Project: **970**

Project title: **TARANTO**

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In the past year, we have finished one manuscript entitled 'Drivers of the decadal variability of the North Ionian Gyre upper layer circulation during 1910-2010: a regional modelling study'. It is submitted to 'Climate Dynamics'.

In this paper, we provide a first attempt to fill the knowledge gap on decadal variability of the North Ionian Gyre (NIG) upper layer circulation before the 1980s, which arises from sparse observations. A long simulation over the period 1901-2010 with an eddy-permitting ocean circulation model MPIOM for the Mediterranean Sea is performed (Fig.1) to study this variability. The model is driven by the atmospheric forcing from the 20th century reanalysis data set ERA-20C (Poli et al. 2016), ensuring a consistent performance of the model over the entire simulation period. The main modes of variability known in the Eastern Mediterranean Sea, in particular the decadal reversals of the NIG circulation observed since the late 1980s and the Eastern Mediterranean Transient are well reproduced. We find that the simulated NIG circulation prior to the observational period is characterized by long-lasting cyclonic phases with weak variability during years 1910-1940 and 1960-1985, while in the in-between period (1940-1960) quasi-decadal NIG circulation reversals occur with similar characteristics to those observed in the recent decades (Fig.2a). Our simulation indicates that the NIG circulation is rather prone to a cyclonic mode with the occasional appearance of decadal oscillations. The coherent variability of the NIG circulation mode and of the Adriatic Deep Water (AdDW) outflow implies that external forcing triggering strong AdDW formation is required to kick the NIG into an anticyclonic circulation and, thus, to produce an oscillatory behavior (Fig.2b). A sensitivity experiment (referred to CW, the standard simulation is referred to CTL) mimicking a cold winter event over the Adriatic Sea supports this hypothesis (Fig.3). Our simulation shows that it is the multi-decadal variability of salinity in the Adriatic Sea that leads to periods when low salinity prevents strong AdDW formation events. This explains the absence of quasi-decadal NIG reversals during 1910-1940 and 1960-1985.

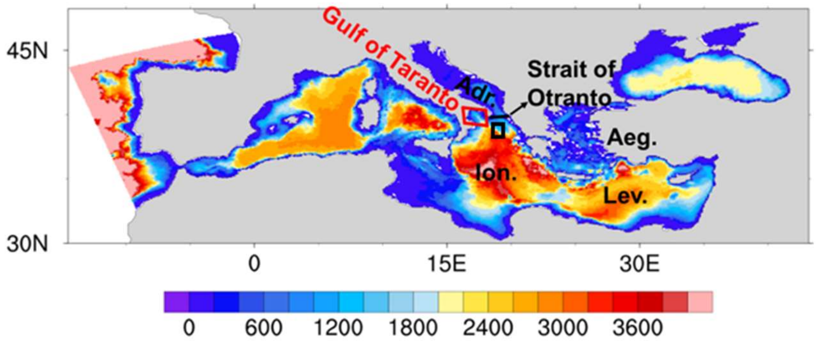

Fig.1 Model domain and the bathymetry (m). Adr: Adriatic Sea, Ion: Ionian Sea. Lev: Levantine Basin. Aeg: Aegean Sea. Red box is the Gulf of Taranto. Black box marks the area over which the zonal current velocity is calculated. The black line shows the Strait of Otranto.

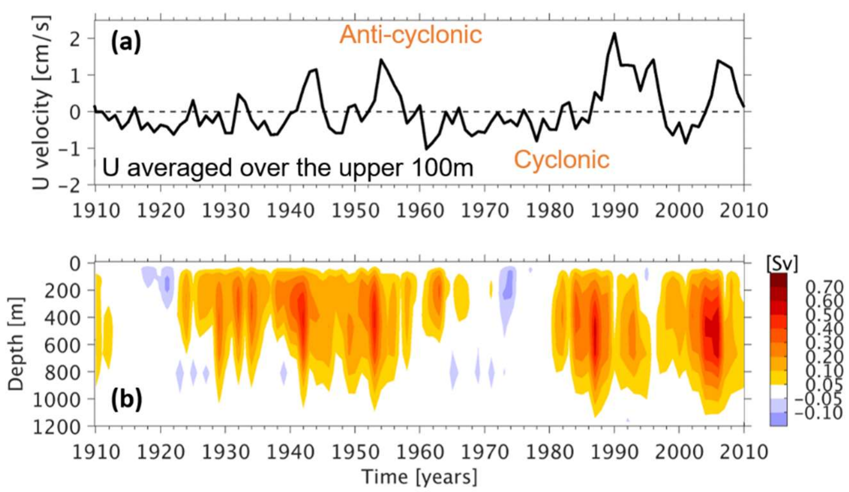

Fig.2 (a) Zonal component of the current velocity averaged over the upper 112m in the area denoted by the rectangle in Fig.1. (b) Time series of the meridional overtuning stream function across the Otranto Strait (line in Fig. 1) during 1910-2010. Note the nonlinear spacing of the color bar.

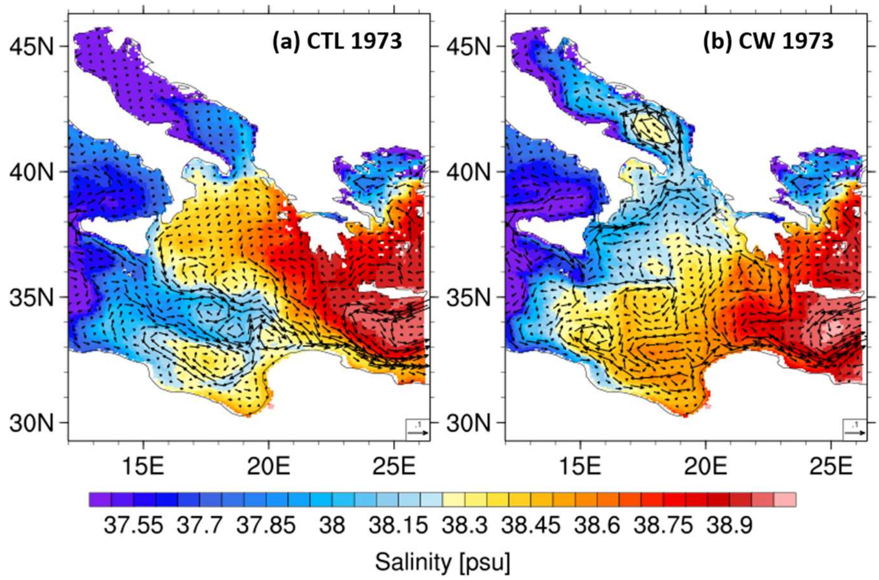

Fig.3 Annual mean salinity and currents (m s^{-1}) averaged over the upper 124m depth in 1973 for (a) CTL and (b) CW

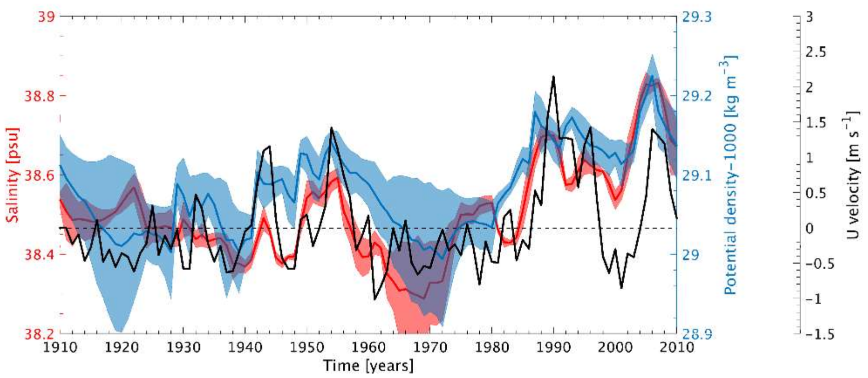

Fig.4 Time series of annual mean salinity (red), potential density (blue), both averaged over 206m-727m depth and over the Southern Adriatic Sea, and NIG circulation index (black) for the period 1910-2010. Black dashed line represents the velocity of zero. Shaded areas denote the range of data variations within one standard deviation

References

Poli P, Hersbach H, Dee DP, Berrisford P, Simmons AJ, Vitart F, Laloyaux P, Tan DG, Peubey C, Thépaut JN, Trémolet Y et al (2016) ERA-20C: An atmospheric reanalysis of the twentieth century. Journal of Climate 29(11):4083-4097