Tide induced vorticity shedding in the strait of Rio-Antirio (Greece), a numerical experiment

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Rio-Antirio a 2200m wide and 60m deep strait, lies in the northern side of Peloponnese (Greece), connecting Patraikos gulf with Corinthiakos gulf. The axis of the channel has a NE-SW orientation of about 60° and the line connecting the tips of the headlands show a departure from 90° from the axis of the channel. The bathymetry shows that the offshore coastal region, in both headland tips, drops quickly in the first 200m at a depth of 50m (fig 1a). The geometry of the area and the measured current velocities are favouring to produce alternating jet flow and separation phenomena behind the headlands. These kinds of flow patterns effect the long term transport rates of pollutants, nutrients and also the erosion and deposition mechanisms. Knowledge of the details of the flow field and of the mechanisms that participate in vorticity shedding and dissipation is increasingly interesting.

The strait presents interesting flow phenomena behind its headlands during the cycle of the M2 tide, which is the driving circulation forcing for this area. Plans for the construction of a bridge across the strait, in conjunction with the interesting vortices observed during field experiments, a two dimensional finite difference numerical model was examined, to study the flow field and also to provide technical parameters for the bridge design.

The two dimensional finite difference numerical model developed uses the depth integrated shallow water momentum and continuity equations. The model was verified from experimental data taken from current meters, tide gauges, drogues and air photos.

Numerical experiments performed for the different tide heights and a number of the approximately geometries. The results analysed lead to conclusions about the threshold for the flow to be separated and vortices to make their appearance in the flow field (fig 1b). The analysis of the calculated vorticity distribution patterns shows the life time of these vortices within a tide cycle as also the way the vorticity is advected by the background flow. These vorticity distribution maps reveal the interaction of the vortices generated in the first half of the tide cycle with those of the second one. The last thing that is examined with the aid of the model results is the bottom stress distribution and the regions with maximum shear are established.

These regions coincide with the region of active seabed erosion as mapped during a survey using a high resolution subbottom profiling system.

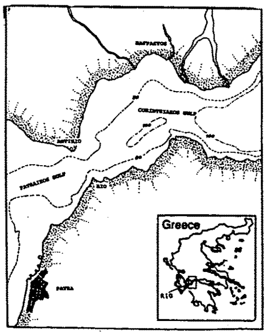

fig 1.a

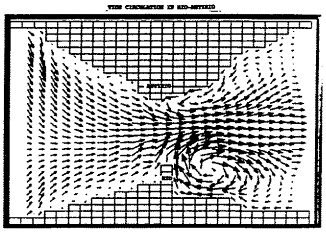

fig 1.b

The autumnal circulation pattern of the Cretan Sea and adjacent basins during the POEM experiment

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Despite a rather long history of the study of the Cretan Sea the autumnal circulation pattern was remained somewhat unclear up to now. Thanks to the POEM experiments CTD data were collected, between November and the first ten days of December 1986, from an intense grid of stations in the Cretan Sea and adjacent basins of the NW Levantine and S Ionian Basins.

The maps of the dynamic height topography and of the geostrophic flows (Figs. 1, 2) reveal that the general circulation pattern of the area under investigation consisting of different horizontal scale cyclonic and anticyclonic gyres interconnected by currents.

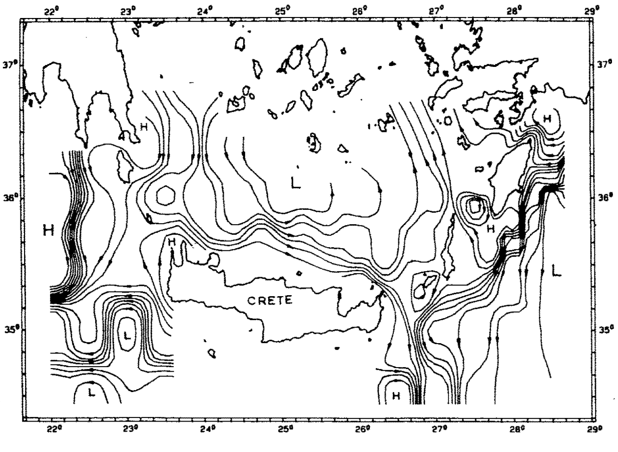

Fig. 1.- surface dynamic height topography of Cretan Sea and adjacent basins relative to 500 m, autumn 1986.

The main features of the circulation pattern in the Cretan Sea this transient season were: a) the large cyclonic flow region, which occupied the greatest part of the sea, b) the northward flow region in the eastern part, c) the two small scale anticyclonic flow regions in the area of the western Cretan Arc straits and d) the intense anticyclonic gyre within the area of the Karpathos Strait. In contradiction to the winter 1987 flow pattern (ZODIATIS, 1991b) this autumnal period the main current, which prevailed in the Cretan Sea, was meandering from the NW to the east and was of the same direction to that of summer 1987 (ZODIATIS, 1991a).

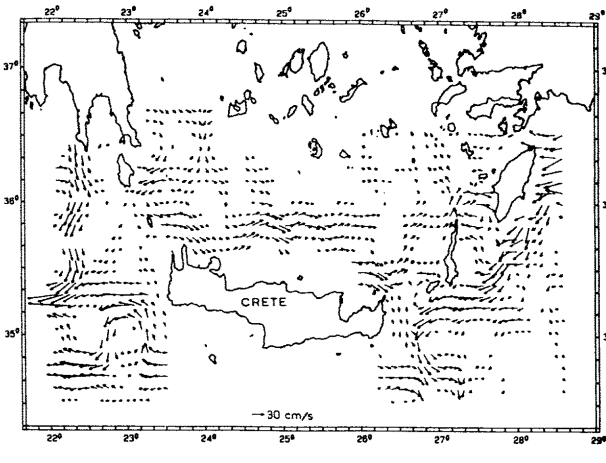

Fig. 2.- Surface geostrophic flow pattern of the Cretan Sea and adjacent basins, autumn 1986.

The circulation pattern of the adjacent basins was similar to that of winter-summer periods 1986, 1987 (ZODIATIS, 1992). It was determined by the activities of the Asia Minor current and of the large Rhodos cyclonic gyre in the NW Levantine Basin. In the south Ionian Sea the large anticyctonic gyre south from the Greece mainland and the cyclonic flow region SW of Crete island were dominated. However, the present seasonal variabilities of the location, deformation of the boundaries of the above gyres and of the currents influenced in a lesser degree the circulation of the Cretan Sea in comparison to other seasons.

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