BAROTROPIC ASPECTS OF THE TYRRHENIAN CIRCULATION

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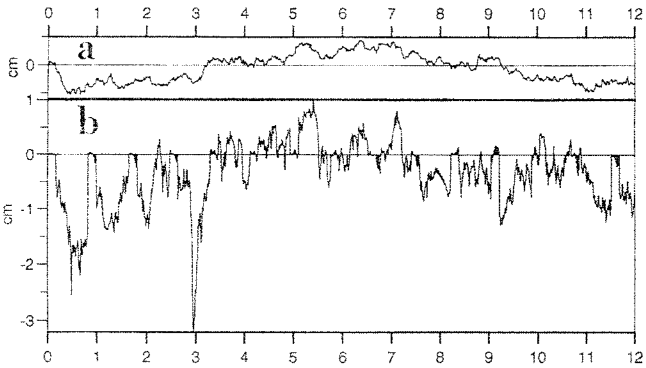
A shallow water model for a homogeneous incompressible fluid is implemented in domains representing the central Mediterranean and the Tyrrhenian sea in order to perform process oriented studies on the high frequency barotropic transport in the straits of Sicily and on the wind-driven circulation in the Tyrrhenian sea, respectively.

As far as the central Mediterranean is concerned, the system is excited (a) by a prescribed flow through the western and eastern "open" boundaries (the straits of Sardinia and the Ionian sea) thus simulating a remote pressure forcing, (b) by a wind stress curl -both forcings having a white temporal structure ranging from 0.5 to 20 days- and (c) by a wind set up that is then allowed to relax.

Several peaks are found in the power spectrum of the response within the strait, both of irrotational and rotational character. The irrotational motions give a substantial contribution to the total fluctuating transport in the strait. Rotational peaks at 2.2, 2.8, 3.5 and 6.1 days are found, no matter what forcing is used. They are travelling quasigeostrophic motions localized north of Tunisia and in the strait. We suggest that they aretopographic Rossby modes supported by the topographic variation north of Tunisia and Sicily and within the strait and constricted by theadjacent coasts. A simple calculation based on the formula for non-divergent Rossby modes in a closed basin gives theoretical eigenperiods for rectangular basins defined by the geographical limits just defined that are very close to those found in the spectroscopic analysis. It is to be noticed that the topographic beta effect is much larger than the planetary beta effect, the latter being virtually negligible.

The study of the wind-driven circulation in the Tyrrhenian sea is part of a research project in the framework of the EEC-MERMAIDS II program, aimed at analysing the barotropic response to the wind stress in Mediterranean subbasins. A "closed" Tyrrhenian sea with a spatial resolution of about 1/4 degree (25 km) is forced by the twice daily, 1 x 1 degree National Meteorological Center (Washington, DC) momentum flux data. The wind data are linearly interpolated spatially onto the regular model grid and temporally between two sampling times. In Fig. a, the time series of the sea surface displacement in the middle of the basin is presented for the perpetual year forcing computed by averaging the instantaneous winds over the 9 available years (from 1980 to 1988). One has a typical cyclonic circulation during winter and an anticyclonic regime with smaller regions of cyclonic circulation from April through August. These results are in substantial agreement with those of ROUSSENOV, STANEV, ARTALE and PINARDI (1993). They found that -in the framework of a GCM of the whole Mediterranean with realistic atmospheric parameters- the Tyrrhenian sea exhibits a seasonally "recurrent gyre" of this kind, which is considered as peculiar of the Mediterranean barotropic general circulation.



Moreover the present free surface model is able to describe the rapid barotropic adjustment to the fluctuating winds. As an example the time series relative to the 1981 year forcing is presented in Fig. b (same scale as in Fig. a). It is evident the large variance of the signal compared to that of the climatological year. Such an information on the high frequency variability can be relevant for passive tracer dispersion studies, for which a knowledge of the basic velocity field in the whole frequency domain can turn out to be fundamental to obtain correct lagrangian trajectories and, therefore, to achieve correct dispersion estimates.

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SINKING OF THE LEVANTINE INTERMEDIATE WATER IN THE TYRRHENIAN BASIN

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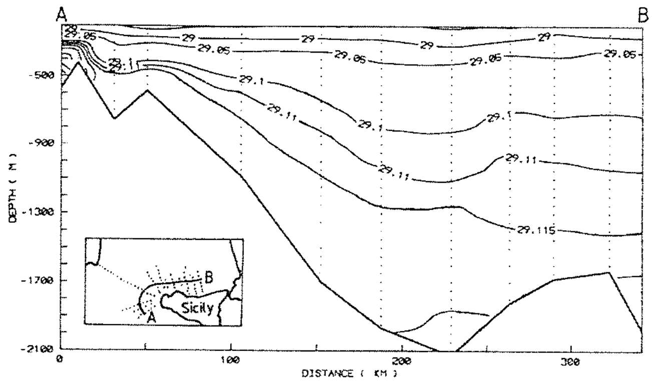
The Tyrrhenian Basin is a semi-enclosed basin whose most important opening is the Sardinia- Sicily cross-section. The Levantine Intermediate Water (LIW) inflows only through this passage, along the Sicilian coast (KRIVOSHEIA and OVCHINNIKOV, 1973).

Intensive hydrographic surveys and long term current measurements in the Southern Tyrrhenian basin permitted to evidence a direct connection between the LIW outflowing from the Strait of Sicily and the LIW water entering the Tyrrhenian Sea. The current is characterized by a well developed mean flow entering the Tyrrhenian basin year round, but with higher values during the cold season. While a part of it flows at the canonical depth for this type of water, a considerable volume was seen to sink from about 300 m at the sill strait to more than 1800 m of depth, where it follows the isobaths and can be clearly observed as far as the Eolian Isles. This vein was observed in different seasons and its characteristics can be considered largely stable year round.

In the Sicily channel, the LIW has a σ_θ of about 29.10 or more, while in the Tyrrhenian sea, at the same depth (300-400 m), σ_θ ranges between 29.00 and 29.05. Thus, the LIW originated in the Rastern Basin, is denser than the resident Western Mediterranean Water. Once in this basin, it settles down at a level (1800-1900 m of depth), that is determined by the relative densities of the waters. The progressive deepening of the LIW along the principal route from the Strait of Sicily to the Tyrrhenian Sea, can be observed in the isotherms, isohalines and isopycnes evolution. In particular, the isopycnes clearly tend to follow the bottom slope (Figure). This process appears to be similar to the Mediterranean Outflow from the Strait of Gibraltar, which was seen to cascade along the Atlantic continental shelf (PRICE *et al.*, 1993).

The estimation of the physical parameters influencing the sinking of the LIW vein, like the density difference between the inflow and the local density, the current intensity, the bottom slope and the bottom friction, permit to give indications on the vein dynamics and on its mixing with the resident water. In particular, an important part of the mixing between the Levantine Intermediate Water and the Tyrrhenian Deep Water seems to happen in this very limited area.



Vertical cross-section of σ_θ from (A) the Sicily Channel to (B) the Tyrrhenian Sea

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