Evaluation of Wave Propagation Parameters using MATLAB Simulation Software

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Abstract: *In wave Propagation, the terminology that has grown up around the ionosphere and types of Wave Propagation includes several names and expressions. In this paper, here we will find out different parameters like Maximum Usable Frequency (MUF) for Sky Wave Propagation and Radio Horizon for Space Wave Propagation using Simulation software i.e., MATLAB. But MATLAB software requires licence. Here these different parameters of wave propagation are evaluated using Simulation software MATLAB Online for free.*

Keywords: MATLAB, Maximum Usable Frequency (MUF), Radio Horizon.

I. INTRODUCTION

Multiple tools are available in the market, but MATLAB is still the most popular tool. MATLAB is a programming language developed by MathWorks. It is software used for high-performance visualization, mathematical computation, and programming. But MATLAB is not open-source; it is a proprietary tool. Proprietary software is owned by an organization or an individual and is not "public-domain software" that can be freely distributed. It is designed to give students fluency in MATLAB programming language. Problem-based MATLAB examples have been given in simple and easy way to make your learning fast and effective.

II. OVERVIEW

Even before Sir Edward Appleton's pioneering work in 1925, it had been suspected that ionization of the upper parts of the earth's atmosphere played a part in propagation of radio waves, particularly at high frequencies. His experimental work showed that the atmosphere receives sufficient energy from the Sun for its molecules to split into positive and negative ions.

The ionosphere is the upper portion of the atmosphere, which absorbs large quantities of radiant energy from the Sun, thus becoming heated and ionized. There are variations in the physical properties of the atmosphere such as temperature, density and composition. As the different types of radiations received, the ionosphere tends to stratified, rather than regular, in it's distribution.

The most important ionizing agents are ultraviolet and α, β and γ radiations from the Sun, as well as cosmic rays and meteors. The ionosphere consists of four main layers D, E, F1 and F2. in ascending order. The last two layers combine at night to form one single layer.

The parameters which is to be calculated using MATLAB are, Maximum Usable Frequency (MUF), Radio Horizon.

Critical Frequency for a given layer is the highest frequency that will be returned down to earth by that layer after having been beamed straight up at it. The critical frequency for the F2 layer is between 5 to12 MHz

Maximum Usable Frequency (MUF) -

It is also a limiting frequency, but for some specific angle of incidence other than the normal. If the angle of incidence (between the incident ray and the normal) is Θ then

$$\text{MUF} = (\text{critical frequency})/(\cos\Theta)$$
$$= f_c \sec\Theta$$

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This is the so-called secant law, and it is very useful in making preliminary calculations for a specific MUF. However, the MUF is defined in terms of the angle in practice. Rather it is defined as MUF is the highest frequency that can be used for the sky wave communication between two given points on the earth. Normally the values of MUF are in the range of 8 to 35 MHz

Figure of MUF given below-
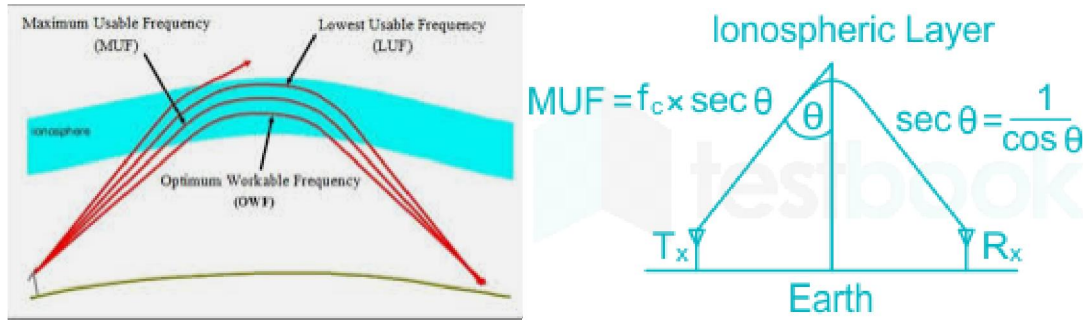
Radio Horizon-

The Radio Horizon for Space Wave Propagation is about four-third as far as the optical horizon. This beneficial effect is caused by the varying density of the atmosphere, and because of diffraction around the curvature of the earth. The radio horizon of an antenna is given by

$$dt = 4 \sqrt{ht}$$

Where,

dt= distance from transmitting antenna, Km

hr= height of transmitting antenna above ground, m

For receiving antenna same formula is applicable. Thus, the total distance will be given by addition
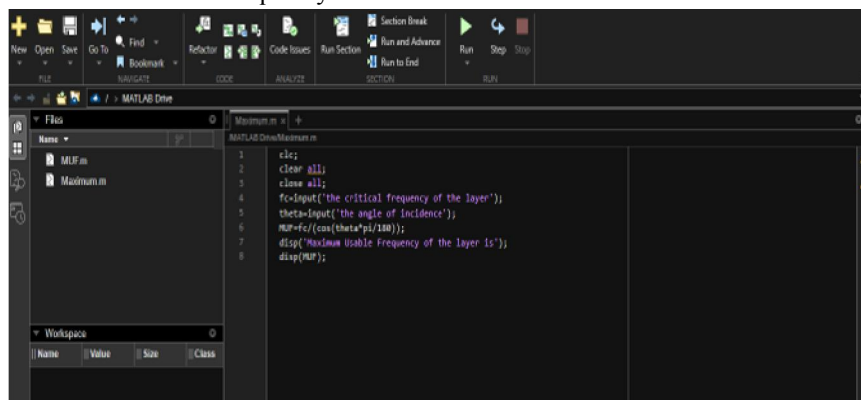
Therefore,

$$d = dt + dr = 4\sqrt{ht} + 4\sqrt{hr}$$
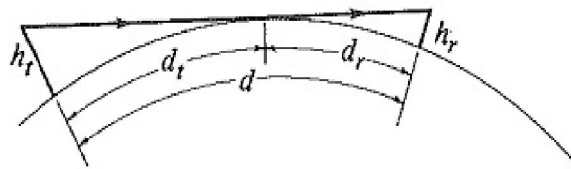
III. MATLAB CODE
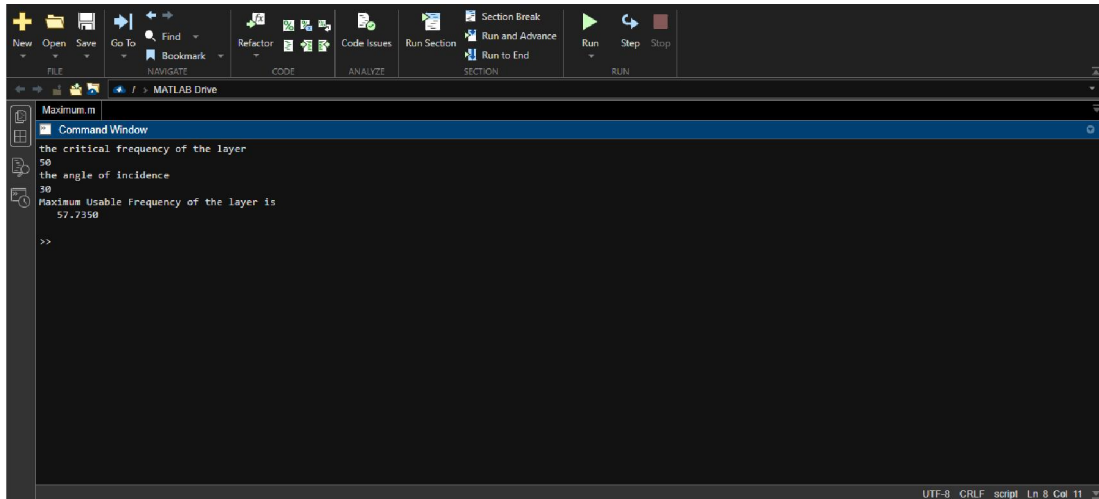
MATLAB Code for Maximum Usable Frequency


```
1   clc;
2   clear all;
3   close all;
4   fc=input('the critical frequency of the layer');
5   theta=input('the angle of incidence');
6   MUF=fc/(cos(theta*pi/180));
7   disp('Maximum Usable Frequency of the layer is');
8   disp(MUF);
```
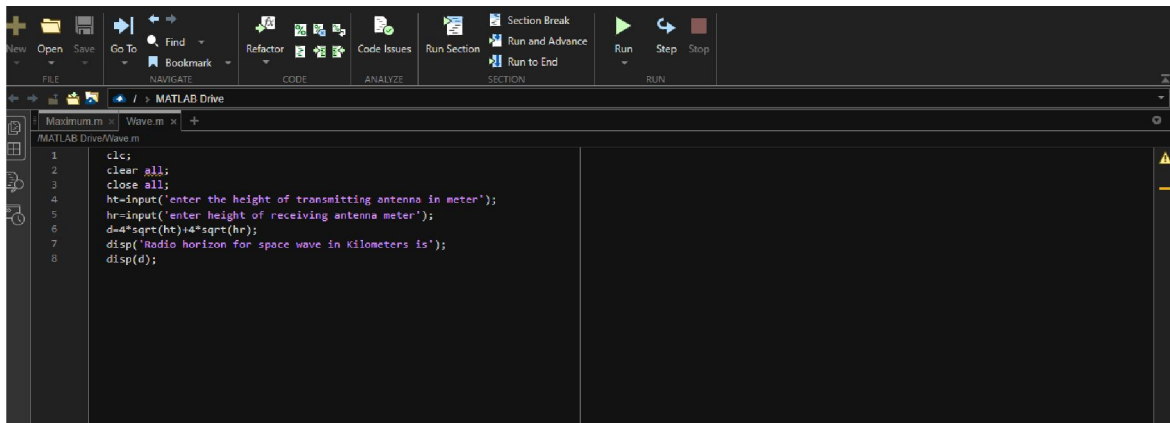
IV. SIMULATION RESULT
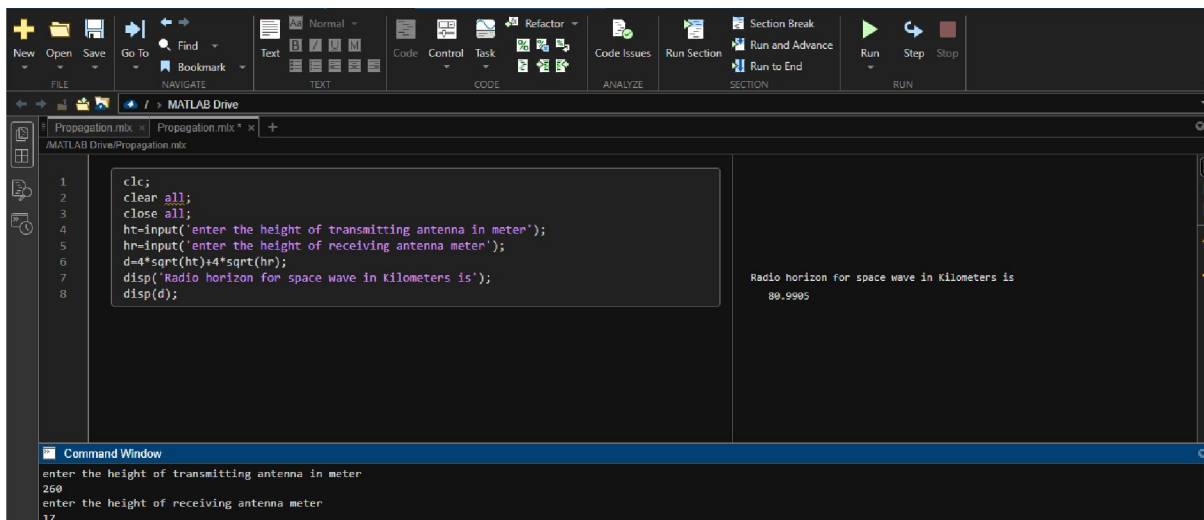
V. MATLAB CODE FOR RADIO HORIZON

VI. SIMULATION RESULT

VII. CONCLUSION

Thus, it has been observed that the different parameters of Wave Propagation can be calculated using simulation Software i.e., MATLAB online for free.

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