ON THE CYCLONIC WIND-DRIVEN FLOW IN THE RIJEKA BAY DURING WINTER

Mirko Orlić* and Milivoj Kuzmić**

* Geophysical Institute, Faculty of Science, University of Zagreb, Zagreb, Yugoslavia

** Center for Marine Research Zagreb, Rudjer Bošković Institute, Zagreb, Yugoslavia

Summary

The cyclonic orientation of the flow in the Rijeka Bay, driven by the bura wind during winter, is explained by the difference in depth between the two basins that connect the Bay with the open Adriatic Sea.

Résumé

Le caractère cyclonique de la circulation dans le Golfe de Rijeka provoquée par la "Bora" en hiver, est expliqué par l'inégalité de profondeur entre les deux bassins reliant le golfe avec la Mer Adriatique.

From February 6 through March 23, 1981, currents were measured in the Rijeka Bay, a basin in the northeast Adriatic Sea. The Aanderaa RCM 4 current meters were deployed at four stations, on two depths. Sampling interval was 10 minutes. Preliminary data analysis (Gačić et al., 1983) has already shown that the wind is of primary importance for the dynamics of this basin. More detailed investigation, using the anemographic data from the Rijeka Airport (45°13'N, 14°

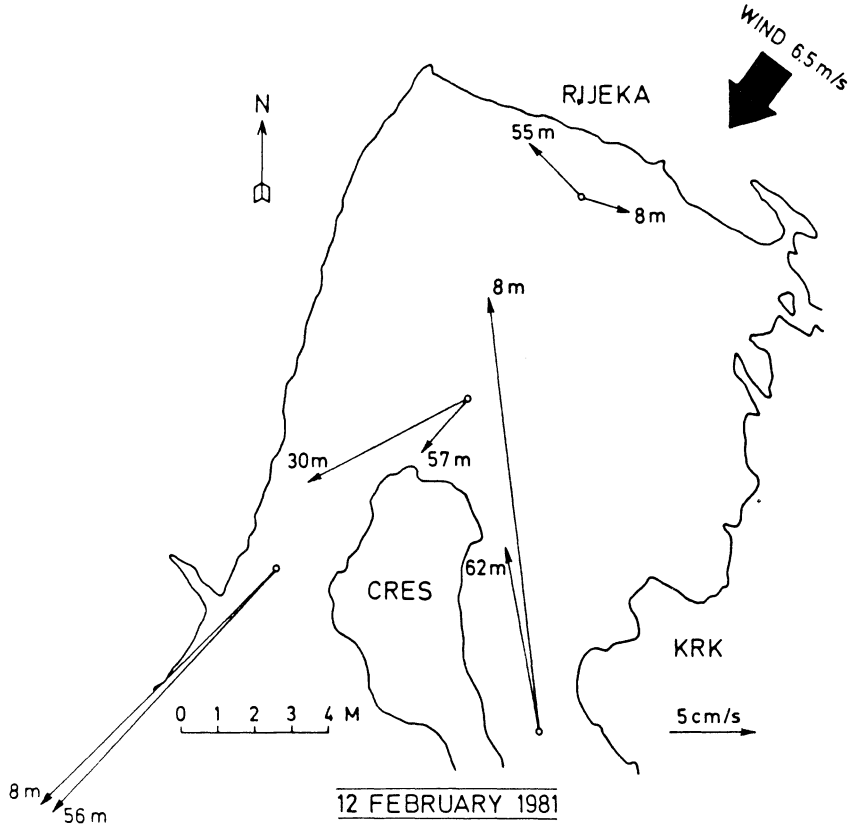


Figure 1

Figure 2

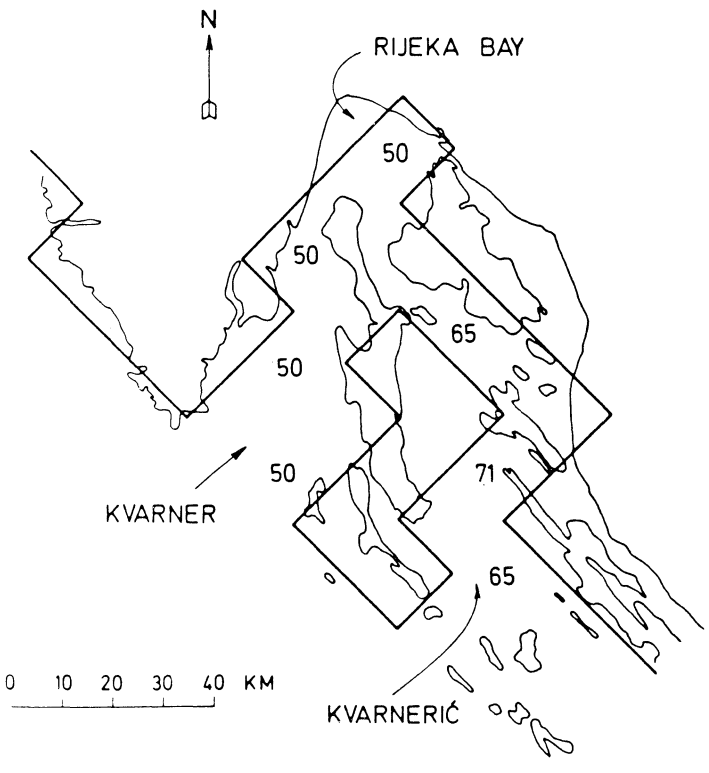
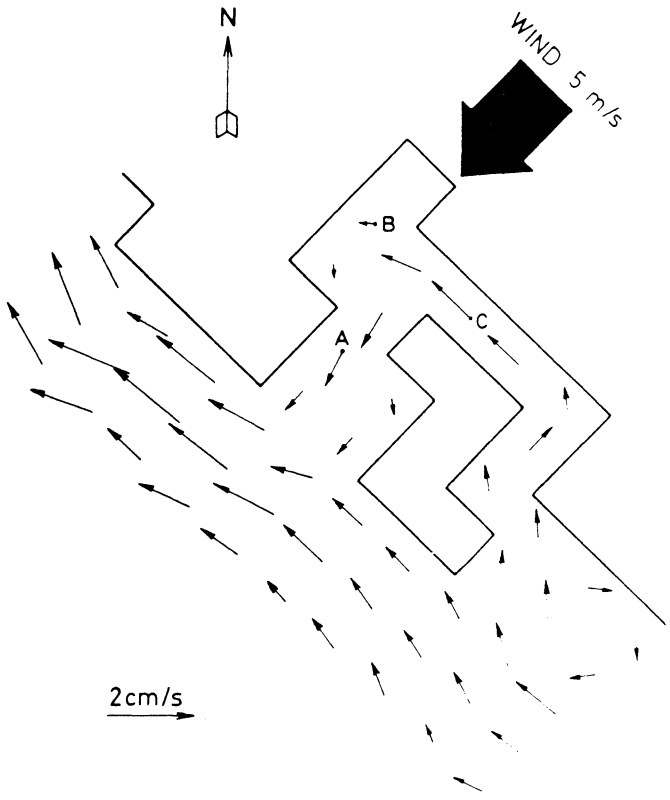


Figure 3



35'E, 85 + 10 m), brought into focus the bura wind, dominant winter air flow from the northeast quadrant. The response of the sea to the influence of bura was found to be characterized by the cyclonic circulation in the southern part of the Bay (a situation with the strongest daily-mean wind is shown in Figure 1).

In order to explain this feature of bura-driven flow in the Rijeka Bay, we ran a three-dimensional hydrodynamical numerical model for the area shown in Figure 1. The model simulates the impact of suddenly imposed, uniform and constant wind on the homogeneous, motionless sea in the f-plane. Non-linear interaction and lateral friction are neglected, and hydrostatic approximation is made. The vertical problem is solved in the model by the eigenfunction method (Heaps, 1972). The results of the Rijeka Bay model (Kuzmić et al., 1981) did not show any perceptible deviations from the Ekman dynamics for small, closed basins. Since the Rijeka Bay is a basin of almost flat bottom, and spatial variations of wind above such a small basin may be neglected, this result was not surprising. Yet, the empirical data called for further explanation.

Therefore, the model has been extended over the whole Adriatic Sea, with the Rijeka Bay covered by a somewhat coarser grid (Figure 2). The modelled vertically averaged currents now revealed the cyclonic flow in the Bay, for the case of the bura wind (Figure 3). This can be clearly seen looking at the points A, B and C (Figure 3), which approximately correspond to the current-meter stations in the southern part of the Rijeka Bay.

The difference between that and the previous model results suggested immediately the interpretation. The Rijeka Bay is connected with the open Adriatic via two basins, the Kvarner and the Kvarnerić (Figure 2). The latter, located on the southeast, is deeper than the former, northwestern basin. This favours the formation of cyclonically oriented bottom-slope current. The Bay itself, with its flat bottom, is passive in the process, responding simply to the outside imposed dynamics.

However, even the last model did not manage the reproduce the empirical distribution of currents with depth. We believe that inadequate representation of the Rijeka Bay topography is a probable reason. The work on the new model is under way; it will cover the Rijeka Bay with a fine-scale grid, and the results from the whole Adriatic model will be used as the open-boundary conditions for the submodel.

References

M. Gačić, M. Orlić, V. Dadić and M. Karabeg (1983): Temporal variations of current field in Rijeka Bay, VI^{es} Journées Étud. Pollutions - Cannes 1982, 165-171.

N.S. Heaps (1972): On the numerical solution of the three-dimensional hydrodynamical equations for tides and storm surges, Mém. Soc. Roy. Sci. Liège 6/1, 143-180.

M. Kuzmić, M. Karabeg i M. Orlić (1981): Numeričko modeliranje dinamike okrajnjih akvatorija - primjer Riječkog zaljeva, Num. metode u tehnici III - Stubičke Toplice 1981, 405-420.