M4 BREEZE INFLUENCE ON WAVES AND VERTICAL CURRENT PROFILE IN THE COASTAL AREA BASED ON EOF ANALYSIS (VILANOVA I LA GELTRÚ, BARCELONA)

J. Antonijuana[95], G. Simarro[96], J. Guillén[13], M. Nogueras[90], A. Mànuel[74], A. Palanques[97], P. Puig[98]

Abstract
This article presents some preliminary results on the breeze influence on waves and vertical current profiles during eleven months of data recorded by an Acoustic Wave and Current Profiler installed in the OBSEA platform in the coast of Vilanova i la Geltrú (NW Mediterranean). The collected data has been analyzed using Empirical Orthogonal Functions and spectral analysis.

Keywords - Breezes, current profiles, EOF analysis

INTRODUCTION

Although regional scale winds were generally considered to dominate upwelling processes, the influence of local sea breezes has recently shown to be relevant in these phenomena [1]. The upwelling episodes, which bring the deep waters to the surface, and drive the surface waters offshore, are of major importance in biological processes [2], algae blooms [3], and morphodynamics [4]. In this work we evidence the dominant role of the sea breezes in the across shore velocity profiles near the shore off Vilanova i la Geltrú (NW Mediterranean) through Empirical Orthogonal Functions technique and spectral analysis.

THE MONITORING SYSTEM

The monitoring of wind speed and direction was carried out at 1 minute interval using a Davis Vantage Pro weather station placed on a land station near the coast. Waves and currents were recorded using the expandable Seafloor Observatory (OBSEA) from SARTI (Technological Development Centre for Remote Acquisition and Data processing System) operated by the UPC [5]. The OBSEA subsea station is located at a depth of 20 m, 4 km offshore of Vilanova i la Geltrú and is equipped with a Nortek acoustic Doppler current profiler (ADCP) AWAC 1MHz. The ADCP is mounted on a bottom tripod in an upward-looking configuration, and measures currents every 10 minutes, averaging 1 minute bursts at 1 Hz in water cells spaced 1 m. Waves (significant wave Hs and peak period Tp) are also measured hourly by the ADCP in bursts of 8.5 minutes at 2 Hz.

MEASUREMENTS

Time series of wind were acquired at the offshore meteorological station and, simultaneously, waves and currents were measured with ADCP from July 13th 2011 to June 24th 2012. Wave conditions during the study period showed the occurrence of storms of a moderate intensity. The time series has been split in three periods A (summer), B (winter) and C (spring).
The ADCP data was analyzed using Empirical Orthogonal Functions (EOFs) [6]. The observed current pattern at a given time is provided by the sum of the EOF modes (called Fi (z)), each being modulated by the value of the corresponding principal component (the amplitudes ai(t)) at that time. A common use of the EOFs is to reconstruct the data by truncating this sum, that is, by using only the first few terms which capture the dynamical behavior of the data. In this case, the first two modes allowed a good representation of the whole set of data.

RESULTS

The wind velocity, wave height and EOF amplitudes of the across and along velocity were subjected to spectral analysis. Wind velocities spectra displays a pronounced peak at the diurnal frequency (period of one day) that represents sea breeze activity. Wave height spectra showed a significant diurnal frequency in the A period but this peak is less clear in the C period (were the mean Hs was higher) and it just does not show up in B. Therefore, diurnal frequency of waves appears in spring and, mainly, summer periods when sea breeze activity appears to be the main stirring mechanism for waves. Moreover, the across velocity is also strongly affected by sea breeze activity because a pronounced peak at the diurnal frequency is found in their principal component a1 in all the periods. The EOF spatial modes show the current profile. The across velocity profile is dominated by the surface flows, which appears to be induced by breezes.

ACKNOWLEDGMENT

OBSEA has been installed within the framework of ESONET (European Seas Observatory NETwork; FP6-2005-Global-4, ESONET 036851-2), EMSO (European Multidisciplinary Seafloor Observation; Framework Program-FP7 Infraestructures-2007-1, Proposal 211816) and the project Sistemas Inalámbricos para la Extension de Observatories Submarinos (CTM2010-15459). ADCP and associate sensors used in this paper belong to the Coastal Ocean Observatory (http://coo.icm.csic.es/). Researchers from the CSIC and UPC are members of the Associated Unit UPC-CSIC Tecnoterra. Gonzalo Simarro is
supported by the Spanish government through the "Ramón y Cajal" program.

REFERENCES

[1] C.B. Woodson, D.I. Eerkes-Medrano, A. Flores-Morales, M.M. Foleyd, S.K. Henkel, M. Hessing-Lewis, D. Jacinto, L. Needles, M.T. Nishizaki, J. O'Leary, C.E. Ostrander, M. Pespeni, K.B. Schwager, J.A. Tyburczy, K.A. Weersing, A.R. Kirincich, J.A. Barth, M.A. McManus, L. Washburn, "Local diurnal upwelling driven by sea breezes in northern Monterey Bay," Continental Shelf Research, vol. 27, pp. 2289-2302, 2007.

[2] G.H.Rau, S. Ralston, J.R. Southon, F.P. Chavez, "Upwelling and the condition and diet of juvenile rockfish: a study using 14C, 13C, and 15N natural abundances," Limnology and Oceanograph, vol. 46, pp. 1565–1570, 2001.

[3] G. Basterretxea, E. Garcés, A. Jordi, M. Masó, J. Tintoré, "Breeze conditions as a favoring mechanism of Alexandrium taylori blooms at a Mediterranean beach", Estuarine, Coastal and Shelf Science, vol. 62, pp. 1–12, 2005.

[4] G. Masselink, C.B. Pattiaratchi, "Sea breeze climatology and nearshore processes along the Perth Metropolitan coastline, Western Australia," Coastal Engineering, vol. 26, pp. 3165-3177, 1998.

[5] A. Mànuel, M.Nogueras, J.del Río. "Features and capabilities of the OBSEA. Test bed for scientists and technicians: flexibility, connectivity and real time data delivery," Instrumentation Viewpoint, vol. 10, pp. 13-14, 2010.

[6] W. J. Emery, R.E. Thomson, "Data Analysis Methods in Physical Oceanography," Elsevier B.V., Netherlands. 2004.