# To Study the Implications of the Evaporation Duct for Ground Waves Path in Pakistan Coastal Water through Statistical Assessment

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**Abstract:** In this communication we have studied the environmental changes in the Pakistan coastal water. Evaporation Duct is the continuous phenomena and occurs due to climatic changes in the region. It is generally observed that atmospheric occurrences have great impact on radio waves communication over the sea and especially in coastal waters. These climatic variations are also the main reason for the formation of evaporation duct in Pakistan Coastal water. The height of the duct varied according to the weather phenomenon. In this study we selected four different positions to take the observations in the formation evaporation duct and propagation of radio wave through these ducts. The data are collected from National Institute of Oceanography (NIO) and plotted as the time series profiles of potential temperature, pressure and humidity cause the refractive index of the air in this region. They are of particular importance at the extreme limits of propagation and allow the radio waves to propagate beyond the horizon. It is important to claim that this research work can be profitable for the better and affective utilization of ground waves communication path in Pakistan coastal water.

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**Keywords:** evaporation duct, radio wave communication, coastal water

## 1. Introduction

The earth atmosphere is divided into three separate regions or layers. They are troposphere upto 7.5 miles from the sea level virtually, all weather phenomena that is variation in temperature, density, cloud formation and air pressure takes place in troposphere. These conditions have great effect in the formation evaporation duct which is also affects the propagation of radio waves. The stratosphere is from 7.5 miles upto 31 miles located in between troposphere and ionosphere. The temperature through out this region or layer is considered to be almost constant because of little water vapor present, this layer has already little effect on radio waves. The ionosphere is extended upward from above 31 miles to the height about 250 miles. The troposphere is the lower part of the earth's atmosphere and maximum affected by the weather parameters like temperature, pressure and humidity. It is observed after several experiments that in troposphere region, the temperature is found to decrease with altitude at a rate of approximately 7ºC per kilometer [1] [2]. In the troposphere communication covered the frequency ranges VHF (30-300 MHz) and UHF (300-3000 MHz). In this study both the spatial and temporal scale is considered to carry out the propagation occurs in troposphere.

## 2. Statistics of Evaporation Duct

In this paper we have to consider the Snell's Law in which a radio ray projected into the atmosphere will have to travel from a denser to rarer medium and will refract downwards towards the surface of the earth [2]. Figure below shows the four refractive conditions in the troposphere.

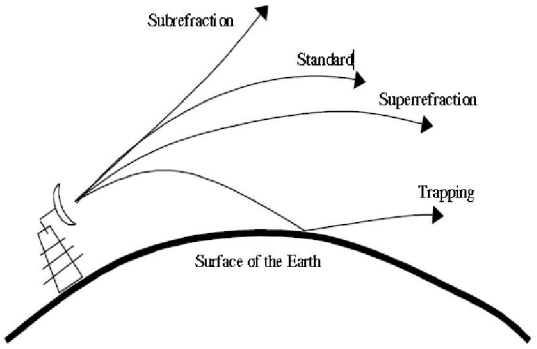


**Figure 1.** The four refractive conditions in the troposphere.

Refractive index of the particular area plays a vital role in the formation of duct. It is normal, the

refractive index, n, and decrease with altitude in the troposphere [2] [3][4].
Refractivity, N, is defined as follows:

$$N = (n - 1) * 10^6$$

A typical value for n at sea level is 1.000350. A few meters above sea level, this might decrease to a value such as 1.00030. This value of refractive index is considerable very small and negligible with hardly any visible deviation. Above the sea level this small but rapid change in the refractive index profile that facilitates the formation of Evaporation Duct.
A refractivity N is also given as:

$$N = 77.6/T(P + 4810 * e\ /T)$$

All three terms P, T and e are actually define the height of the evaporation duct.

## 3. Materials and Methods

In this study we observe the analysis and modeling the formation of evaporation duct in four different positions in Pakistan Coastal Waters. The geographical views of the stations are given below:

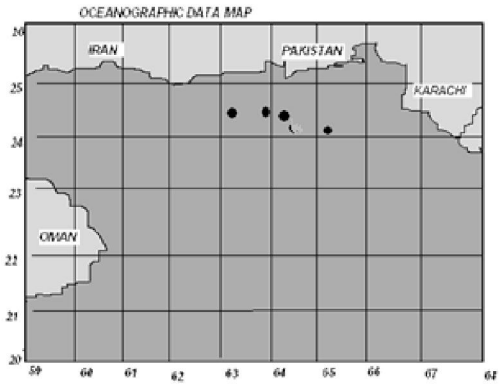


**Figure 2:** Graphical view of understudying stations.

The graphical analysis will clearly explain and gives the easy understanding to the readers to evaluate the difference between the weather conditions of Pakistan coastal waters 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 National Institute of Oceanography, Karachi regions. Survey Echo Sounder (Hydro Star 4900) and Echo Sounder (NJA – 193S) are utilized to carry out deep sea and low depth data respectively. Current meters of models, 108,308 MKIII are used to gather information of temperature, pressure and conductivity parameters [7][8][9][10].

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

## 4. 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.

It is practically confirmed that the presence of evaporation ducts over the costal area is highly dependent on the physical processes and interactions that exists at the air-sea boundary layer [1][6]. After several data collected from the under study positions it is observed that the difference in temperature play an important role in the formation and size of the duct. It is concluded that the stable atmospheric condition is present in the Pakistan Coastal Environment because colder air (indirect contact with Cold Ocean) remains beneath the warmer rising air.

The second phase of the study is to analyze the propagation of radio wave through the duct and the various results are obtained from a research experiment being conducted in the Pakistan Coastal Sea by the different Radio Systems, a number of scatter plots have been produced that try to explain the correlation between enhanced signal strength occurrences and specific meteorological conditions in the Pakistan Coastal Sea through UHF radio link. The graphs below show the signal strengths were observed in the area under study.

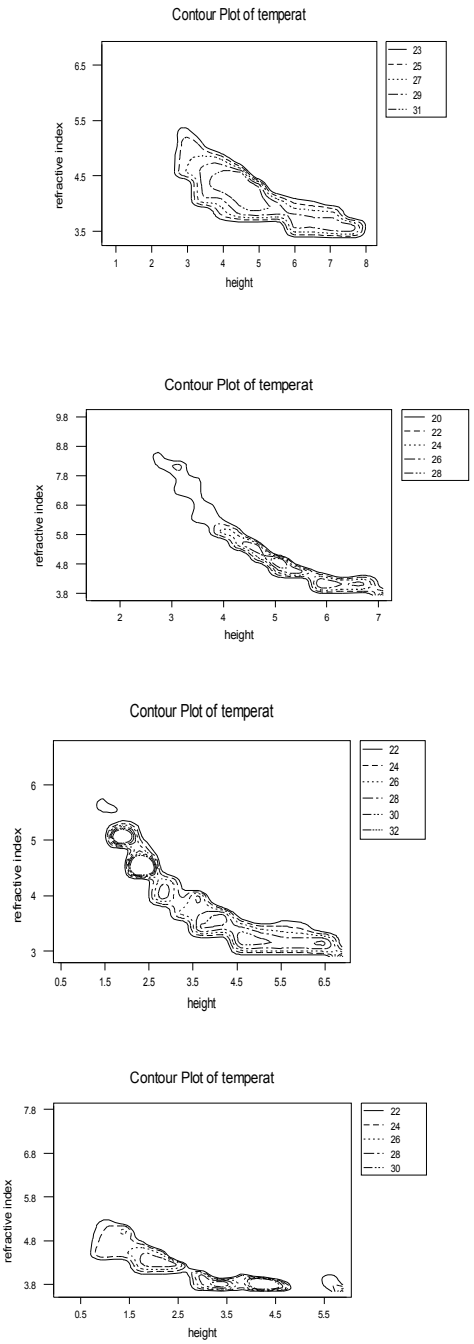


**Figure 3:** Graphical analysis of evaporation duct of the four stations

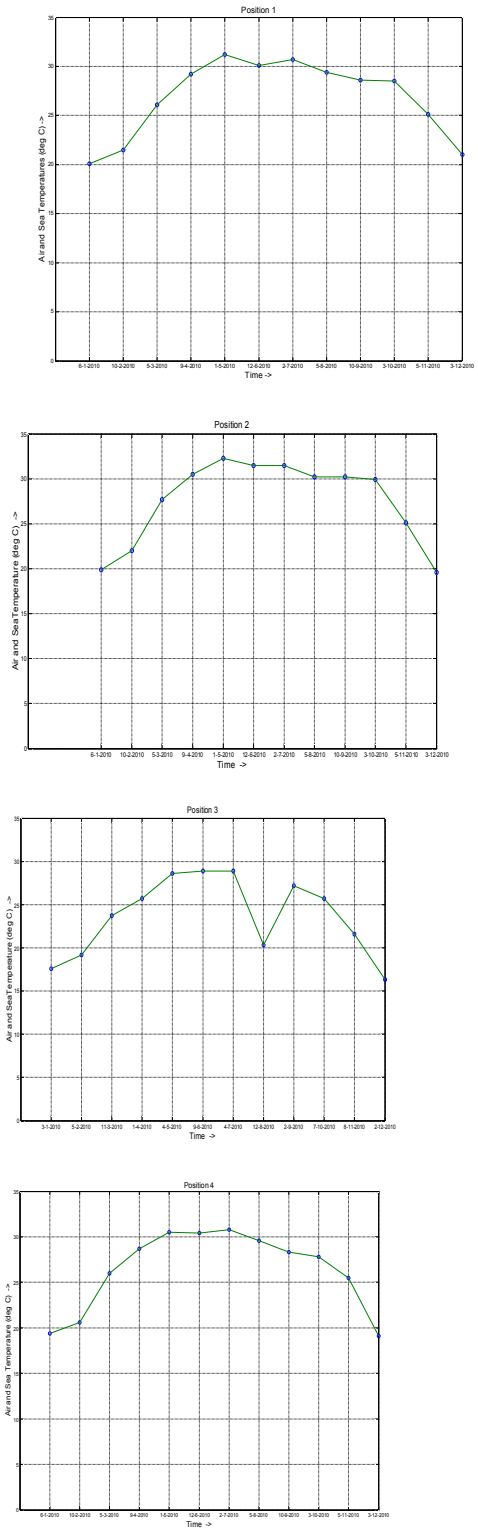


**Figure 4:** Graphical analysis of signal strength in the evaporation duct of the four stations

## 5. Conclusion

In this study an effort is made to clear the mind by observing the analysis result of the area under study that the coastal environments evaporation duct heights depend constantly changing weather conditions over the sea has an vital aspect in marine and coastal environments. The main is the wind speed. When sea breezes are the dominant wind flow, duct heights can be highly variable over a 24 hour cycle. Due to these unusual tropospheric phenomena radio waves to have higher signal strengths and to travel longer distances than expected. Therefore, the influence of evaporation ducts on over-sea radio wave propagation needs to be thoroughly investigated. Research in this area will have implications for maritime communication systems used in coastal cellular telephone networks, commercial shipping, naval radar operations and sea rescue. Out of four positions, three positions have similar parameters and the size of the evaporation duct is almost same but in position number three the physical parameters is different.

5/25/2013

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