BIOGEOCHEMICAL PROPERTIES OF ADRIATIC DENSE WATERS

M. Giani [1]*, V. Kovacevic [1], V. Cardin [1], B. Mihai [1], L. Ursella [1], F. Rampazzo [2], D. Berto [2], F. Savelli [2], G. Catalano [3], S. Cozzi [3], C. Cantoni [3] and A. Luchetta [3]

[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - mgiani@ogs.trieste.it

[2] Istituto Superiore per la Protezione e la Ricerca Ambientale-ISPRA; Chioggia, Italy

[3] Istituto di Scienze del Mare ISMAR-CNR, Trieste , Italy

Abstract

Distribution and characteristics of dense waters in the Adriatic Sea were monitored during their formation in winter 2008, and later, in autumn at the end of the seasonal stratification period in the Adriatic Sea. Different types of dense waters were identified on the basis of their physical features. In order to characterised their biogeochemical properties dissolved oxygen, nutrient, and particulate organic matter (chlorophyll a, particulate organic carbon, particulate nitrogen and phosphorus) were analysed.

Keywords: Adriatic Sea, Particulates, Oxygen, Nutrients, Organic Matter

The Adriatic Sea is one of the few sites in the Mediterranean Sea where dense waters are formed. This process represents an important driving engine for the circulation and ventilation of deep waters of the Eastern Mediterranean. Though the physical properties and mechanism of formation are well described [1], the biogeochemical features are known only for the dissolved inorganic nutrients [2]. Even less information is available for the particulate organic matter [3] and its relevance in the carbon cycling in the Mediterranean Sea. The whole Adriatic Sea system responds significantly to climatic variability, which acts on the properties of the water masses originating in the Adriatic, as well as on the exchange with the adjacent basins. The state of the art presented in this work derives from two cruises carried out in February and October 2008 in the framework of SESAME-EU-FP6 and VECTOR projects. During the winter season, cooling and evaporation triggered mixing leading to dense water formation over the northern shelf, and deep convection in the Southern Adriatic. The biogeochemical characteristics of these dense waters depend on the site and timing of preconditioning and formation. The North Adriatic Dense water (NAdDW) formed in winter flows southwards partly refilling the Middle Adriatic Pit increasing the oxygenation degree of those bottom waters and partly flowing into the Southern Adriatic Pit. The NAdDW is cooler and well oxygenated, especially if formed in late winter. In some years the maximum density (σ_θ) can reach more than 29.8 kg/m^3 [1], depending on frequency and intensity of northeasterly dry wind (Bora). In February 2008 maximum values observed in the northern Adriatic were 29.6 kg/m^3 for σ_θ (figure 1)

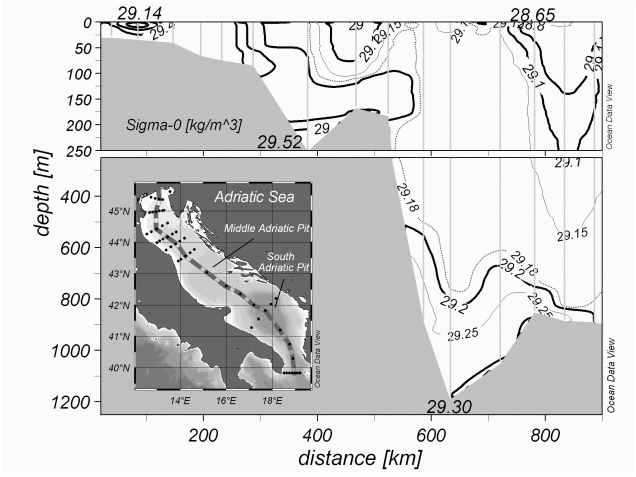

Fig. 1. Vertical distribution of density along the NW-SE longitudinal section of the Adriatic Sea.

and 106% for oxygen saturation (figure 2), indicating the beginning of primary production processes. They were richer in particulate organic carbon and nitrogen with respect to the other dense waters present in the basin during winter. The dense waters near the bottom of the Middle Adriatic Pit were oxygen depleted (figure 2) and had higher nutrient concentrations. The increase of oxygen saturation (from 65% to 75%) and the decrease of inorganic nutrient concentrations from February to October indicated the advection in the Middle Adriatic Pit of new dense waters.

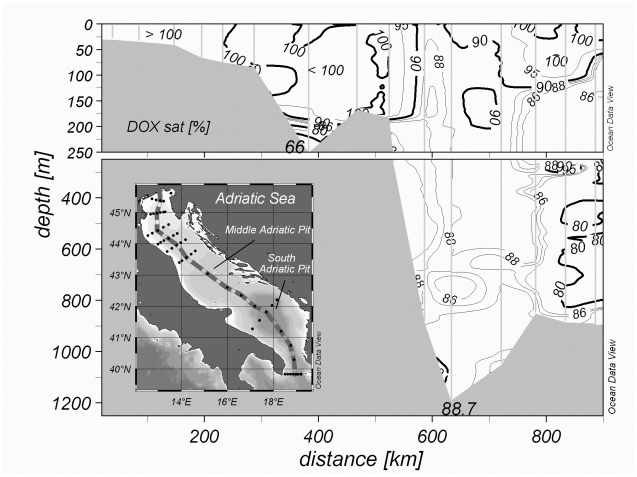

Fig. 2. Vertical distribution of dissolved oxygen along the NW-SE longitudinal section of the Adriatic Sea.

During this period the convection reached 700-800 meter depth in the Southern Adriatic (figure 1) bringing the nutrient rich undersaturated Levantine Intermediate Waters up to the surface, which just after the oceanographic cruise gave rise to a phytoplankton bloom within the Southern Adriatic cyclonic gyre, as observed from the chlorophyll-*a* distribution from MODIS AQUA satellite images. In autumn the SAdDW, which occupies the bottom of the Southern Adriatic Pit, got warmer, slightly less dense, more undersaturated than in winter. Contemporarily an increase in the concentrations of nutrients and suspended particulate matter took place due to the settling of particulate matter and degradation processes. The Adriatic Dense Water (ADW), is a mixture of deep waters formed in the Southern Adriatic, in the Northern and in the Middle Adriatic [1]. It flows out from the basin through the Strait of Otranto in depth along the western flank. The Ionian surface and Levantine Intermediate Waters flow into the Adriatic along the eastern flank. The ADW had similar concentration of suspended particulate matter both in February and October 2008. However, the saturation of dissolved oxygen decreased to 80% and the nutrient concentration increased in October 2008, due to the remineralization processes.

References

1 - Gacic M., Lascaratos A., Manca B.B. and Mantziafou A., 2001. Adriatic deep water and interaction with the Eastern Mediterranean Sea. *In*: Cushman-Roisin, B. *et al*.(eds.) Physical Oceanography of the Adriatic Sea, Kluwer Acadenic Publishers, pp 111-142.

2 - Zavateralli M., Raicich F., Bregant D., Russo A. and Artegiani A., 1998. Climatological biogeochemical characteristics of the Adriatic Sea. *Jour. Mar. Syst.*, 18: 227-263.

3 - Civitarese G., Gacic M., Vetrano A., Boldrin A., Bregant D., Rabitti S. and Souvermezoglou E., 1998. Biogeochemical fluxes through the Strait of Otranto (Eastern Mediterranean). *Cont. Shelf Res*., 18: 773-789.