Climate fluctuations over the last deglaciation: a high resolution record from the Western Mediterranean

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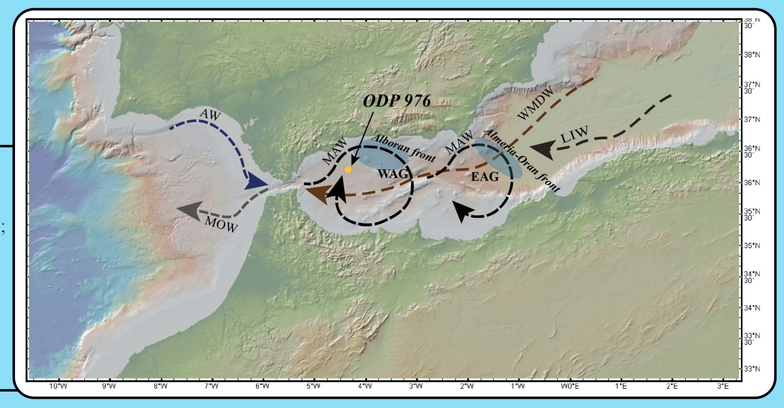
Aims and Methods

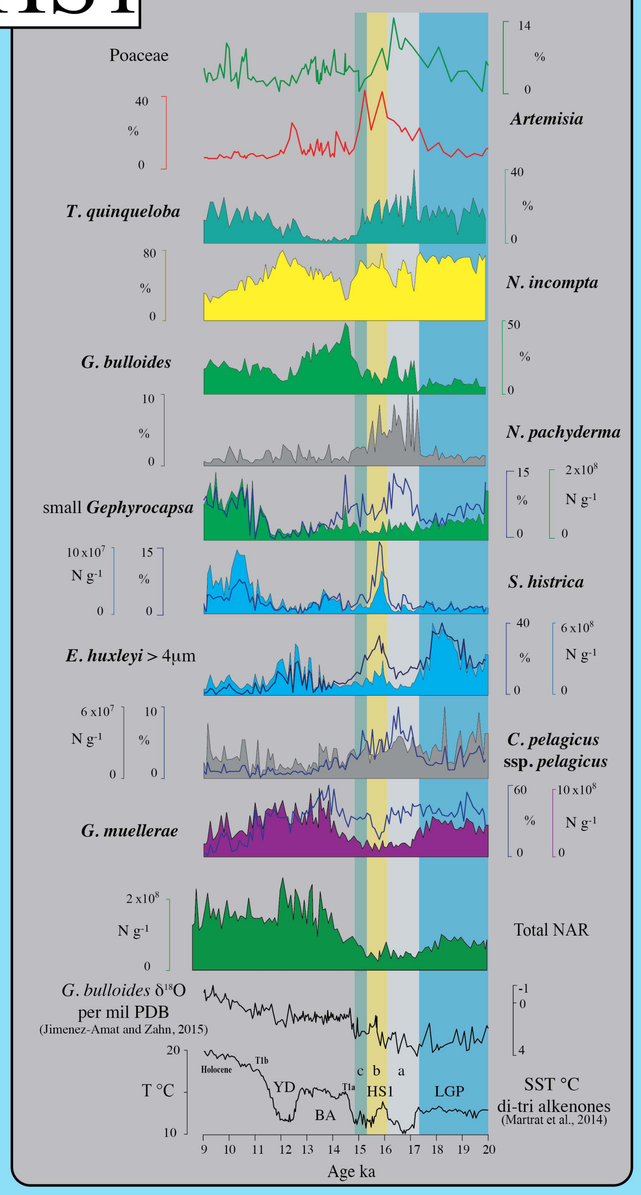
The ODP site 976 in the Alboran Sea (Western Mediterranean) has been chosen for a high stratigraphic resolution study on the calcareous plankton assemblage in the last 20 ka. The site presents the unique opportunity to compare the coccolithophore and foraminiferal curves with highly detailed geochemical proxies (Martrat et al., 2014) and pollen data, allowing for a thorough comparison between land and sea.

107 samples have been analyzed with a centennial years scale resolution for the 9-20 ka BP interval. Quantitative analysis has been performed with a Light Microscope counting 500 specimens per sample. Coccolith absolute abundance curves have been reconstructed using the formula from Flores and Sierro (1997). For the planktonic foraminiferal analyses, the 150 μm residue was selected. Samples were split to obtain a fraction containing more than 300 specimens. Pollen data come from Combourieu-Nebout et al (2009)



Oceanographic set:
Alboran Sea oceanographic circulation.
AW (Atlantic Water);
MOW (Mediterranean Outflow Water);
WMDW (Western Mediterranean Deep Water);
LIW (Levantine Intermediate Water);
MAW (Modified Atlantic Water);
WAG (Western Alboran Gyre);
EAG (Eastern Alboran Gyre).
In blue shade:
Alboran and **Almeria-Oran** upwelling fronts.

HS1



Heinrich Stadial 1 (HS1):

Coldest surface waters and decrease in productivity

- Decrease in total nannofossil accumulation rate (NAR) as a result of SST strong decrease and fresh meltwater input

HS1a

Maximum polar/subpolar water influx

- Maximum abundance in *C. pelagicus* ssp. *pelagicus* and *N. pachyderma*

North Atlantic westerlies induced upwelling conditions

- Relative high values of small *Gephyrocapsa*, *T. quinqueloba* and *G. bulloides*

Moister conditions on land

- Relative high abundances of Poaceae related to relative low abundances of *Artemisia*.

HS1c: *cool surface waters and aridity on land*

Reduced polar-subpolar influx

- Decrease in *N. pachyderma* and *C. pelagicus* ssp. *pelagicus*

Persistence of aridity on land

- High abundance of *Artemisia*

HS1b

Relative warmer surface temperature

- *G. muellerae* and *C. pelagicus* ssp. *pelagicus* decrease. Change in abundance between *N. pachyderma* and *N. incompta*, as a signal of the relative climate amelioration

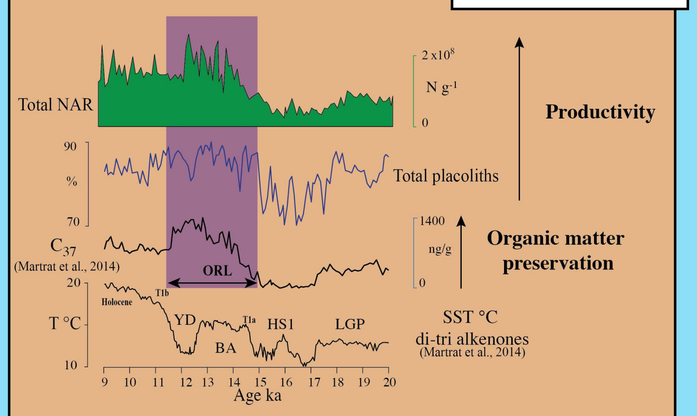
Decrease in salinity during still cold water conditions

- Spike in *S. histrica* likely marks fresher/turbid water during relative climate amelioration
- *E. huxleyi* > 4μm peak: Large *Emiliania* (LE) increase seems to be linked to both a cold phase and likely a decrease in salinity in the basin also marked by concurrent planktonic $\delta^{18}O$ depletion.

Aridity on land

- Peak in *Artemisia*

ORL1

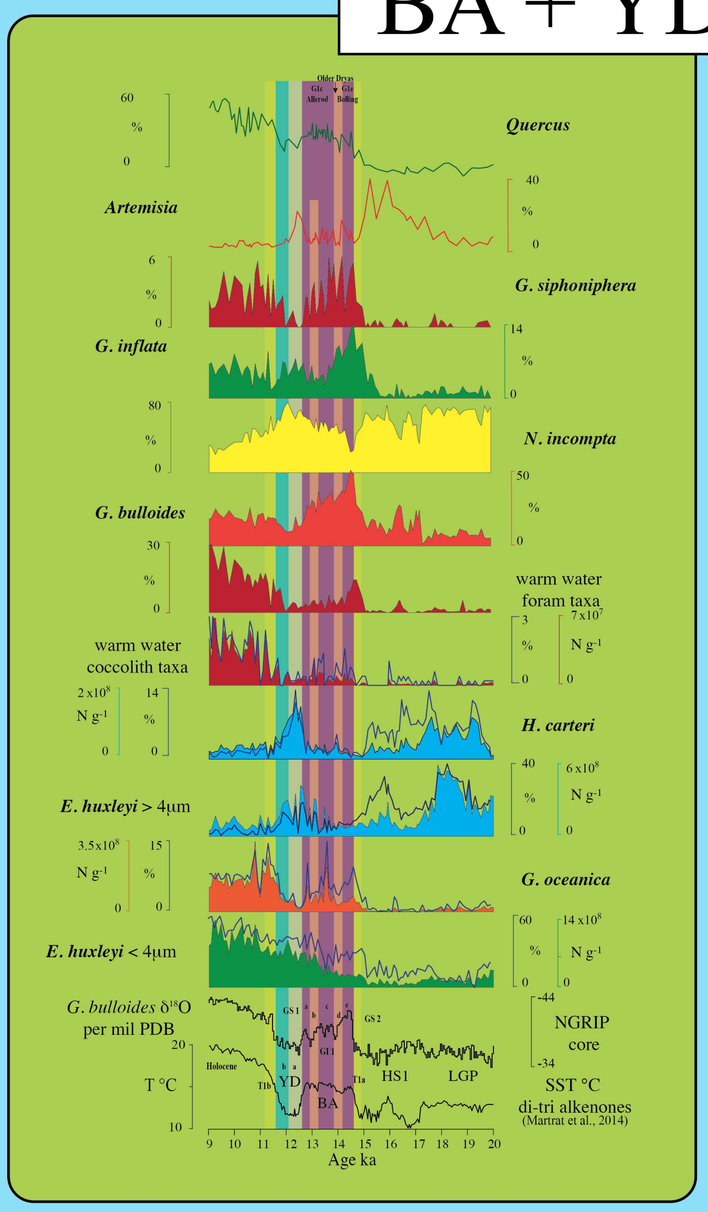


Organic Rich Layer 1 (ORL1)

Enhanced surface water productivity

- Increase in total NAR and total placoliths, concomitant with enhanced organic matter preservation

BA + YD



Bølling-Allerød (BA)

Surface water warming and short-term warm/cold pulses linked to higher variability during Greenland Interstadial 1

Warm Atlantic Surface Water (ASW) jet associated with water mixing

- increase in *G. oceanica* and *G. inflata*
- increase in *G. bulloides*

Warmer surface waters, more humid conditions

- foram and coccolith warm water taxa increase
- increase in *Quercus*

High frequency variability in ASW jet

- Peaks of *G. oceanica* concomintant with **GI-1e, c** and **a** succession

Towards the onset of Holocene condition

- Abundance reversal between *E. huxleyi* < 4μm (Small *Emiliania*, SE) and LE (Flores et al., 2010)

Younger Dryas (YD)

YDa

Cold and dry phase

- Increase in in *N.incompta*, LE and *Artemisia*

Erosion on land and detrital transport into the basin

- Peak in *H. carteri*

Productivity increase

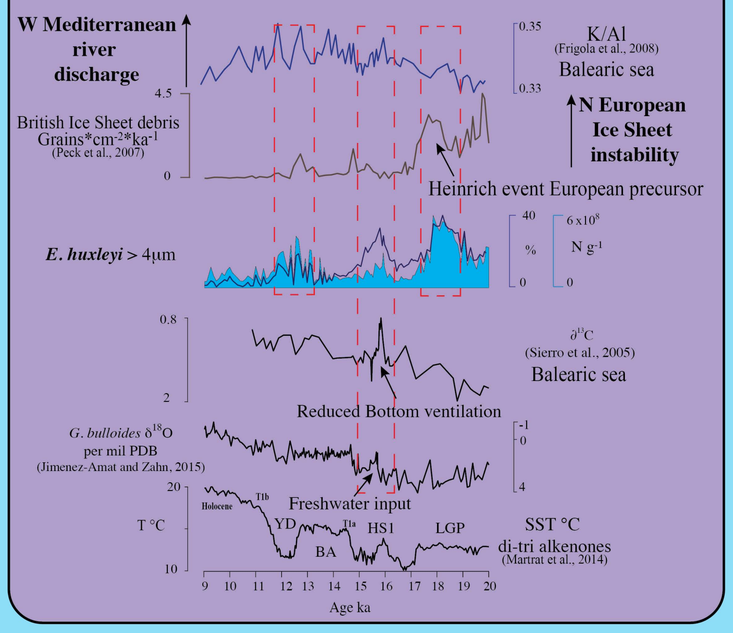
- Maximum value of total NAR

YDb

Relative warmer and more humid conditions

- Warm water forams increase
- Increase in *Quercus*

Large *Emiliania*



Large *Emiliania*

A proxy of European ice sheet instability and surface water freshening

- Peaks in LE match increases in British Ice Sheet (BIS) - derived debris during LGP, freshwater input, decrease bottom water ventilation and increases in riverine discharge during HS1 and YD

Conclusion

The rapid shifts in climate sensitive taxa support the hypothesis that each of the climate phases-sub/phases is characterized by a complex pattern, forced by strong interaction between ice-sheet instability, melt water discharge entering the Gibraltair Strait, North Atlantic weterlies and moisture availability, clearly impacting over surface water temperature, salinity, productivity and vegetation on land

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