DYNAMICS OF A MID-ADRIATIC COASTAL AREA. FIRST EXPERIMENTAL RESULTS OBTAINED IN THE FRAMEWORK OF PRISMA-2 PROJECT

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Abstract

The Adriatic Sea coastal area offshore Ancona (Italy) has been intensively investigate in the framework of the Italian national PRISMA-2 project. Hydrological and current meter data collected during the first summer leg (July-September 1996) have been analyzed; preliminary results show typical synoptic dynamics resulting from the combination of the thermohaline field with the atmospheric forcing. We computed the alongshore transport by means of the geostrophic method adjusted with current meter data; the results show an average southeast transport in the surface warmer layer of about $55*10^3$ m^3/s. This coastal flow carry on also the fresh waters originated from the dilution of the river outflow in the northern Adriatic Sea. This fresh water transport estimation is about $2*10^3$ m^3/s. These measurements were made at the beginning of September 1996 with very favorable meteorological conditions, therefore we can suppose our estimation not affected by external forcing as the wind stress.

Key-words : Adriatic Sea, coastal waters, water transport

Introduction

Recently the Italian coastal areas of the Adriatic Sea have been intensively investigated in the framework of the Italian national PRISMA-2 research program that is a multidisciplinary study focused on the physical and biochemical processes which determine the fate and the distribution of all the pollutants discharged in the Adriatic Sea.

The general circulation of the Adriatic Sea, as derived by several experimental and modeling studies, shows a seasonal and annual dependent cyclonic characteristic. Typically the surface circulation in the southern and middle Adriatic Sea consists of a smooth flow encircling cyclonically the entire basin, while during the winter the general circulation consists of several cyclonic gyres (1, 2, 3).

The cyclonic circulation of the Adriatic Sea is intensified in the central coastal region, about at latitude 43.5° N, where the local bathymetry shows a strong inclination over a wide longhsore area (4).

The flow along the Italian coastlines is also characterized by the presence of fresh waters coming from the river discharges and transporting substances as pollutants and nutrients. Furthermore coastal waters offshore Ancona, as literature reports on the basis of some hydrological surveys, show a strong seasonal variability of the physical and bio-chemical parameters depending on river discharges.

Sampling

During the summer 1996 synoptic surveys (3÷4 days each) were carried out, at interval of about one week, along the coastal zone offshore Ancona, performing hydrological casts along transects perpendicular to the coast and to the expected flow (see figure 1). These transects have been extended to include the coastal waters, the frontal area and the "open sea". The position of frontal system was detected on the basis of synoptic surface measurements collecting continuously temperature and salinity (conductivity) data during a fast survey previously carried out. During the summer, the presence of the front was revealed mainly by the strong changes in salinity values more than in temperature.

Simultaneously current meter time series were collected by three moored instruments positioned in two locations of the studied area (figure 1).

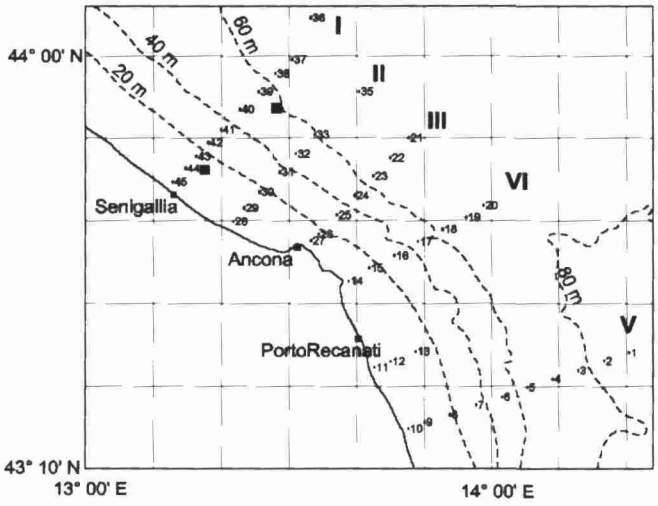

Figure 1 : Hydrological casts and mooring positions. Isobath are show every 20 meters.

Discussion

Typically the vertical structure of the water column (as shown in figure 2) exhibits the presence of a coastal low salinity zone with the minimum close to the surface. The solar heating, especially in this period, affects the surface layer with a well developed thermocline. Below it two water masses may be identified mainly on the basis of their salinity values. Maximum salinity values highlight the influence of the Modified Levantine Intermediate Water (MLIW) in the eastern (right) flank of the section, while close to the bottom, in the western continental slope, relatively low salinity and temperature values are mostly indicative of waters originated in the Northern Adriatic Sea during the winter season [5].

From these hydrological and current meter data we calculated the alongshore transports in this area. The results reported in the table are concerning with the data collected during the survey of 2-4 September 1996. These measurements have been made at the end of a period in which the meteorological conditions were favorable and consequently we can suppose these values representative of a state not affected by the atmospheric forcing (wind stress).

Transport values have been obtained on the basis of the classical geostrophic method imposing the zero reference level, on first step, at the base of the thermocline (at about 10-20 meters depth, see figure 2). Subsequently the data have been adjusted using the low-pass filtered current meter time series recorded in two different sites (figure 3).

Results

In table 1 we reported the transports, obtained along five sections performed from Senigallia to Porto Recanati (figure 1), computed for the two alongshore directions.

Table 1 : Transport estimations calculated from hydrological and current meter data collected during 2-4 September 1996.

Section number	Transport of "marine" water m^3/s		Transport of fresh water m^3/s	
	SE	NW	SE	NW
I	62670 (83%)	12483 (17%)	2998 (99%)	38 (1%)
II	54893 (77%)	6803 (23%)	1924 (98%)	36 (2%)
III	37304 (73%)	13459 (27%)	1428 (92%)	130 (8%)
IV	54745 (80%)	13456 (20%)	1975 (97%)	57 (3%)
V	66132 (77%)	19218 (23%)	2024 (90%)	234 (10%)
Mean	55154 (78%)	13084 (22%)	2070 (95%)	99 (5%)

Obviously, along the southern-east direction we found larger transports (78%) which are bordered in the coastal flow of warmer water over the thermocline.

The concentration of the fresh water was calculated by the:

$$C = \frac{\bar{S} - S}{\bar{S}}$$

where $\bar{S}$ is the salinity of the local MLIW and S the salinity of the southeastern flow; integrating over all the transect we obtained the "fresh" transport reported on table along the sections of figure 1. It is clear, from figures 2 and 4, that the low salinity values are close to the coast and, obviously, over the thermocline therefore these fresh waters are carried out in the warmer coastal layer.

The mean transport of about 2000 m^3/s obtained for the fresh water is consistent with the total fresh inflow of all rivers discharged in the northern Adriatic Sea (that is about twice of the Po river one) [6].

Some changes of the calculated transports in the different sections (particularly between the first and the others) can be due by the distinct geo-