A-359

New records of environmental change in the central and western Mediterranean Sea from organic molecular proxies

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1. Oceanographic setting and age models

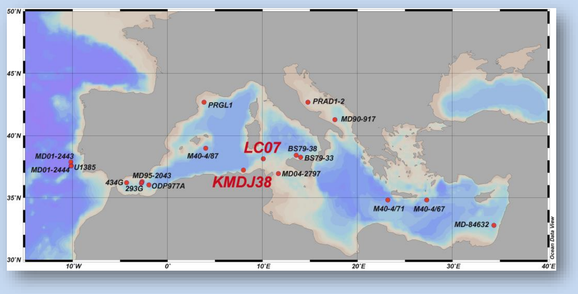


Figure 1. Bathymetric map of the Mediterranean Sea with the location of the studied cores (LC07 and KMDJ38) together with other cores for which, at least, one continuous G/I cycle based on molecular biomarkers, reaching modern times, has been published.

► The Mediterranean region is particularly sensitive to global climate, being considered a climate change hotspot given its recent greater warming compared to global trends. Records of changes in the Mediterranean have been widely documented through reconstructions using deep sea sediments (Fig. 1), but there are still poorly covered regions and time periods.

► Here we focus on the relatively shallow Strait of Sicily, a region of surface and deep water interchange between the eastern and western Mediterranean basins, and on the Algerian Margin (Fig. 2, 3). For this, we present recently published data from core LC07 (Strait of Sicily, Martínez-Dios *et al*. 2021), which provides a low resolution (nearly) continuous record covering ~one million years (Fig. 4), and preliminary data from core KMDJ38 (Algerian Margin) covering the last 55 kyr at a higher resolution (Fig. 5).

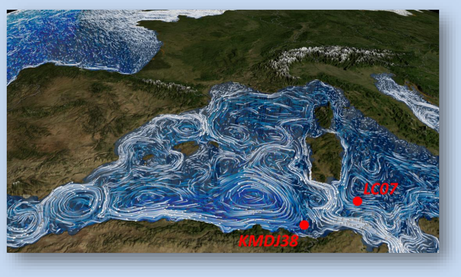


Figure 2. Simulation of surface (white) and deep (blue) current flows in the Mediterranean Sea during year 2005 using the ECCO2 high resolution ocean and sea ice model (obtained from http://svs.gsfc.nasa.gov/3820). The location of the studied cores (LC07 and KMDJ38) are indicated.

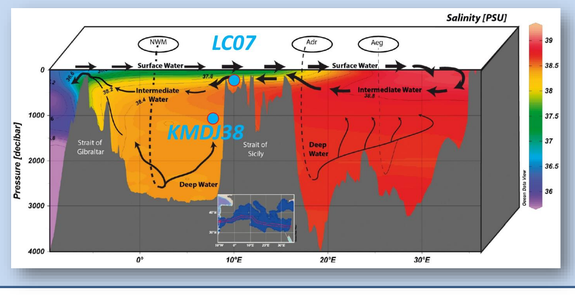


Figure 3. Cross section showing the distribution of salinity and the general circulation of the Mediterranean Sea. The thicknesses of the arrows indicate the relative flow rates. Major deep-water formation areas are identified. Adapted from Powley et al. *2018. The locations of the studied cores (LC07 and KMDJ38) are indicated.*

LC07: 38°8.72'N, 10°4.73'E; 23.66 m, 488 m depth

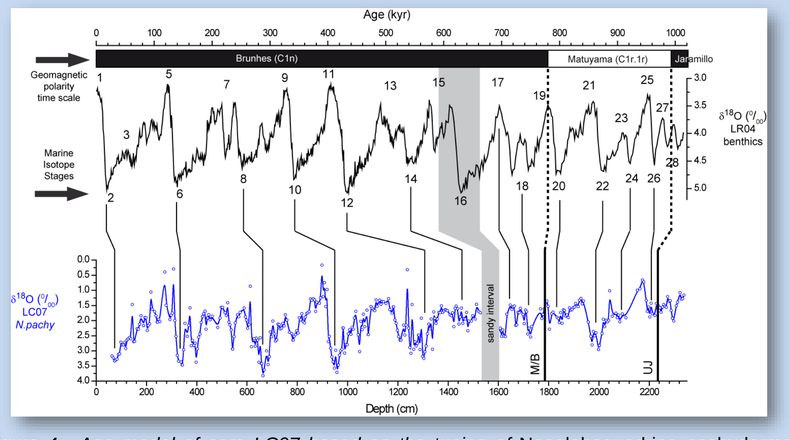


Figure 4. Age model of core LC07 based on the tuning of Neogloboquadrina pachyderma *(dextral) δ18O (data from Dinarès-Turell* et al. *2003) with the LR04 benthic δ18O stack (Lisiecki and Raymo 2005). The occurrence of a foraminifer-rich sandy interval and the position of the Matuyama/Brunhes (M/B) and upper Jaramillo (UJ) reversal boundaries (also used in the age model) are indicated.*

KMDJ38: 37°13.49'N, 8°0.01'E; 8.07 m, 1057 m depth

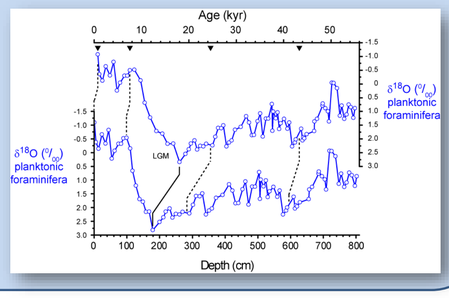


Figure 5. Age model of core KMDJ38 based on four 14C measurements (black triangles, data from Giresse et al.*, 2013) and the LGM at 18 kyr.*

2. Choices of $U^{K'}_{37}$-SST calibrations

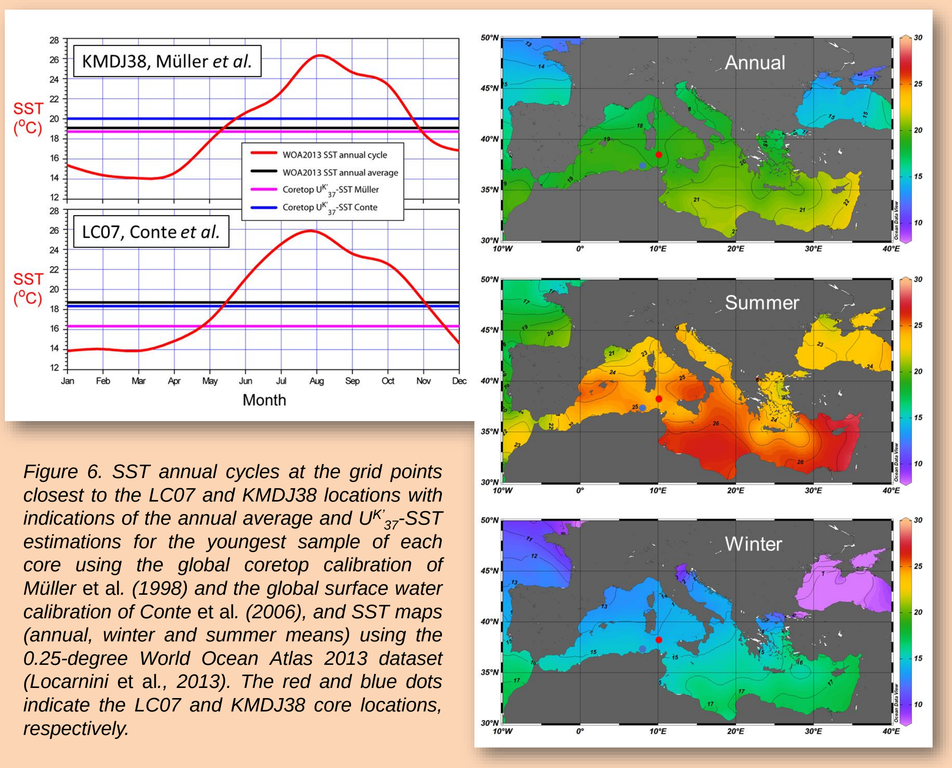


Figure 6. SST annual cycles at the grid points closest to the LC07 and KMDJ38 locations with indications of the annual average and $U^{K'}_{37}$-SST estimations for the youngest sample of each core using the global coretop calibration of Müller et al. *(1998) and the global surface water calibration of Conte* et al. *(2006), and SST maps (annual, winter and summer means) using the 0.25-degree World Ocean Atlas 2013 dataset (Locarnini* et al.*, 2013). The red and blue dots indicate the LC07 and KMDJ38 core locations, respectively.*

3. $U^{K'}_{37}$-SST paleoreconstructions

$U^{K'}_{37}$-SST vs $\delta^{18}O$ — Strait of Sicily

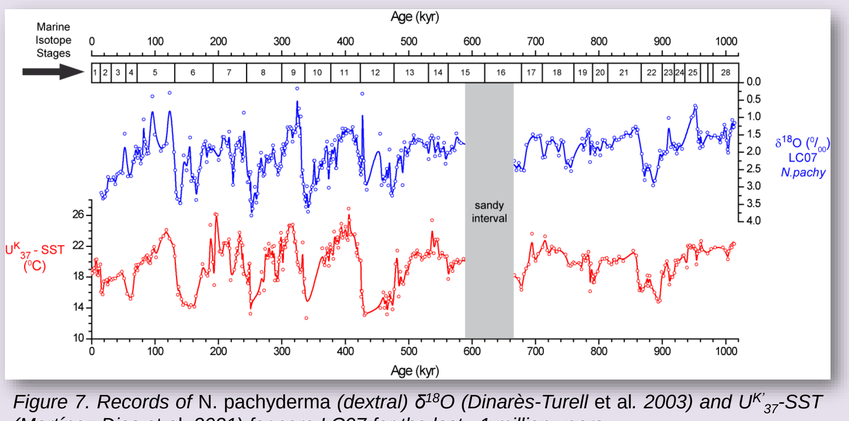


Figure 7. Records of N. pachyderma *(dextral) δ18O (Dinarès-Turell* et al. *2003) and $U^{K'}_{37}$-SST (Martínez-Dios* et al. *2021) for core LC07 for the last ~1 million years.*

Algerian Margin

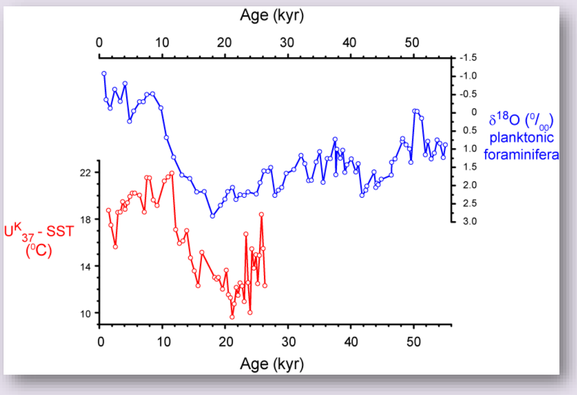


Figure 8. Records of planktonic foraminifera *δ18O (Giresse* et al.*, 2013) and $U^{K'}_{37}$-SST (this study) for core KMDJ38 for the last 55 kyr.*

Comparisons with other records

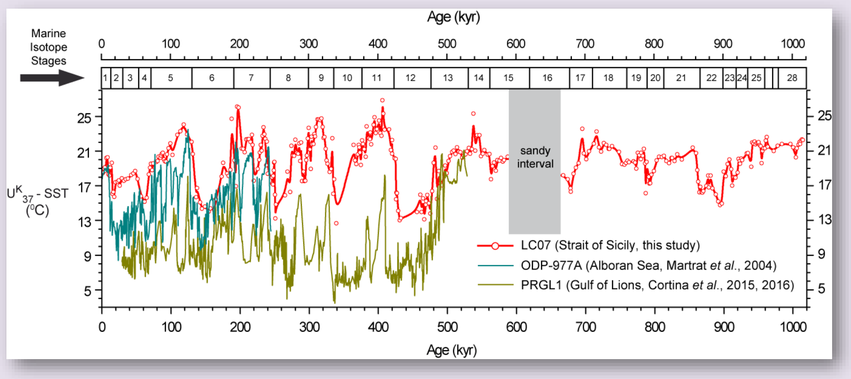


Figure 9. Comparison of the $U^{K'}_{37}$-SST record from core LC07 (Martínez-Dios et al. *2021) with the two longest $U^{K'}_{37}$-SST records published so far in the Mediterranean Sea (data for ODP-977A in the Alboran Sea is from Martrat* et al. *2004 and these for PRGL1, in the Gulf of Lions, are from Cortina* et al. *2015, 2016).*

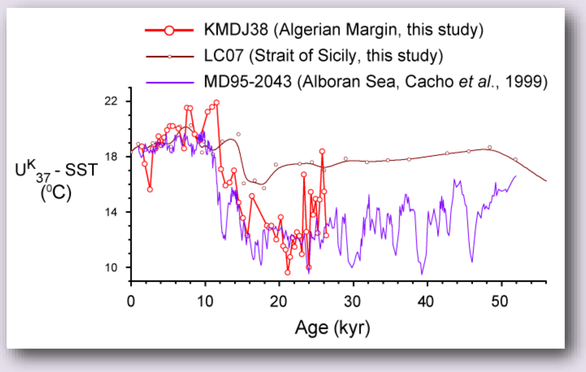
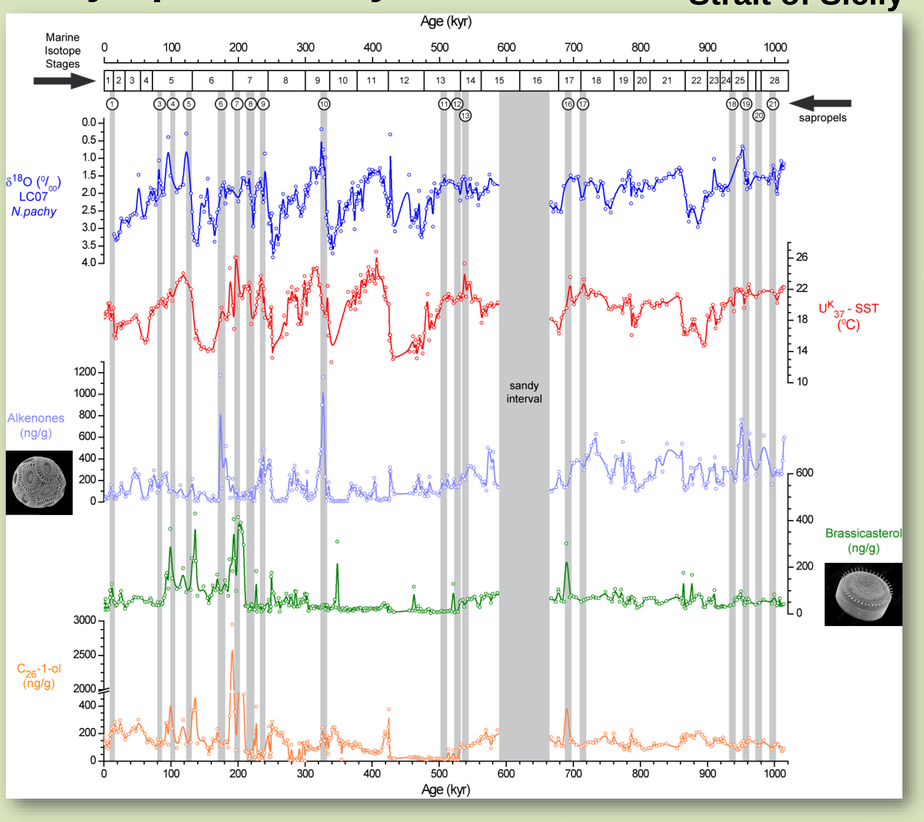


Figure 10. Comparison of the $U^{K'}_{37}$-SST records from cores KMDJ38 (Algerian Margin, this study), LC07 (Strait of Sicily, Martínez-Dios et al. *2021) and MD95-2043 (Alboran Sea, Cacho* et al. *1999).*

4. Phytoplankton dynamics

Strait of Sicily



Algerian Margin

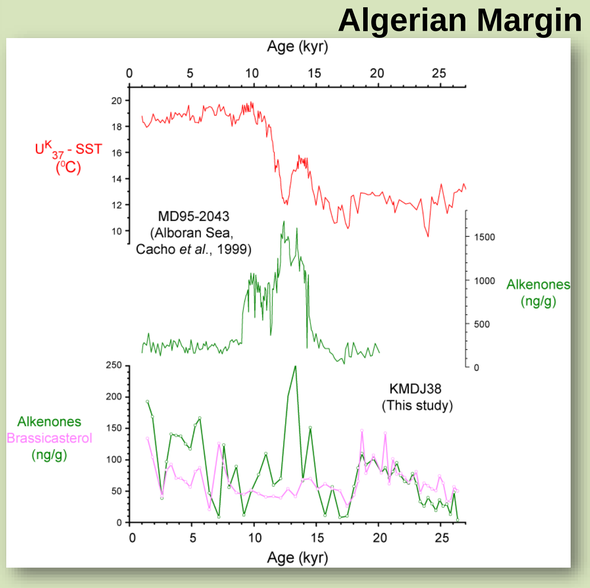


Figure 11. Molecular biomarker records from core LC07 (Martínez-Dios et al. *2021), including $U^{K'}_{37}$-SSTs and the abundances of marine origin lipids (long chain alkenones, brassicasterol) together with the terrestrial* n*-hexacosan-1-ol concentration and the LC07* N. pachyderma *(dextral) δ18O (data from Dinarès-Turell* et al.*, 2003), for comparison. Grey vertical bars indicate sapropels, based on the dates from Ziegler* et al. *(2010) and Konijnendijk* et al. *(2014).*

Figure 12. Abundances of phytoplankton related biomarkers from cores KMDJ38 (Algerian Margin, this study) and MD95-2043 (Alboran Sea, Cacho et al. *1999, including also the $U^{K'}_{37}$-SST record from this core for reference).*

5. Key points from this study

► A molecular biomarker record covering the last 1 million years is presented, for the first time, in the Mediterranean Sea (Figs. 7, 9, 11), together with preliminary data from the Algerian Margin (Figs. 8, 10, 12).

► SSTs in the Strait of Sicily were consistently warmer than other records located further to the west (Fig. 9) whereas, in the Algerian Margin, they resemble those in the Alboran Sea, albeit exhibiting brief warmer episodes (Fig. 10).

► In the Strait of Sicily, alternate peaks of alkenones and brassicasterol concentrations coeval to several sapropels suggest distinct proliferation of coccolitophores and diatoms during these periods (Fig. 11).

► In the Algerian Sea, a peak in the concentration of alkenones during the deglaciation, not followed by brassicasterol, matches similar results reported in the Alboran Sea, where the occurrence of an organic rich layer was described (Cacho *et al*. 2002).

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Acknowledgements:

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