

What do marine archives tell us about the current warming in the Mediterranean?



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Introduction

Dataset and methods

SSTs variability

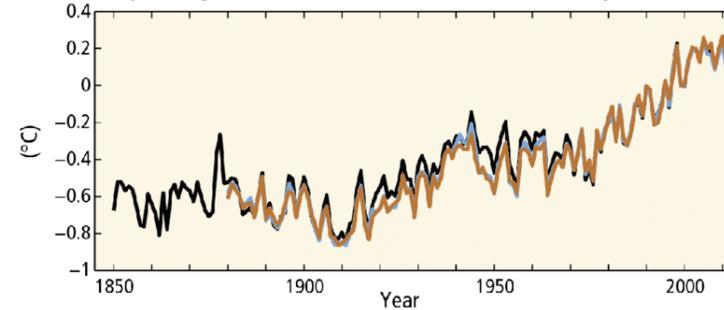
Med vs global SSTs

20th century warming

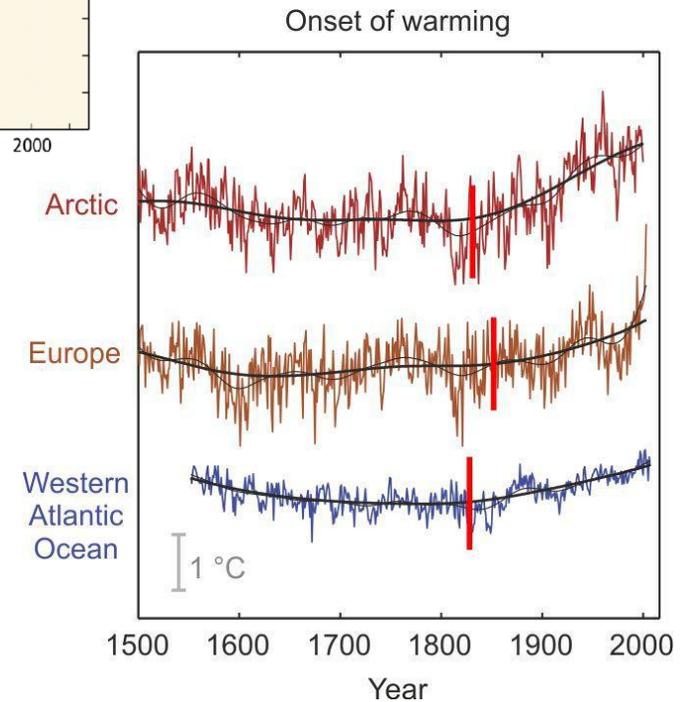
Conclusion

While post-industrial warming is observed worldwide, there is also evidence of different regional responses to this change (IPCC, 2014). Furthermore, the recent study of Abram et al. (2016) highlights differences in the time of emergence of warming from region to region, with early warming in tropical oceans, northern hemisphere land masses and the Arctic Ocean. Some regions of the earth are more vulnerable to changes than others. The Mediterranean is one of these hot spots of climate changes but also human impact due to growing population in coastal regions. With regard to climate, the Mediterranean sub-basins have their own behavior and environmental stressors.

(a) Globally averaged combined land and ocean surface temperature anomaly



IPCC 2014



Abram et al., 2016

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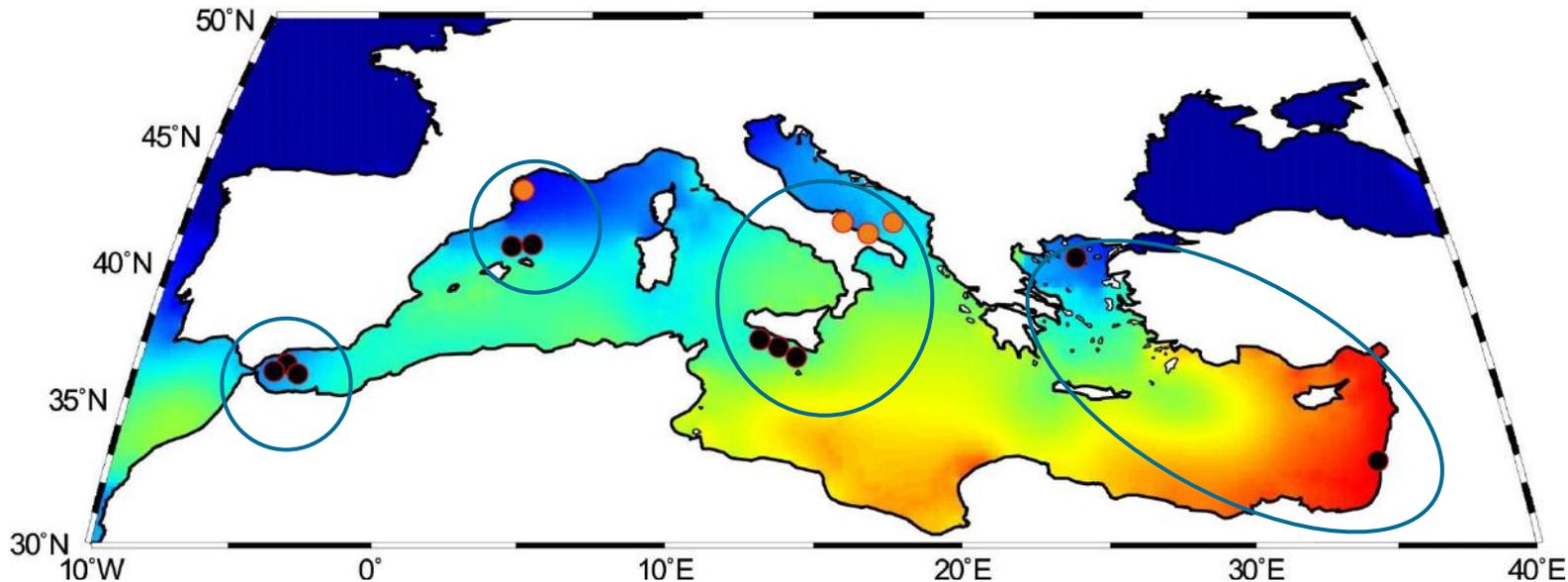
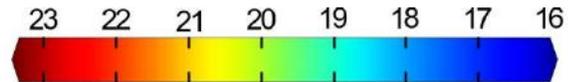
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TTR17-1_384B (Nieto-Moreno et al. 2013) ; TTR17-1_436B (Nieto-Moreno et al. 2013) ; TTR-17_434G (kodrigo-Gámiz et al. 2014); MINMC-2_MINMC-1 (Moreno, et al. 2012); Gol-Ho1B_KSGC-31 (Jalali et al. 2016) ; MIN2 (Cisneros et al. 2016); INV12-15 , SW104-ND-14 , CSS00-07 (Jalali et al. 2018); SW104-ND11 (Margaritelli et al. 2020); ANSIC-03-342, ANSIC-03-407 (Incarbona et al. 2016) ; MEDECOS-II-M2 (Gogou et al. 2016) ; Eastern Med continental shelf (Sisma-Ventura et al. 2014)



Map of the annual mean SSTs (1955–2012) from the World Ocean Atlas database showing the location where marine reconstructions have been generated.

- **14 high temporal resolution SST records**, most are based on **alkenone paleothermometry**.
- **Four** records have been produced within **MISTRALS/PaleoMeX** program (orange dots).
- Data are distributed across **4 sub-basins** (Alboran Sea, NW Med, central Med and Eastern Med basins, e.g. North Aegean and Levantine basin).

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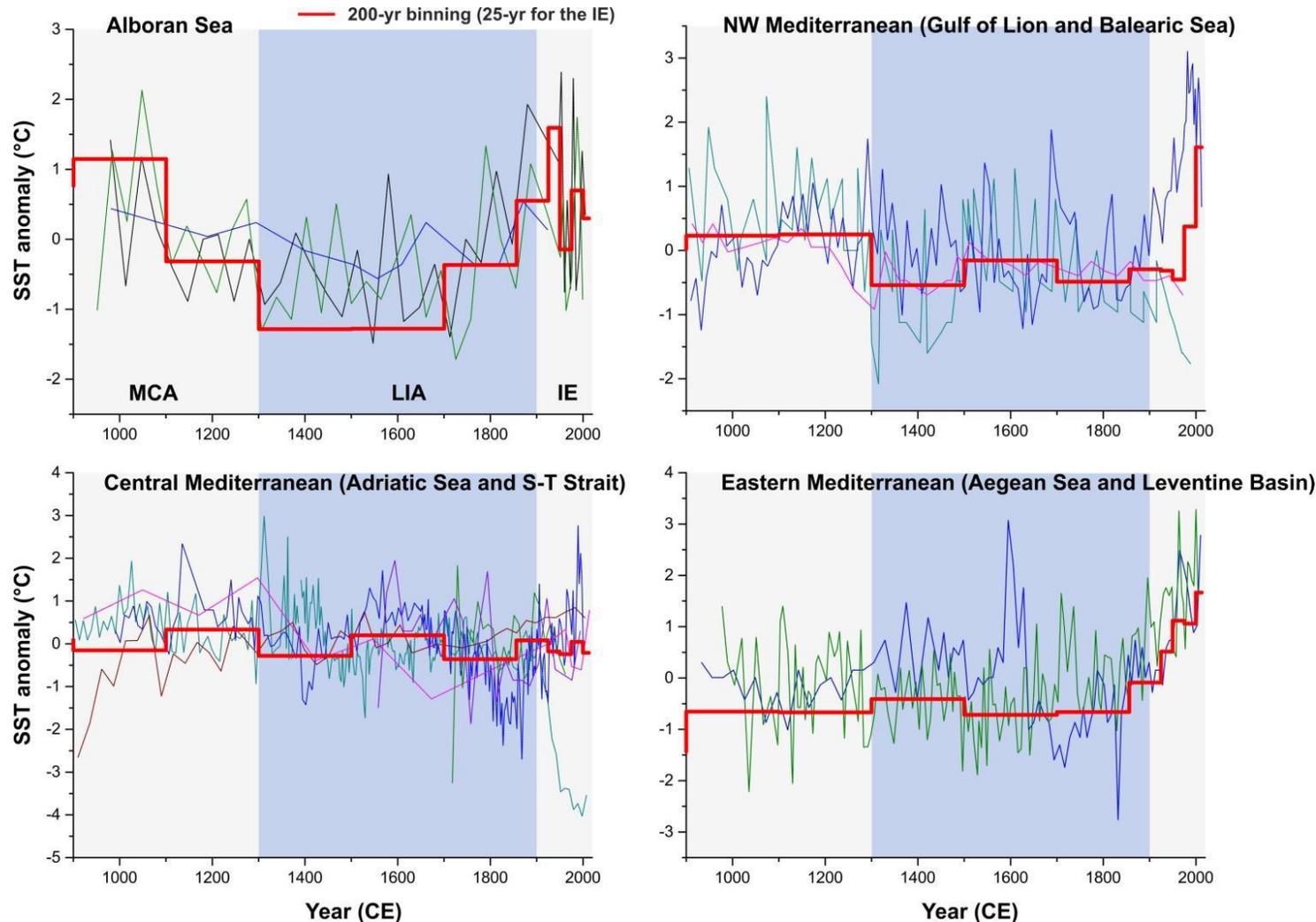
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- The thick red lines indicate the average of all records in each sub-basin (200-yr binning between 900 and 1900 CE and 25-yr binning thereafter).
- SST records in the **4 sub-basins show significant differences in particular in the Alboran Sea.**
- **Long-lasting warming around 1600 AD!!**
- **Pronounced SST rise during the Industrial Era** in the Gulf of Lion and Eastern Mediterranean.

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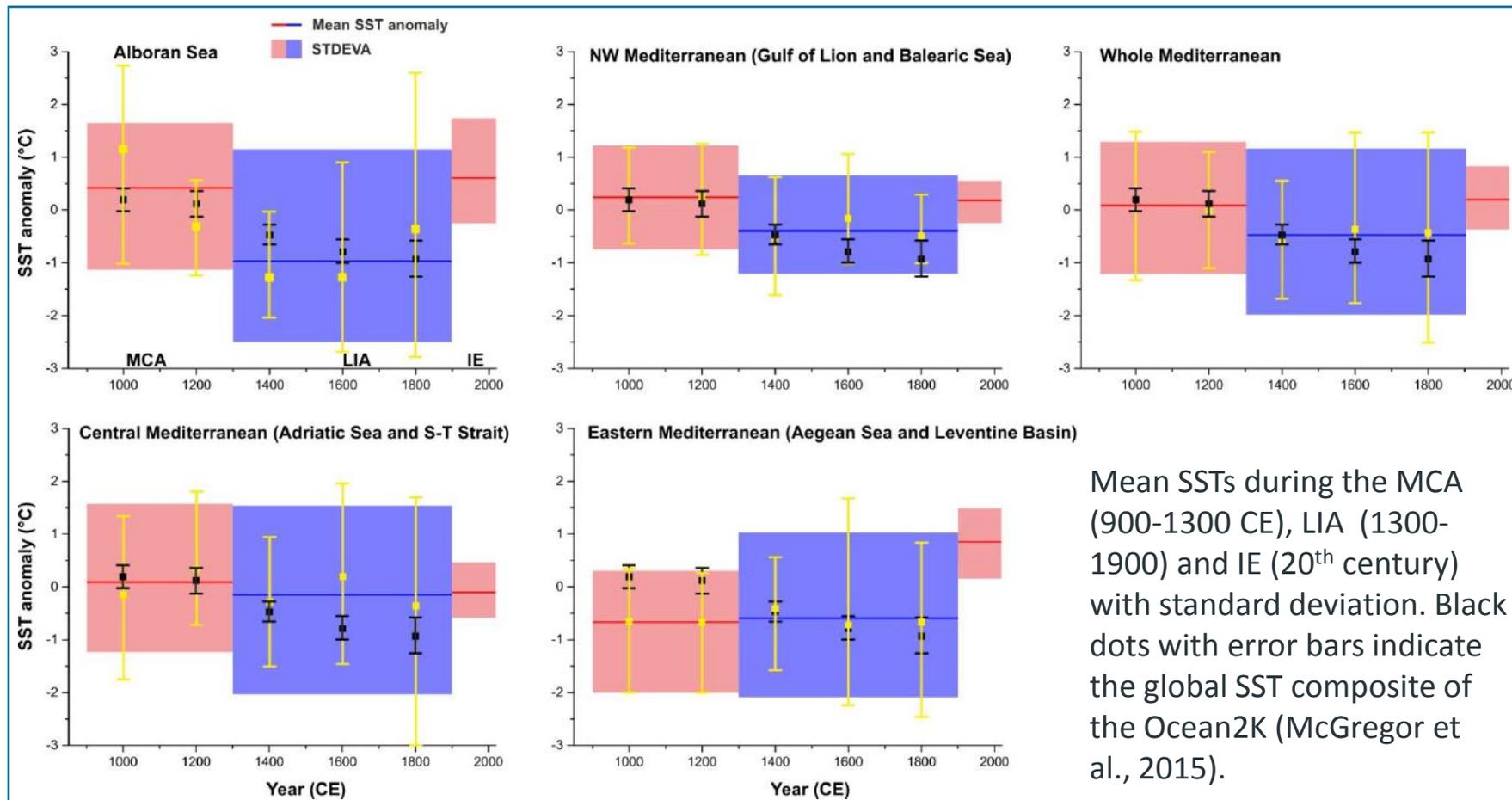
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Mean SSTs during the MCA (900-1300 CE), LIA (1300-1900) and IE (20th century) with standard deviation. Black dots with error bars indicate the global SST composite of the Ocean2K (McGregor et al., 2015).

- The **long-term cooling** seen in the global Ocean SST compilation **until 1800 CE** is **recorded** in the Mediterranean sub-basins, **except for the eastern Med.**
- The **Alboran** and **Eastern Med** show **exceptional 20 century warming** that **exceeds the MCA mean.**
- **Warm MCA** across the basin except for the **eastern Med.**

W-E SST seesaw pattern

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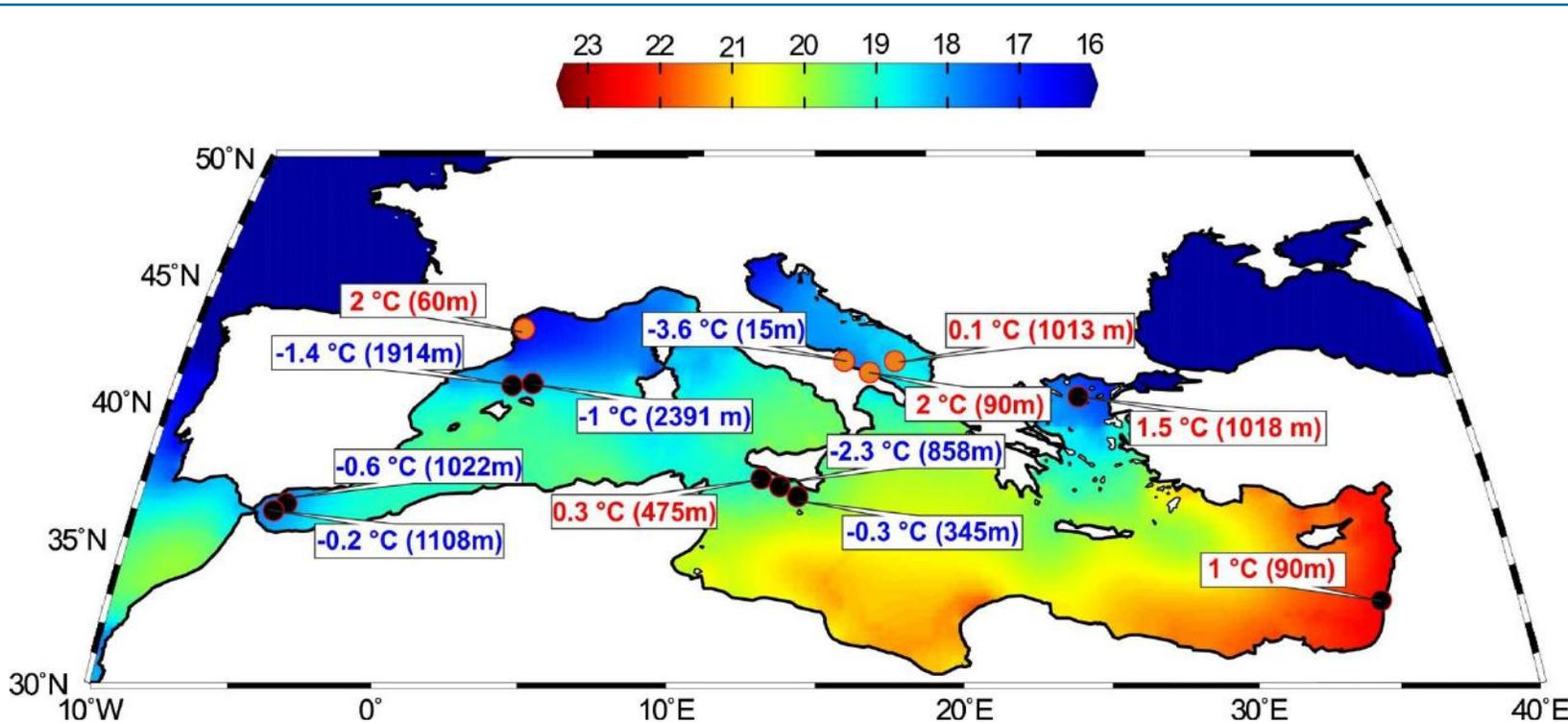
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Mean SST warming over the 20th century. Depth of each core used in this study is also shown.

- **Warming trend over the 20th century** in the **Gulf of Lion**, south **Adriatic**, **Aegean Sea** and **Levantine Basin**, in agreement with observations (2°C).
- **Other sub-basins show cooling trends.**

The highest warming trends (1.5-2 °C) are recorded in the three Med convection regions (G. of Lion, S Adriatic and Aegean Sea).

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- This compilation evidences different SST signals in the Mediterranean sub-basins reflecting advection and atmospheric forcing at local scale.
- SSTs are generally warm during the MCA except for the eastern Mediterranean.
- Outstanding warm episode around 1600 CE during the cold LIA climate, also reported in the North Atlantic by Richter et al. (2009), possibly attributable to advection.
- Comparison to the global SST composite shows similar long-term cooling until 1800 AD, except for the eastern Mediterranean.

The mean SSTs during the IE exceed those of the MCA in (1) Alboran Sea due to advection of warmer NA waters, and (2) in the G. of Lion and the Aegean Sea, probably reflecting a reduction of convection in these two regions.