Physics of the oceans
Waves
Gulf of Genoa

Physique des océans
Oscillations
Golfe de Gênes

A numerical verification of a shelf oscillation in the Gulf of Genoa

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ABSTRACT

A depth-integrated model of the Ligurian Sea has been used to investigate high frequency oscillations in the Gulf of Genoa. A random excitation along the open boundary of the basin has provided two significant waves with period of 0.42 and 0.45 hour respectively in the frequency band from 1 to 5 cph. This result agrees with a previous experimental analysis of sea level records at Genoa (Caloi, Spadea, 1961).

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RÉSUMÉ

Une vérification numérique
d'une oscillation côtière dans le Golfe de Gênes.

Dans ce travail, nous avons étudié des oscillations de courte période dans le Golfe de Gênes par une méthode H-N. Une excitation aléatoire le long de la limite ouverte de la Mer Ligurienne a révélé deux oscillations significatives ayant une période de 0,42 et 0,45 heure dans la bande de fréquence : 1-5 cph. Ce résultat est en accord avec l'étude expérimentale du niveau de la mer à Gênes, déjà effectuée (Caloi, Spadea, 1961).

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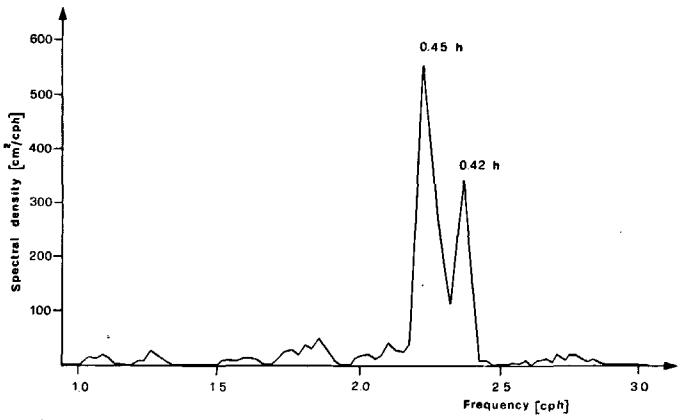
INTRODUCTION

In an earlier paper (Caloi, Spadea, 1961), it was pointed out that a visual inspection of sea level records at Genoa revealed a high frequency oscillation with a prevailing period of 0.42 hour. This oscillation was identified with a seiche of the Gulf of Genoa, assuming an oscillating shelf up to the depth of 100 m from Savona as far as Chiavari. It was also stated explicitly that this almost periodic wave was recorded "almost continuously" superimposed on the normal tidal signal, with an amplitude which occasionally reached 5-6 cm.

In the present note, we used an H-N model of the Ligurian Sea in an attempt to predict a shelf oscillation of about 0.42 hour in the Gulf of Genoa.

RESULTS OF THE NUMERICAL MODEL

The choice of a depth-integrated method was constrained by the desire to keep the mathematical model simple, while including Coriolis and frictional terms, so that it is physically realistic. Wind stress and pressure terms have been neglected in the equations since they do not contribute to the dynamics of this particular investigation. Along the open boundary from Nice to Calvi, the elevations were given as a random function of time in a range from -10 to $+10$ cm, according to the numerical technique of Radach (1971). We briefly recall that this numerical approach has been previously employed to compute the longitudinal free oscillations of the Ligurian Sea (Papa, 1977). At the northeastern entrance into the



Figure

Mean power spectrum of the computed sea level elevations in the continental shelf near Genoa.

Tyrrhenian Sea, we assumed an artificial solid boundary which is physically well justified. The model was run to simulate 200 hours of real time computation starting from an initial state of rest. In this preliminary investigation, we stored the sea level elevations in the coastal area near Genoa at intervals of 0.1 hour, in order to analyse the frequency band from 1 to 5 cph. In this connection, it must be remarked that only 1 800 elevation values were employed for spectral analyses, since the initial transient state of 20 hours was removed. Power spectra at eight grid sample points have been suitably averaged to obtain mean values which could be representative for the Gulf of Genoa. The final result of this analysis is shown in the Figure, where two well-defined peaks emerge from the background noise at the frequency of 2.22 cph (T=0.45 hour) and 2.36 cph (T=0.42 hour). Since the mean noise level in the spectra was of about 0.2 cm, we conclude that the amplitudes of the two waves (9 and 6 cm respectively) are highly significant, even if we take account of the error confidence limits. With 18 degrees of freedom the 80% confidence limits lie between 0.57 and 1.43 of each spectral estimate.

Looking at this result, we put forwards the hypothesis that the two high frequency waves provided by the numerical model in the continental shelf near Genoa could be actually identified with the non deterministic oscillation which was revealed by Caloi and Spadea in 1961.

Future work will be concerned with a detailed experimental description of this coastal seiche by means of an all solid-state data logger which records slow sea level oscillations in a frequency range from tsunamis to astronomic tides (Ottonello, Papa, 1980).

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