Project: **970**

Project title: **TARANTO**

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In the past year, we continued working on the second paper and deepened the analysis of the model results. The focus of this paper is to evaluate the applicability of the sediment record-based reconstruction of sea surface temperatures in the Mediterranean Sea by using a high-resolution regional physical-biogeochemical ocean model. The model explicitly simulates the full cycle of the temperature signal recorded in organic matters from its origin in the connection with phytoplankton production to its preservation along with the detritus depositing on the sediment. The simulation from 1901 to 2010 provides interannual to sub-decadal data to evaluate the relationship between the spatial/temporal variations of sediment temperature proxy and the upper ocean temperatures.

To assess the validity of global core-top calibration in the Mediterranean Sea, we compared the modeled climatological temperature tracer in the sediment detritus flux (wprotem) with the annual mean SST across the Mediterranean, following a method similar to the global core-top calibrations (e.g., Conte et al. 2006). The sediment temperature tracer shows strong linear correlations with the spatial distribution of the simulated annual mean SST (Fig. 1). In the deep ocean (deeper than 200 m), the relationship is characterized by a steeper slope, greater than 1, while in the shallow ocean (shallower than 200 m), the correlations are weaker, with a regression slope of less than 1. These remarkable relationships are virtually identical to the initial global core-top calibrations (e.g., Conte et al. 2006). However, the different regression coefficients and varying regression slops corroborate the previous findings that regional factors play an important role in the robust interpretation of temperature signals (Leider et al. 2010).

In addition, the temporal variations of the sediment temperature tracer and SST behave differently from their spatial distribution. This is evident in the regression slope between the co-located sediment temperature tracer and annual mean SST over the period from 1910 to 2010 (Fig. 2). The western Mediterranean Sea shows a slope closer to that generated by the core-top calibration, whereas the eastern basin deviates more. The largest deviations in slope from the core-top calibration occur in areas with the lowest correlations in coastal regions (figure not shown). These differences between spatial and temporal regressions suggest that applying a single calibration equation developed from a global dataset to a local sediment core may lead to biased interpretations of past temperature signals, as it fails to account for regional factors.

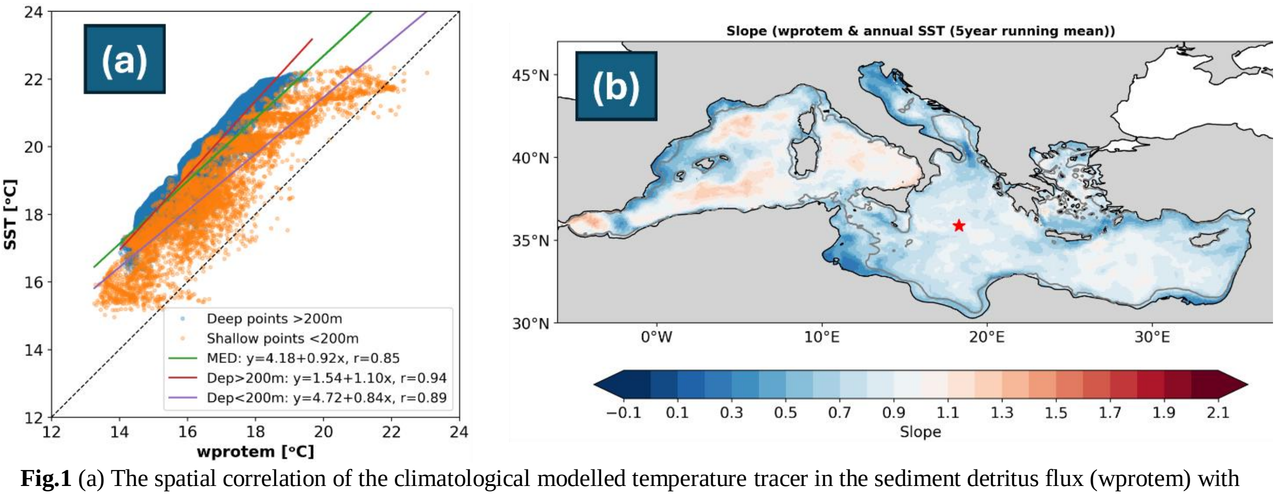

Fig.1 (a) The spatial correlation of the climatological modelled temperature tracer in the sediment detritus flux (wprotem) with annual mean SST. Both climatological wprotem and annual mean SST are calculated over 1910-2010. Blue dots represent data in the deep sea (>200m), while orange dots represent data in shallow regions (<200m).
(b) The linear slope between wprotem and SST (both are 5y-running mean) for each model grid in the Mediterranean Sea. Grey line is 200m depth isolines. Red star represents the location of the station analyzed in Fig.2.

From previous analysis, we found that in coastal areas, non-sinking processes (e.g., resuspension) significantly disrupt the preservation of the upper ocean temperature signal in the sediment. Recently, we found that in the deep ocean, where erosion is rare, the deposition of non-local material does not significantly effect the temperature signal correlation between the sediment and the upper ocean.

To represent deep-sea conditions, we selected a station in the Ionian Sea (location shown in Fig.1b), where the model shows a strong temporal correlation between the sediment temperature tracer and SSTs (r = 0.96 for winter SSTs centered in February and r = 0.8 for annual mean SSTs).

The sediment temperature tracer (wprotem) closely follows the variations in winter SST (Fig. 2a). No erosion events occurred during the simulation period, but several sharp increases in sediment flux were detected (Fig. 2b). The concurrent rise in the age signal recorded in the detritus flux (Fig. 2c) suggests that the origin of the deposited material lies in non-local sources rather than locally enhanced detritus production. Between 1990 and 2010, a well-developed, long-lasting intrusion event was identified through changes in the age tracer, which coincides with the development of the Eastern Mediterranean Transient (EMT) and reflects a deep-water mass replacement (Roether et al., 1996). These intrusion events tend to introduce a slight cooling bias to wprotem. However, neither the sharp, short-term intrusions nor the mild, long-term ones significantly bias the relationship between wprotem and upper water temperatures.

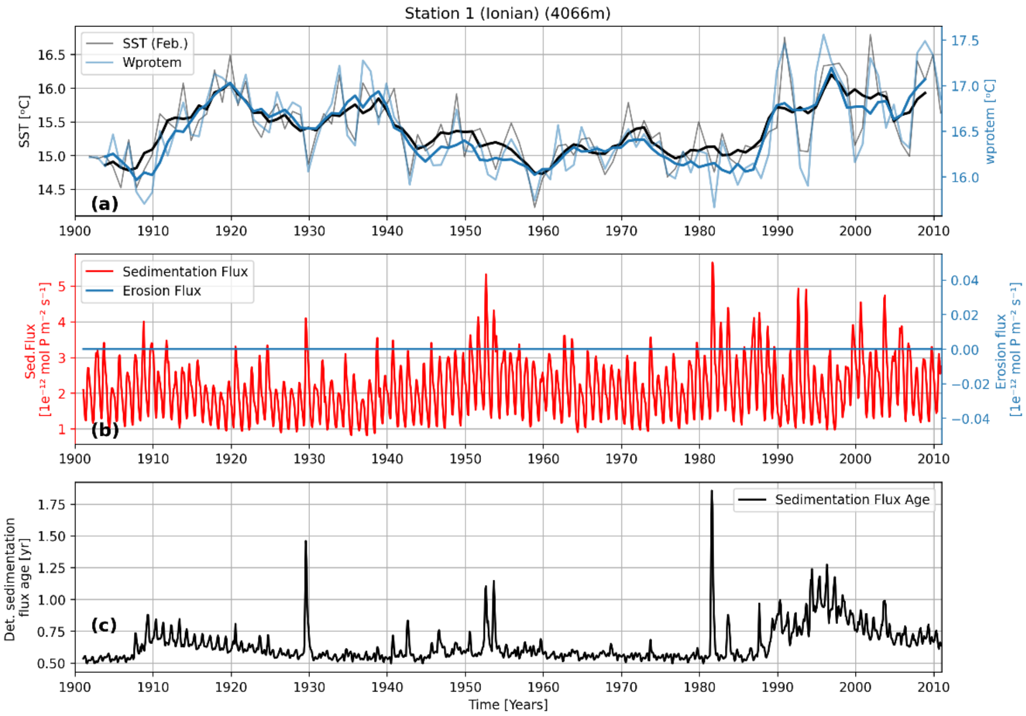

Fig.2 Time series at the station located in the central Ionian Sea as marked in Fig.1b. (a) winter SSTs (centered in February) and yearly mean wprotem. Yearly time series (thin lines) are overlaid with their 5year-running mean (thick lines). (b) monthly detritus fluxes to the sediment and monthly erosion fluxes. (c) the age of the deposited detritus.

We have incorporated this newly obtained information into the manuscript, which is currently under internal revision. The submission is planned for next year.

References:

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