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Radio wave propagation mechanism in Bangladesh

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Abstract

To study the radio wave propagation mechanism, the field strength was predieted by calculating the radio refractive index throughout Bangladesh i.e.. at Rajshahi, Rangpur, Sylhet, Dhaka, Khulna, Barisal, Comilla and Chittagong for the years from 1986 to 1995. It was observed that the values of surface refractivity N lie between 332 to 420. The values of surface refractivity is higher in the wet season. The variation of field strength is proportional to the variation of refractivity. The field strength of ground wave depends on the conductivity of the soil i.e. the type of the soil.

Introduction:

Radio waves are electromagnetic waves which radiated form transmitting antenna, travels though the propagation media to distance places where they are picked up by receiving antenna. Propagation of radio waves in VHF, UHF and SHF bands are affected by the meteorological condition in the troposphere. The troposphere is an inhomogeneous medium which contains gases and water vapour. The condition in the troposphere always changes with time. So the amount of bending (refraction) of radio waves also changes from time to time. This influences the relative path length of the direct and the ground reflected component of the space wave. Hence the field strength of the space wave at the receiving point changes with time, i.e. fading of the wave occurs. So the radio engineers should have proper knowledge about the radio refractive index of the troposphere for designing trouble free radio link in a particular region for space wave.

Radio broadcasting in the MW band (300-3000 KHz) is by far the commonest mode of communication with the widest audience in developing countries. A portable transistor receiver is a constant companion of the citizens of the rural areas in Bangladesh More and more broadcasting stations and relay stations are setting up to meet the requirement of the people. However the degree of fidelity in speech and music is not up to our expectation. To solve the problem, before setting up a new station, design engineers should have prior knowledge about the electrical parameters particularly the electrical conductivity of the soil over the radio wave travels. To avoid the co-channel and adjacent channel interference, measurement of field strength is also necessary for the communication engineers.

Considering the above problems, the refractive index and the field strength of the radio waves were investigated at different regions in Bangladesh. The present work will help the engineers and physicists for optimizing the radio wave propagation system in this regions.

Analysis and Calculation of Data

Radio waves in the VHF, UHF & SHF bands propagate through the troposphere. Troposphere is the lower part of earth's surface up to a latitude of about 10 km at the polar region and 16 km at the equator. The field strength of the waves in the VHF , UHF & SHF bands depends on the surface refractivity. The refractivity depends on the meteorological condition in the troposphere. The surface refractivity (N) of the troposphere in the range of frequencies up to 100 GHz is given by the formula (Oyinloye. J. O., 1987)

$$N = \frac{77.6}{T}\left(p + 4810\frac{e}{T}\right) \quad \text{.....(1)}$$

Where P is the total pressure of air in millibar

e is the partial pressure of water vapour in millibar

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Variation of field strength of the space wave depends on the surface refractivity and on the height of the receiving and transmitting antenna. The field strength is calculated form the formula (Dolukhanov, M., 1971)

$$E_{ms} = \frac{21.8\sqrt{P_{1kw}G_1}}{2_{km}\lambda_m} h'_{1m} h'_{2m} \quad \text{mv/m} \quad \text{..... (2)}$$

The parameters h'_{1m} & h'_{2m} of the above equation completely depends on the term. $\left(\frac{dN}{dh}\right)$ Therefore the field strength also depends on the change of refractivity with height $\left(\frac{dN}{dh}\right)$

The field strength of ground wave(<2MHz) transmitted from the transmitter(Dhaka "Kha"). received at Rajshahi, Rangpur, Sylhet, Barsial & Chittagong was calculated by using the mixed path method (Xianru and Zhenzhong, 1987)

Result and discussion:

The variation of surface refractivity in Bangladesh for the years 1987 & 1992 at the places Dhaka. Chittagong, Sylhet, Khulna and Rangpur are shown in fig. 1 & 2 respectively. The values of surface refractivity during the dry season (Nov-Mar) lie between 332 to 372 and the values of surface refractivity during the wet season (Apr-Oct) is in the range from 372 to 420. The surface refractivity depends on humidity, pressure and temperature. In the wet season the amount of water vapour remains high and so the values of refractivity is high. On the other hand the water vapour in the dry season is low as a result getting the lower values of refractivity.

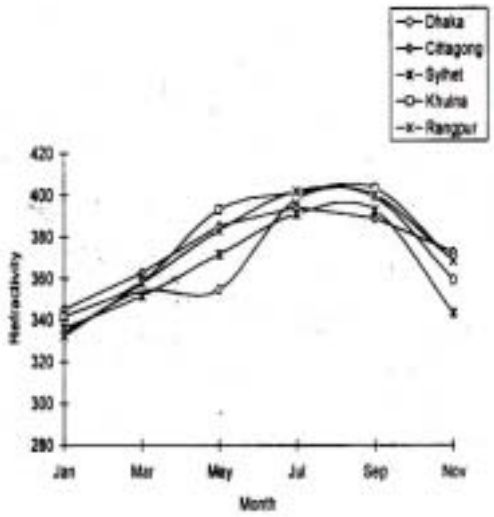

Fig-1: Variation of refractivity for the year 1987

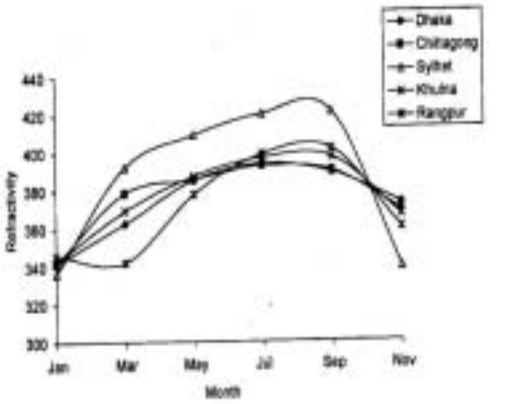

Fig-2: Variation of refractivity for the year 1992

The surface refractivity map of Bangladesh for months Jan and July is shown in fig. 3 & 4. From the map it is observed that the values of surface refractivity depend on the season.

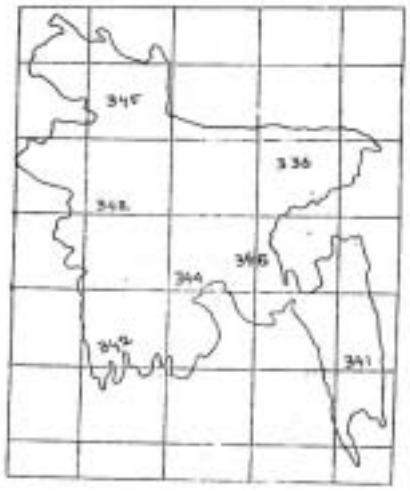

Fig-3: Surface refractivity map of Bangladesh for in month of January.

Fig-4: Surface refractivity map of Bangladesh for the month July

The variation of field strength at Dhaka for the year 1992 is also shown in fig. 5. During the wet season the value of $\left(\frac{dN}{dh}\right)$ is higher, the space wave bends rapidly towards the earth's and so the wave travels shorter path, from the transmitter to receiver. Since the wave travels a shorter path the attenuation of the wave due to the tropospheric parameters is minimum and the field strength is maximum. On the other hand during the dry season the value of $\left(\frac{dN}{dh}\right)$ is lower so the space wave bends slowly towards the earth's surface and the wave travels a larger distance as a result the field strength is minimum.(Hossain M. M. pramanik B. K. 1999).

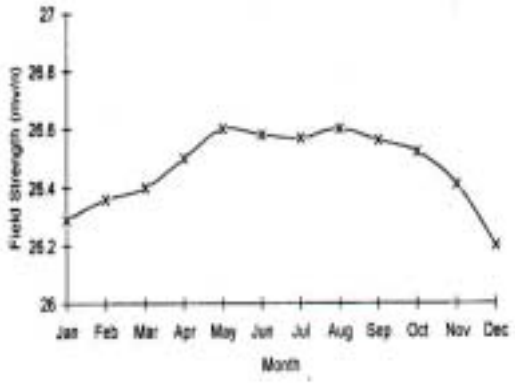

Fig-5: Variation of field strength at Dhaka for the year 1992

The variation of the field strength at Sylhet & Khulna was also observed. The results are also analogous to the variation of the field strength at Dhaka.

The field strength of ground wave (<2MHz) transmitted from the transmitter (Dhaka "Kha"), received at Rajshahi, Sylhet, Barisal and Chittagong was calculated by using the mixed path method (Xianru and Zhenzhong, 1987). It was found that the field strength is about 2.35 mv/m at Rajshahi, 1. 7314 mv/ m at Chittagong. 3.9226 mv/ m at Sylhet and 12.0554 mv/ m at Barisal. The results agreed with the standard values. The ground wave propagated from Dhaka (Savar) to Rajshahi travels over fertile soil 25 km, river (fresh water) of 8 km and dry soil of 82 km. From Dhaka to Chittagong it travels over fertile soil of 162 km and 18 km of river (fresh water). From Dhaka to Barisal it travels over fertile soil of 56 km and 14 km of river (fresh water). On the other hand it travels over fertile soil of 67 km, dry soil of 23 km and over hill of about 5 km for the case of Sylhet. It was observed that the field strength of the ground wave depends on the conductivity of the earth surface.

Conclusion:

From result and discussion, it may be concluded that the variation of surface refractivity is divided into two classes over the year. The surface refractivity mainly depends on partial pressure of water vapour. The field strength of the space wave depends on the refractivity i.e., the meteorological condition of the troposphere. On the other hand the field strength of ground wave completely depends on the conductivity of the surface over which it is propagated.

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