Long term changes in the deep sea: examples from two Mediterranean Channels

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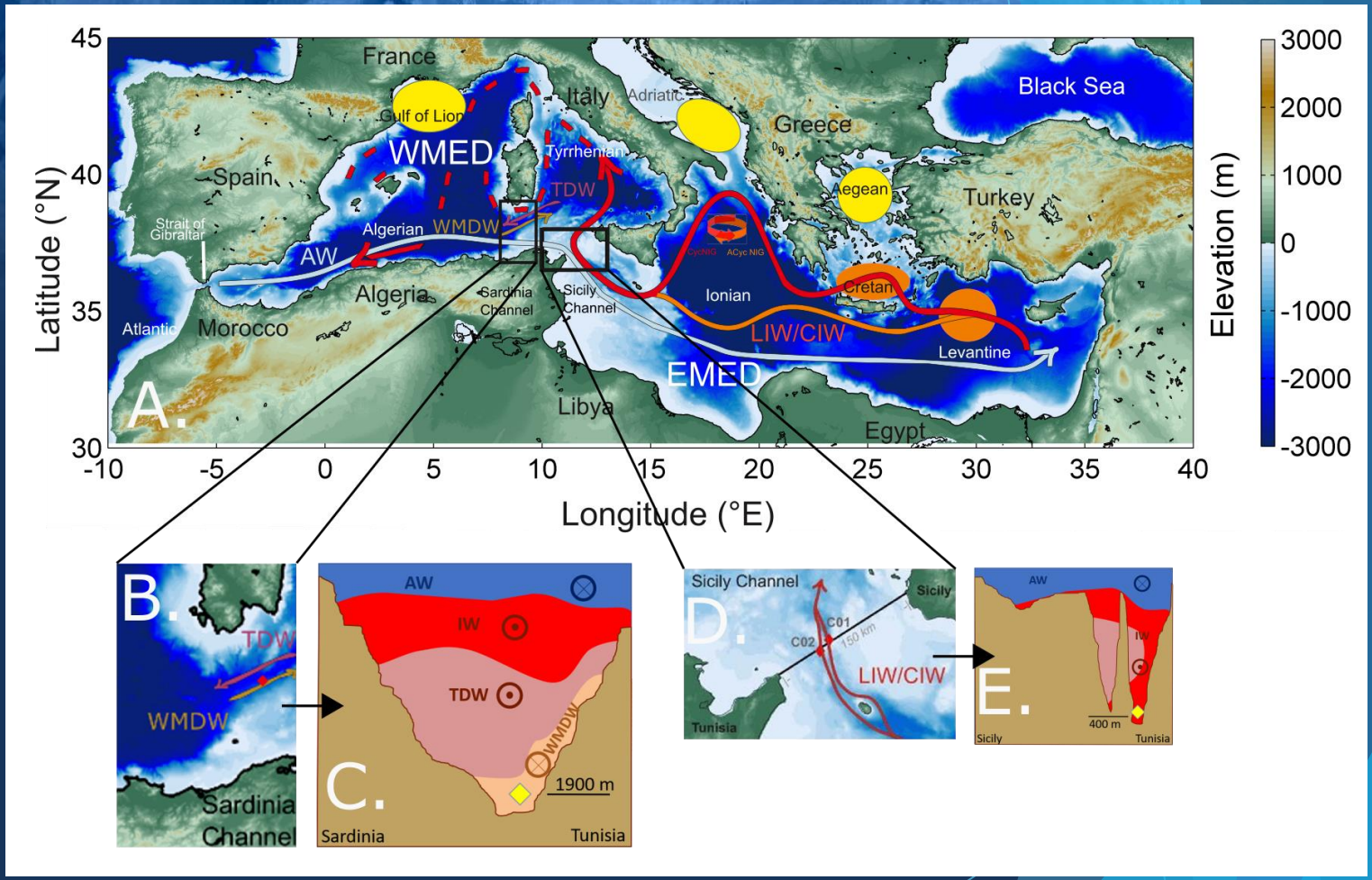
Monitoring choke points

What we wanted to do?



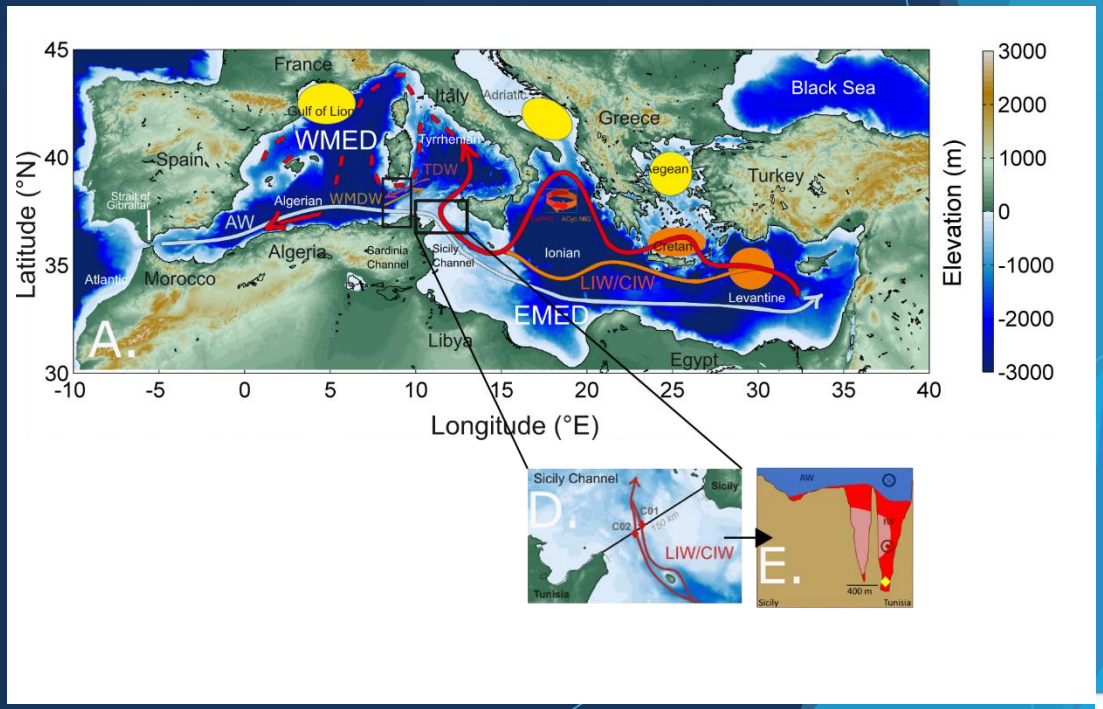
to asses how much **temperature** and **salinity** (and density) have changed over the past decades in the Med Sea, by monitoring two of its choke points

Monitoring choke points: Sicily Channel

The SC is the most important **Mediterranean choke point** after Gibraltar

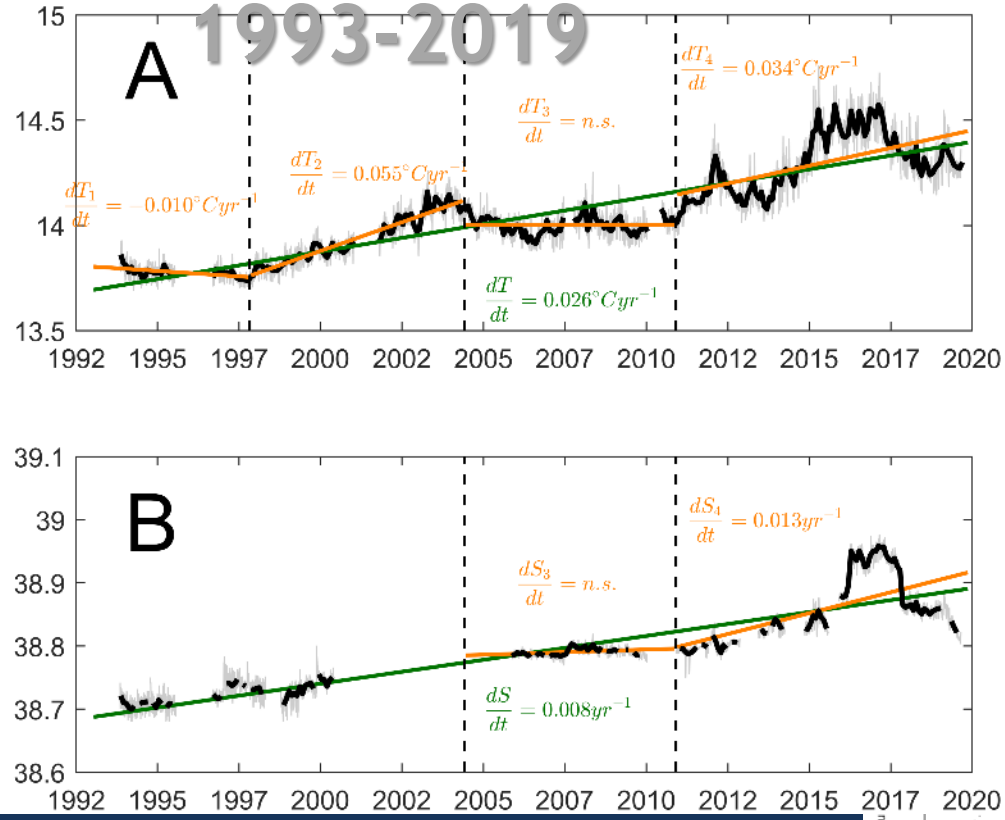
- It separates the sea in two main basins, the EMED and the WMED
- Monitoring this choke point allows to **intercept all water masses** flowing between the EMED and the WMED
- A sill depth of about 500 m mainly prevents exchanges of deep waters

Here it is possible to observe the variability of heat and salt carried by the **most ubiquitous Mediterranean water mass**, the **Intermediate Water** (IW), which forms in the EMED and flows towards the WMED, eventually exiting towards the **Atlantic Ocean**.



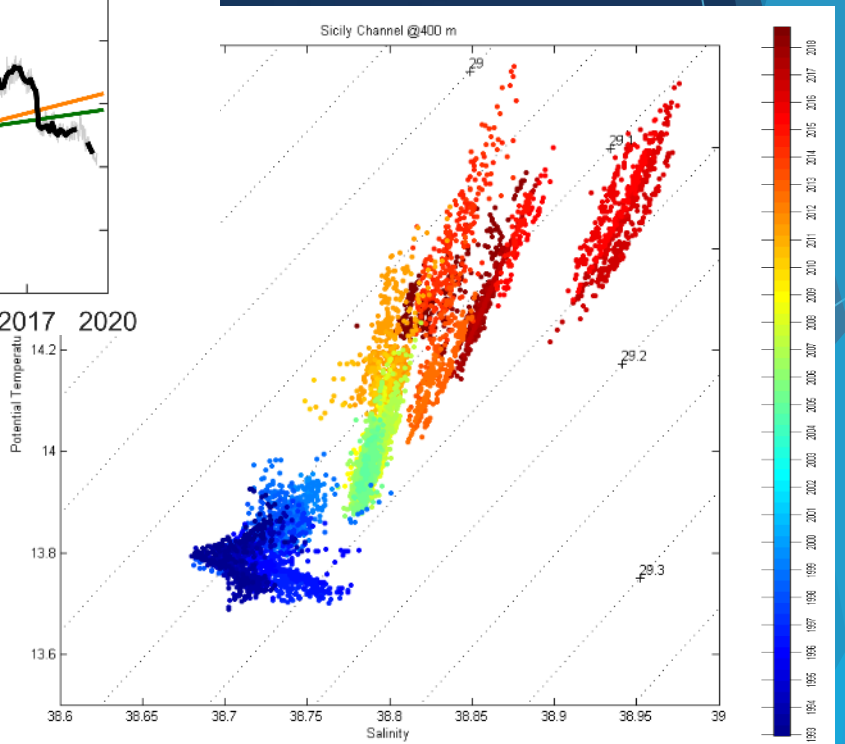
Sicily Channel

Intermediate Water: long time series



- T and S co-vary
- trends are subject to changes, slowdowns and accelerations

- ΔT/dt=0.03 °C/yr and ΔS/dt=0.008 /yr



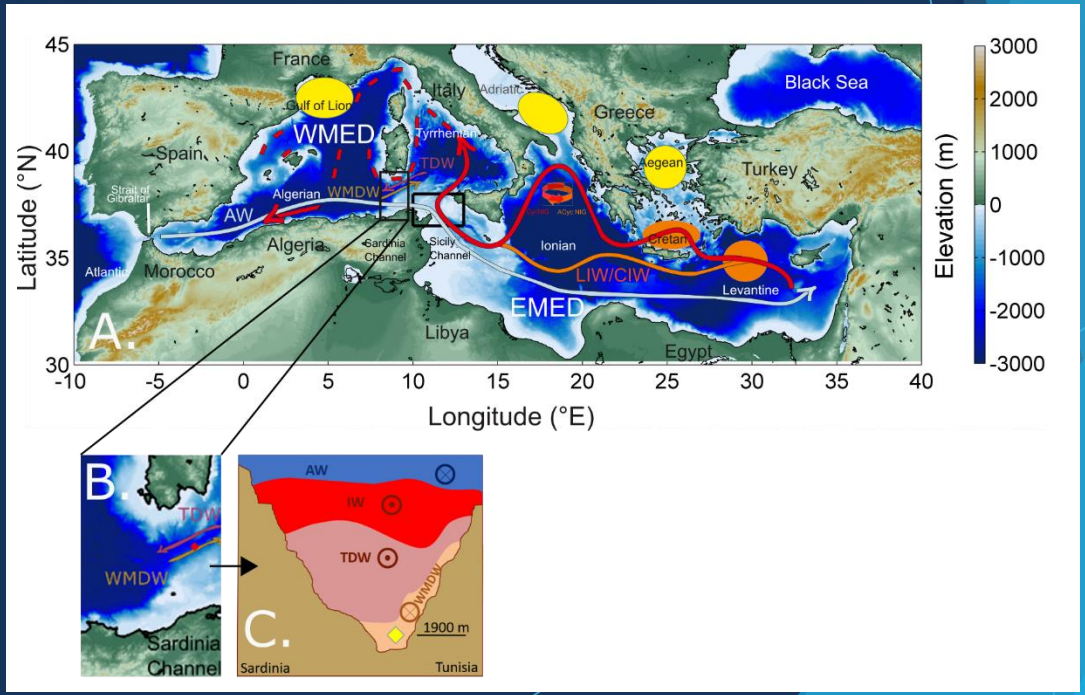
Intermediate Water

Monitoring choke points: Sardinia Channel

The Sardinia Channel has a sill depth of 1900 m

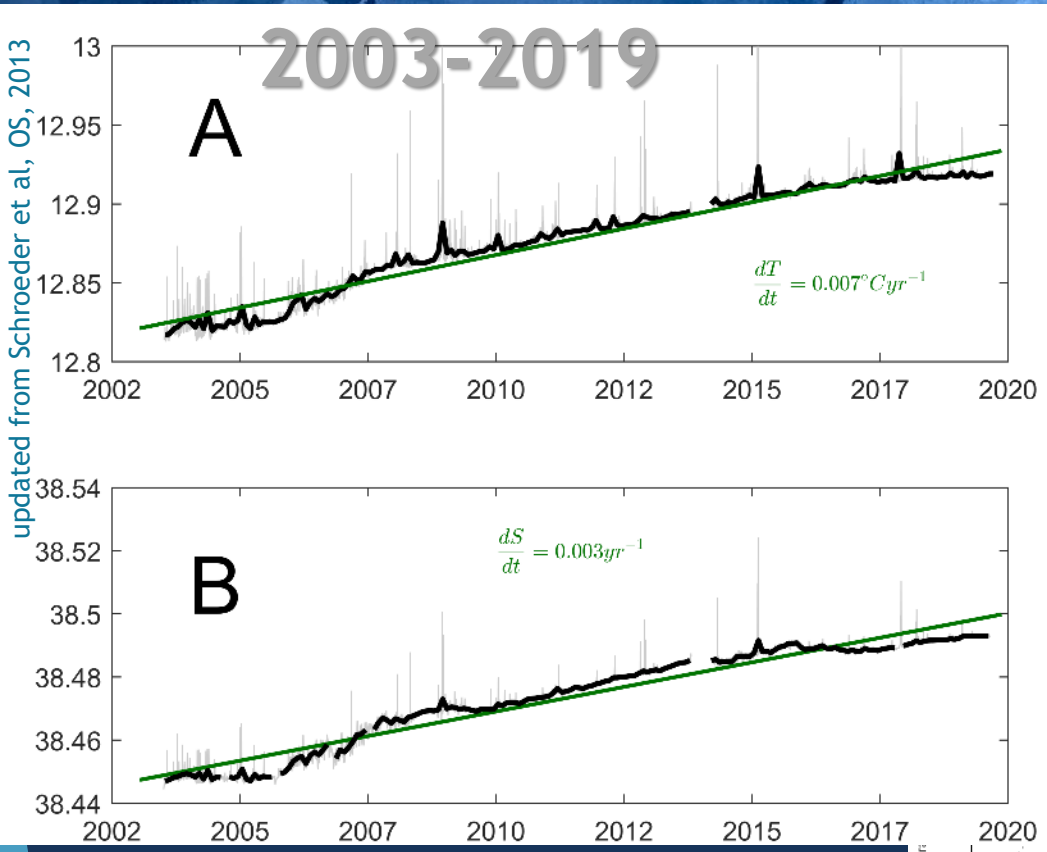
- It separates the Algerian basin (>2500 m) from the Tyrrhenian basin (>3000 m)
- Monitoring this choke point allows to **intercept all deep water masses** flowing between these two basins
- mooring is mainly located wihthin the WMDW vein, entering the Tyrrhenian, but occasionally it also regsiters outflowing TDW

Here it is possible to observe the propagation of the signal of the WMT from the Algerian basin to the Tyrrhenian, that took place since 2010 (5 years after the onset of the WMT) starting to fill up also the deep Tyrrhenian with the deep anomalous water



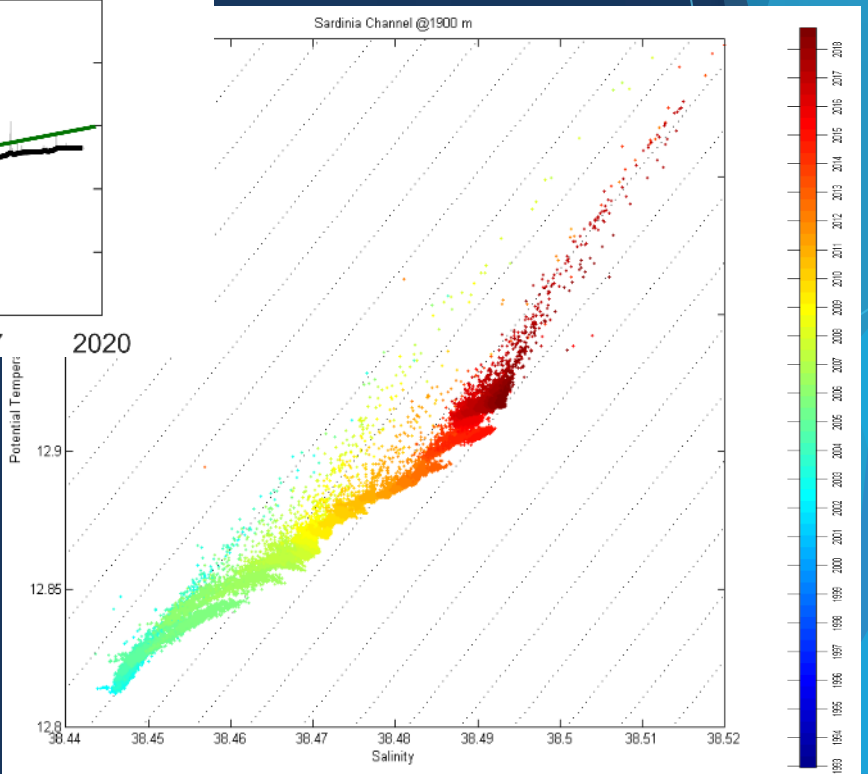
Sardinia Channel

Deep Water: long time series



updated from Schroeder et al, OS, 2013

➢ alternation of WMDW (lower T and S, 12.81-12.91°C, and 38.45-38.49), flowing east, and TDW ("pulses" of higher T, >12.9-13 °C, and S >38.48-38.5, flowing west

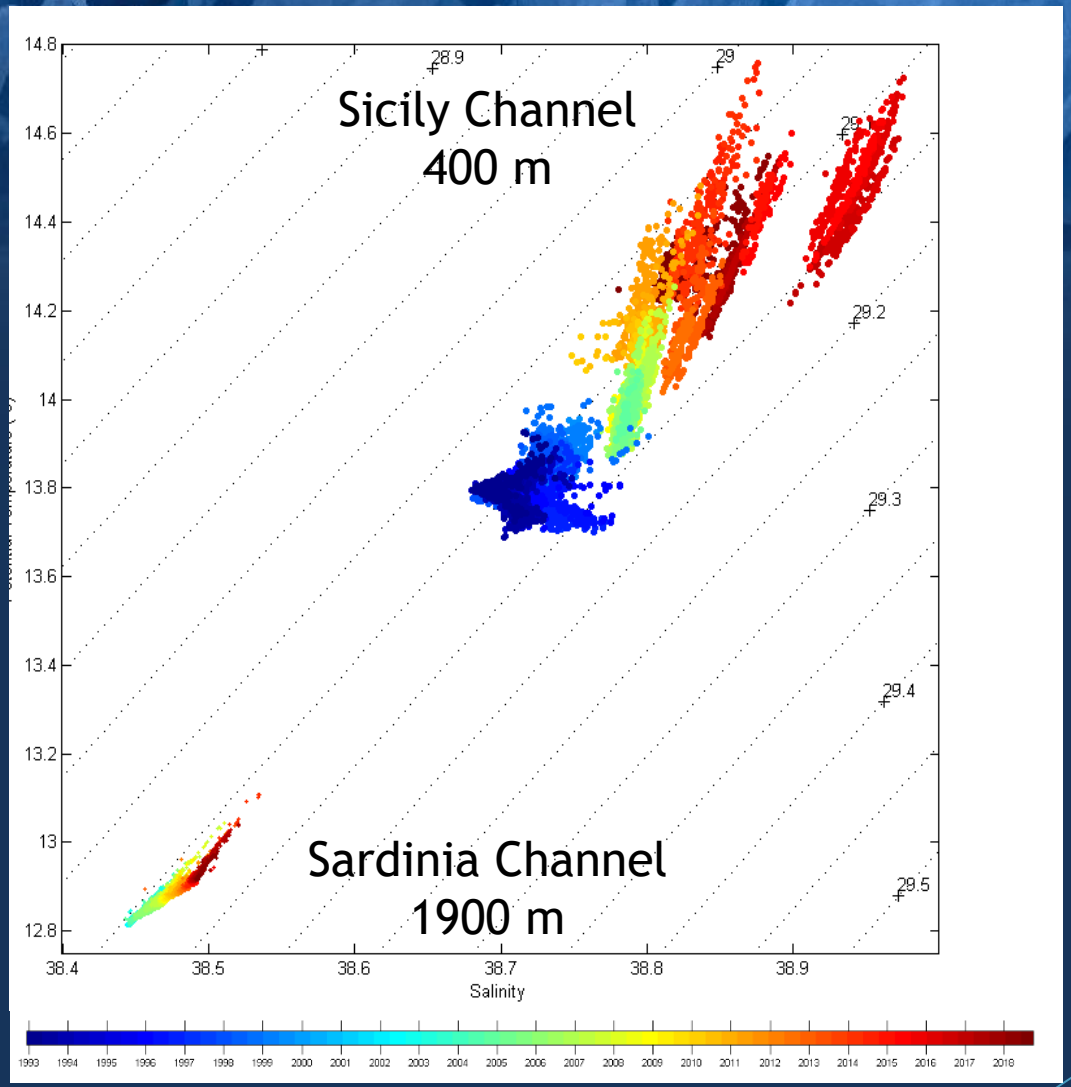


➢TDW pulses are of short duration (1 day-1 week), due to an interface displacement between the two DW masses

➢ΔT/dt=0.007°C/yr and ΔS/dt=0.003 /yr

Deep Water

Long term changes in different layers



The long-term trends observed in these Mediterranean Channels are at least

one order of magnitude greater than those reported for the **global ocean** intermediate layer

and at least **twice as high** as those reported for the global deep ocean

Long-term changes

INSTM

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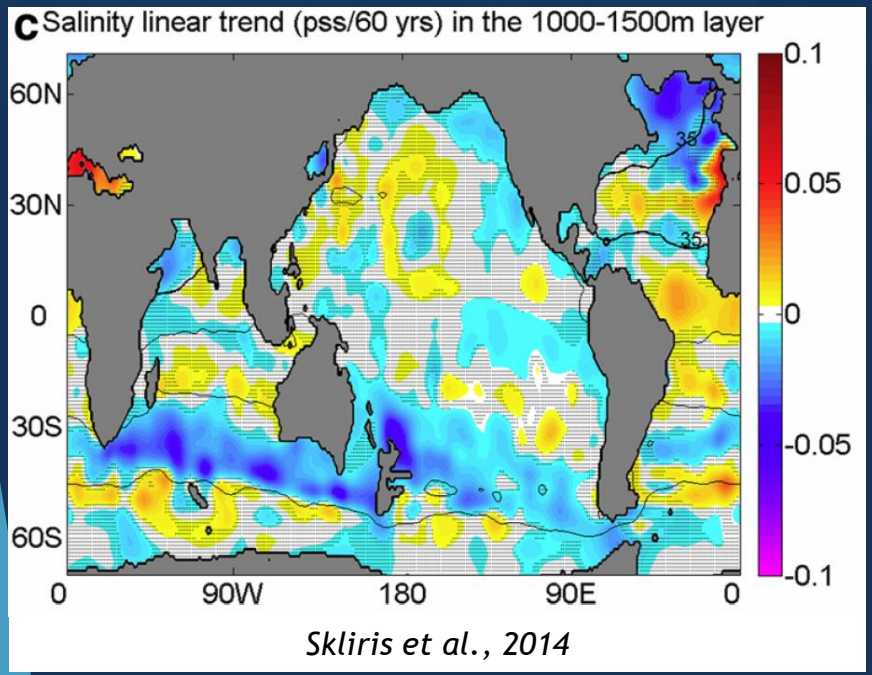
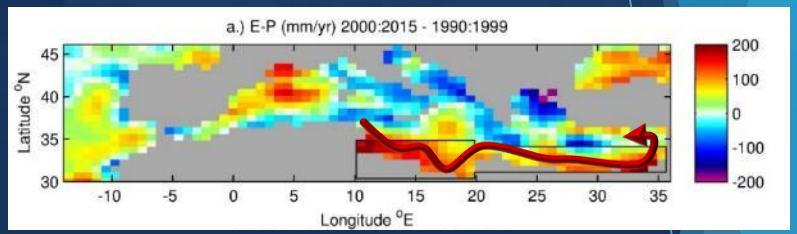
Long term changes: Salinification

1950-2010: below 1000 m the Mediterranean underwent the strongest salinity gain **anywhere in the world ocean**

→ "**Mediterranean signal**" clearly imprinted in the N-Atlantic IL



Skliris et al., 2014



Between 2000-2015 and 1990-1999 the **E-P increases** mostly in the south-eastern Mediterranean

The area with the **strongest change** coincides with the eastward pathway of the surface water

→ Consistent with increasing **warming and salinification** of SW and the consequent increase of T and S in IW

Long-term changes

Key messages

- WMDW has been **filling up** with anomalous dense (warm and salty) waters, that were able to overflow into the deep Tyrrhenian (ventilation)
- **import of salt and heat** from the EMED to the WMED has increased: this will enhance the tendency of the western DWF sites to produce **warmer and saltier deep waters**
- **strong Mediterranean changes** stand out when compared with global average trends - **regional amplification of climatic signals**
- Mediterranean is a **climate change hot spot**: we expect a continuation of the **warming** and **salinification** process in the WMED and EMED
- **causes** of the observed trends: role of a **changing climate** (warming, changes in the hydrological cycle) **over the Mediterranean**, especially EMED, where IW forms: its modifications are then transferred to all Mediterranean water masses
- the long-term records in two Mediterranean channels reveal how **fast the response to climate change** can be in a **marginal sea** compared to the global ocean - **essential role of long time series in the ocean**

Key messages