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Atlantic Water in the Northeastern Ionian Sea

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INTRODUCTION

THE ATLANTIC WATER (AW) that flows into the Mediterranean Sea, through the Strait of Gibraltar, is recognized by its relatively low salinity. The spreading pattern of the AW in the Eastern Mediterranean is not unambiguously documented -see inter alia MALANOTTE-RIZZOLI, HECHT (1988); and also, ÖZSOY, HECHT and ÜNLÜATA (1989). In the Ionian sea, the AW has been known to occur intermittently (HOPKINS; 1978). When it exists, the AW stands out above the more saline waters of Levantine origin (WÜST; 1961). Occasionally, the AW itself is partly overtopped by the relatively warmer and more saline surface water (SW); and, in this case, its signature is a subsurface salinity minimum. The northward propagation of the AW in the Ionian Sea, especially under strong southerly winds, extends to the Strait of Otranto (HOPKINS; loc. cit) entering the Adriatic as a surface inflow, via the eastern side of the Otranto Strait, in winter (OVCHINNIKOV; 1966) . In this paper the main objectives will be to delineate the extent of the Atlantic water influence on the water masses and circulation in the northeastern Ionian Sea, and estimate its penetration in the Adriatic Sea, during late winter early spring 1986.

DATA AND METHODS

CTD data were collected by R.V. "AEGAION" at 22 stations in the northeastern Ionian Sea, during POEM-01-1986 Cruise (15-24 April 1986). The data were subjected to conventional methods of analysis.

RESULTS AND DISCUSSION

Distribution of characteristics at the surface

In the northern part of the study area, relatively heavy water is flanked by lighter water, which is consistent with a cyclonic movement. In the southern part, the closed isolines, separating relatively lighter water in the centre from heavier water at the periphery, stand out. This is indicative of anticyclonic motion, and induces a horizontal convergence at the surface and a divergence at depth, so that vertical motion (sinking) would occur in the centre.

Isopycnal Surface Analysis

The analysis rests on three isopycnals that have been chosen so that to cover spatially the entire range of AW presence within the study area.

Topographies

On the uppermost surface, the small differences in depth do not give much indication of the direction of the flow. However, on the deeper surfaces, over the northern part of the study area, there is a mild downward slope in a manner which indicates, assuming geostrophy, a weak cyclonic flow relative to the deeper water. The same topographies provide also, under the aforementioned assumptions, an anticyclonic flow in the southern part of the study area.

Salinity distribution

At the southernmost part of the study area interpenetrating tongues occur, which might indicate an anticyclonic circulation in this part of the study area, in agreement with the dynamic inferences from the configurations of the topographies of the same isopycnal surfaces, and also from the distribution of the properties at the sea-surface.

Water Mass Analysis

The spreading pattern depicted by all the charts, (showing the percentage concentrations of the main water masses on each of the isopycnal surfaces considered), corresponds closely to that inferred from the analysis of the salinity distribution on the same isopycnal surfaces, and demonstrates the extent of the influence of the AW in the northeastern Ionian Sea.

It is evident that the major influence of the AW is mainly restricted within the area of the inferred cyclonic flow, whilst its influence is being diminished southwards, being practically absent from the area of the deduced anticyclone.

Geostrophic Fluxes

The geostrophic circulation pattern indicates the presence of a cyclonic flow over the northern part of the study area,(with which the largest transport of AW is associated); whilst in the southern part of the study area, the circulation connected with the area of maximum steric height yields an anticyclonic flow, (transporting negligible amounts of AW).

CONCLUSIONS

CTD data, collected in the northeastern Ionian Sea during late winter/early spring 1986, are used to identify the extent of Atlantic water (AW) influence on the water masses and local circulation. It is shown that a major portion of the AW stream is fed by the cyclonic circulation, which occurs north of 37°30'N, into the Adriatic Sea; whilst only a negligible fraction thereof participates in the large-scale anticyclone which dominates the area south of 37°30'N.

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Diagnostic/Metagnostic Modelling of the Western Mediterranean's General Circulation with a 3D primitive equations k-ε Model

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ABSTRACT

An essential characteristic of a mathematical model is its *accuracy*, i.e. its ability to reproduce reality in the framework of the model's objectives. In this regard, one must make a distinction between *diagnostic models* which emphasize accuracy in state space and *metagnostic models* which emphasize accuracy in physical space.

A diagnostic model is generally devised to investigate, in details, particular mechanisms, scrutinize the behaviour of the specific state variables and elucidate fundamental questions. Very refined in its representation of, sometimes, rather subtle processes, it may be content with very crude approximations of the physical world (constant depths, rectilinear coasts, infinite ocean, steady two-dimensional fronts, rigid sea surface ...).

A metagnostic model, on the contrary, is in general called upon to tackle a practical situation and may not ignore the real field conditions (depths, coastlines, actual atmospheric forcing ...). Its aims however is to assess the consequences of particular events and provide the marine nowcasts and forecasts which will assist interdisciplinary field studies, planning and management. The model must be sound, expeditious and efficient but is not required to provide detailed information on the delicate machinery subtending its parameterization schemes.

From a purely scientific point of view, of course, the distinction is meaningless. Processes must be studied thoroughly using models of increasing sophistication and realism, converging to a truly *prognostic model*.

However the convergence is generally slow (It appears to have been particularly stagnant, in fact, in the case of the Western Mediterranean's General Circulation).

Modellers participating in huge interdisciplinary research programs may not be satisifed, in answering the biogeochemists' questions, with current, temperature, salinity ... fields calculated in a hypothetical square box rigid lid ocean. The answers must be realistic and require the operation, on a routine basis, of a system-oriented (as opposed to process-oriented) metagnostic model.

In illustration, the GHER metagnostic model developed and run for the study of the Western Mediterranean's General Circulation in the scope of the EEC EROS 2000 Project is briefly described with emphasis on the parameterization of sub-grid scale processes.

It is shown that the model reproduces well the main trends of the general circulation and evidences essential synoptic processes such as deep water formation, coastal upwellings, gyres ... .

The model, tuned in to diagnostic modelling, is then applied to process studies, jointly and severally with the LODYC diagnostic model in the scope of the EEC Euromodel Project.

It is shown how parallel diagnostic and metagnostic simulations can improve, continuously, both types of models ; diagnostic studies providing useful information to improve the mathematical representation of dominant processes, metagnostic nowcasts and forecasts supplying realistic boundary conditions by which one can progressively free oneself of the rigid wall box-ocean limitations.

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