TWO-DIMENSIONAL STRUCTURE OF THE TIDAL FLOW AT THE STRAIT OF GIBRALTAR

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Abstract
We present the analysis of current data obtained during an intensive vessel-mounted ADCP survey carried out on November 2003. The analysis include the assimilation of the data into a 2D tidal model, the interpretation of mean currents, semidiurnal and fortnightly variability, along with the estimation of the exchaged water transports and the interpretation of the hydraulic state of the exchage by mean of the Froude number of the flow.
Keywords : Strait Of Gibraltar, Currents, Tides, Water Transport.

The Strait of Gibraltar is the only connection between the Mediterranean Sea and the Atlantic Ocean .It is roughly a channel 50-70 km long with a minimum width of around 13 km (Tarifa Narrows) to the west of the minimum depth of 280 m at the main sill of the Strait (Camarinal Sill). An intensive vessel-mounted ADCP survey was carried out on November 2003 at Tarifa Narrows and Camarinal Sill (figure 1.a), to investigate the cross-strait structure of the flow. The survey was made during two one-day periods, at different stages of the spring-neap tidal cycle (figure 1.b).

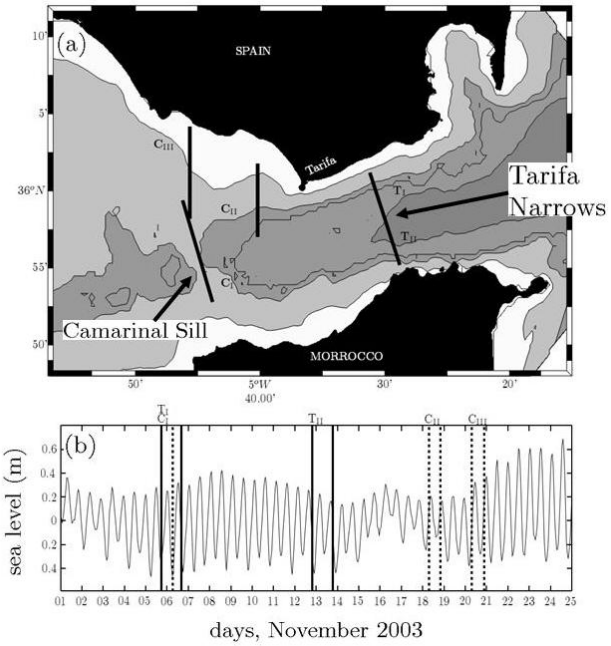

Fig. 1. (a) Bathymetry of the Strait of Gibraltar with the location of the sections occupied with the vmADCP shown as black lines. (b) Sea level at the nearby harbour of Ceuta (upper panel) with the time location of the across strait intensive surveys.

A 2-D tidal model has been used to assimilate the measurements to a synoptic dataset. This dataset allows for a description of the two-dimensional structure of mean and semidiurnal tidal currents of both the Atlantic inflow and Mediterranean outflow. As anexample, figure 2 shows the mayor axis output from the 2D tidal model. The observations are in good agreement with the known characteristics of tidal and fortnightly variability of the flow. It has been recently shown [1] that the fortnightly variability is the consequence of two contributions, the tidal rectification and the subinertial current fluctuations. These authors have found that the fortnightly variability of these two contributions is much larger at the Carmarinal than at the East part of the Strait (Algeciras-Ceuta section, which is not far from the Tarifa section). We have found that both contributions are significant in the upper layer in Camarinal section. The subinertial currents in Camarinal are stronger on the neap tidal period than on the spring one. On the other hand, a smaller fortnightly variability is found in the subinertial currents in Tarifa section. Some interesting patterns can be observed at the northern shore of Camarinal Section. The zonal mean velocity in the uppermost 75 m shows three cores, named as shelf, shelf-break and outer cores. The shelf-break and outer cores have negative meridional velocities, that is, they show a negative inclination of the mean currents. On the contrary, the shelf core has small meridional velocities, what implies a nearly zonal flow there. This type of topographic constriction of the mean currents have not been previously reported. The exchanged transports have been estimated using the model velocities. The upper and lower layer transports, and the net transport are defined as in [2]. However, a problem arises in the estimation of the interface depth, as simultaneous hydrological (salinity) data are not available. The instantaneous along-strait zero velocity surface is not adequate since one or both layer flow reverse with tidal periodicity, and a zero velocity interface does not always exist. The interface was estimated by using the zero velocity interface and defining its upper and lower bounds with the help of historical salinity data. Finally, Froude number estimations give subcritical conditions at Tarifa Narrows, pointing to the fact that during the survey the exchange was submaximal.

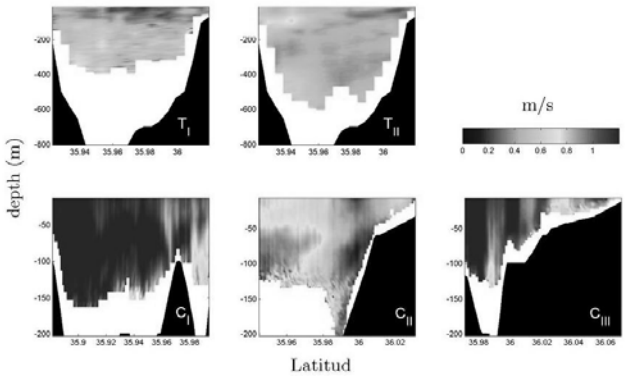

Fig. 2. Example of the output of the 2-D tidal model for the M_2 tidal currents: semimajor axis at the five sections, in m/s.

References

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