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SOME ACOUSTIC FEATURES OF THE LEVANTINE SEA

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ABSTRACT

Hydrographic data collected in winter and summer are used to study the horizontal distributions of the mean vertical sound speed, the sound speed along the sound channel axis and the depth of that axis. Similar features are observed in winter and summer. The shallower channel axis and the lower sound speed are found in the north area, where cyclonic eddies are acting, while deeper channel and higher sound speeds are found in the south and near continental shelf. Due to pressure effect on sound speed at deep stations, the mean vertical sound speed in the deep areas are higher than that near the continental shelf. Generally sound speed is higher in summer in the Levantine Sea.

INTRODUCTION

The Levantine Sea, which is the eastern part of the Eastern Mediterranean Sea, is one of areas whose dynamics and hydrography have received much attention in the last two years since 1984. However the acoustic properties of this sea have important applications; in marine surveys, in fisheries as well as in detection of submerged bodies in the sea.

In this paper two questions will be discussed:
1- What are the horizontal distributions of the Mean Vertical Sound Speed (MVSS)?
2- What are the characteristics of the sound channel axis in the area of the study?

Since the area under investigation has different hydrographic conditions in winter and in summer, the seasonal variations of these acoustic properties well be dealt with.

DATA AND METHODS OF ANALYSIS

The main source of data in this work is the International Hydrographic Data Center. Hydrographic data in winter; represented by February, and in summer; represented by August, are used for the calculation of the

sound speed in the sea water. The deep stations, which have stable vertical water columns, are considered for the determination of the depths and the speeds along the sound channel axis, while only the hydrographic stations measured up the near bottom are used to estimate the MVSS.

The sound speed has been calculated using the empirical formula recommended by Fofonoff and Millard (1983).

The MVSS, (Maul and Bishop, 1970) can be expressed by:

$$MVSS = Z/T \qquad (1)$$

where Z is the total depth and T is the travelling time of the sound beam from surface to bottom.

Because of the stratification of the water column, the column was divided into series of layers with thickness z_i, associated with speeds v_i. The time interval t_i for a sound beam to pass vertically through a given layer (i) is:

$$t_i = z_i/v_i \qquad (2)$$

and:

$$T = \Sigma\, t_i \qquad (3)$$

From 1,2 and 3 we get:

$$MVSS = \Sigma\, z_i/\Sigma\, z_i/v_i \qquad (4)$$

RESULTS

A- The MVSS in the Levantine Sea

In winter, the MVSS in the Levantine Sea varies between 1515.7 and 1533.6 m/sec. These values are higher than those in other parts of the world ocean, due to higher temperature and salinity values in the Mediterranean deep waters. In this season, the upper layer becomes strongly mixed and, therefore, the pressure influence on the vertical sound speed distribution is expected to be significant. The lower MVSS is found near the continental boundries, while the maximum values are found in the central part of the sea, where the speed reaches 1533.6m/sec. (Fig.1a).

In summer, (Fig. 1b) the MVSS is higher than that in winter, it varies between 1519.2 and 1544.5 m/sec. This can be explained by the higher temperature of the upper layer in summer. The horizontal distribution shows that the MVSS decreases towards the continental shelf and that the highest values (>1530 m/sec) are found in west and north-west parts of the Levantine Sea, which is also an area of maximum values in winter.

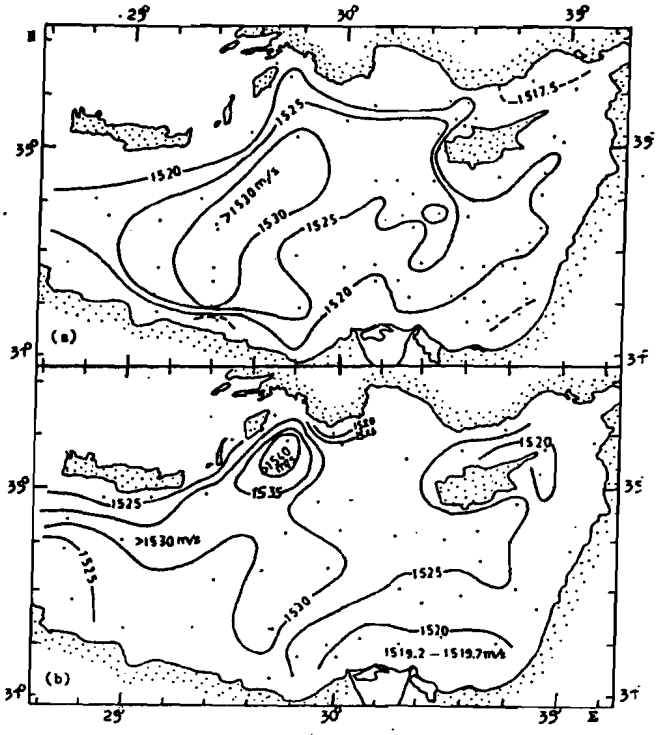

Fig. 1. The horizontal distribution of the M V S S in the Levantine sea in winter (February, a) and summer (Autumn, b). Location of hydrographic station.

Therefore, inspite of the different ranges of MVSS in winter and summer, the two seasons show the same general features for the horizontal distributions.

B- The Characteristics of the Sound Channel Axis

Two main characteristics of the sound channel are considered the sound speed at the channel axis (i.e. the minimum value along the vertical and the depth of that axis).

In winter, the sound speed along the axis of the sound channel in the Levantine sea varies between 1511.8 and 1522.0 m/sec.(Fig.2a).The highest values are found in the south and the east of the sea while the lower values are found south of Crete and Cretean sea straits. In the same season, the axis is found at depper levels(400-500m) in the south and the east of the basin, (Fig.2b), while this axis comes to the upper surface layer in the north-west of the sea, where winter active mixing processes are creating homogenous cooler vertical water column. This evidence is associated with lower sound speed along the sound channel axis.

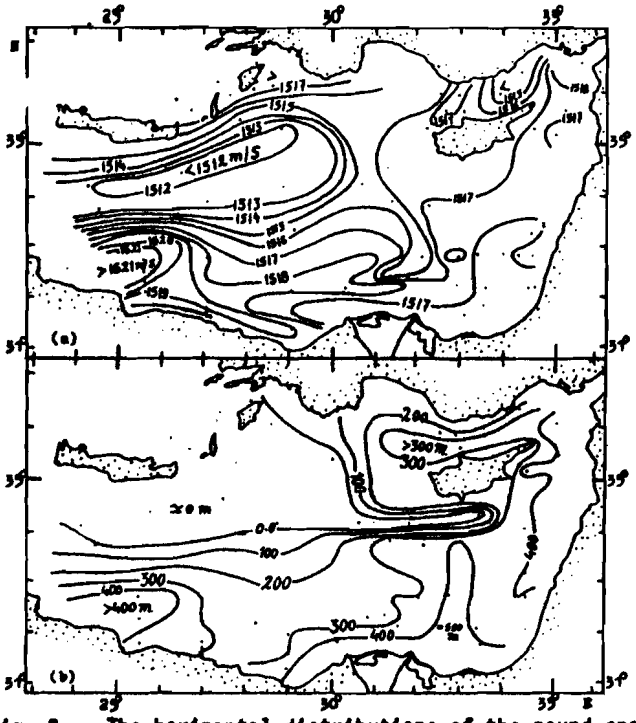

Fig. 2. The horizontal distributions of the sound speed along the sound channel axis (a), and the topography of this axis (b), in the Levantine sea, in winter (February). Depths from the sea surface.

In summer, the sound speed along the axis of sound channel lies between 1513 and 1520 m/sec, which is higher than that in winter, (Fig.3a). The areas of minimum sound speed are, again, in the north and the west parts of the Levantine sea, while approaching the continental shelf, the speed increases. In the north of the Egyptian coasts, the speeds along the axis are nearly 1510-1515 m/sec as in winter, the areas of high sound speed coincide with the areas of deeper sound channel axis. In the central and the eastern parts of the sea, the axis depth is 400-500 m, (Fig.3b). In the northern and the western parts of the sea, the axis is shallow (150 - 300 m).

DISCUSSION

The horizontal variations of the MVSS, the sound speed at the sound channel axis and the immersions of that axis in the Levantine sea in winter and summer show a common features where the depper axis depth are found in the south of the basin, associated with higher sound speed, and the shallower axis is found in the north, with lower sound speed. This feature

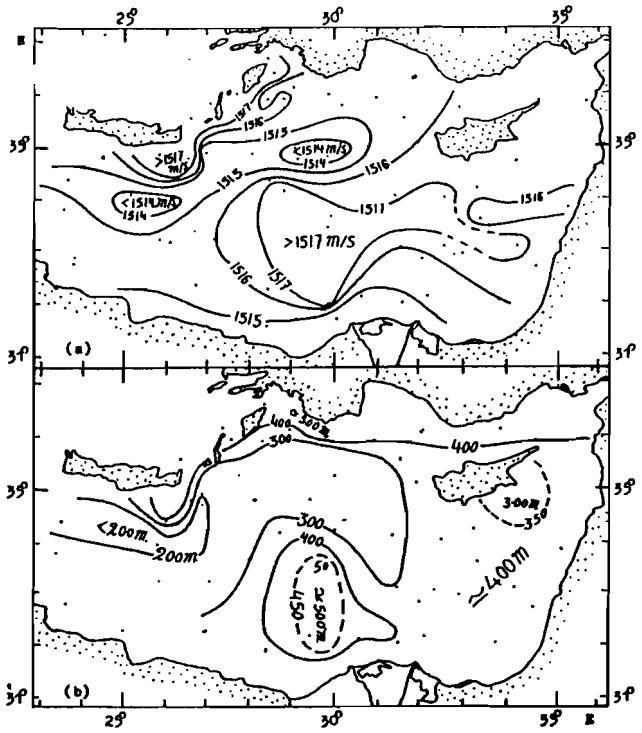

Fig. 3. The horizontal distributions of the sound speed along the sound channel axis (a), and the topography of this axis (b). in the Levantine sea, in summer (August). Depths from the sea surface.

could be related to the known hydrography and dynamics of the area, with cyclonic eddy in the north and an anticyclonic gyre in the south. However, the MVSS has an opposit trend; the higher values are found in the north while the lower values are in the south, and near the continental shelf. This evidence could be interpretted by important action of pressure on sound speed at the deep stations off the continental shelf.

Since the northern part of the Levantine sea has lower sound speeds than the southern ones, this part could be an area of convergence of sound beams.

CONCLUSIONS

The variability of the acoustic properties of the Levantine sea shows coherent results in both winter and summer. These results are correlated with the dyanmic features and could be usefull in marine applications.

REFERENCES

Fofonoff N.P. and R.C. Millard Jr., 1983. "Algorithms for computation of fundamental properties of sea water" **UNESCO Technical Papers in Marine Science (44).**

Maul A. and C., Bishop, 1970. "Bref exposi sur la vitesse moyenne du son pour les sondages." **Revue Hydrographique Internationale**, Vol. XLVII, 2: 89-96.