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3D Mathematical Modelling of currents and dispersion in the Northern Adriatic

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Among the different measures for water-quality improvement in the Northern Adriatic, mathematical modelling plays a significant role. Some measurements of current velocities, temperature, and salinity were also executed in 1984-86, mainly in the Piran and Koper Bays.

The mathematical model is three-dimensional, nonlinear, and includes equations simulating dispersion of heat, salinity or contaminants.These parameters affect the density according to the equation of state and variable density in return' influences the velocity field (For details see Rajar, 1989). A one equation turbulence model is used for the vertical distribution of the "turbulence viscosity", (based on the eq. for turbulence kinetic energy) including the influence of stratification which is expressed by the Richardson number (Rajar et al, 1989).

The possiblity to simulate the transport of contaminants gives the possibility to extend the present hydrodynamic model into a water-quality model. The model is used also to simulate circulation in lakes.

With the model we have simulated the circulation in the whole Northern Adriatic and especially in the Trieste Bay (Fig. 1) and Piran Bay and Koper Bay, which are parts of the Trieste Bay, where the water quality is most endangered.

The results of the modelling show that the very polluted water from the Italian po river reaches the Yugoslav coast at different meteorologic conditions. For the Trieste Bay (Fig. 1) many simulations were made and compared with the results of measurements. It was shown that the tidal forcing and the wind forcing are of the same order of magnitude. Fig. 1 represents simulation of currents during falling tide, with the wind increasing during the day up to 4,5 m/s. A relatively strong stratification took place (9°C and 1,6 °/oo difference in temperature and salinity at the surface and at the depth of 22 m). The bulk movement of the water is out of the region (during falling tide), with the right deflection due to the Coriolis effect.

Weaker winds (Fig. 1) cause only the surface layer to move with the wind; no destratification takes place. The measurements confirm this fact. Simulation and also the observations show that more than two days of strong "Bura" wind are necessary to "mix" the stratified layers.

In the smaller Piran Bay and Koper Bay, the tidal influence is small compared with the wind forcing. However, we have studied the circulation due only to tidal forcing, since conditions for dispersion of contaminants are the worst in windless days. Summarized results of measurements during the periods of week winds ($v < 2$ m/s) show a cyclonic circulation during rising tide in both bays. During falling tide, anticyclonic circulation is formed in the Piran bay, but in Koper bay again a kind of cyclonic vorex is formed, presumably due to flow out of the Trieste bay and around the cape, which closes the Koper Bay at the North.

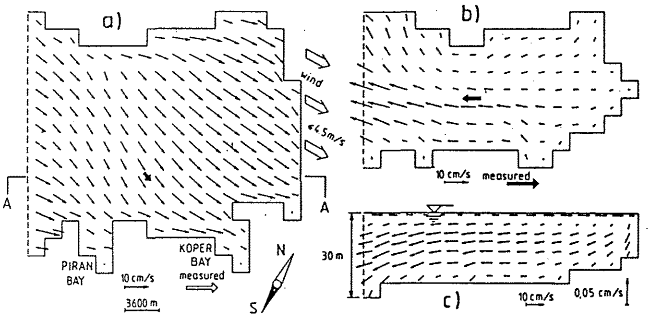

Fig. 1 Computed currents in the Trieste Bay a. Surface currents b. Bottom currents c. Vertical cross-section A-A

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O-VI9

Dynamical coupling between the Mediterranean Sea and the atmosphere. Boundary conditions at the air-sea interface

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ABSTRACT

In oceanography, the need of accurate boundary conditions at the air-sea interface is critical. Indeed the coupling between the atmosphere and the sea is intense, especially via the turbulent fluxes of humidity, temperature, and momentum. A parameterization of these fluxes is then required. To achieve this, one needs to couple hydrodynamical and meteorological models.

A 2-D integral coupled ocean-atmosphere model has then been developed to simulate the transient interactions between the two boundary layers. The heat, water, and momentum exchanges at the interface are investigated, notably to analyze the clouds generation, their possible persistence and the resultant feed-back on the oceanic variables. The solar and IR radiative fluxes are parameterized as functions of the temperature and humidity profiles and vary then with the meteorological events.

This model has already been tested in the Tropics where the dynamics of the coupled ocean-atmosphere system has been proved to be highly dependent on the advective rates and the turbulent fluxes at the interface. The model embedded in an atmospheric GCM and in the GHER Oceanic GCM is applied to the Mediterranean Sea, providing more accurate turbulent fluxes as boundary conditions for the modelling of the general circulation, and on the other hand, contributing to the parameterization of the incidence of meteorological conditions upon the formation of dense waters.

The development and the generalisation of this kind of coupled model will therefore give a highly expected tool to the modellers of the Mediterranean Sea.