

Status of and the potential for the understanding of the western Mediterranean Sea

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This paper focuses on the circulation of the water masses because we now have relatively good data sets and seemingly efficient theoretical models, which allows us to expect a correct understanding of this basic phenomenon in the very near future.

The gross features of the circulation, at least in regions where it is relatively stable, and mainly for what concerns the surface layer of Modified Atlantic Water (MAW), have been established several decades ago from a quite-surprisingly very reduced number of hydrological casts. But, it is only since a few years that satellite data and long current time series have provided us with a significantly improved description of the mesoscale variability of the circulation and, to a lesser extent, of its seasonal variability.

We first review the most important results concerning the mesoscale variability, recently obtained in the Alboran Sea and in the Algerian and northern basins mainly. This variability manifests itself either as fluctuations of the major coastal currents, such as meanders, or as coherent structures resulting from instability processes affecting these currents, such as eddies. The space (some tens to a few hundreds of km) and time (a few weeks to several months) scales of these mesoscale phenomena, as well as their relatively intense signature in remotely-sensed and in situ measurements, allow an efficient description of their characteristics: it is obvious that the importance of these phenomena has been greatly underestimated for a long time. Now, even if they are easily measured and relatively well described, the understanding and modelling of the mesoscale phenomena are generally far from being satisfactory.

Interesting results have also been obtained concerning the seasonal variability, in the Straits of Gibraltar and Sicily and in the Corsican Channel as well. As the actual working of the whole sea -which basically transforms surface waters into deeper ones during the winter- is seasonal, one could expect a clear corresponding variability of the circulation. But this takes no account i) of the characteristics of the Strait of Gibraltar which constrains the exchanges with the ocean to be more or less maximal, ii) of the relatively large intensity of mesoscale phenomena and other subinertial variations of the flows and iii) of the fact that direct current measurements are neither numerous nor long enough to give an accurate estimation of the transports. Now, even if not easily estimated, the seasonal variability may be expected to be quite well understood with numerical models.

A better understanding of this seasonal variability is the primary objective of PRIMO, a several-year "International Research Programme in the Western Mediterranean" supported by IOC and ICSEM, in which most of the physical oceanographers interested in the western Mediterranean Sea are involved. Our strategy is to conceive an experiment aimed i) to specify more accurately the major characteristics of the seasonal variability of the circulation and ii) to check for all the mechanisms expected to be responsible for such a variability.

Another point to which it would certainly be fruitful to pay more attention concerns the mean paths described by the Levantine Intermediate Water (LIW) and by the western Mediterranean Deep Water (MDW). In fact, on the basis of hydrological and direct current measurements, it seems obvious that both water masses basically flow cyclonically along the continental slope in the whole sea. This is of primary importance, because such paths offer simple conditions to check for the validity of numerical models (for LIW) or because the forcing mechanisms are far from being obvious (for MDW); moreover, we suspect the circulation at depth to significantly influence, at least in some regions, the circulation of the surface layer.

Finally, we emphasize the relatively close similarities which exist with other semi-enclosed seas such as the eastern Mediterranean Sea and the Japan Sea, and we underline the various interests of companion studies.