Formation and Circulation of the Intermediate and the Deep Waters of the Mediterranean Sea

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Formation and circulation of intermediate and deep waters in the Mediterranean Sea is a broad topic implying many complex dynamical and thermodynamical processes, most of them being unknown up to now.

During the last ten years, a major discovery regarding these problems, has been undoubtedly the recognition of ubiquitous mesoscale eddy features in all the basins of the Mediterranean Sea:

- cyclonic and anticyclonic eddies associated with the Algerian and the Ligurian currents (MILLOT, 1991)
- complex patterns of circulation in the eastern Mediterranean Sea (ROBINSON *et al.*, 1991)
- cyclonic eddies around the Alboran anticyclonic gyre (TINTORE *et al.*, 1991)

to name a few. This is not too peculiar to the Mediterranean Sea since similar features had also been discovered 20 years ago in other oceans like the Atlantic Ocean for instance.

Obviously these widespread and intense mesoscale eddy features in the Mediterranean Sea must be clearly understood in order to make progress regarding formation and circulation of water masses such as Levantine Intermediate Water and Western and Eastern Mediterranean Deep Waters.

Concerning the deep convection and formation of Western Mediterranean Deep Water, the importance of the mesoscale had already been recognized a long time ago during the Medoc experiments (GASCARD, 1978), (KILLWORTH, 1979). More recently attention has been focused on three aspects all related to deep and bottom water formation:

- θ/S variability in bottom water characteristics (LACOMBE *et al.*, 1985)
- Small scale phenomenom ($u = v = w = 10$ cm/s; $x = y = z = 1$ km) influenced by atmospheric forcing (SCHOTT and LEAMAN, 1991)
- large scale barotropic circulation strongly influenced by bottom topography (MADEC *et al.*, 1991).

These three aspects should now be integrated in order to progress in our complete understanding of deep and bottom water formation processes. As noticed by (LACOMBE *et al.*, 1985), the phenomenom of variable bottom water and the processes which produce it, may be relevant to our understanding of water formation.

Last but not least, significant progress has been made during the past ten years in strait dynamics mainly in the strait of Gibraltar (ARMI and FARMER, 1988), (FARMER and ARMI, 1988) but also in the strait of Sicily. The importance of these straits for the general circulation of water masses and their formation in the Western and Eastern Mediterranean Seas, is now better understood (BRYDEN and STOMMEL, 1984). The variability in transport through the strait of Sicily compared with the much more stable transport through the strait of Gibraltar is quite intriguing.

Most of these new discoveries are resulting from observations, but in some cases they are also confirmed by numerical modelling. In this presentation we will try to review these new aspects thoroughly. Based on past observations, high resolution 3D numerical models, and advanced technology, we will also indicate new perspectives in the monitoring of the Mediterranean sea that should allow us to envision the construction of an operationnal model by year 2000.

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