A MULTIDISCIPLINARY OBSERVING SYSTEM TO UNDERSTAND OCEANOGRAPHIC PROCESSES IN THE OPEN ADRIATIC SEA

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Abstract

Eulerian high frequency measurements coming from the E2M^{3}A observatory, located in the Southern Adriatic Pit, give invaluable multidisciplinary information to understand processes on different time scales, as they provide several unique features that cannot be found in other observing systems. Intrusion of northern waters into the deepest layer of the pit, lateral advection and dense water formation in the area are among the processes involved. A better understanding of the processes influencing the carbonate system, especially during winter cooling, is obtained by means of an automatic monitoring of the carbonate system set up, which measures two of its main variables i.e. the partial pressure of CO2 (pCO2) and the pH. The amount of the dense water formed also influences the water exchange between the Adriatic and Eastern Mediterranean.

Keywords: Open sea, Time series, South Adriatic Sea, Carbon, Monitoring

Continuous measurements are essential to assess the interannual variability of the thermohaline circulation, water masses properties and transports, and biochemical contents. The need for high-frequency sampling to resolve events and rapid processes and the long sustained measurements of multiple interrelated variables from the sea surface to the seafloor is provided by the observatory E2M^{3}A located in the area of the Southern Adriatic Pit at 41° 31.971'N, 18°03.787'E. The dynamics of the southern basin is dominated by the presence of a quasi-permanent cyclonic gyre that intensifies in the winter season creating the conditions for the production of dense and oxygenated waters. Thermohaline measurements collected at the E2M^{3}A since 2006, almost continuously, give valuable information of the variability of the ocean's interior. The sudden temperature and salinity decreases, depicted in the time-series (Fig.1) and noticed after each winter convection phase confirms the effectiveness of dense water formation processes (especially during winters 2008/09 and 2011/12), which transfer colder and fresher surface waters toward deeper levels. Furthermore, the high frequency sampling permitted to detect positive bottom trends in temperature and salinity, associated with a saw-tooth pattern caused by the concomitant effect of intrusion of very dense waters (cold but relatively fresh) of northern Adriatic origin, and local mixing dynamics.

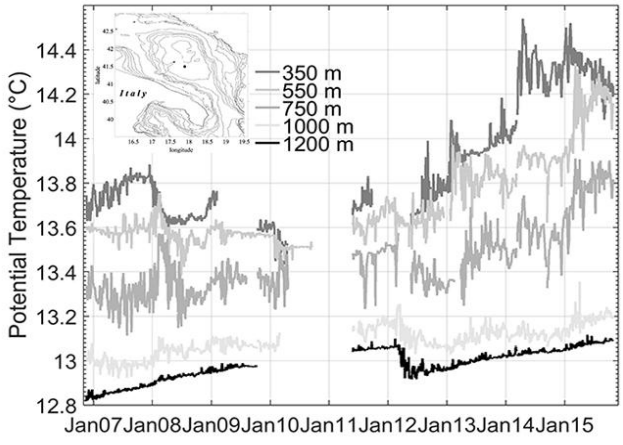

Fig. 1. Saw-tooth and deep-water formation signal from temperature data at different depths in the souther Adriatic Sea

The joint analysis of thermohaline and current records highlighted an intense mesoscale activity (e.g. passage of cyclonic and anticyclonic eddies), and revealed a diurnal zooplankton vertical migration in the upper layer. The multivariable approach is enhanced by the sediment traps positioned at two levels (below the photic layer at-125m and near the bottom at -1050m) allowing the understanding of the processes that are responsible for the high-frequency and interannual variability of new production and of phytoplankton biomass in the oligotrophic southern Adriatic. During the first 15 months of the experiment fluxes of particulate matter showed high seasonal variability, with maximum values in late winter-spring season. Total mass fluxes (TMF) measured at the shallower trap were generally lower that those measured at the bottom trap, ranging from 38 to 412 mg m^{-2} d^{-1}, with a time- weighted average of 159 mg m^{-2} d^{-1}, whereas at the bottom trap TMF varied from 33 to 885 mg m^{-2} d^{-1}, with a time-weighted average of 198 mg m^{-2} d^{-1}. The organic carbon flux, followed the same seasonal trend, with higher values below the photic zone, varying from 2.5 to 19.5 mg m^{-2} d^{-1}, with a mean of 5.0 mg m^{-2} d^{-1} at the shallow trap.

The estimation of the air-sea interaction at the site, one of the factors that plays an important role in triggering the convection, confirms the importance of the southern Adriatic as a site of dense water formation. The heat flux time series also depict the non-homogeneity in winter heat loss intensity [1] between the northern and southern Adriatic basins [2].

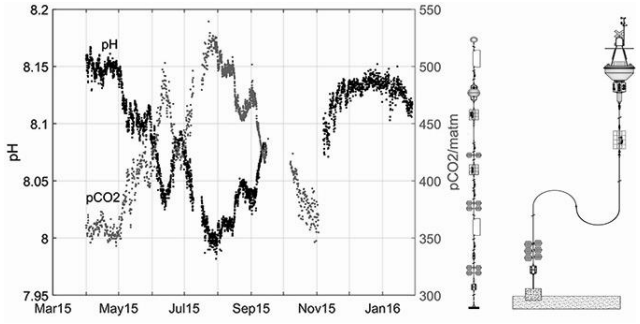

Fig. 2. Data from the carbonate automatic monitoring system at the E2M^{3}A

The automatic monitoring of the carbonate system set up on the E2-M3A buoy (Fig. 2) is measuring two of its main variables i.e. the partial pressure of CO_2 (pCO_2) and the pH. This allows a better understanding of the processes influencing the carbonate system in the southern Adriatic, especially during winter season. A strong seasonal variability was evidenced during the surface measurements of pH and pCO_2, which is roughly connected to the thermal effects (temperature variation from 14.16 °C in April to 30. 26 °C in July) on the CO_2 solubility and on the dissociation of carbonic acids forms, besides to the microbiological activity of heterotrophs and primary producers. The variations of pH measured during more than 8 months ranged from 7.98 (July) to 8.17 (April), while pCO_2 values ranged from 348 (October) to 539 µatm (July).

References

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