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A coupled generation-propagation model for internal tides, with an application to Gibraltar

Agostino LONGO, Maria MANZO and Stefano PIERINI

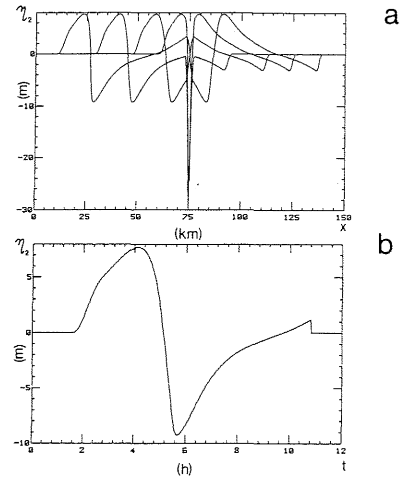
Istituto di Oceanologia, Istituto Universitario Navale, Via Acton, 38, 80133 Napoli (Italia)

The internal tides, i.e. those long internal waves generated by the interaction of a tidal current with variations in bottom topography, have been recognized in many oceanic sites, near the shelf edges and particularly in straits, were tidal currents are very strong and shallow sills are present. The propagation of such internal tides out of the straits where they are generated gives rise to dispersive internal waves and to strong one-sign current pulses accompanied by solitary isopycnal displacements. An example of this is given by the internal tides generated in the strait of Gibraltar, whose eastward propagation out of the strait leads to the solitary internal patterns observed in the Alboran sea (KINDER, 1984), that were recently described through a two dimensional, nonlinear dispersive model (PIERINI,1989).

In this propagation model the internal tide in the strait of Gibraltar was prescribed as a function of time on the basis of the knowledge of field data. A more general theoretical approach should imply the determination of the internal tide by means of a generation model, whose input is given by the mean flows and tidal currents. This problem was faced by the authors, and a one-dimensional nonlinear hydrostatic two-layer model with topography was thus developed (LONGO, MANZO and PIERINI, 1990a-b)) and applied to the region of interest.

In Fig. (a) an example of internal sèmidiurnal tide at times t=3,6,9,12 hours is shown for a maximum tidal current U=0.4 m/s in the absence of mean flows and for geometrical and hydrographic values representative of the strait of Gibraltar at the Camarinal sill (centered at x=75 km). During the first half tidal cycle an internal disturbance develops near the sill. When the tide slackens and then reverses the perturbation thus generated travels away from the underwater barrier giving rise to an internal tidal cycle. The domain of integration is much longer (150 km) than the real strait, but this is required to avoid the interaction of the waves with the ends of the domain. On the other hand, a time series taken near the obstacle (within the strait) does represent the correct response. Fig. (b) shows such a time series at 10 km from the center of the sill

The signal in the example of Fig. (b) is suitable as an input for the 2D propagation model by PIERINI (1989). Therefore this is an example of how a wave generation model can be used in conjunction with a wave propagation model. The oceanographic information needed to feed this coupled model now reduces to the knowledge of the mean and tidal flows in the strait.



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Fractal fronts in the Mediterranean Sea

S. MARULLO*, A. PROVENZALE**, R. SANTOLERI*** and V. ARTALE****

*Telespazio, Roma (Italia)
**Istituto di Cosmogeofisica del CNR, Torino (Italia)
***Istituto di Fisica dell'Atmosfera del CNR, Roma (Italia)
****ENEA-CRE Casaccia, Roma (Italia)

We study the fractal and statistical properties of surface temperature fronts in the Mediterranean Sea. Temperature isolines have been obtained by satellite measurements and refer to quite different climatological conditions. The principal result is that the temperature isolines display the properties of fractal curves with a fractal dimension of about 1.3. This result is consistent with other analyses of turbulent isolines and isosurfaces both in laboratory flows(1) and in geophysical flows (perimeter and surface area of clouds and rain fields(2) and perimeter of plancton patches in the sea). It is interesting to recall that drifter trajectories in large and meso-scale ocean flows display the properties of fractal curves, again with a dimension of about 1.3,(3,4,5) a fact that suggests the existence of a precise relationship between fluid parcel trajectories and temperature isolines. We briefly discuss some of the possible implications of these results and compare our findings with the results of numerical simulations.

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