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The next climate bifurcation as inferred from the Iberian margin paleoarchive

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The western European lands were settlement regions for Homo during the late Pleistocene. Fortunately for recent civilizations, since the beginning of the present warm period about 11,500 years ago (Holocene), the climate of Europe has maintained relatively stable, tending toward progressively cooler climate conditions in accordance with the slow decrease in summer insolation in the northern hemisphere. However, the climate of preceding analog warm periods deviated from this apparently stable stage giving rise to dramatic short-term cooling stages (stadials) immediately followed by well-defined returns to more warmth (interstadials). There is a pressing need for high resolution paleoclimatic sequences to evaluate the imprint of this particular centennial scale climate variability on the enigmatic and controversial life extinctions of the last ice age and thereby to position the next bifurcation of the climate in its proper context.

In this study, new sediments recovered north of Minorca have allowed continuous reconstruction of climatic history over the past 115,700 years at temporal resolution of 167$\pm$42 years, using fossil organic compounds synthesized by marine and continental flora (MD99-2343: 40°N, 4°E, 2,391 m below sea level; sedimentation rate up to 44 cm/1,000 years). The core was retrieved from the sedimentary drift formed by the western Mediterranean deep water (WMDW). This specific water mass belongs to the complete circulation system which characterizes the semi-enclosed Mediterranean basin: surface Atlantic water enters through the straits of Gibraltar, north-westerly

winter winds blowing over the Mediterranean shelf system cause surface waters to downwell and subsequently a deep outflowing to the Atlantic occurs.

The reconstructed MD99-2343 sea surface temperature (Uk'37-SST) showed remarkable consistency with the twenty five average yearly atmospheric temperature oscillations observed in Greenland δ18O profiles (correlation coefficient with a Monte-Carlo scheme of r=0.87; n=641 samples). For the late Weichselian and the Holocene 10 AMS-14C dates were available. The recorded warm and cool events, respectively labelled here as Iberian margin interstadials (IMI) and stadials (IMS), exhibited a persistently repeated saw-tooth morphology. The oscillations always commenced with an abrupt warming in just a few centuries (for example, up to 10.5°C in 2,800 years or 6.4°C in 800 years), followed by a gradual cooling over several hundred or several thousand years and, particularly the long oldest events, ending in a final, rapid cooling phase (i.e. a fall of 4°C over 700 years). In the region of study these shifts were truly enormous and rapid, considering that 11,500 years ago, the last deglaciation involved an abrupt warming of 8.4°C in 2,900 years.

Different hydrological indicators were identified at the Iberian margin new core. Firstly, the relative proportion of the tetraunsaturated C37 alkenone homolog to total C37 alkenones synthesized by the coccolithophora flora (C37:4). Independently of the extension of northern ice sheets, the appearance of this alkenone, which in cultures is only synthesized at very low temperatures, was indicative of full glacial conditions during numerous events (IMS-2a, 5, 9, 13, 15, 19, 20, 21, 22, 25). Secondly, the n-hexacosan-1-ol (C26OH) and the n-nonacosane (C29), representative compounds of vascular terrestrial plants, traced wind strengthening and arid, cold conditions. Both continental proxies evolved in remarkable parallelism consistent with their common origin (r=0.74). However, their resemblance was especially reduced during harsh cold spells and at the final phase of long, mild periods, when inputs of ancient materials that have suffered extensive alteration processes, reached the core location.

The new data may provide a sound basis for understanding the atmospheric and oceanic mechanisms related to the formation of the Mediterranean outflow dense waters and their influence on the North Atlantic circulation. In addition, this study evidences the non-linear feedbacks relevant to rapid climate variability in the region, clarifying the steps leading to glaciation after warm, stable periods similar to the present one.