SURFACE SEICHES AND INTERNAL KELVIN WAVES OBSERVED OFF ZADAR (EAST ADRIATIC)

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Abstract

Surface seiches and internal Kelvin waves are documented by the data collected in the Zadar and Pasman Channels during summer 1994, and are reproduced using analytic and numeric models. Energy loss at the head of the basin is allowed by imposing radiation condition there, while nodal line is enforced at the basin mouth. Surface seiches are found to be excited by a strong meteorological disturbance which occurred in late summer 1994, whereas internal Kelvin waves could be related to a meteorological perturbation which preceded deployment of the instruments.

Key-words: Adriatic Sea, straits and channels, air-sea interactions, models

Introduction

Surface seiches of the Adriatic Sea have been widely examined since the beginning of this century (1). A major part of the work concentrated on standing waves of the whole Adriatic Sea (2), but coastal seiches also attracted some interest (3). Much less effort went into investigation of internal waves, both progressive and standing, which occur in the Adriatic coastal area. In one of the rare studies of such phenomena internal Kelvin waves have been experimentally detected in the Vir Sea (4). In this work both surface seiches and internal Kelvin waves will be explored on the basis of temperature, salinity, current and sea level data collected in the Zadar and Pasman Channels (Middle Adriatic) during summer 1994. Moreover, empirical findings will be interpreted using simple analytical and numerical models.

Results

Current and temperature time series have been collected between 28 June and 21 July and between 24 August and 18 September 1994 at seven stations (S-1 to S-7) and depths of 3 to 5 m from the sea surface and 4 to 5 m above the bottom. Vertical profiles of temperature and salinity were recorded on four occasions, while moorings were deployed and recovered, at 7 transects comprising 29 stations. Sea level were permanently registered at the Zadar tide-gauge station. The basin and experimental setting is illustrated in Fig. 1.

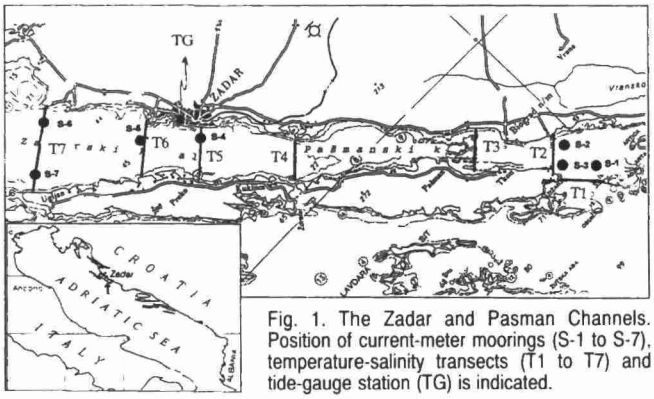

Fig. 1. The Zadar and Pasman Channels. Position of current-meter moorings (S-1 to S-7), temperature-salinity transects (T1 to T7) and tide-gauge station (TG) is indicated.

On 25 August 1994 a well-developed synoptic system coupled with mesoscale thunderstorms passed over the region causing strong surface seiches with sea level amplitude of about 20 cm and maximum current amplitude of cca 15 cm/s. All current-meter records northwest from the basin constriction, i.e. from transect T3 (7-9 m deep, 1.5 km wide) registered the seiches, which swiftly decayed after both the first and the second storm (*e.g.* data collected at station S-4, Fig. 2). The period determined by spectral analysis of measured currents and sea level series is about 2.1 hours. At the same time the records at stations S-1 to S-3 contained no oscillations of this period. So, the 2.1-seiche appeared in the channel area northwestward from the basin constriction. The seiche has been reproduced using simple one-dimensional rectangular basin model. Governing equations are shallow-water equations, with nodal line imposed at the basin mouth (x=0), and radiation condition applied at the head of the basin (x=L) in order to allow for the energy loss through the constriction area. Results of this model are plotted in Fig. 3. Furthermore, one-dimensional Defant-type model, which allows for the variable basin topography, has been applied on the Zadar and Pasman Channels. The theoretical results obtained for the amplitude of the first mode (Fig. 4) agree with empirical findings.

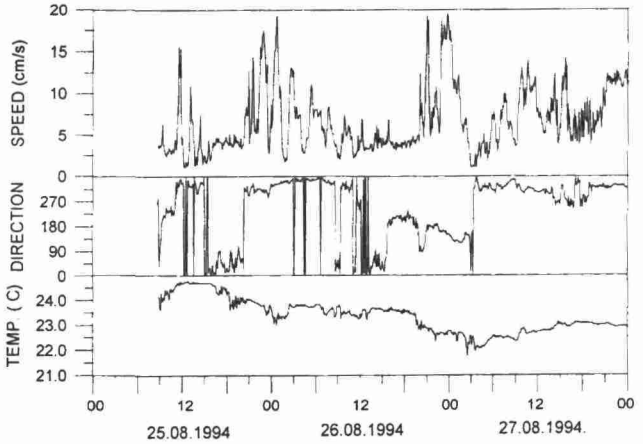

Fig. 2: Record of current speed and direction, and sea temperature at the surface layer of station S-4 during the disturbance 25-27 August 1994.

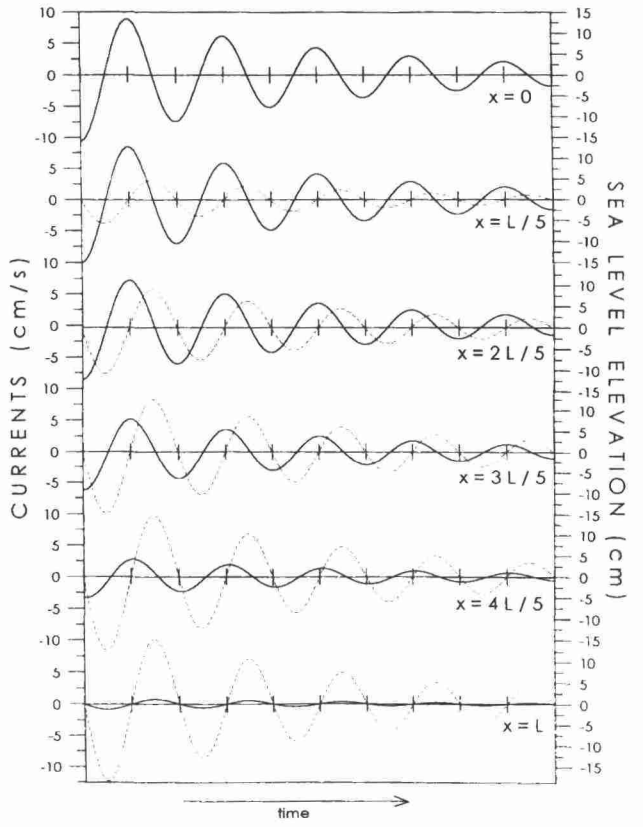

Fig. 3: Modelled sea level (thin) and current (thick) time series in the idealized rectangular basin. Here, one-dimensional barotropic model with radiation condition at the head (x=L) and imposed nodal line at the mouth (x=0) is used. Theoretical value of the period equals 2.1 hours.