ANALYSIS OF FLUCTUATING DYNAMICS OF WATER MASSES THROUGH OCEANIC ENVIRONMENT AT PAKISTAN SOUTHERN OCEANIC REGION

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ABSTRACT: *In this communication we have studied the physical properties in the southern regions of Pakistan. The data are plotted as the time series profiles of potential temperature, salinity and potential density anomaly on depth scales to observe the temporal variation. T-S graphs were also plotted by using Minitab and Lab View software to identify the water masses of that area. T-S graphs show in the regions three distinct salinity, considered as individual water masses. This fact makes the characterization of water masses more difficult than in the deep ocean where the most of the water is not in contact with the atmosphere. Arabian Sea high salinity water mass is the shallowest of the three high salinity masses and lies at the bottom of the equatorial surface water. It is important to claim that this research work can be profitable for the design of communication systems involving submerged antennas with improved signal-to-noise ratios and is comprehensive attempt to establish an understanding for the fluctuating dynamics of water masses and their effects on radio wave propagation in the southern region of Pakistan.*

Keywords: *water masses, circulation of water, fluctuating dynamics*

INTRODUCTION

The basic tool for water mass classification and analysis is the temperature-salinity (T-S) diagram in which the two conservative properties are plotted against each other. A homogeneous water mass, i.e. a water mass of uniform temperature and salinity, shows up in a T-S diagram as a single point (Allen 1997)[1]. The temperature - salinity combinations identified by the water mass points or curves are known as source water types. In the theory of water masses a water type is a point in the T-S diagram; water with the corresponding temperature and salinity may or may not exist. Source water types are T-S points representing water masses as they exist in their formation region. Because they are associated with real water masses it may be more difficult to see why they, too, do not necessarily represent an existing volume of water. But water mass properties are not constant in time; they reflect variations in the atmospheric conditions at the time of water mass formation.

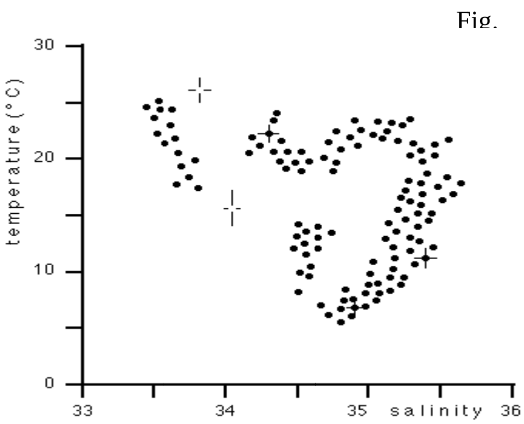


Fig. 1. Sketch of a T - S time diagram as it is developed from frequent observations.

Measurements are made every other day. Each dot represent a measurement[15].

If we define the water mass by taking the average temperature and salinity from the two years, the resulting source water type gives a good description of the water mass; but it does not represent any water as it actually exists. A complete description of a water mass requires specification of its source water type (or source water types) and standard deviations (variances) for temperature and salinity. A homogeneous water mass that can be represented by a single source water type has only a single standard deviation for temperature and another single standard deviation for salinity. These water masses form at the ocean surface, and their temperatures and salinities reflect surface conditions where they formed.

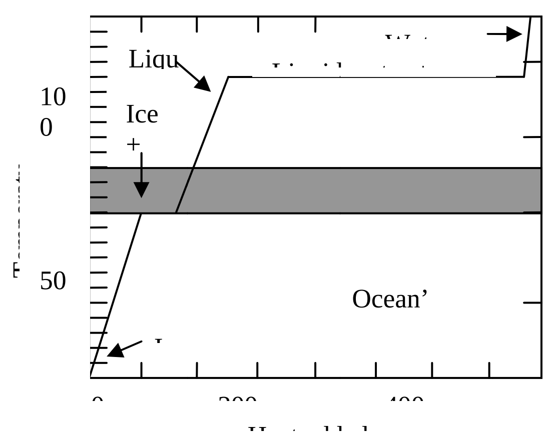


Fig. 2. **Temperature changes when heat is added to ice, liquid water, or water vapor.**

Note that the temperature of the system does not change in mixtures of ice and liquid water or liquid water and water vapor [6].

If a newly formed water mass is denser than its surrounding waters, it sinks to a level determined by its density relative to the density distribution in the nearby ocean. Below the surface, water masses are moved by subsurface currents, often for thousands of kilometers. After hundreds of years (possibly 1000 years), the deep waters return to the ocean surface, again to exchange gaseous with the atmosphere and to be warmed by heat from the sun. Subsurface water mass movements can be traced by using changes in dissolved gas concentrations, especially dissolved oxygen, and the presence of pollutants from nuclear weapons testing and even atmospheric pollutants, such as chlorinated hydrocarbons [9]. The densest water masses in the ocean form in Polar Regions, where waters of moderately high salinity are intensely cooled at the ocean surface. These processes increase the depth of the pycnocline by the sinking of dense waters from the surface. If dense enough these water masses may sink all the way to the bottom and flow along the ocean floor.

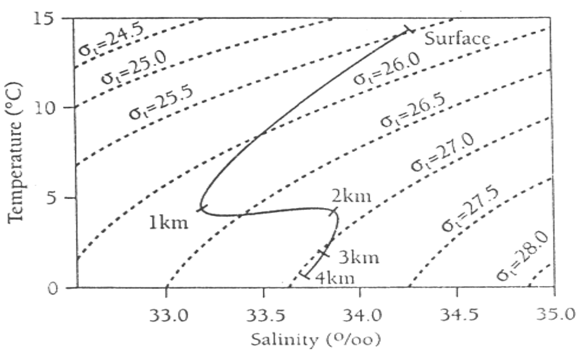


Fig. 3. Water masses can be identified by plotting variations of temperature and salinity as a function of depth on a T-S diagram.

Although temperature can increase with depth and salinity can decrease with depth, water mass density can only remain constant or increase toward the sea bottom. Density increases between the surface and a depth of 3 km but remains unchanged between 3 & 4 km.[15]

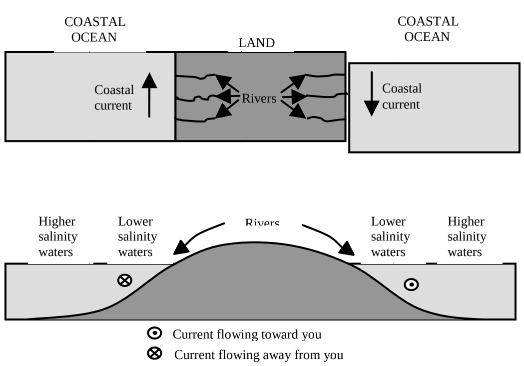


Fig. 4. Sloping Sea surfaces coastal currents resulting from river discharges into coastal waters of the Northern Hemisphere [14]

The properties of the waters in the regions especially the coastal belts are constantly changing. Seasonal influences are magnified by the proximity of land, which brings with it an increased annual range in atmospheric temperatures and a concentration of freshwater supply through river runoff.

Coastal oceans are shallow ocean regions lying over continental shelves. They are strongly affected by nearby lands, river outflows, large human populations, and industrial and agricultural discharges [11]. Coastal oceans are also highly variable. Their currents, water characteristics, and even marine life change over relatively short distances and short periods of time [11]. Coastal-ocean waters respond within a few hours to winds blowing over months. Coastal-ocean distances are also shorter than those involving the open ocean. Many coastal waters are partially isolated from the open ocean. For instance, parts of the Southern California Bight are partially isolated from the open Pacific Ocean by the Channel Islands, off Santa Barbara to the north Bays, harbors and fjords have restricted communication with the sea.

MATERIALS AND METHOD:

For the study and analysis of the southern regions of Pakistan we have selected some different stations along the coastal belt of Arabian Sea. The geographical views of the stations are given below:

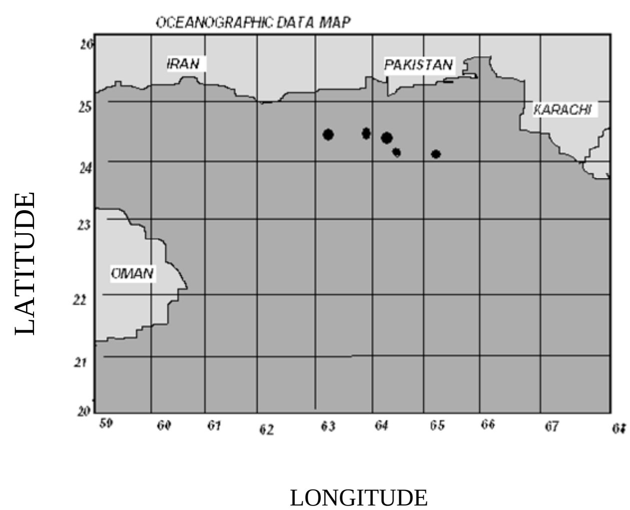


Fig. 5. Graphical view of understudying stations

The graphical analysis will clearly explain and gives the easy understanding to the readers to evaluate the difference between the physical properties of coastal regions of Arabian Sea and other regions of the oceans. The data used in the under study area is collected by the help of equipment provided by the Pakistan Naval Authority and Institute of Oceanography, Karachi regions.

SURVEY ECHO SOUNDER (HYDRO STAR 4900):

The module ELAC Survey Echo sounder Hydro Star 4900 is the new generation deep sea echo sounder, capable of measuring up to 10,000 m water depth, a state-of-the-art tool for precise and reliable survey tasks. The unit is available as stand-alone system or can be integrated in a 19”-rack, also allowing integration into already existing navigation-or survey systems. The Hydro Star 4900 complies with IHO accuracy regulations for survey echo sounders.

ECHO SOUNDER (NJA – 193S):

Model NJA – 193 s, echo sounder is designed in accordance with imco, recommendation 1976 (resolution a. 224 vii).

If the ultrasonic wave (200 kHz) in from of beam having such a certain extent is emitted by the transducer toward the bottom of the sea, the wave is propagated in the sea water at the velocity of 1500 m/s, reflected on the bottom of the sea and returned into the vibrator of the transducer. The transducer has two functions of emitting and receiving an acoustic wave and this unit is assembled in this depth sounder. Therefore, the depth can be determined by measuring the lapse of time from the emission of the acoustic wave to the reception of the reflected wave on the bottom of the sea. If the depth is considered as 150m, for example, the acoustic wave emitted reaches the bottom of the sea in 1/10 seconds (150/1500 = 1/10 sec) and returns to the surface of the sea in 1/10 seconds. Therefore, it proves that the depth is 75m if the time from the generation of the wave to the reception of the reflected wave is 1/10 sec, or that it is 150m if the time is 1/5 sec. it is, however, necessary to pay attention to the fact that the depth is a distance from the ship's bottom to the sea bottom, not the depth from the surface of the sea to the bottom of the sea, since the transducer is mounted on the ship's bottom.

CURRENT METERS:

The Model 108 MkIII and 308 are impeller based current meters measuring speed and direction, which can also have Conductivity, Temperature and Pressure parameters fitted. From these additional parameters Salinity, Density and Speed of Sound are calculated. The system is modular and instruments can be upgraded if desired. It is a direct reading only instrument. The Model 308 is a self recording instrument, which can also be used simultaneously for real time measurements. Both units can be used directly with a PC or with the operation Model 8008 Control Display Unit. This unit has 3 data communication methods built in which offer considerable flexibility for configure ration and use with a wide number of cable types and lengths. Sampling and averaging periods are set up using a PC 8008 CDU, and the set up is retained until overwritten. Calibration for all sensors is held within the instrument and data is provided in engineering units. Power may be taken from its internal batteries (308 only), from the 8008 CDU or from a surface battery or power supply. Self recording units have 128 Kbytes memories as standard (1 Mbyte optional). The 128 Kbytes memory can store 30,000 speed and direction records (or 12,000 speed/direction plus CTD records). Other products in this range are the Model 6000 MkIII direct reading and self recording CTD, the Model 315 logger and the Model 710 and 720 shore based and seabed mounted Tide Gauges.

MARINE CONDUCTIVITY, TEMPERATURE AND DENSITY (MCTD):

MCTD is designed to optimize your ability to collect high precision salinity data. The MCTD also offers users the ability to interface optional sensors such as light. pH, and Oxygen, and to transmit data from these sensors in conjunction with the CTD information. The basic instrument measures conductivity using a high stability inductive conductivity sensor which calibrated over the oceanographic range of 0-70 mmho/cm (0-7 S/m). Temperature is measured with a high accuracy platinum thermometer mounted in pressure protecting sheath. Optionally a high can be provided. Pressure uses a fully temperature compensated semi-conductor strain gauge transducer. The user can select any of the parameters for readout. Data is transmitted in calibrated ASCII physical units and counts for optional channels. The user can select primary CTD channels, DC digitizer channels, or calculated data for direct output or recording in optional data storage. The Command/Data Serial Port is accessed from the top end cap connector and supports either RS-232C or RS-485 levels communication. Instrument configure ration, channel enabled, time functions, and data averaging are all configure red using simple ASCII commands given to the instrument via the Command/Control port. A computer using any terminal emulation program can be used to interact with the instrument, see the command section for specific command and responses. FSI also offers complete IBM/PC compatible software.

GLOBAL POSITIONING SYSTEM (GPS) (4000SST)

The 4000SST performs surveys in static, kinematics, and pseudo static modes. It also determines time, latitude, longitude, height, and velocity. A navigation option is available. The 4000SST receives L1 and L2 signals sent from the Global Positioning System (GPS) NAVSTAR satellites. The receiver automatically acquires and simultaneously tracks from 8 to 12 GPS satellites; it precisely measures carrier and code phases and stores them in an internal, battery backed-up memory. GPS survey baselines are measured by observing GPS satellite data simultaneously with receivers positioned at each end of the baseline. One baseline can be measured by using two units simultaneously; two baselines can be measured by suing three units simultaneously, and so on. Latitude, longitude, ellipsoidal height values, and the GPS satellite ephemeris data are referenced to the World Geodetic System (WGS-84). WGS-84 is almost identical to the North American Datum, NAD-83, used in North America. The recorded satellite carrier-phase signal measurements are high-precision data, which require post processing to obtain survey results.

Scientists are becoming more aware of the connection between physical processes and computation and many now find it useful to view the world in computational terms The properties of the waters in the regions especially the coastal belts are constantly changing. Seasonal influences are magnified by the proximity of land, which brings with it an increased annual range in atmospheric temperatures and a concentration of freshwater supply through river runoff.

[2]. Consequently, computer simulation is sometimes viewed as a third form of science, halfway between theory and experiment. Furthermore, understanding can be enhanced through the use of advanced computer graphics to

convert large volumes of data into vivid and comprehensible patterns. Because of national security concerns, some existing data sets are limited in accessibility. Also, because of the wide range of acoustic frequencies, ocean areas and geometries of interest to researchers, it is virtually impossible to accommodate all observational requirements within normal fiscal constraints. Sometimes acoustic data are collected from sea without the supporting oceanographic data The properties of the waters in the regions especially the coastal belts are constantly changing. Seasonal influences are magnified by the proximity of land, which brings with it an increased annual range in atmospheric temperatures and a concentration of freshwater supply through river run off [7].

Temperature is basic to any physical description of the ocean. It is the easiest and therefore the most common type of oceanographic measurement made.

RESULTS AND DISCUSSION:

This analysis gives two main ideas, the first one is to compare the coastal properties with the deep sea and, the second is the comparison between Pakistan Coastal Regions with other coastal regions of the world. In this research the graphical view of the data collected from different locations of Pakistan coastal regions. Minitab is being used for the analysis of the oceanographic data received from different resources. Minitab is a powerful, comprehensive and easy-to use environment for technical computing. It provides engineers, scientists and other technical professionals with a single interactive system that integrates numeric computation; visualization and programming.

The data and graphical analyses of T-S parameters evaluated at different locations are described below:

STATION	LAT & LONG	TIME hh:mm	DATE
1	24 46.4 64 15.8	7:04	10.06.2005
2	24 50.1 63 15.4	20:46	23.06.2005
3	24 12.2 64 42.6	15:00	06.05.2006
4	24 46 63 59.8	8:19	17.11.2006
5	24 12 65 25	6:00	30.09.2007

In this analysis dynamics of water masses through oceanic environment at Pakistan south oceanic region, **a**fter study the selected positions along the coastal zones of Arabian Sea I observed that the basis of water mass analysis in the deep ocean is the derivation of water mass properties in the formation region are small compared to the property differences that are observed between different water masses at some distance from their formation region [8].

The situation in the coastal ocean is quite different. Many coastal regions are well mixed, so T-S graphs of the selected positions which mentioned in the figure 6 show variations of temperature and salinity with depth, are not often found in the coastal ocean. Even where

24° 46.4´N 64° 15.8´ E

DEPTH	SALINITY	TEMPERATURE
0	36.546	23.29
10	36.546	23.0
20	36.541	23.67
30	36.605	23.70
50	36.683	23.69
75	36.643	23.29
100	36.703	23.51
125	36.345	21.90
150	36.085	20.78
200	35.867	20.00
250	35.999	18.02
300	36.077	16.45
400	35.956	15.49
500	35.840	14.31
600	35.734	12.81

24° 46´ N 63° 59.8´ E Depth

DEPTH	SALINITY	TEMPERATURE
0	36.362	23.60
10	36.411	23.81
20	36.432	23.78
30	36.481	23.80
50	36.669	23.66
75	36.635	23.46
100	36.497	23.06
125	36.381	22.22
150	36.347	21.89
200	36.284	21.15
250	36.057	19.28
300	35.933	17.79
400	36.010	15.77

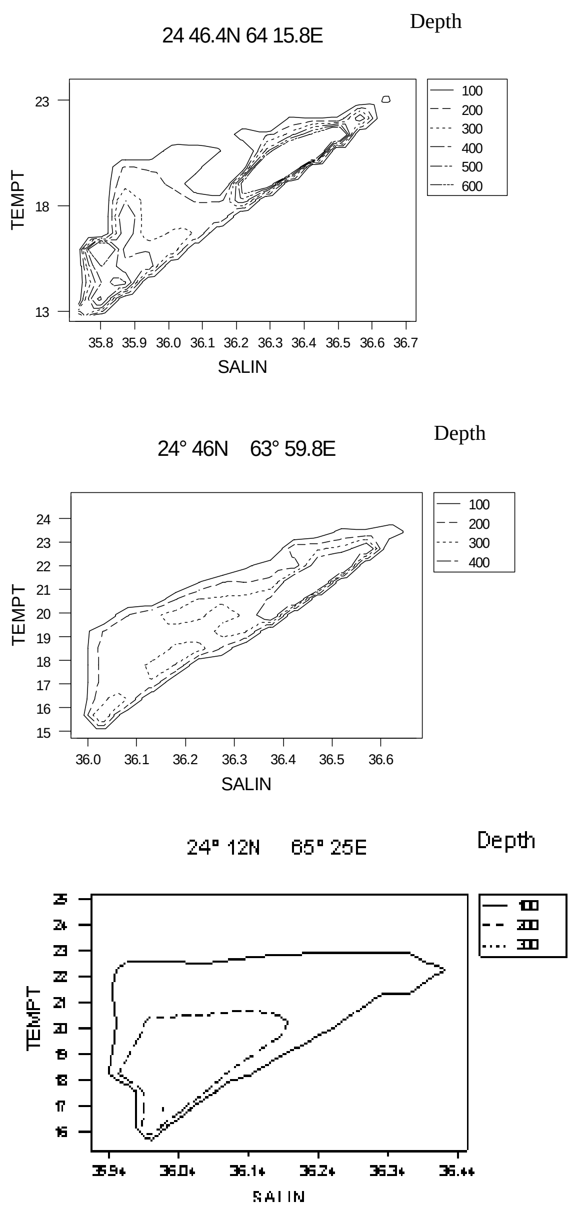
24° 12´N 65° 25´ E

DEPTH	SALINITY	TEMPERATURE
0	36.340	24.14
10	36.320	23.99
50	36.350	23.94
100	36.330	23.62
150	36.280	21.80
200	36.110	19.47
250	36.120	17.71
300	36.230	16.62
400	36.010	14.41
500	35.830	12.96
600	35.610	11.21
700	35.590	10.95
800	35.500	9.88
1000	35.440	9.08
1200	35.290	7.66
1400	35.143	6.29

vertical stratification is present, a large part of the water column is still taken up by the surface mixed layer, which in a T-S graph is represented by single water type. Undergo large changes from season to season.

24° 46´N 65° 25´ E

DEPTH	SALINITY	TEMPERATURE
0	35.960	24.94
10	35.950	24.50
20	35.930	23.99
25	35.927	23.80
30	35.990	23.78
50	36.140	23.59
75	36.150	23.16
100	36.250	22.88
125	36.440	22.59
150	36.350	22.24
175	36.350	21.55
200	36.110	20.59



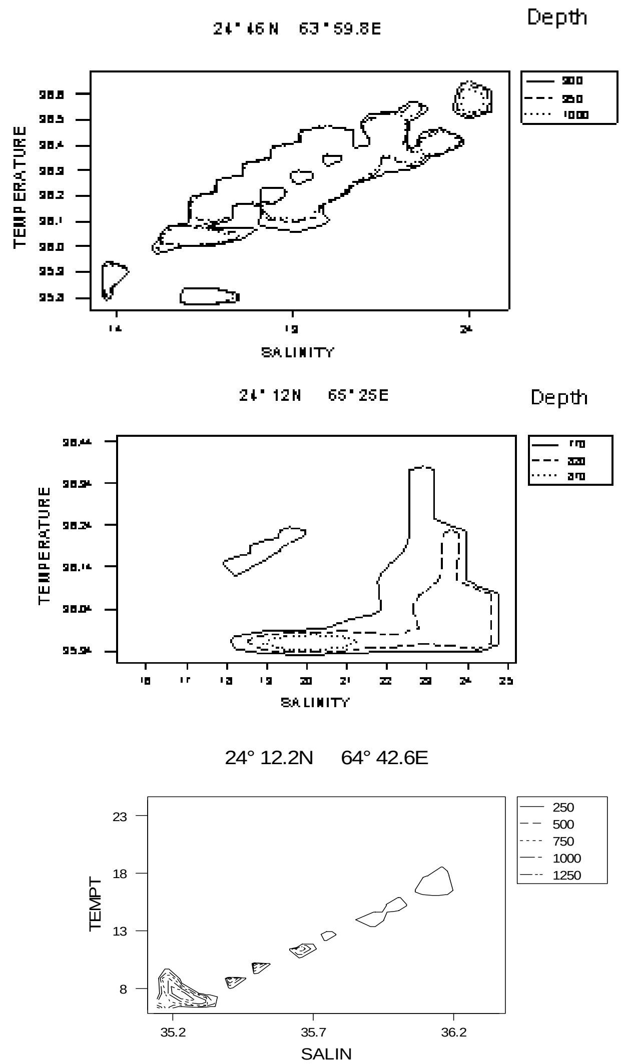


Fig. 6. T-S models of stations under studying with respect to depth.

If the T-S properties of the coastal ocean area averaged over the year, the resulting standard derivation is much larger than any variation that may exist as a result of stratification in the water column at any particular time. Although water properties in the coastal ocean undergo large variation they do not fluctuate in a random fashion but follow a seasonal cycle. It is possible to make use of this and define the water masses of the coastal ocean through the use of the so called T-S time graph. Other than plotting temperature against salinity as both vary with depth, we plot the values of both variables in the mixed layer against each other as they very over the year. The sequence of the observation taken over a year defines a T-S relationship in the time that reflects the weekly and secondly changes of the two properties. Establishing a T-S time graph for a particular coastal ocean region requires an observational effort over many years and is therefore much more demanding than the effort required establishing a T-S graph for a deep ocean station [4]. In this study an effort is made to understand the properties of the waters in the Pakistan southern oceanic region which are constantly changing.

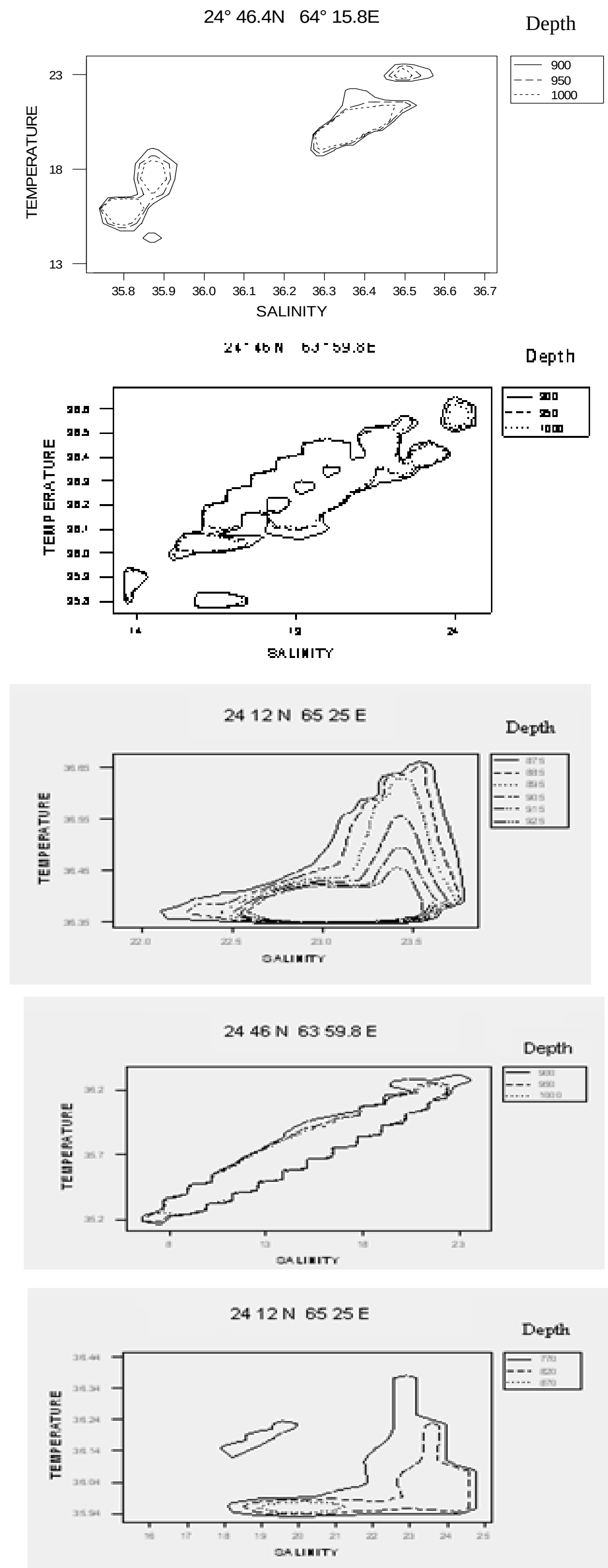


Fig. 7. Graphical analysis of the results of density with respect to temperature and salinity of the understudy stations.

In this study, an attempt is made to understand the physics of water masses formation process. The basic tool for water mass classification and analysis is the temperature-salinity (T-S) graph in which the two conservative properties are plotted against each other. A homogeneous water mass is a water mass of uniform temperature and salinity. The best known examples of this kind are the water masses of the permanent thermo cline known as Central Water. The air-sea interaction and the water exchange with the Indian Ocean control and maintain the major chracteristics of the water masses and the circulation in the southern Arabian Sea. Due to the atmospheric forcing there is upwelling all along the Somali coast that moves northward and divert to open Arabian Sea. This advects significant amounts of up welled water into the open Arabian Sea during the southwest monsoon and acts as a conduit for Gulf of Oman.

VLF ANTENNA:

Antenna is a device used either for the emission or for the reception of radio waves. An emitting antenna is a device supplied by an electric power generator at certain frequency and radiating radio waves in medium. These waves are generated through the emission of a variable current along the emitting antenna. A receiving antenna is a device whose function is to receive the effects of radio waves emitted by a distant source. The interaction between an antenna and an electromagnetic wave produces on the antenna a variable current identical to the current that would have been necessary for this antenna to emit the wave.

The shapes and dimensions of the emitting and receiving antennas depend on their intended use as well as on the frequency. The main characteristics of antennas are their radiation pattern, the power gain, the directivity, the beam width, the aperture, the polarization, the current distribution along the antennas, their effective height and their impedance.

Sea water hides the submarine when they submerged and the communication with them is a difficult technological task which requires specific techniques and devices. Normal radio wave communication cannot travel through thick conductors such as salt water. The normal practice for the submarine is to surface and raise an antenna above the water surface to use standard technology. This is not feasible for nuclear-powered submarines. VLF radio waves (3-30 KHz) can penetrate sea water down to a depth of roughly 20 meters. In the exercise the ships can advise the submarine when it is safe to surface. Accuracy can be signaled by the submarine to the attacking ship. It can facilitate number of devices exist these communications. Quality and range of transmission varies with water conditions, local noise level, and reverberation effects. Normal sonar communicates between ships should be possible at ranges out to 12,000 meters. ELF communications systems make use of a principle in physics where the attenuation of radio waves (electromagnetic waves) from sea water increases with the frequency of the signal. This means that the lower the frequency a radio transmission, the deeper into the ocean a useable signal will travel. Radio waves in the very low frequency (VLF) band at frequencies of about 20,000 Hertz (Hz) penetrate sea water to depths of only tens of feet.

Whereas, ELF waves penetrate sea water to depths of hundreds of feet, permitting communications with submarines while maintaining stealth

CONCLUSION:

In this study an effort is made to clear the mind by observing the analysis result that salinity and temperature are the main factors for the water masses. In some regions there are increased in salinity with the increased in the depth but temperature continuously decreased. In maximum area the salinity and temperature decreased with the increased in the depth and further analyzing of density in different regions. The density distribution of the waters of the area under observation clearly gives an idea that denser waters prevail during September and to a certain extent during October and November also. Along with dense waters, in a few instances there appears to be isolated areas of less dense waters at the surface. Such drastic changes in density between adjoining water masses is a common phenomenon during monsoon only. The exchange of heat between the ocean and the atmosphere depends strongly on temperature. The speed of sound and propagation of radio waves in the upper layers of the ocean is most strongly dependent on the temperature. Temperature further influences the kinds and rates of chemical reactions occurring in the ocean. The distribution of nutrients and other biologically important substances depends on temperature and the resulting density stratification.

The present study has clearly indicated that the pattern of distribution of density along the coast of Pakistan is comparable with the coast of west India, which is constantly changing.

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