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Observation of internal solitary waves generated in a strait

K. NITTIS*, A. LASCARATOS* and E. SALUSTI**

* University of Athens, Department of Applied Physics, Laboratory of Meteorology, 33 Ippocratous Street, 10680 Athens (Greece)
** INFN, Dipartimento di Fisica, Università "La Sapienza", Piazza A. Moro, 00185 Roma (Italia)

Packets of internal solitary waves observed in summer 1986 in the gulf of Korinthos ,Western Greece, are described in this note. Thermistor chain data (from 10 to 60 m at 5m intervals) were collected at a station 17 km east of the Rio-Antirio strait (western entrance of the gulf, sill depth 60 m) from 26 june to 29 july in 15 min. intervals. The strait is 5 km wide and has a sill depth of 60 m. Important tidal currents are known to be present in the strait. Upwellings have been reported to occur in the north-western coasts of the gulf extending to the Rio-Antirio strait [5]. The internal solitary wave signal was extracted from measurements by first applying a high pass filter to each of the original time series. The in-phase lowering and rising of the interfaces (a well known characteristic of solitary waves) [7] were visualized by multiplication of all individual high-pass time series.

A series of internal solitary waves were thus observed. They appeared at the end of distinct upwelling events and were found to occur every 12.45 hours at flood tide. It is evident from those remarks that their generation mechanism is related both to upwelling and tide. In fact, strong tidal flow and strong winds, which generate upwelling, form an important isopycnal depression behind the sill [2]. When both the wind stops and the tidal-flow reverses, the released energy disintegrates into internal waves. The tide-sill interaction has already been reported in litterature [1] as a solitary wave generation mechanism. In our case, it seems that this mechanism is not sufficient in itself. When the conditions following an upwelling event are also present, solitary waves are produced.

In figure 1 are shown the two strongest solitons observed. Their amplitudes were computed to be 15 and 10 meters respectively and were found to fullfill the shallow water KdV theory requirements [4], namely that : $\mathrm{sqrt}(a/H)=O(H/\lambda)$ where a,H,λ denote the amplitude, total depth and wavelength respectively. It can be seen that the second wave displays positive polarity (upward thermocline displacement), an unusual feature in

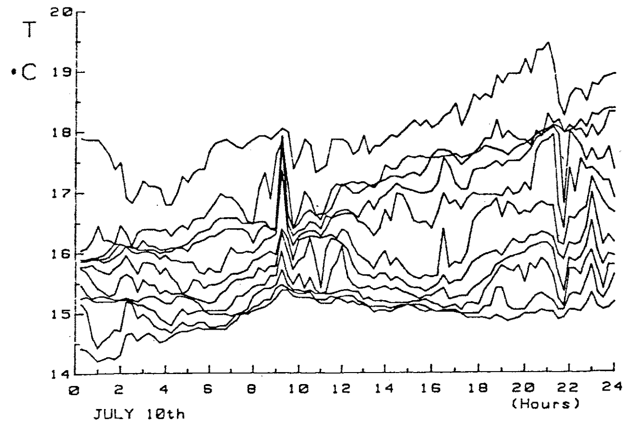

Figure 1

marine solitary waves. Such positive polarity waves are predicted by KdV theory [6] to occur in the case of thicker upper layer ($h1>h2$) and have been simulated in numerical experiments [3]. It is suggested that the change of polarity took place during the passage of the wave over a 40 meter deep neighbouring bank.

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O-I4

A model for the Alboran Sea internal solitary waves

Stefano PIERINI

Istituto di Oceanologia, Istituto Universitario Navale, Via Acton 38, 80133 Napoli (Italia)

The propagation into the Alboran Sea of the interface depression generated at the Strait of Gibraltar by the interaction of the semidiurnal tidal current with the main (Camarinal) sill is studied numerically by using a unidirectional model with two horizontal space dimensions (PIERINI, 1986).

An initial waveform within the strait -just east of the sill- has been determined whose evolution compares well with the train of internal solitary waves detected in the Alboran Sea via current measurements at different depths, as described by KINDER (1984).

The agreement is good in two points (where data are available) located at about 45 km East of the strait, the first aligned with the strait axis and the second 20 km to the North.

Moreover, the shape and amplitude of such initial condition is in agreement with a typical interface depression generated by the interaction of the tidal current with the sill.

A series of numerical experiments with different initial conditions is also performed and the reason why solitary waves may or may not be observed in the Western part of the Alboran Sea is thus clarified.

In general, the horizontal shape of the waves is similar to that exhibited in pictures taken by the Space Shuttle Challenger.

A discrepancy between the numerical and the observed shape, i.e. the higher curvature of the waves in a beam aligned with the strait axis, is to be accounted for the advection due to the Atlantic water inflow which is not modelled here.

The present study helps to understand the observed connection between the weakening of the Atlantic water jet (and corresponding weakening of the Alboran Sea gyre) and the appearance of energetic internal solitary waves.

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