

Design and Deployment of Low-Cost Drifting Buoys for Coastal Monitoring Applications

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Abstract – Several Low-Cost Drifting Buoys (LCDB) have been designed and constructed at ICMAN-CSIC to determine flow characteristics of The Guadalquivir River estuary and The Gulf of Cádiz continental shelf. Position and velocity of the drifters can be sent to a local server periodically. The battery module has been dimensioned to provide the experiment with duration longer than two weeks. Flow patterns registered by the LCDB successfully match Acoustic Doppler Current (ADC) data from some others moored ADC profilers.

Keywords – Low-cost drifters, GPS/GPRS tracker, hydrodynamic pattern, real-time coastal monitoring

INTRODUCTION

The coastal shelf of the Atlantic Andalusia is characterized by a high primary production, which occurs even over periods of the seasonal cycle when the rest of the basin undergoes a profound oligotrophy. The origin of such a considerable production and the mechanisms that favour its temporal stability are still unknown although physical forcing on both the local biogeochemical cycles and the input of nutrient and trace metals from the mouths of the rivers that drain into the Gulf of Cádiz, can be claimed as elements responsible for the ecosystem richness [1].

Therefore, it is important to find new and/or more affordable methods to characterize the dynamics of the water flows taking place in the Gulf of Cádiz. In particular, several low-cost drifting buoys (LCDB) have been designed, constructed, and, subsequently, deployed at various stretches of the Guadalquivir River Estuary and of the Gulf of Cádiz continental shelf.

By tracking the position of those drifters, it is possible to determine superficial flow patterns and turbulent dispersion taking place in those areas. For consistency, the velocity patterns registered by those drifters can be compared with other data source present at the estuary [2].

DESING AND CONSTRUCTION

The drifter covers have been constructed using 63-mm-tick Polyvinyl Chloride (PVC) PN-10 pipes. These covers are 50-centimetres-length, watertight, hollow cylinders containing two external battery packs and a low-cost GPS/GPRS personal tracker, as shown in figure 1. Surrounding the cover, there is a floating foam-ring that keeps one third of the drifter above the water surface. The bottom side of the cover has an anchor attached in order to minimize the influence of the wind in the movement of the drifter.

The battery packs consist of 18 AA-alkaline cells, supplying a nominal voltage of 13.5 volts and a capacity of 50 watts•hour. The two battery packs are connected in parallel and grant power autonomy longer than two weeks when position reports are sent every ten minutes. A DC/DC converter conditions this power supply avoid damages in the GPS/GPRS tracker.

The GPS/GPRS tracker is a low-cost commercial model with the following characteristics: GPS frequency 1,575.42MHz, Datum is WGS-84, Reacquisition < 0.1sec, TTFF Position Accuracy is 10 meters RMS without SA and Velocity Accuracy 0.1m/s without SA. This tracker can be configured to send automatic position-velocity reports periodically. In our deployments, this period has been initially set to 10 minutes and it has been changed on the fly via SMS depending on the evolution of the experiment.

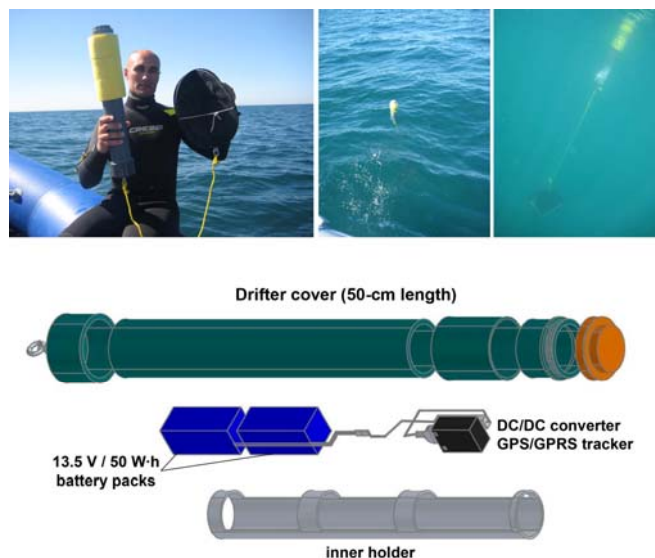


Fig. 1. Top: pictures of the LCDB deployment at the Gulf of Cádiz. Bottom: diagram and components of a LCDB.

The automatic reports sent by the tracker are GPRMC NMEA sentences, also known as “Recommend Minimum NMEA” sentences, and they are transmitted via GPRS to a local server. When there is not GPRS service, these reports are recorded in internal memory in order to be sent when the GPRS service is re-established. The GPRMC sentence consists of twelve comma-delimited words, including satellite derived time, date, latitude, longitude, speed and bearing.

LCDB DEPLOYMENTS

Buoy deployments began on April 19, 2009, in The Guadalquivir River estuary. The average duration of the buoy drifts in the estuary was more than six hours (tidal period). Buoys were deployed from a boat at various distances from the river mouth. Figure 2 shows the trajectory followed by one of the drifters deployed nearby La Puebla del Río, Sevilla, on that date.

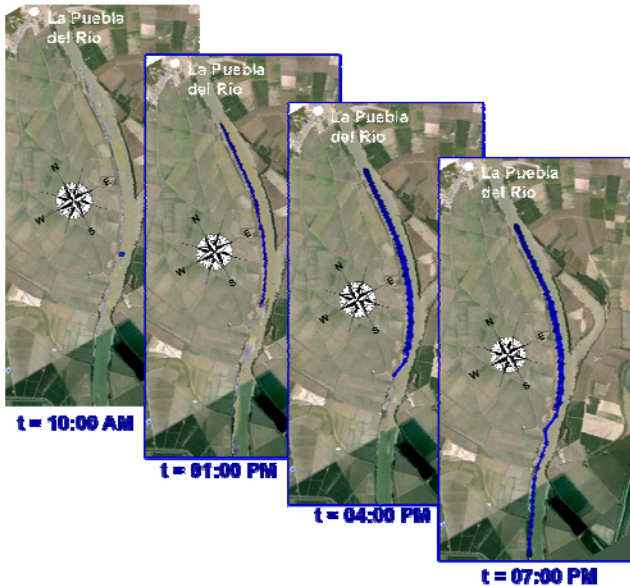


Fig. 2. Trajectory followed by one of the LCDBs deployed on April 19th, 2009, nearby La Puebla del Río, Sevilla.

A second deployment was carried out in the vicinity of the new lock of the Seville harbour on May 20th, 2009 (figure 3). The aim of this experiment was to determine the water current velocity at the entrance of the lock at nearly high tide. The experiment started at 12:55 UTC and it took 5 hours.

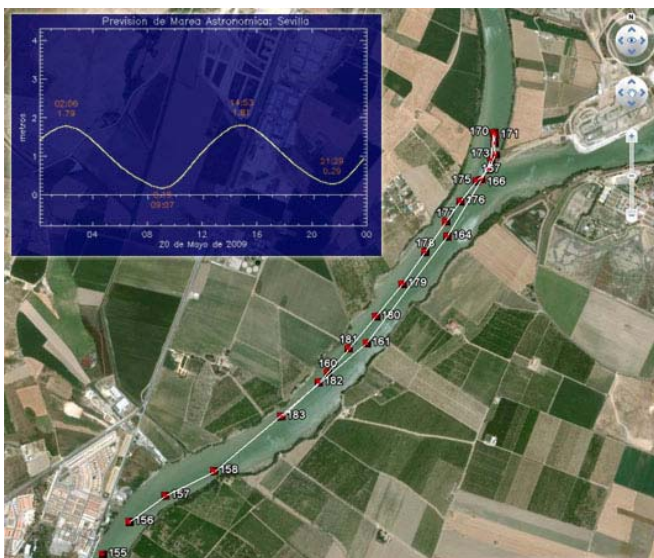


Fig. 3. Trajectory followed by one of the LCDBs drifters deployed on May 20th, 2009, nearby the new lock of Sevilla's harbour. The top left corner shows the prevision of astronomical tide for that date.

The most recent and longer deployment was performed in The Gulf of Cádiz continental shelf waters. The LCDB was released at Mazagón (Huelva) on July 2nd, 2009, and it was collected at Rota's waters on July 12th. It travelled more than 100 kilometres during those 10 days. In figure 4, it is shown the complex trajectory followed by the drifter; a clear evidence of the big amount of factors influencing the surface water dynamics in the area.

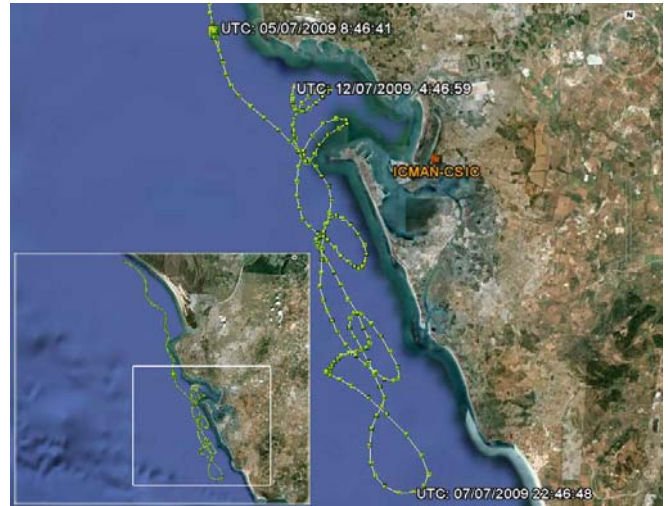


Fig. 3. Deployment of a LCDQ in Mazagón on July, 2nd, 2009. At the bottom left corner, the complete trajectory followed by the drifter. The main picture shows a detail between Rota and Cape Roche.

I.T. INFRASTRUCTURE

In order to register the LCDB position in real-time, the GPRMC NMEA sentences sent by the drifter are recorded by a Web server and stored in a database. A php application has been developed to communicate with the drifters, to reprogram some internal parameters of them, to add more devices to the experiment and visualize and export the data to some standard formats (ASCII, xls, mat, kmz) easing the graphical representation of the information.

REFERENCES

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