Remote sensing of the generation and propagation of internal waves in the Strait of Gibraltar

Claude RICHEZ

Laboratoire d'Océanographie Dynamique et Climatologie, LODYC, Université de Paris 6, PARIS (**France**)

During the international GIBRALTAR EXPERIMENT, in 1985-1986 (KINDER and BRYDEN, 1987), we realized from an aircraft equipped with a Synthetic Aperture Radar, a survey of the strait of Gibraltar, during two semidiurnal tidal cycles (RICHEZ and KERGOMARD, 1990 and RICHEZ, 1992).

The SAR images clearly illustrate the generation and evolution of an internal structure, at the sill of Camarinal, during the westward phase of the tidal cycle. Its relation to a detailed topography of the sill is in agreement with the theoretical work of HIBIYA (1990). When the westward tidal current relaxes, this structure, moving east over the sill crest, transforms into an eastward propagating internal bore. At the same time, a lee-wave appears on the eastern side of the sill of Camarinal, as observed and explained by ARMI and FARMER (1988). It is obvious that the diurnal component of the tide plays a major role in determining the type of nonlinear wave train travelling along the strait and its speed of propagation. Two solitons with the same amplitude propagated at a mean speed of 2.1 to 2.6 m/s, during the first flight, while during the following tidal cycle, a train of dispersive nonlinear internal waves appeared in the Tarifa Narrows and the speed of propagation of the leading wave was about 1.9 m/s.

The ARMI and FARMER (1988) echosounder and mooring in situ observations helped the interpretation of the SAR images, and are quite in agreement with them.

Some images from the french satellite SPOT, taken at different tidal coefficients give an idea of the variability of the occurrence of this phenomenon in the strait of Gibraltar. At neaps, with weak tidal coefficient, we cannot detect any clear generation of internal structure at the sill of Camarinal. At springs, an other solitary wave event can be detected at the eastern end of the strait of Gibraltar, 2H:30 to 4H after the passage of the principal bore. We give a tentative explanation of this feature, already observed by ZIEGENBEIN (1969, 1970).

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