Dynamical T-S analysis of Mediterranean Sea water masses

Emil V. STANEV* and Jean-Marie BECKERS**

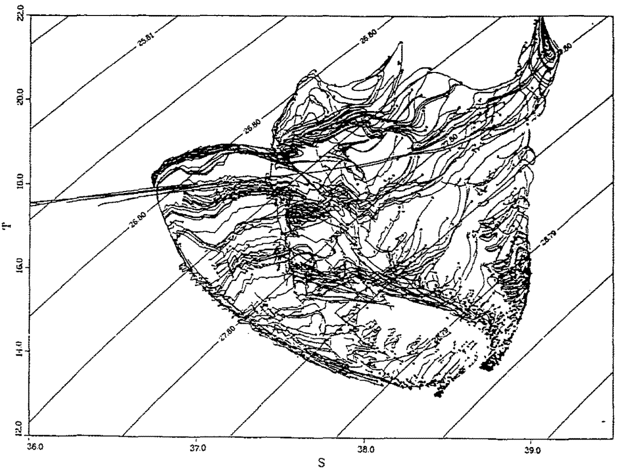
*Department of Meteorology and Geophysics, University of Sofia (Bulgaria)
**National Fund of Scientific Research, GHER University of Liège (Belgium)

T-S analysis was widely applied to study the water masses in the Mediterranean Sea. In the pioneering work of Wüst (1960), the efficiency of the core method to investigate intermediate and deep circulation was manifested. However, classical T-S analysis does not incorporate any local or remote physical information concerning the displacements of the particles in T-S space. This can be easily understood, since no such information existed in that time when the T-S analysis was developed. At present, numerical models provide us with a valuable information which can be used to increase substantially the understanding that can be obtained from the T-S analysis.

In the analysis proposed in the present paper the hydrological data are used to initialise a numerical model which we use as a tool to define the velocity field. Further, the displacement of Lagrangian particles in the T-S space is analysed in order to find some general properties of the water masses formation and mixing along trajectories.

Based on Levitus' (1982) data set, a combination of robust diagnostic and fully prognostic techniques is used to evaluate for the Mediterranean Sea a climatology consistent with the physics of the Princeton OGCM. Model experiments are carried out with 28 levels and with a horizontal resolution of $\Delta\lambda = 1/3$, $\Delta\phi = 1/4$. The model is forced mechanically by wind stress taken from Hellerman and Rosenstein's (1983) data. Sea surface temperature and salinity are prescribed from Levitus' (1982) data. Exchange flows in the Strait of Gibraltar are explicitly prescribed with 1.5 10^6 m^3s^{-1} each. At the most, model adjusted salinities and temperatures depart from Levitus' initial data by 0.02 and 0.05°C in deep layers and by 0.1 and 1°C in the pycnocline. The simulated circulation is generally cyclonic. Velocity profiles reveal a subsurface jet at about 50m advecting Atlantic water eastwards. With increasing depth a reversal of zonal flow is simulated with a core at about 300m advecting Levantine Intermediate Water westwards. The model simulated T-S indices for the entire Medirranean Sea does not deviate substantially from the initial ones. For about 5% of the grid points Lagrangian displacement $\vec{x}$ is calculated from $\dot{\vec{x}} = \vec{v}(\vec{x})$, see the figure, where velocity $\vec{v}$ is taken from the model data. The trajectories illustrate the preferable mixing patterns. Their analysis can be used to define the general processes of water masses formation and transformation what is the topic of this paper.

TRAJECTORIES IN T-S SPACE



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