Eighteenth Indian Expedition to Antarctica, Scientific Report, 2002
Department of Ocean Development. Technical Publication No. 16, pp 199-211

"A STUDY OF MARINE AMBIENT ACOUSTIC NOISE IN RELATION TO MARINE LIFE IN ANTARCTIC WATERS" DURING AUSTRAL SUMMER OF XVIII INDIAN EXPEDITION TO ANTARCTICA (1998-99)

Arivind kumar Saran
National Institute of Oceanography, Dona-Paula, Goa 403004

ABSTRACT:

The exploration of the Antarctic Ocean (Southern Ocean) receives much attention by Oceanographers of various disciplines, because the ocean supports all the animal life and has the tremendous influence on meteorology and bio–geo-physical problems. Any climatic ocean changes are, of course, of interest in their own right. The thermal and dynamical structure of some coupled atmosphere / ocean models undergo drastic changes, such as virtual cessation of the thermohaline circulation preventing the ventilation of the deeper layers. This could have profound impact on marine life. Towards this, It is atmost to make measurements of ocean temperature over large transects.

XBT fall rate variation in waters of extreme temperature and the resulting depth error has been addressed using controlled XBT-CTD data sets collected from this cruise in the southern Ocean. Mean depth errors deduced from the data sets collected in this cruise and also other data sets available are significantly different from those reported earlier for tropical and sub-tropical regions. The comprehensive study of Hanawa et. al 1995 (making use of controlled XBT-CTD data), mostly from tropical and sub-tropical waters, showed that the manufacturer's equation underestimates the probe's fall rate. This is manifested by the mean negative depth error reported from this region. Observed as well as the analytical results suggest that the probe has a decelerating tendency due to viscosity effect in this high latitude waters and the existing correction scheme is not appropriate for the XBT data from regions of such extreme low temperature.

It is therefore, necessary to conduct more controlled XBT-CTD experiments in this region for substantiating the exact nature of error for this region and then developing an appropriate depth correction scheme.

OBJECTIVES:

To carry out theoretical and experimental studies to understand the interaction of random noise field with scatters of arbitrary shape and size of marine life. Towards this, it is proposed to study the acoustic ambient noise in the sea south of 40°S latitude and relate these to the physical origin at select locations around the Antarctica & Polynea coast.

AIM OF THIS STUDY IS TO:

1) Collect baseline data on physical characteristics of Indian Ocean & Antarctic Ocean waters in the 1 deg. regular interval using a portable CTD / XBT.

2) Use the acoustic environment and animal behaviour, through construction of acoustic ray propagation following / using the software developed at NIO and through use of underwater hydrophone of width bandwidth determine if marine lives, modify their behaviour in response to the presence of human activities in the Antarctic waters and the prevailing underwater acoustic ambient noise.

DATA COLLECTION METHODS :

OCEANOGRAPEIC:

During the XVIIIth Indian Antarctic Expedition [14 December 1998 to 30 March 1999], controlled XBT-CTD observations were carried out onboard MV Polar Bird in the Southern Ocean. In order to obtain nearly coincident temperature profiles of both CTD and XBT, Sippican make, T-7 XBT probes were launched when CTD operational depth was about 100 m. A Seabird (SEE-19) shallow water type CTD, having a depth range of 500 m was used. We could not operate the deep CTD due to winch constraints on the vessel.

Total 96 stations of Expendable Bathy Thermograph (XBT) observations have been made in the area of Interest along the cruise / voyage track(s) On board MVPotar Bird. The XBT measurements had commenced from Latitude 6° 35.5' N & Longitude 69° 25.4' E to Latitude 68° 00.0' S & Longitude 14^0 41.2' E at every one degree latitude regular intervals. The cruise track covered a very long stretch from Mormugao port on India's West coast to the Continent of Antarctica Figure 1.

The XBT records in the depth range (0-760 m) have been obtained at # 76 stations which includes 5 repeat launching of probes as the vessel do not have any XBT launching pad / platform on the starboard or port side and causes the earthing of the signal wire with the ship's body thereby repeat casts. During return voyage 20 XBT stations data was collected starting 68 deg S to 50 deg S.

The composite profiles of XBT and CTD temperature data collected during the expedition is plotted in **Figure 2** for inter comparison. This information about the hydrography of the Southern Antarctic waters will help to address the XBT fall rate in the waters of extreme temperatures.

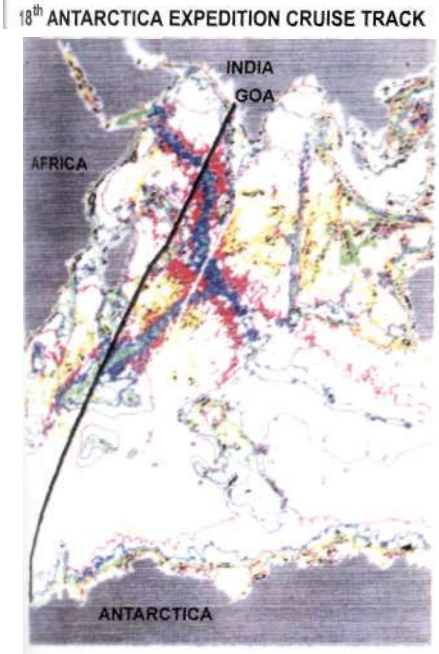


Figure 1 : Cruise Track

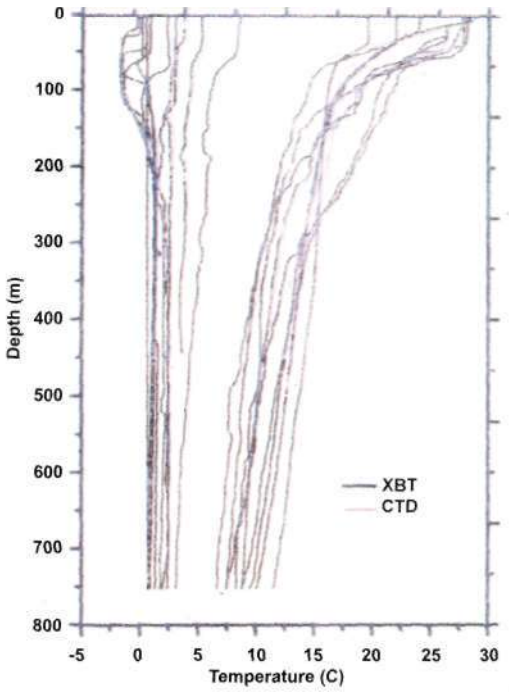
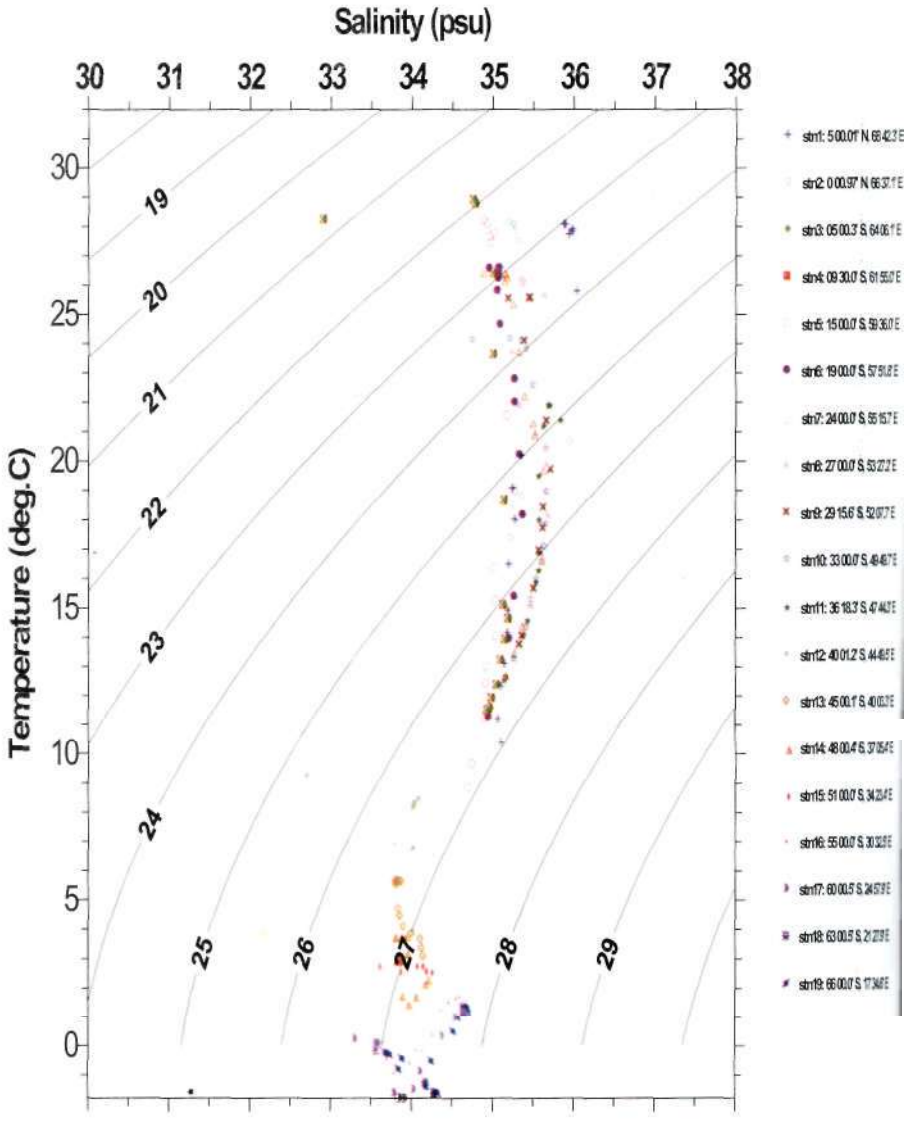


Figure 2 : Temperature profiles along the cruise track (XBT & CTD)



TS - SCATTER PLOT OF CTD STATION DATA ALONG THE CRUISE TRACK FOR 18th ANTARCTICA EXPEDITION

Figure 3

ACOUSTICS:

Measurement of acoustic ambient noise field in the coastal waters of the Antarctica was done from 12/2/1999 till 24/2/1999 on India Bay - Ice shelf as depicted in Figure 4, by lowering the ITC - 6080C hydrophone from the forecastle deck on starboard side of the ship MV Polar Bird.

The block diagram of the experimental set up is shown below.

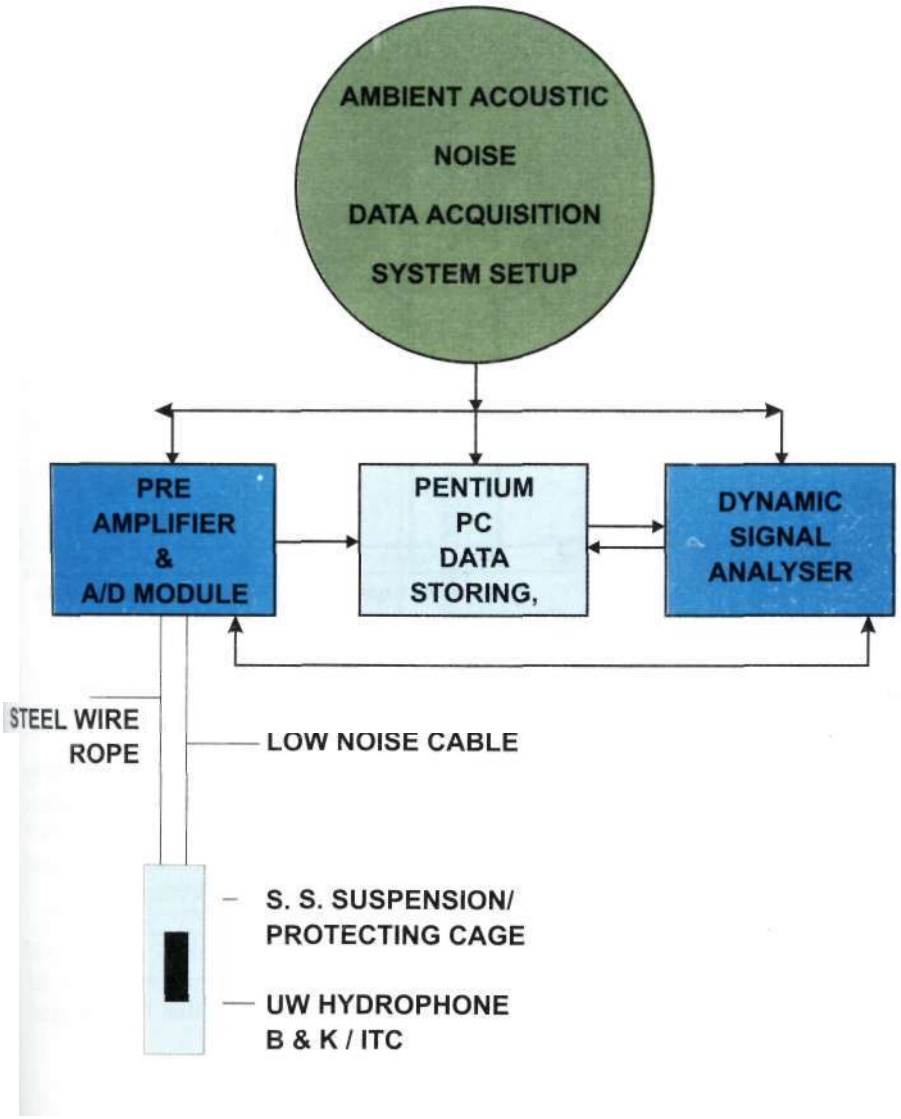
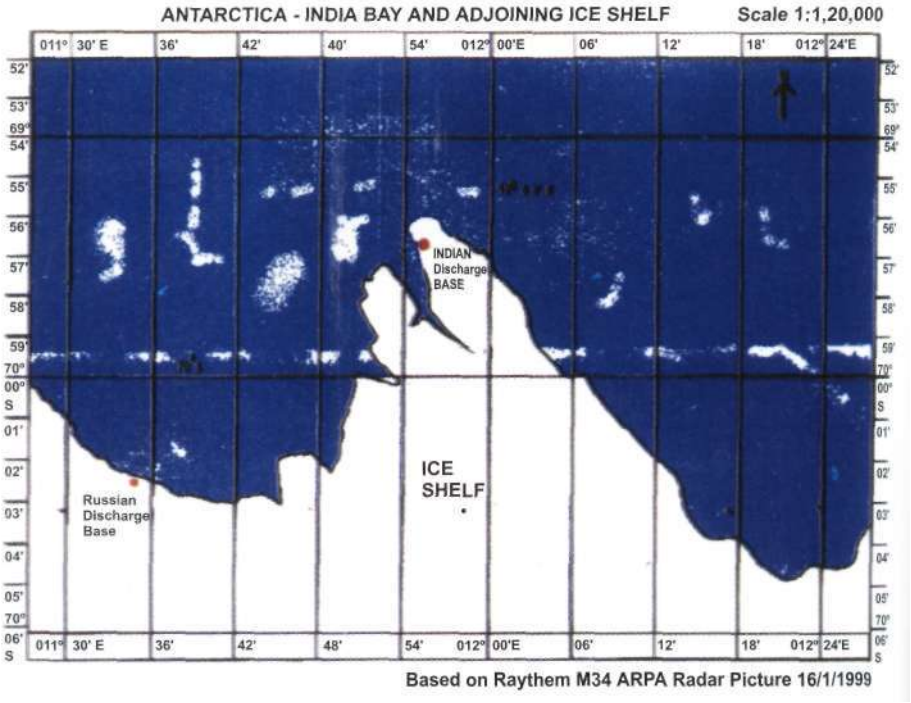


Figure 4 : The map showing location of India Bay Ice shelf where ambient acoustic measurements are made.



The analog signal from the hydrophone was preamplified and analysed on-line by using HP-3451 Dynamic Signal Analyser. The real time signal and the power spectrum of the signal was computed and the plotted online by using HP 3451 Dynamic signal analyser and plotter so as to check the presence of the signal available in the oceanic waters of Polynea sea at India Bay of Antarctica.

On few occaions whales were sighted and the signals was recorded. In absence of any sightings of whale / marine animals ambient acoustic sea noise was also noted and plot taken as shown in Figure S. In this figure it can be seen that 100m V signal at high frequency is present.

Figure 5 : Record of Acoustic ambient noise at India Bay Antarctica

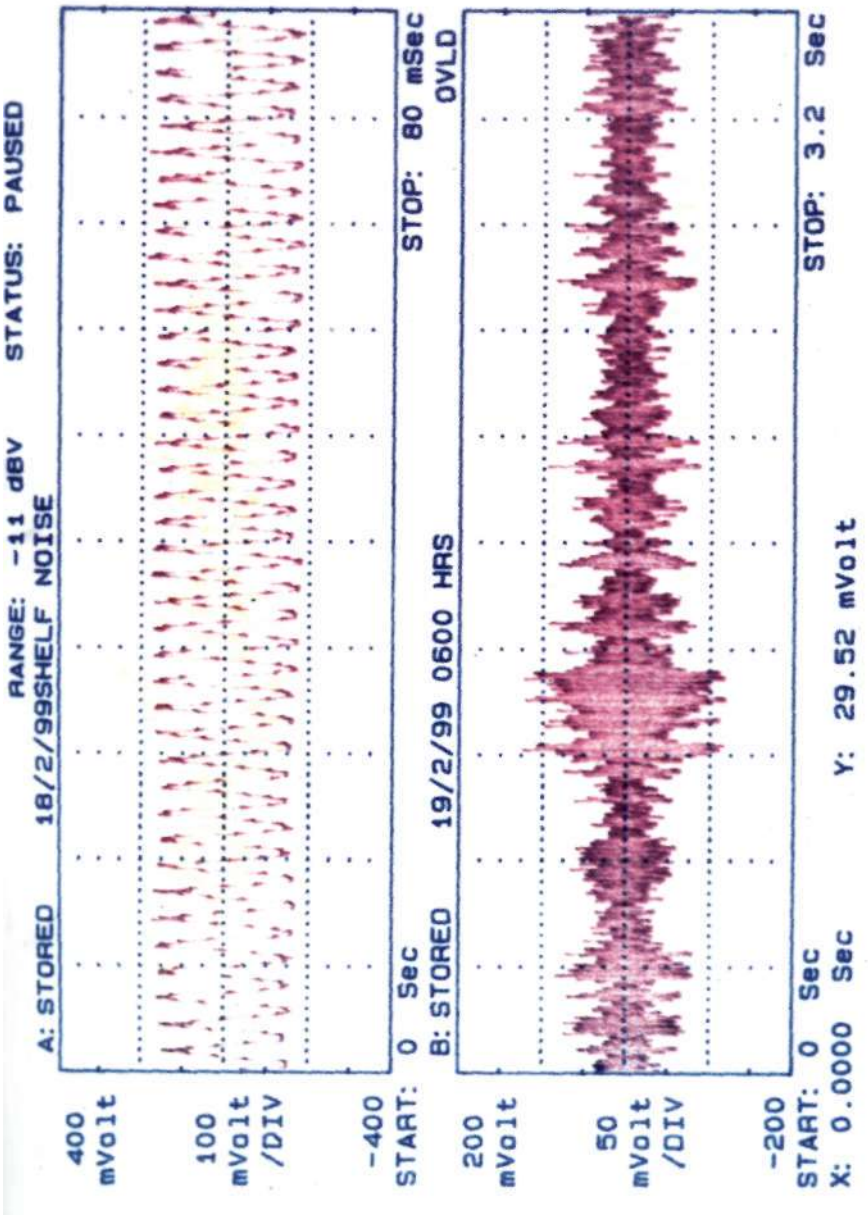
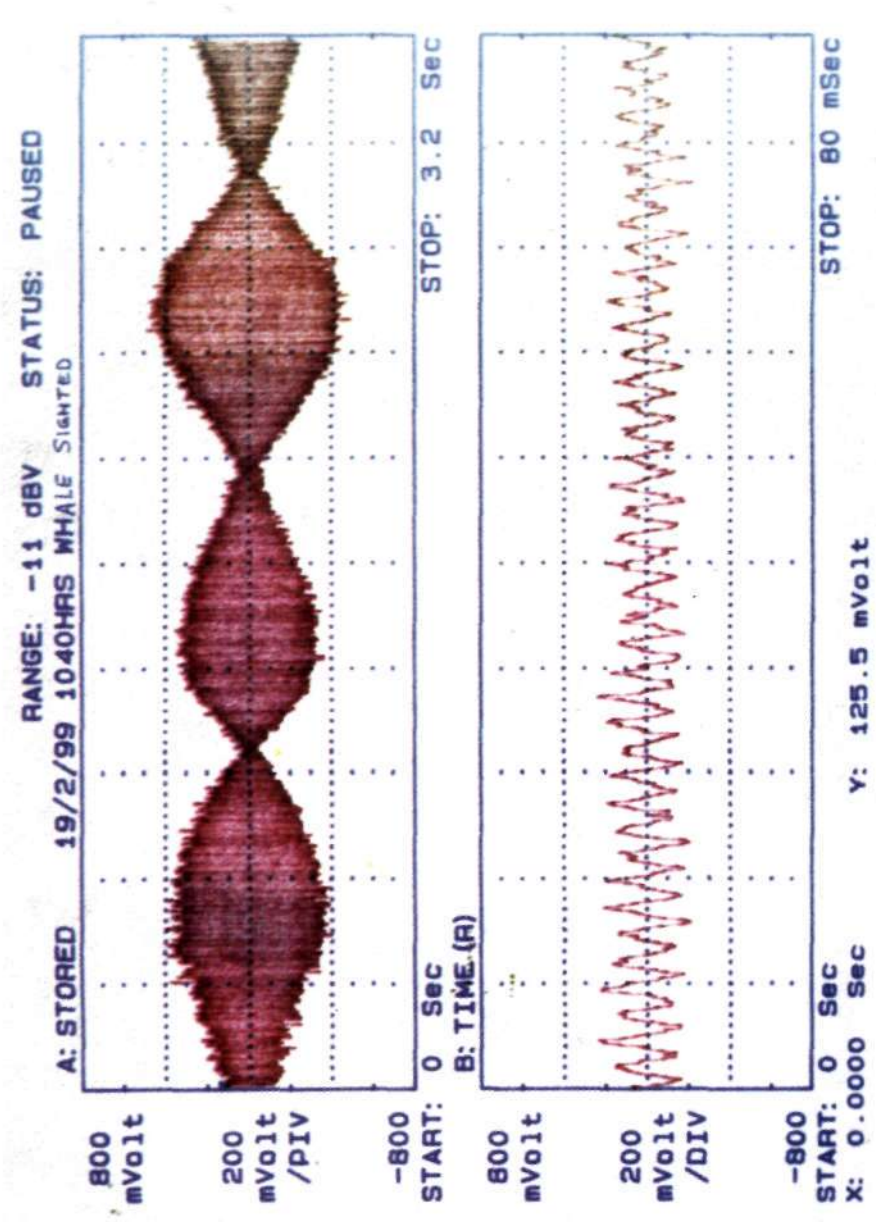


Figure 6a : Acoustic Signals of Whales sighted at India Bay Antarctica (real time plot).



The detailed F F T analysis of the signal received is done using M A T L A B and the plot is shown in the Figure 7. The time-frequency contour plot is shown in Figure 8. The Sampling frequency is 230.4 K H z . and the bandwidth is taken from 8-80 K H z for processing and logging of the ambient acoustic signal at the Antarctica waters in this experiment as shown in the block diagram. The analog to Digital data is stored in the PC and then used for processing using M A T L A B software. The plot above at Figure 6a is the plot at real time on the occasion when the school of whales were sighted on 19/2/1999 in the India Bay, Antarctica. The data is then plotted using M A T L A B and shown in the Figure 6b as shown below. One can clearly see that there are two distinct frequencies;

a) signal from the marine m a mm a] (whales) sighted and
b) the ship's high frequency noise.

Figure 6b : Acoustic Signals of Whales sighted at India Bay Antarctica, plot using MATLAB .

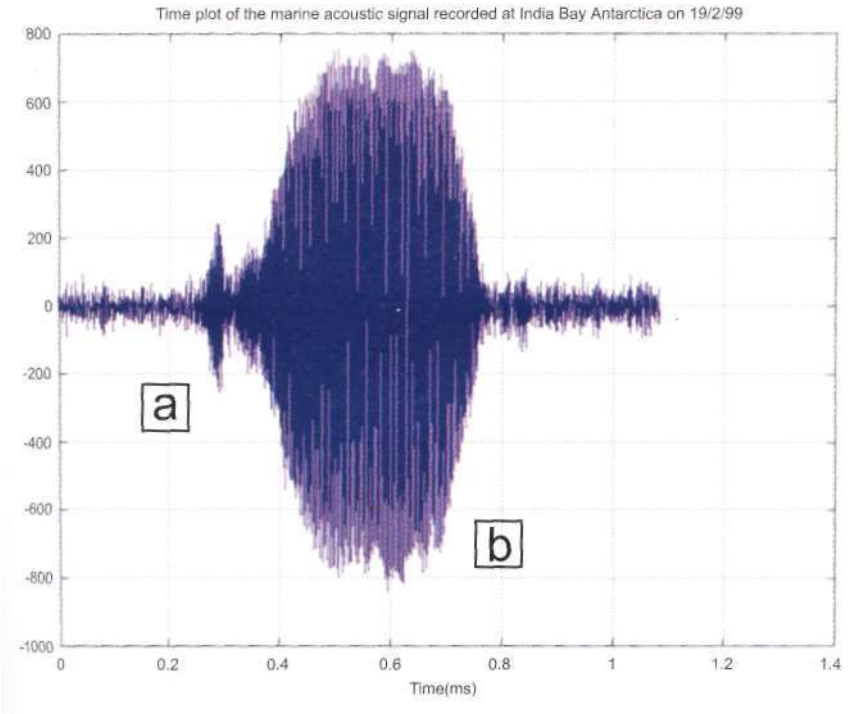


Figure 7 : Frequency Spectrum of the Signal

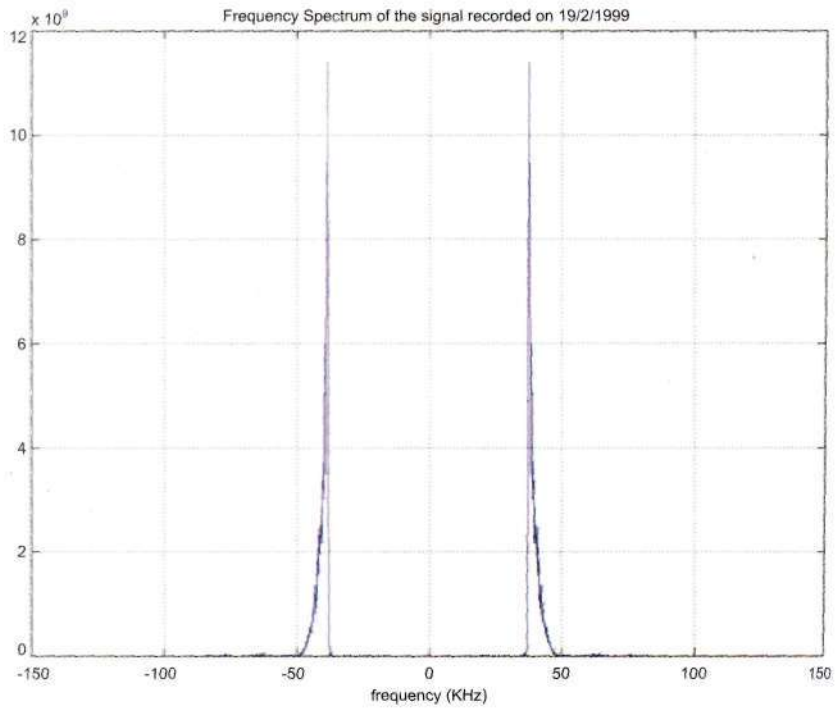
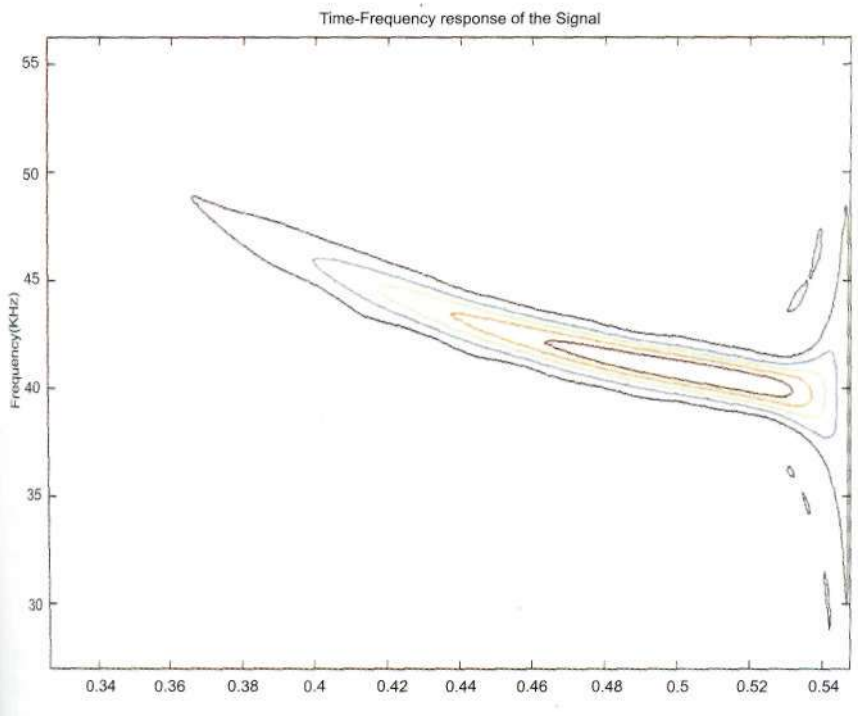


Figure 8 : Contour plot of the marine acoustic signal received on 19/2/1999 in the India Bay, Antarctica.



CONCLUSIONS:

Oceanographic:

XBT-CTD experiments conducted in tropical and subtropical waters revealed the underestimation of the probe's fall rate in these regions. Similar XBT-CTD experiments in high, latitudes (Antarctica and sub-Antarctic waters) overestimates the fall rate of the probes in the region. These observed and analytical results of fall rate in lower latitudes (warm waters) and higher latitudes (cold waters) suggest the existence of the following three oceanic zones based on the probe's fall rate behavior.

a) Zones, where probes fall faster than the manufacturer's specification causing negative depth error and requires depth correction.

b) Zones, where the probes fall in accordance with the fall rate specification of the manufacturer require no depth correction.

c) Zones, where probes fall slower than the manufacturer fall rate specification causing positive depth error requires depth correction.

Acoustic:

a) The Antarctic waters, especially India Bay. is potentially rich areas for marine mammal (whales) presence, thereby acoustic signals aused by their movements, dives or communication are interesting signals to record.

b) The presence of marine mammal (whales) are sporadic events and cannot be predicted and so is the acoustic signals generated by them. A long term record (continuous for 2-3 years) are essential in order to deduce any inference for species classification / migration or behavioral aspects.

c) The snapshot acoustics signature for a day or two was available during this expedition for recording as most of the time the India Bay waters were not weather conducive for making measurements.

d) The time frequency plot gives an understanding for identifying the whale signals in presence of other type of ambient acoustic noise prevailing at that time.

ACKNOWLEDGEMENTS:

The author record their sincere gratitude to Dr. Ehrlich Desa. Director.National Institute of Oceanography. Dona-Paula. Goa for his guidance and constant cncouragement.leader of the XVIII expedition. Shri Ajay Dgar and Station Commander Shri K.R.Shan arc greatfully acknowledged for the lacililies and support to the member of NIO) in executing the Held tasks. Thanks are also due to the fellow expedition members and DOD for their kind cooperation. The author thank Dr P.C Pandey. Director. NCAOR For his help in making the observation successful.

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