NITROGEN AND AOU: USEFUL TOOLS FOR SHORT-TERM PREDICTION OF END SUMMER HYPOXIC EVENT IN THE NORTH ADRIATIC SEA BOTTOM LAYER

M. Marini [1], A. Russo [2], R. Signell [3], F. Grilli [1], A. Campanelli [1], A. Artegiani [1] *, D. Bigazzi [2]

[1] CNR – Institute of Marine Science (ISMAR), Ancona, Italy
[2] University of Ancona, Dept. of Marine Science, Italy
[3] SACLANT Undersea Research Centre, La Spezia, Italy

Abstract

During late summer 2002 three oceanographic cruises carried out in the North Adriatic Sea allowed analysis of a hypoxic event in the bottom layer . Physical and chemical parameters (Nitrogen and AOU: apparent oxygen utilization) were studied to define an approach for prediction of hypoxic events in the North Adriatic Sea. A 1D equation was formulated to predict the evolution of bottom dissolved oxygen content. The utilized methodology is supported by the weak circulation in the bottom layer of the hypoxic area during the period.

Keywords: Chemical oceanography, dissolved oxygen, nitrogen, hypoxia, Adriatic Sea

The Adriatic is a continental basin of the Eastern Mediterranean Sea, located between the Italian peninsula and the Balkans; it is elongated in the SE-NW direction.

The northern sub-basin is vary shallow and gently sloping, with an average bottom depth of about 35 m. River runoff is particularly strong in this area and affects the circulation through buoyancy input and the ecosystem by introducing large amounts of organic matter. Po river, with an average annual discharge of 1500 m^3s^{-1} , accounts for about 50 % of the total northern Adriatic river runoff (1).

The bottom water layer most frequently exposed to hypoxic events (2) is often influenced by a cyclonic circulation gyre governed by the Po plume, trapping its fresh waters at surface (3). Low current velocities at the gyre centre, enhanced stratification (reducing vertical mixing) and high turbidity (stopping sunlight in the first meters) due to the fresh water, high production and sedimentation are some of the factors that cause hypoxic events in this area (typically occurring between Sept.-Nov.).

Three oceanographic cruises were conducted in the northern Adriatic Sea (more than 600 CTD casts) from 16 September to 16 October 2002 by the R/V G. Dallaporta and R/V Alliance. Both utilized CTD probes were SBE 911plus, equipped with redundant T-C sensors, SBE 43 dissolved oxygen (DO) and other ancillary sensors, and coupled with SBE Carousel water samplers. Water samples were collected to analyze nutrient salts (4) and DO with potentiometric titration method (5) were used to verify the probe DO sensors.

The bottom layer currents were examined through the ROMS ocean model, initialised by the CTD data and forced by the LAMI meteorological model.

During the period of investigation, the hypoxic area increased on the bottom layer (Fig. 1). In some stations dissolved oxygen reached about 30 % of saturation.

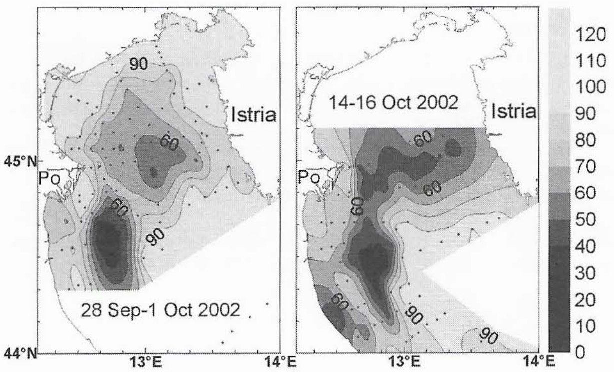

Fig. 1. Bottom dissolved oxygen (expressed as % of saturation) distribution; sampling dates are reported within each map.

The average AOU:N(NO_2+NO_3) ratio obtained on 30 bottom stations, in the hypoxic area, during the total period studied whose 35 ± 22, in agreement with Zavatarelli *et al.* (6) and Degobbis (7). High standard deviation associated with this ratio reflected the high variability of the data and of the biological and physical processes controlling the nutrient levels in the North Adriatic basin. Also the linear correlation coefficient between the paired data used to compute the ratio was calculated; the linear relationship are statistically acceptable: $p<0.01$.

The oxygen saturation values found on the bottom stations are used to calculate a prediction equation of hypoxic event in the time in this area. The daily consume found is: 0.7825%, the kinetics is:

$$O_2\%_{sat}=O_2\%_{\text{initial value}} - 0.7825t_{day}$$

$r=0.604$; $n=49$ statistically acceptable at $p< 0.01$. It represents a good tool to predict the temporal evolution of bottom hypoxic events at the end of summer in stable weather conditions. Model simulations demonstrated that the bottom layer of the hypoxic area was influenced only by weak currents, and bottom waters inside the hypoxic area were nearly stagnant. This fact justifies the stationary hypothesis assumed for the equation. The observed AOU:Nitrogen ratio is normal for this region hence supporting the general validity of this kinetics. In conclusion this equation can be assumed generally valid during conditions when cooling and mixing events are not sufficiently strong to mix the entire water column.

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