MONTHLY AND SEASONAL OSCILLATIONS OF THE EASTERN ADRIATIC CURRENT

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Abstract
Long-term ADCP measurements were carried out between November 2007 and December 2008 along the Croatian internal and territorial waters. Preliminary results of monthly and seasonal oscillations of the Eastern Adriatic Current are presented.
Keywords: Adriatic Sea, Currents, Circulation

Introduction
The Eastern Adriatic Current (EAC) is a branch of the general Adriatic cyclonic circulation along the eastern part of the Adriatic Sea with predominant NW direction. It is well known that EAC varies seasonally, being strongest in winter and weakest in summer [1]. In 2007 the scientific and research program – „The Adriatic Sea Monitoring Program" was implemented. Part of this program consisted on current measurements along the Croatian internal and territorial waters, during a year long period. The measurements started in November 2007 and finished in December 2008. They represent a novel contribution to Croatian physical oceanography, incorporating the greatest number of stations up to date, as well as providing the longest time-series available.

Materials and methods
During the first 6 months current measurements were performed at 20 current meter stations: S01 to S20 (Fig. 1), and in the next 6 months at other 20 current meter stations: S01 to S05, S08 to S14, S16, S18, S20 and S21 to S25 (not shown in Fig. 1). For the first time a large number of long current time-series (forty time series with six-months of measurements) was obtained simultaneously by using ADCP current meters with a sampling interval of 15 minutes and 2 m vertical resolution. Basic statistical analysis of current flow and spectral analysis of currents at all stations were applied. Monthly and seasonal oscillations of the current field were obtained through calculation of the monthly current vectors.

Results and discussion
The spectral analysis of currents showed that energy distribution, depending on the frequency, differed at all stations in both measurement periods. This leads to the conclusion that acting forces in individual sea areas occur with completely different intensities. In the current spectra, gradient currents most frequently have maximum energies, while wind and tidal oscillation energies are somewhat weaker. Some other phenomena and processes, such as fundamental Adriatic seiches and inertial oscillations [2], were also observed in the current spectra. The analysis of measurements shows a general NW circulation (Fig. 1) along the Croatian Adriatic coast – the well known Eastern Adriatic Current (EAC). The resulting circulation may be explained as a modification of the long-periodic gradient currents through the permanent influence of tidal oscillations and wind, while seiches and inertial oscillations are transient. The maximum current speeds were within a range of 55 to 80 cm/s in the surface layer, and from 20 to 30 cm/s in the bottom layer (depending on the station's depth). The absolute current speed maximum of 102 cm/s was measured at station S03 near Rt Kamenjak cape, which is very close to the extreme current speeds recorded in the Adriatic Sea. Mean monthly current speeds were mostly between 5 and 15 cm/s, and usually below 5 cm/s in the bottom layer. Very intense current oscillations were recorded at the seasonal and monthly period at all stations. Generally, that circulation is stronger in the autumn and winter (cold seasons) than during the spring and summer (warm seasons), but there are also exceptions to this general rule. The strongest circulation was observed in February (Fig. 1), and the weakest in August, which matches the present understanding of seasonal sea current oscillations along the eastern Adriatic coast [1]. In February 2008, the circulation matched with the already well-known NW circulation along this coast (Fig. 1). The dominant NW circulation was deformed in some sea areas by the direction of the shore or channel. The circulation was barotropic, which is typical for the winter season. The strongest surface circulation was recorded at S03 (Rt Kamenjak cape) and S11 (open sea in front of the Šibenik archipelago), where the mean monthly current vector was around 12.5 cm/s and the stability factor around 70%. Bottom circulation was significantly weaker, mostly under 5 cm/s. It is important to stress that the circulation at S01 and S02 was in an opposite direction, so that it may be assumed that there was a cyclonic eddy in the northernmost part of the Adriatic [3]. Generally speaking, the weakest circulation was recorded in August 2008, when the mean speeds of the surface monthly current vectors were under 5 cm/s, and those at the bottom were under 2 cm/s. The circulation was baroclinic due to the presence of the strong pycnocline. It appears that in August 2008 two eddies were present in the northern Adriatic: a cyclonic eddy north of the Po-Rovinj joining line and an anticyclonic eddy south of the same line, with the presence of the Istrian Coastal Countercurrent (ICCC) south-west of Rovinj [3].

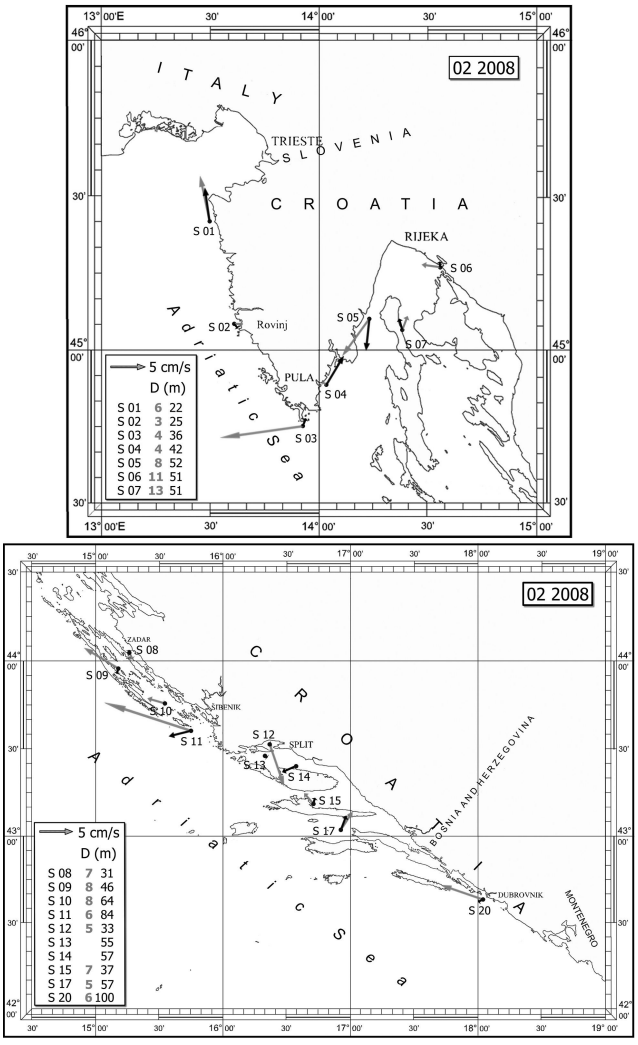

Fig. 1. Monthly mean currents for February 2008 for the subsurface (gray) and near-bottom (black) layer, in the northern Adriatic (top) and middle and south Adriatic (bottom).

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References
1 - Cushman-Roisin B., Gacic, M., Poulain, P.-M. and Artegiani, A. (eds), 2001. Physical Oceanography of the Adriatic Sea. Kluwer, Dordrecht, 304 p.
2 - Leder, N. and Orlic, M., 2004. Fundamental Adriatic seiche recorded by current meters. *Ann. Geophys.*, 22: 1449-1464.
3 - Supic, N., Orlic, M. and Degobbis, D., 2003. Istrian Coastal Countercurrent in the year 1997. *Nuovo Cimento*, C 26: 117-131.