Recent climate variability and amplification revealed from indicators in the Gulf of Taranto

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SOMMARIO

- High resolution marine cores
- From sediment to samples
- Temperature indicators ($\delta^{18}$O and alkenones)
- Ionian circulation bimodal pattern
- Conclusions
MEDITERRANEAN SEA

Semi-enclosed and stratified basin
Deepest regional sea of the Mediterranean: IONIAN SEA
Shallow-water Central Mediterranean cores (Gallipoli terrace, Ionian sea; water depth ~200 m)

- flat region
- no direct river discharge
- close to the Campanian area; unique site in the world for historical documentation of volcanic eruptions

Particularly favourable site for high resolution studies of past climate variations
CORE DATING

• Radiometric methods (\(^{210}\text{Pb}\)) - upper 10 cm
• Tephroanalysis:

22 eruptions of Vesuvio from Pompei (79 AD) to the most recent in 1944 AD

• 1638–1944 detailed catalogues (Arnò et al., 1987)
• before 1638 sparse documentation

LINEAR TIME-DEPTH RELATION:  \text{depth}(\text{cm}) = (0.0645 \pm 0.0002) \ y_{\text{BT}}

\[ y_{\text{BT}} = \text{year before top (top=1979AD)} \]

\[ \Delta x = 2.5 \text{ mm} \]
\[ \rightarrow \Delta t = 3.87 \text{ y} \]

constant over the last two millennia and across the whole Gallipoli Terrace
Temperature reconstruction based on $\delta^{18}O$
in foraminifera of GT90-3 core (Gallipoli Terrace)
sample - 6 g:

- calgon solution 5%
- $\text{H}_2\text{O}_2$ 10% (organic material)
- sieve (150 µm)
- oven at 50 °C
- 20-30 shells of *Globigerinoides ruber*

560 samples

Mass spectrometer
(ETH - Dr. S.M. Bernasconi)

$\delta^{18}O$ of the shells
Exceptionality of the series

Length (2200 y)
Homogeneity
High-resolution $\Delta t = 3.87$ y
Based on accurate dating

$\delta^{18}O$ of GT90-3 core (Gallipoli Terrace)

Taricco et al., *Clim. of the Past*, 5, 171, 2009
Different spectral methods reveal highly significant oscillatory components with periods of about 600, 350, 200, 125 and 11 years and a millennial trend.
Comparison with Central Alps temperature


Millennial scale variation (trend) in agreement
Low temperature around 0 AD
mismatch between $\delta^{18}O$ and temperature $\Rightarrow \delta^{18}O_{\text{water}}$ contribution

the modern 0.5‰ $\delta^{18}O$ decrease (after 1850) could be entirely due to temperature?

$\Rightarrow$ ~ 2 °C in agreement with alkenone-derived SST

Alkenones-derived SST (G. J. M. Versteegh et al., Geochem., Geophys., Geosys., 8, 2007)
This remarkable modern increase (1.5 – 2 °C) indicates a local amplification in the shallow, semi-enclosed Gulf of Taranto.
Global surface temperature series

From Brohan et al., *J. Geophysical Research*, 111, 2006
δ¹⁸O – SST comparison greatly improves if we extract from δ¹⁸O series only the trend and 200 y variability components found by SSA.

(components present in the majority of NH temperature reconstructions over the last millennium)

trend and 200 y oscillations in δ¹⁸O are temperature driven.
Ionian circulation can explain the 11 y cycle?

From Gacic et al., 2010, Can internal processes sustain reversals of the ocean upper circulation? The Ionian Sea example, *GRL*, 37, L09608

- **local winds**: not the primary forcing of the surface circulation
- **internal oceanic processes** may prevail on wind stress in determining vorticity variations in the Ionian Sea
Adriatic-Ionian bimodal oscillating system

- LIW = Levantine Intermediate Water (salty and warm)
- ADW = Adriatic Deep Water (dense bottom water)
- MAW = Modified Atlantic Water (cold)

- two regimes: cyclonic and anticyclonic Ionian upper-layer circulation
- DECADAL variations of salinity and density data collected in the Southern Adriatic (coherent with changes in the sea level height in the northern Ionian)
CONCLUSIONS

• We measured a high-resolution homogeneous δ¹⁸O time series in a well-dated core taken from the Ionian sea

• Spectral analysis reveals the presence of highly significant oscillatory components with period of 600, 350, 200, 125 and 11 y, respectively

• Our record reveals the most prominent climatic features of the last two millennia

• The trend and the 200 y δ¹⁸O components are temperature driven in the last centuries

• Salinity and circulation not negligible effects