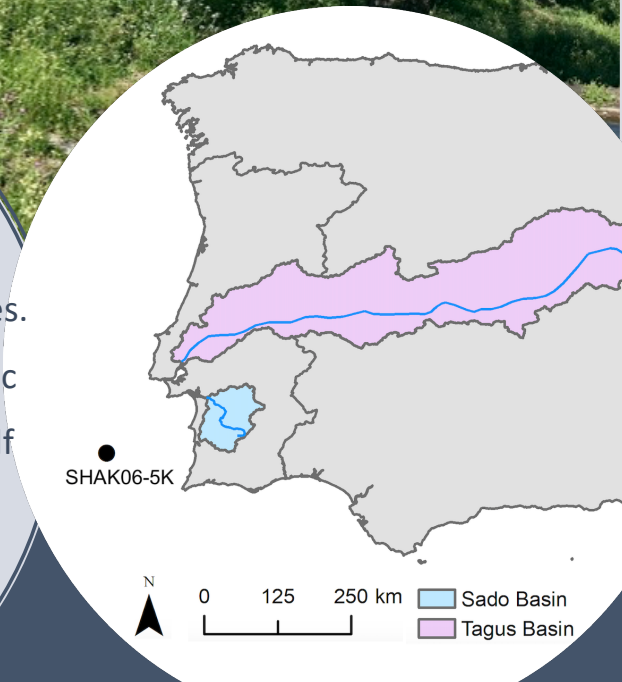


RATIONALE:

With the unprecedented rate and nature of today's global warming, understanding the response of vegetation to abrupt events is becoming increasingly critical. Although no geological period is an analogue for future change, the last deglaciation and Holocene (with deglacial CO_2 concentrations similar to pre-industrial levels, and well understood radiative forcing boundary conditions) can provide insight into vegetation responses to millennial and centennial-scale abrupt events.

This project aims to document the response of western Iberian vegetation to centennial and millennial-scale climate change, focusing on hydrological variations over the past 28 thousand years using pollen and leaf-wax *n*-alkane biomarker records from Portuguese Margin marine core SHAK06-5K.

The Portuguese Margin is a benchmark location to study joint terrestrial & palaeoceanographic impacts of abrupt events from the same sediment samples. The region is linked to Greenland and Antarctic water masses, and its narrow continental shelf and close proximity to the Tagus and Sado rivers lead to rapid delivery of sediment to the Tagus Abyssal Plain.



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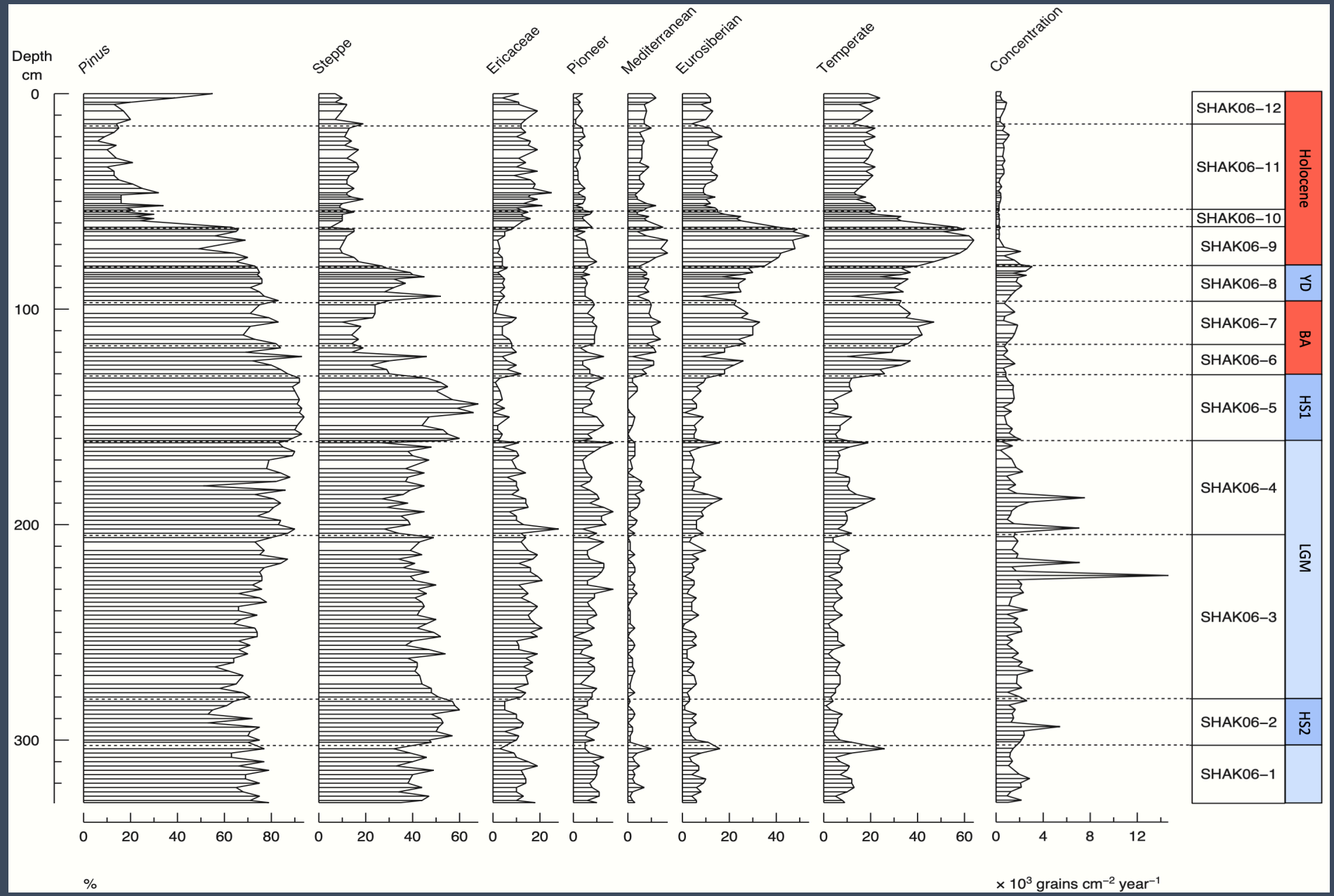
RESULTS: SHAK06-5K Summary Pollen Diagram



RESULTS: SHAK06-5K terrestrial and marine records

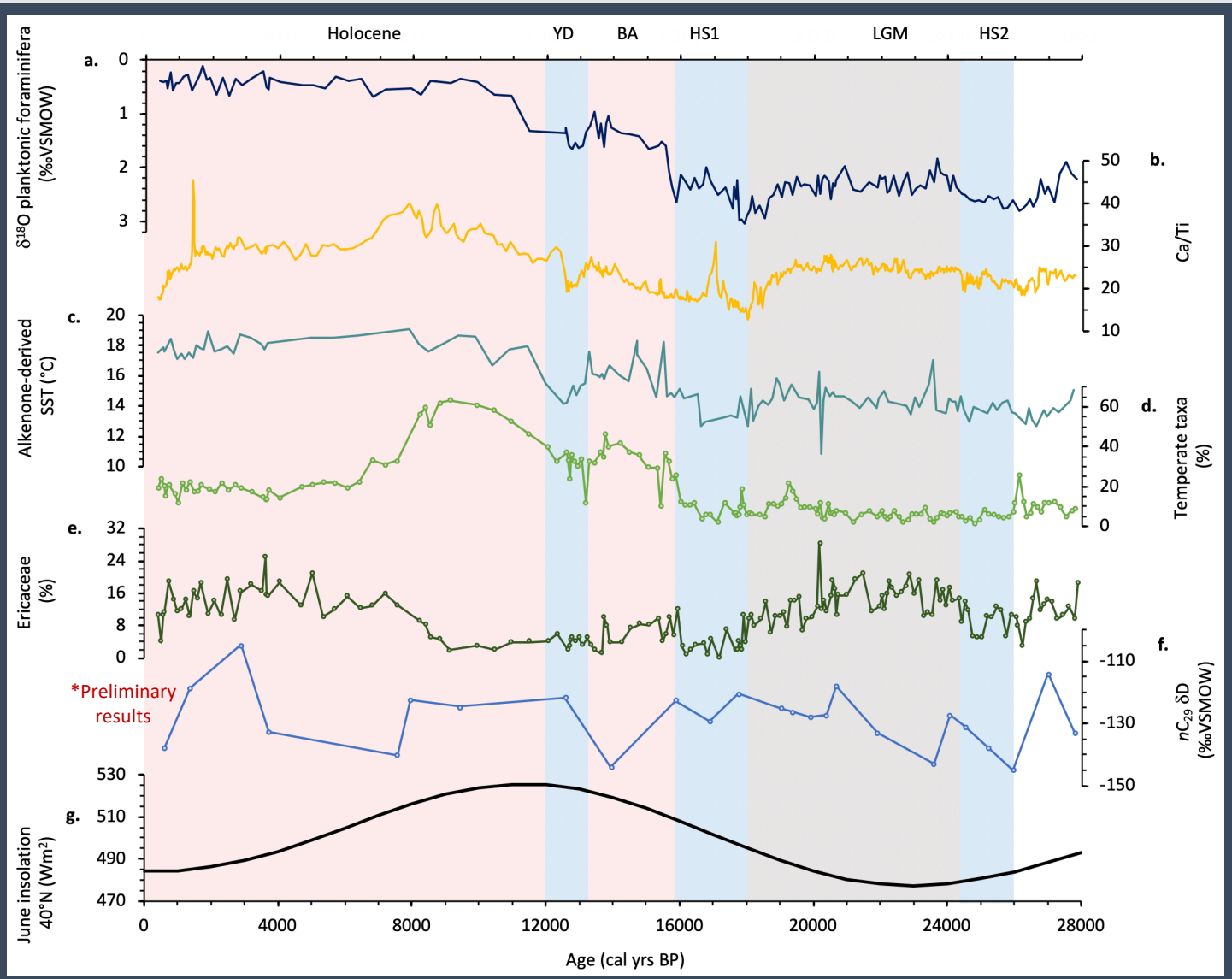
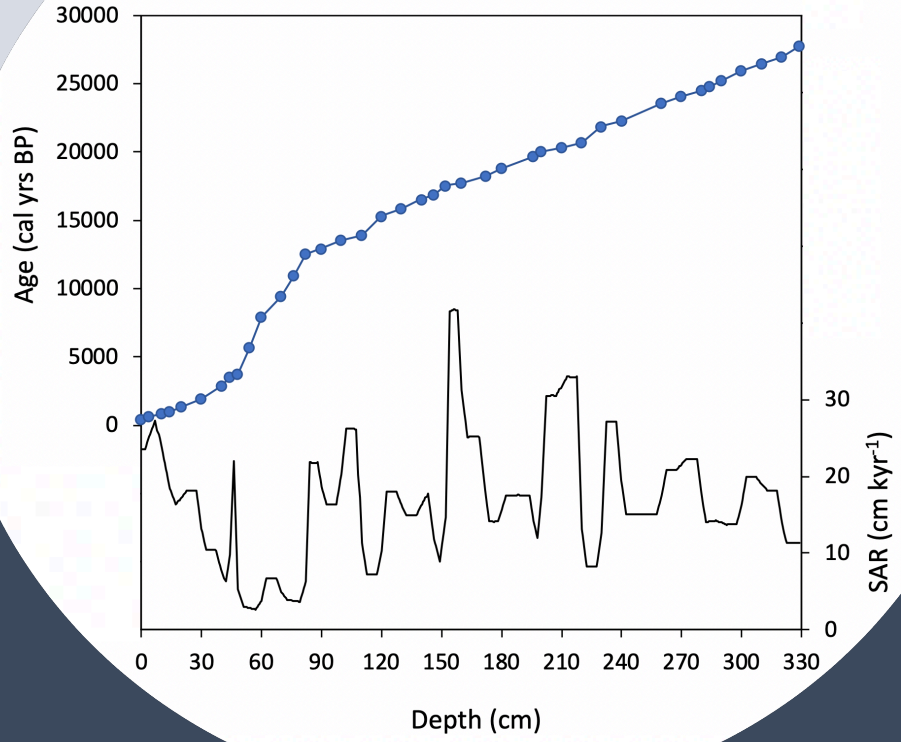


Figure 1: From SHAK06-5K a. $\delta^{18}O$ planktonic foraminifera (Ausin et al., 2019a); b. Ca/Ti (Ausin et al., 2020); c. Alkenone SST (°C) (Ausin et al., 2019b); d. Temperate pollen (%); e. Ericaceae pollen (%); f. *n*C29 δD (‰VSMOW); g. June insolation 40°N (Wm2) (Berger, 1978)



Chronology:

40 AMS ^{14}C dates calculated using *G.bulloides* (Ausin et al., 2019a). 30-100 well preserved specimens used for each sample, which were then measured as gaseous targets using the MICADAS at ETH Zurich's Ion Beam Physics Laboratory (Wacker *et al.,* 2013). Depositional age-model (P_Sequence type) produced using Oxcal (Bronk Ramsey, 2009). Calibration conducted using Marine13 (Reimer *et al.,* 2013), automatically applying a static global marine reservoir correction. Core spans the last 27.8kyr, with a mean temporal resolution of 170kyr.

Interpretations and conclusions:

1. Our pollen record indicates the response of regional vegetation to centennial & millennial-scale events. Forests expanded during interglacial/ interstadial conditions and contracted alongside steppe expansion during glacial/ stadial conditions

2. During the deglaciation, our pollen and δD records show synchroneity with the timing of millennial-scale changes in the XRF Ca/Ti ratio, planktonic foraminiferal $\delta^{18}O$ and alkenone-derived SSTs, indicating vegetation and water availability changes in this region are primarily driven by North Atlantic abrupt events during this period

3. Temperate pollen and Ca/Ti, decouple from $\delta^{18}O$ and SST records from the mid-Holocene onwards and demonstrate a closer relationship with boreal insolation

4. The relationship between Ericaceae, $n C_{29} \delta D$ and boreal insolation in the early and mid-Holocene could be explained by boreal insolation maximum (minimum) decreasing (increasing) spring/summer water availability leading to Ericaceae contraction (expansion) (Tzedakis, 2010; Margari et al., 2014) and less (more) negative $n\delta D$

ONGOING WORK:

Research is currently being conducted to explore major plant fractionation controls in the Tagus catchment basin, the dominant terrestrial proxy supplier to our core. Research suggests fractionation can vary between species (van den Bos et al., 2018). Leaf samples of the 10 most dominant taxa in our pollen record have, therefore, been collected and their *n*-alkane isotopes are currently being analysed to assess whether the dominant control of our $\delta^{13}C$ and δD variation is due to interspecies differences in fractionation, or water availability affecting plant physiology. This research will help aid our interpretation of key climatic drivers of abrupt vegetation change in our deglacial record.

References: Ausin et al., 2019a, *Paleoceanography & Paleoclimatology*; Ausin et al., 2019b, *Earth Planetary Science Letters*; Ausin et al., 2020, *Quaternary Science Reviews;* Berger, 1978, *Journal Atmospheric Science;* Bronk Ramsey, 2009, *Radiocarbon;* Margari et al., 2014. *Geology;* Reimer, *et al.,* 2013, *Radiocarbon;* Tzedakis, 2010, *Climate of the Past;* van den Bos et al., 2018, *Journal of Quaternary Science;* Wacker *et al.,* 2013, *Nuclear Instruments and Methods in Physics Research Section B.*