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INTRA-ANNUAL VARIABILITY OF ACOUSTIC CHARACTERISTICS OF THE COASTAL WATERS OFF COCHIN

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ABSTRACT

Intra-annual variability of acoustic propagation characteristics of the coastal waters off Cochin is reported. The sharp negative sound velocity gradients in the surface layers upto 20 m depth and the almost negligible gradients in the deeper layers during monsoon and post-monsoon seasons suggest very small horizontal detection ranges in the surface layers and long ranges below 20 m using an acoustic beam. The positive and slightly negative sound velocity gradients found during winter and summer respectively indicate the possibility of comparatively longer ranges of detection during these seasons, the former season being more favourable.

Key-words: Acoustic propagation, coastal waters off Cochin.

Successful applications of underwater acoustic techniques for fish finding, telemetry etc. require knowledge of the acoustic propagation characteristics and their spatial and temporal variations in the region under consideration. These variations depend on the distribution of temperature and salinity. Analysis of sound velocity data of the coastal waters off the southwest coast of India approximately along 10°N lat. has been carried out to study the intra-annual variability of acoustic propagation characteristics in this region.

Temperature and salinity data collected at different depths on board RV *Kalava* (CMFRI, 1962) in the coastal waters off Cochin were used in the present study. Contours of computed values of sound velocity (Bialek, 1966) and temperature have been drawn on the same figure. The studies have been limited to a maximum depth of about 50 m in the coastal waters.

Vertical sound velocity distribution: The vertical sound velocity profiles representing different seasons are presented in Figs.1 to 4. Fig.1A & B show the vertical profiles of sound velocity and temperature under the monsoon (late August) and post-monsoon (early October) conditions respectively. Both figures show low values of sound velocity in the surface layers, associated with the low temperature resulting from coastal upwelling during these seasons (Rama Sastry and Myrland, 1960). The upwelling also causes the isovels to slope, upwards towards the coast. Compared to the post-monsoon season, both sound velocity and temperature are found to be low during monsoon season because of intense upwelling during this period.

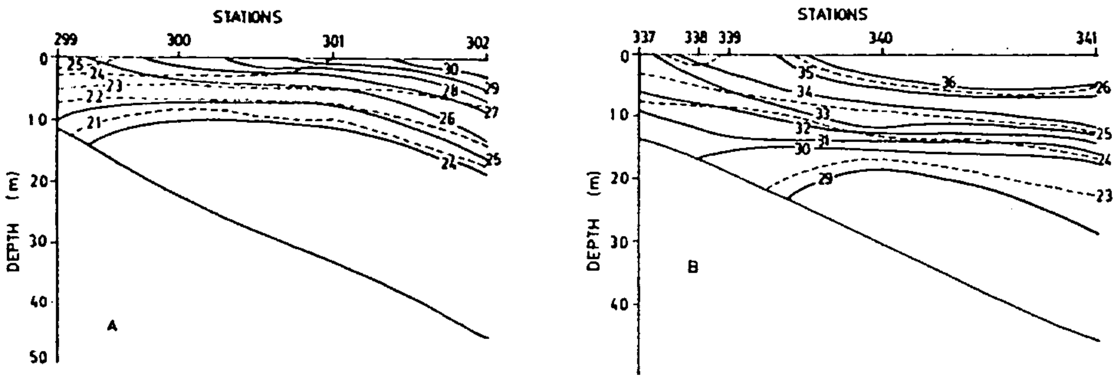

Fig.1. Vertical profiles of sound velocity (full line labelled with values in m/sec deleting the first two digits i.e. '15') and temperature (dotted line labelled with values in °C) during monsoon (A) and post-monsoon (B).

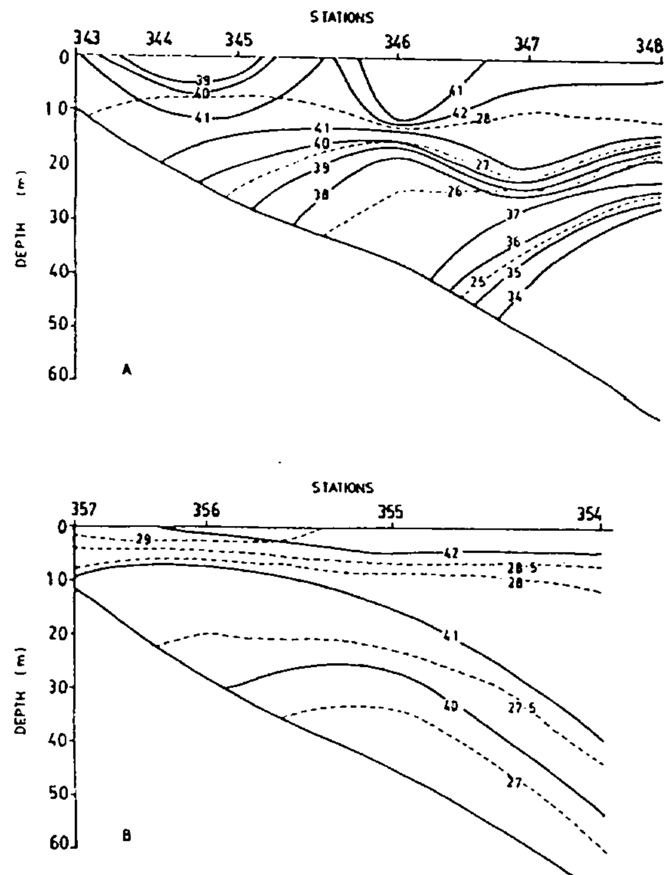

Fig.2. Vertical profiles of sound velocity (full line) and temperature (dotted line) during late post-monsoon (A) and northeast monsoon (B).

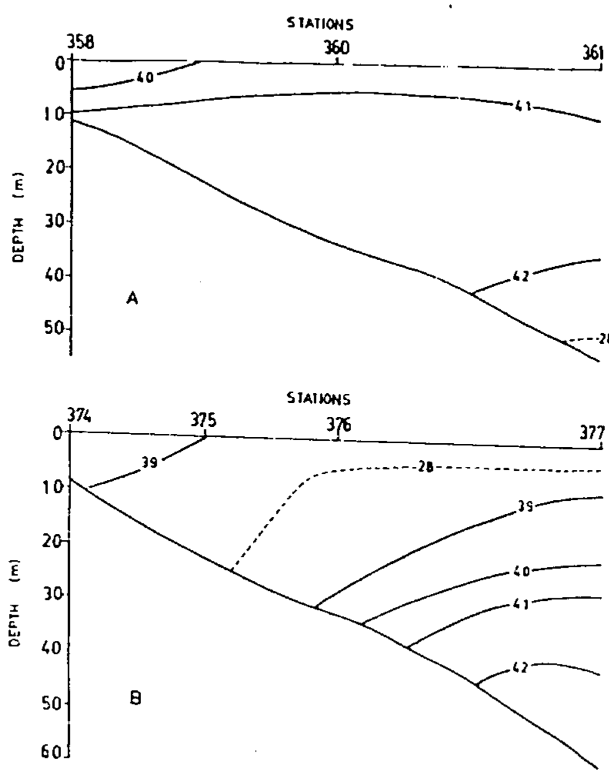

Fig.3. Vertical profiles of sound velocity (full line) and temperature (dotted line) under winter conditions (A and B).

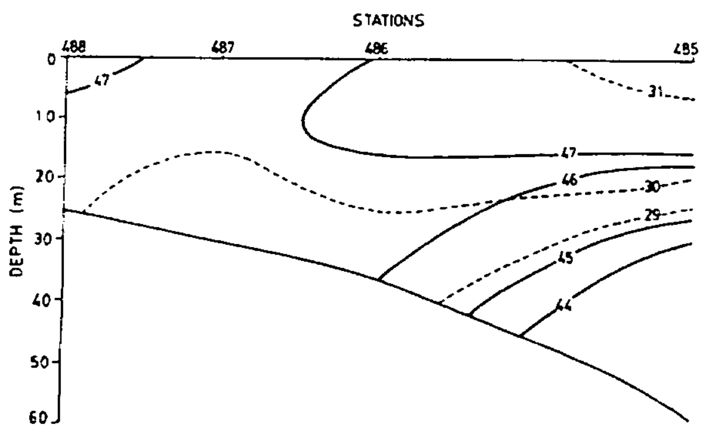

Fig.4. Vertical profiles of sound velocity (full line) and temperature (dotted line) during summer.

During both the seasons strong negative gradients of sound velocity and temperature occur from surface to a depth of 20 m. Even though there are seasonal differences in the magnitudes of sound velocity and temperature, their gradients remain more or less the same during both the seasons. From surface at 20 m, the sound velocity and temperature decrease by about 6 m/sec and 3°C respectively. Figs.1A & B show nearly isothermal water mass below about 20 m. Rama Sastry and Myrland (1960) have attributed the formation of this water mass to the mixing of the upwelled water with the botton current.

Figure 2A shows the vertical profiles of sound velocity and temperature during the fag end of the post-monsoon season (early November). It is seen that the vertical profiles that existed during the post-monsoon season are in the process of breaking up due to change in wind direction and consequent changes in the coastal circulation pattern. The profiles show a cellular structure and a general increase in sound velocity in the surface layers upto a depth of 15 m, especially in the regions nearer to the coast. Below 15 m, a sharp negative sound velocity gradient is observed. The upper part of this velocline appears wavy in association with the cellular structure of the sound velocity profile in the surface layers. Fig.2B depicts the conditions during northeast monsoon season (late November) and shows that the profiles that existed during the post-monsoon season are completely broken up. The sound velocity decreases as depth increases, but there are no sharp gradients. The sound velocities are higher during the northeast monsoon season compared to the monsoon and post-monsoon seasons.

The vertical profiles of sound velocity and temperature under winter conditions (mid December) are shown in Fig.3A. Winter cooling reduces the sound velocity in the surface layers and produces a positive sound velocity gradient. The isovels slope downwards towards the coast indicating coastal sinking. A well formed mixed layer is present. Fig.3B shows the conditions during mid January. Intensive sinking is indicated by the shoreward slope of the isovels. Fig.4 shows the vertical distribution of sound velocity and temperature during summer (mid May). Summer heating increases the sound velocity in the surface layers resulting in a negative sound velocity gradient. The isovels slope downwards towards the coast indicating coastal upwelling.

Variations in acoustical propagation characteristics: The sharp negative sound velocity gradient in the surface layers upto a depth of about 20 m and the nearly uniform velocity at greater depths occuring during the monsoon and post-monsoon seasons (Fig.1) influence the acoustic propagation characteristics in the region. In the surface layers, a horizontal beam will get refracted and bent downwards very sharply so that a surface shadow zone is formed and consequently the possible horizontal range of propagation is very much limited. Below 20 m, the acoustic beam can have a greater range of horizontal propagation. In this case, the acoustic beam is prevented from reaching the surface by the strong negative sound velocity gradients near the surface with the result that the horizontal propagation is as in a bottom duct (Camp, 1970).

During the early part of the transition period, the surface layers upto a depth of about 15 m have positive sound velocity gradients whereas strong negative gradients are found below this depth (Fig.2A). This can cause a horizontal beam to be trapped in a surface duct with negligible penetration downwards. Below 15 m, the horizontal beam will refract sharply downwards. Under this condition, a shadow zone is generally formed below 15 m depth. On the other hand, the slight negative gradients observed during the latter part of the transition period (Fig.2B) will form a surface shadow zone irrespective of the depth of the sound beam source.

During winter, positive gradients of sound velocity are observed in this region (Fig.3). This leads a horizontal beam to be refracted upwards forming a bottom shadow zone (Urick, 1975). Consequently, the horizontal range of propagation will be large because the propagation is much like as in a surface duct.

Slightly negative sound velocity gradients are found during the summer season (Fig.4). A horizontal sound beam will therefore be refracted downwards forming a surface shadow zone during this season. The absence of sharp negative gradients indicates a horizontal range of propagation higher than that during the monsoon and post-monsoon seasons.

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