ASPECTS OF THE SURFACE TYRRHENIAN SEA SUMMER CIRCULATION

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Abstract
A preliminary assessment of the Tyrrhenian Sea surface circulation of summer 2009 is given, based on the results of an operational ocean model, recently developed at ENEA. The numerical simulations reveal a complex circulation structure in the eastern part of the basin, that organizes around several well-defined quasi-permanent gyres. Comparison with altimeter data shows that these gyres are robust features of the summer circulation.
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Introduction
The Tyrrhenian Sea (TS), the main Italian sea, is a deep basin, with complex bathymetry, whose circulation is not yet fully understood. Although local wind forcing certainly plays an important role, the basin dynamics is also affected by the exchanges occurring at the three openings (Sardinia and Sicily Straits, Corsica Channel). In this work, we focus, in particular, on the role of the inflow of Atlantic water (AW) on the surface circulation of the basin. The main tool used is a high-resolution (1/48°, 40 sigma levels) operational model of the TS circulation, developed in the context of the PRIMI Project. This model takes initial and boundary data from MFS [1], and is forced by surface fluxes obtained from ECMWF data.

Results
Figure 1 shows the average 2009 summer surface (at 75 m depth) velocity field resulting from the analyses produced by the operational system, where some well-defined cyclonic and anticyclonic structures have been numbered from 1 to 6. Together with some established patterns, such as the Bonifacio cyclone-antyciclone system, the figure shows some interesting aspects of the circulation that have apparently not been stressed in previous descriptions. The first is the fact that the northward stream of AW entering the basin (known from previous numerical studies, e.g., [2]) bifurcates at about 41° N, with a branch recirculating southward around a very wide cyclonic region (6), and another one circling around the Bonifacio gyre and finally leaving the basin through the Corsica Strait. Contrary to previous descriptions (see, e.g., the classical works [3]), there is no northward AW flow along the Italian coast.

To the east of 6, there is a wide anticyclonic cell that occupies the whole eastern part of the TS, meandering around several well-defined eddies, the cyclone-anticyclone couples 1-2 and 4-5, and the anticyclonic area 3. These structures are present, with some variability, over the whole season. Although recent work suggests a complicated dynamics in the area, this is the first time that such a detailed structure of the circulation has been highlighted. We also note that the anticyclonic structure 1 may be related to the gyres recently described in [4].

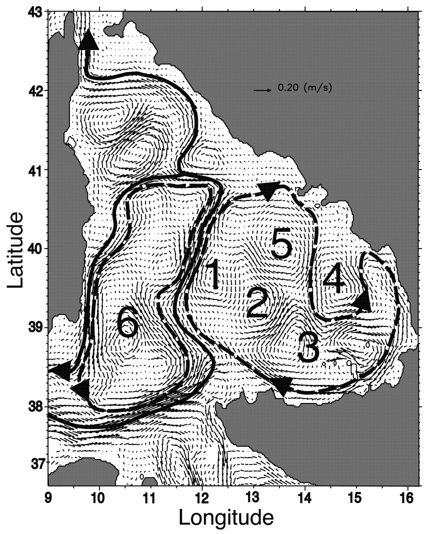

Fig. 1. Velocity field at 75 m produced by the operational model (2009 summer average)

The circulation in the eastern TS is probably mostly determined by the interaction between the local wind stress (that is typically anticyclonic in summer) and the complex topography. However, the fact that the western boundary of the anticyclonic cell is adjacent to the northward AW stream that flows through the central part of the basin suggests that this stream may also contribute to the eastern circulation, and to the associated vortical structures, through exchanges of momentum and vorticity.

It is natural to wonder whether the structures simulated by the model during 2009 are robust features of the summer circulation. To give a first answer to this question, we have analysed the SALTO-DUACS altimeter data provided by AVISO (http://www.aviso.oceanobs.com/duacs/), and we show in Figure 2 the summer average of the absolute dynamic topography over the whole period 1993-2008. The comparison seems excellent, since all the main structures appearing in the numerical results have their counterpart in the altimeter map, with close shapes and positions.

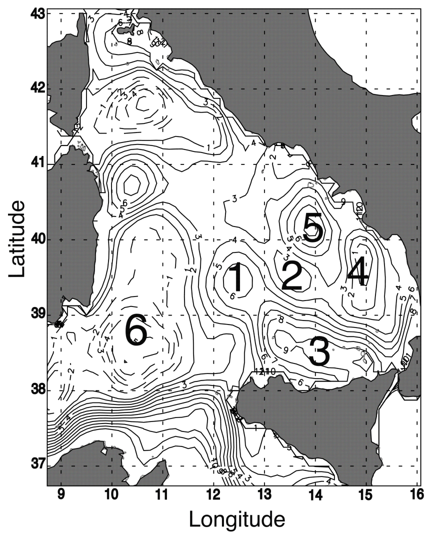

Fig. 2. Absolute dynamic topography by AVISO (1993-2008 summer average)

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