ANNUAL FLUXES OF NITROGEN AND PHOSPHORUS THROUGH THE STRAIT OF OTRANTO (EASTERN MEDITERRANEAN)

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Abstract

Annual rates of nutrient fluxes through the Strait of Otranto are assessed. The Adriatic Sea exports nitrate and phosphate but imports dissolved and particulate organic matter. Total nutrient fluxes are almost balanced. This suggests that the mineralization takes place in the southern Adriatic, and that the highly eutrophic northern Adriatic area has little influence on the rest of the basin.

Key-words: nutrients, Adriatic Sea

Introduction

The Strait of Otranto forms a 75 km wide, and up to 800 m deep connection between the Adriatic and Ionian seas (Fig. 1). The study of its dynamics and biogeochemistry is crucial for estimating budgets and long term changes in the Eastern Mediterranean. A series of seasonal cruises and Eulerian current measurements in the Otranto Strait were carried out to study the biogeochemical characteristics of the strait and to estimate the exchange of water, dissolved nutrients and particulate matter between the Adriatic and the Ionian Sea.

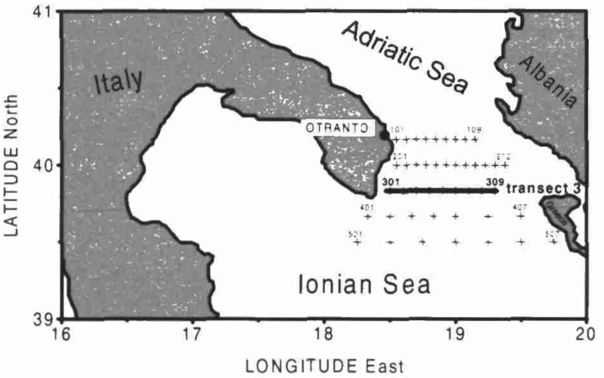

Fig. 1. Study area and station locations.

Fluxes computation

The grid of stations occupied during six seasonal cruises (OTR1-February 94, OTR2-May 94, OTR3-August 94, OTR4-November 94, OTR5-February 95, OTR6-May 95) is presented in Fig. 1. The current data span variable time intervals ranging from 53 days (station 308 at surface) to 597 days (station 304 at intermediate level). Mean current values were calculated by averaging all available time-series at each measurement location (for details on the experimental design, see [1]). The averaged current field was then interpolated over a regular grid (Fig. 2), and the fluxes of water across the strait calculated.

The same interpolation procedure was applied to the annual averaged chemical concentrations (Fig. 2), obtained by using the experimental data on nitrate, phosphate, and particulate nitrogen from seasonal OTR3, OTR4, OTR5 and OTR6 cruises along transect 3, the same transect where current meter moorings were deployed. Due to the low seasonal variability of the distribution patterns over the major portion of the water column except for the surface layer, the use of annual averages does not introduce any significant error into the flux computations. The resulting current and chemical concentration data interpolated to the same regular grid were then multiplied to estimate the material fluxes.

Results and Discussion

Vertical distribution (Fig. 2) of the longitudinal current component shows a cyclonic shear over the entire water column with a maximum inflow/outflow in the surface layer. Another local maximum occurs in the bottom layer associated with the Adriatic Deep Water (ADW) outflow. Dissolved nutrient distributions (Fig. 2) show depleted surface layer (0-50 m), separated from the rest of the water column by a nutricline centered at about 100 m depth. The slight decrease of nitrate and phosphate in the bottom layer is associated with the ADW. In contrast, particulate matter displays maximum concentrations in the surface layer while the rest of the water column (below 300 m depth) is very poor in particulate nitrogen.

Annual flux computations (Fig. 3) show a net loss from the Adriatic of nitrate (29,500 x 10^6 moles y^{-1}) and phosphate (950 x 10^6 moles y^{-1}), representing 26% and 21% of the total export, respectively. Particulate nitrogen (PN) exhibits a net gain of 2,170 x 106 10^6 moles y^{-1} respectively, representing about 30% of the total import (see Table I for explanation). There is also an almost perfectly balanced water exchange as would be expected.

A more detailed analysis of the contributions of the various layers to the exchange is reported in Figure 3. The loss in the layer between 200 m depth and the bottom is responsible for the net annual nutrient export from the Adriatic. On the other hand, for the particulate matter, the most active layers in terms of the transport are the uppermost (from the surface down to 200 m). PN flux computations result in a net positive imbalance (particulate matter gain for the Adriatic by exchange through the Strait of Otranto). This was unexpected because it is known that the western part of the strait, occupied by waters of Adriatic origin, is richer in particulate matter than the eastern sector [2]. We must, however, take into account that the transport is the result of the combined action of water transport and mass distribution. Considering the annual average fluxes of water (Fig. 3), it is evident that the layer from 0 to 200 meters shows a net positive imbalance, giving rise to the corresponding net positive transport of particulates. On the other hand, the higher water flux out of the Adriatic in the layer from 200 meters down to the bottom cannot compensate for the imbalance of particu-

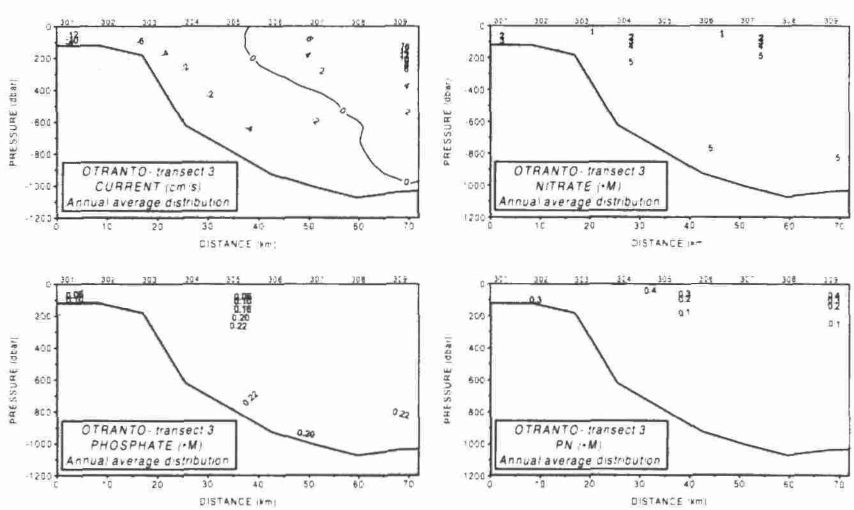

Fig. 2. Annual average vertical distribution of the north current component and biogeochemical compounds.