

APPEARANCE OF TRANSITIONAL MEDITERRANEAN WATER (TMW) IN THE CRETAN SEA (1987 – 2015) IN RELATION TO DENSE WATER FORMATION EVENTS

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Abstract

The appearance of low salinity, temperature, oxygen and nutrient-rich waters inside the Cretan Sea at depths below the saline intermediate water layer is a recurrent phenomenon related to the intrusion of Transitional Mediterranean Water (TMW) from the Eastern Mediterranean Sea. The inflow of TMW through the Cretan Straits acts as compensation for the outflow of equally dense or denser masses. This export is a result of dense water formation (DWF) events taking place inside the Aegean Sea. Hence, TMW intrusions in the Cretan Sea can be used as a tracer of DWF in the Aegean. During the last 30 years data show that TMW intrusion followed both the massive DWF event known as the Eastern Mediterranean Transient (EMT) as well as a less severe DWF event of the late 2000's decade.

Keywords: *Cretan Sea, Aegean Sea, Deep waters, Circulation*

The low salinity, temperature, oxygen and nutrient-rich waters separating the deep from the intermediate layers in the Cretan Sea, represents waters that originate from the transient layers of the EMed, i.e. between Levantine Intermediate Water and EMed Deep Water. However, data suggest that the appearance of such TMW masses in the Cretan Sea is not continuous but displays a rather recurrent character.

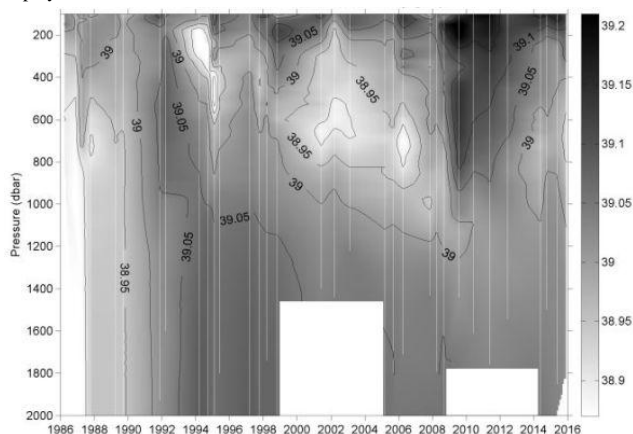


Fig. 1. 1986-2015 Hovmoller salinity diagram in the Central-Eastern Cretan Sea limited between 100 and 2000 dbar. Contour interval is 0.05

Figure 1 shows the Hovmoller salinity diagram in the Central-Eastern Cretan Sea between 1986 and 2015. Data originate from CTD casts conducted by the Hellenic Centre for Marine Research. During the EMT onset period (1987 – 1991) the Cretan Sea gradually increased its salinity (preconditioning phase) followed by a more abrupt salinity increase during the peak-EMT period (1992-1994) which led to the development of maximum salinity (>39.05) and density values ($\sigma\theta > 29.3 \text{ kg/m}^3$) below intermediate layers as a result of the event. By the end of the peak-EMT period (1994-5 onwards) the low salinity TMW mass appears in the Cretan Sea at depths of 200-600 dbar as compensation to the massive outflow of Cretan Deep Water (CDW) from the Cretan basin. Between 1998 and up to ~2008 the TMW core deepened mostly following the deepening of the isopycnals inside the basin which took place during the relaxation phase after the EMT. From 2006 onwards there is a continuous intermediate layer salinity increase in the Cretan basin that gradually reached depths of more than 1000 dbar as reported in [1] and [2]. Consequently, the TMW layer was eroded by diffusive processes with the more saline overlying masses and its core progressively moved to greater depths showing higher salinity values. According to [1] and [2], the salinity increase observed in the Cretan Sea after 2006 acted as a preconditioning factor that finally led to the outflow of dense Cretan Intermediate Water (dCIW) towards the EMed by the end of the decade. As a result of this outflow, TMW progressively re-entered the Cretan Sea from the EMed as early as 2012. In late 2015, the TMW occupied a layer roughly

between 500 and 900 dbar with its core being at 700 dbar with $S < 38.93$.

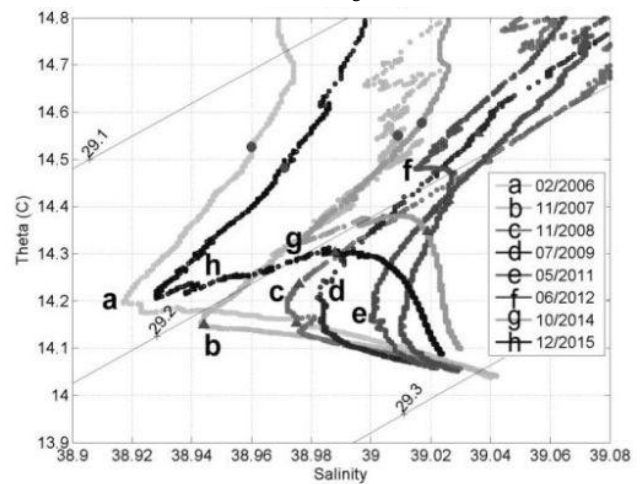


Fig. 2. Theta – S diagram of 2006-2015 CTD casts in the Central Cretan Sea limited to $\sigma\theta > 29.1 \text{ kg/m}^3$

Figure 2 is a Theta-S diagram showing the deep part of CTD casts in the Central Cretan Sea between 2006 and 2015. The deep salinity minimum characterizing the TMW core is clearly seen. From 2006 to 2011 (a to e) the TMW core gradually erodes towards greater depths, increasing both its salinity and density, while the Theta-S curve “smoothens” gradually as a result of mixing. The re-emergence of TMW into the water column starts in 2012 (f) forming a “wedge” in the Theta-S curve which gradually widens moving towards lower core salinity values (g,h) at $\sigma\theta$ density of $\sim 29.17 \text{ kg/m}^3$. According to [3], the appearance of TMW in the Cretan Sea is the result of a compensatory inflow that follows DWF events taking place in the Aegean Sea. As such, TMW presence can be used as a valuable trace of such past or future events.

References

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