Profiling Float Observations in the Aegean Sea

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Abstract

Aiming at gaining a better understanding of the dynamics and variability of the very complex environment of the Aegean Sea, a series of CTD surveys and profiling float deployments was conducted in various Aegean Sea basins and the adjacent west Levantine region. The observations are supplemented by numerical modeling experiments, in order to evaluate the dynamical characteristics of the various sub-basins. The results from this work reveal and/or confirm interesting features of the Aegean Sea dynamics. There is a remarkable difference of the temperature/salinity characteristics between the North and South Aegean sub-basins. At the surface layers the large differences can be attributed to the presence of Black Sea Water (BSW) in the northern basin, while in the Cretan Sea the surface waters are influenced by the warmer and more saline waters of Levantine origin. The deep-water temperature and salinity differences are also important, indicating a possible decoupling of the two sub-basins. The Cretan Sea profiles reveal important changes in the regional stratification, related to the regional abrupt climatic event of the early ‘90s known as Eastern Mediterranean Transient (EMT). Comparison with older observations indicates important mixing processes within and outside the Aegean and a possible evolution of the exchange between the Cretan Sea and the Levantine basin. The Aegean outflow that contributed to the Eastern Mediterranean has been minimized and the waters just outside the Eastern Cretan Straits, below 1000m, are a mixture of deep water of Adriatic and Aegean origin, with the former contributing to a higher percentage compared to earlier observations.

Introduction

The Aegean Sea, situated in the northeastern Mediterranean Sea, is very irregular and its topographic structure very complicated. There are over 3000 islands of various sizes scattered all over the basin dividing the basin in sub-basins of various sizes and depths. A large number of water masses are present in the region, subject to strong variability at various timescales, intense circulation patterns and water mass formation, strong forcing of both wind and thermohaline character.

During the late ‘80s the Aegean Sea became a new more effective deep water source than the Adriatic Sea, since it produced not only denser water, namely the Cretan Deep Water (CDW), but also higher volumes **[1]**. From 1988 to 1995, massive outflow of CDW occurred through the Straits of the Cretan Arc towards the Ionian and Levantine basins, uplifting the older deep waters of Adriatic origin and affecting the exchange between the Aegean and the adjacent basins with the intrusion of Transitional Mediterranean Water (TMW). The origin of the latter is water lying between Levantine Intermediate Water and Eastern Mediterranean Deep Water, which was present in the Cretan Sea intermediate levels (200-600 m) during the first stages of EMT **[2]**. Since 1995 the EMT event started to decay, but its rate of relaxation and the mechanisms involved remain unclear.

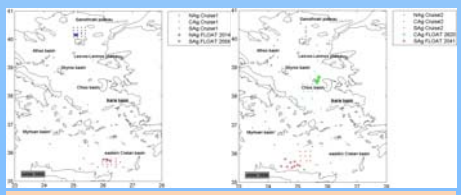

Figure 1. Winter 2005: CTD data during Cruise-1 at 01-10/03/2005 and CTD Float 2014 (NAg, 09-29/03/2005)-Float 2058 (SAg, 14-29/03/2005) profiles. Winter 2006: CTD data during Cruise-2 at 03-13/02/2006 and CTD Float 2620 (CAg, 13/02-29/03/2006)-Float 2041 (SAg, 16/02-28/03/2006) profiles.

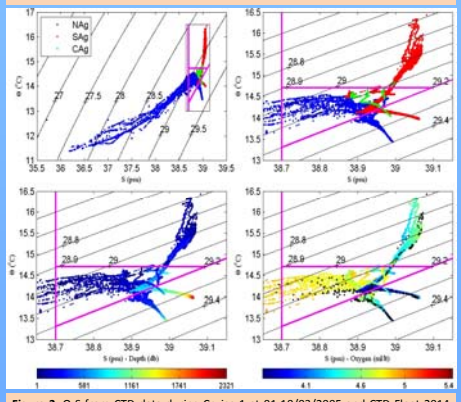

Figure 2. Θ-S from CTD data during Cruise-1 at 01-10/03/2005 and CTD Float 2014 (NAg, 09-29/03/2005)-Float 2058 (SAg, 14-29/03/2005) profiles. Data as a function of the geographical area (NAg-blue, CAg-green, SAg-red), depth and oxygen concentration. The black dots in oxygen concentration denote Floats 2014-2058 data (lack of oxygen concentration data).

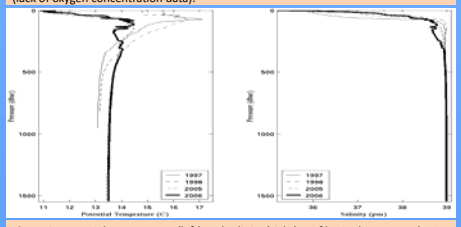

Figure 3. Potential temperature (left) and salinity (right) profiles in the Lemnos basin (NAg) during different years in the post-EMT period.

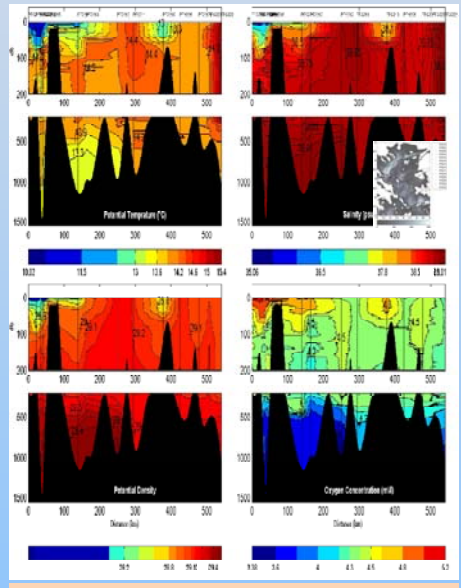

Figure 4. Transects in the north-central Aegean from CTD data during Cruise-2 (winter 2006). The CTD stations mentioned inside the Aegean Sea map.

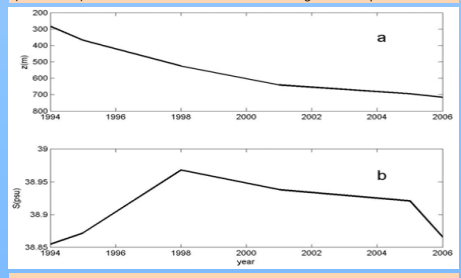

Figure 5. Evolution of depth (a) , salinity (b) of the TMW intrusion in the Cretan Sea.

Method

Lagrangian observations with autonomous profilers and CTD surveys in the region were carried out from 2005 aiming at monitoring changes in the regional characterization and identifying mechanisms involved in the regional variability.

Two cruises were carried out abroad the R/V Aegaeo, during the winter periods of 2005 and 2006, when a total of 44 and 47 hydrographic stations were occupied in the 1st and 2nd cruise respectively (**Fig. 1**). In addition, the shipboard scientific activities consisted of the deployment of four profiling floats, two at each cruise. They are neutrally floating at a specified parking depth and profiling with SeaBird CTD sensors every five days. The parking depths in the 1st cruise were selected relatively close to the bottom, for the Lemnos basin and the eastern Cretan Sea depression, to measure the biggest part of the water column and in order to ensure that the floats are trapped in the basins. Due to the very irregular topography, the parking depth proved to be extremely high for safe profiling in the region. The strategy in the 2nd cruise included much smaller parking depths for the Chios basin and the central Cretan Sea.

Results and Discussion

The combined profiling floats and CTD surveys data sets, compiled with older observations, reveal several interesting aspects of the Aegean Sea dynamics.

There is a remarkable difference of the Θ-S characteristics between the North and South Aegean sub-basins (**Fig. 2**). At the surface layers the large differences can be attributed to the presence of the BSW in the northern basin, while in the Cretan Sea, surface waters are influenced by the warmer and more saline waters of Levantine origin (LSW). The deep-water temperature and salinity differences are also important, indicating a possible decoupling of the two sub-basins.

In the northern Aegean basin important interannual variability is observed (**Fig. 3**). Changes in the water column characteristics in the region are influenced by local water mass formation processes detected during the winter period. Dense intermediate water formation (~29.2 gr/kgr) occurred during the winter of 2006 in the 2nd cruise in the north-central Aegean (**Fig. 4**).

The changes associated with EMT started to decay dramatically confirming its transitional character but subsequent changes were slower and its signal still remains present **[3]**. The Cretan Sea profiles reveal a relatively less saline intermediate layer, produced by the TMW intrusion that is continuously deepening and reached the 800 m during the late observations (**Fig. 5**). Comparison with older observations indicates important mixing processes within and outside the Aegean and a possible evolution of the exchange between the Cretan Sea and the Levantine basin. This current phase is characterized by inflow of the TMW at the deepest part of Kassos strait, while at the same time no outflow of CDW is detected (**Fig. 6**).

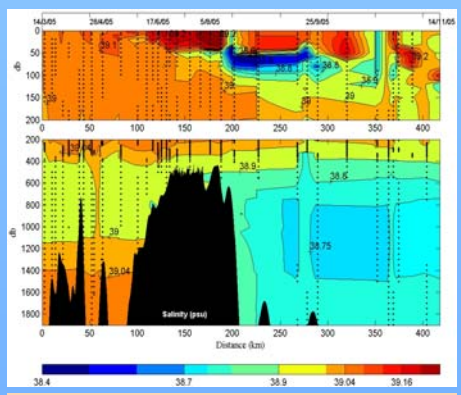

Figure 6. Spatiotemporal transect of the CTD data Float 2058 during its drift from the Cretan Sea to Levantine basin through the deepest part of Kassos strait.

Summary and Conclusion

New innovative methods with autonomous profiling floats give us new tools for monitoring the circulation and stratification and their variability in the Aegean Sea. The results acquired until now together with historical data emphasize the spatial and temporal variability of the Aegean Sea stratification and circulation. The accumulation of large number of data in the region will eventually provide a valuable mean for investigating the dynamics of the Aegean Sea.

References

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