Study of Scattering and Absorption of EM Wave Due to Rain and Storms

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***Abstract*: The Scattering and absorption of Electromagnetic waves is severely affected by rain, storms and dust particle size in terms of attenuation, de-polarization and noise. The vertical looking radiometers will give vertical path attenuation due to rain as well as dust and line of sight link will give horizontal path attenuation whereas the satellite link gives slant path attenuation. In this present paper the methodology of collecting data and methodology for obtaining slant path attenuation using data obtained from vertically looking radiometers and horizontal line of sight links will be given. Validation methodology for the slant path attenuation using beacon receiver will be given.**

Keywords*: *Electromagnetic Waves, Absorption and Storms

1. Introduction :

The use of communication satellites is increasing rapidly and propagation studies at millimeter wave frequencies are of great importance as lower frequency spectrum is getting over crowded. For increasing the channel capacity, the use of ku and ka band is unavoidable. But the rain and dust attenuate the higher frequency signal operating above 10 GHz[1]. The drop size also has effect on the polarization of the radio waves propagating above 10 GHz. At higher frequencies, signal attenuation due to scattering and absorption by the dust particulate depends upon the size and shape of the particle. The frequencies above 30 GHz also have utilization potential in this part of the world for Satellite Communication. So far no significant studies related to effect of rain and dust have been carried out at 35 GHz. It is important to understand about losses in the link at this frequency by conducting experiments so that the link design could be made properly. ISRO is planning to put a beacon operation at 20/30 GHz in future communication satellite. This beacon could be used for propagation studies upto 30 GHz.

2. Experimental :

For obtaining slant path attenuation for planning of Satcom link one has to get two components of the attenuation of the signal. These components are the vertical path attenuation and horizontal path attenuation. In order to collect sufficient propagation data for both horizontal and vertical path attenuation at 35 GHz, the following experimental setup is proposed. The vertical path attenuation is obtained with the help of a microwave radiometer. The radiometer is a microwave receiver, which is calibrated in terms of input noise temperature and the output voltage. The input noise temperature from clear sky in the normal conditions is measured and the output voltage recorded. The change in the output voltage in the presence of dust and rain gives the relationship between the attenuation of signal due to rain and presence of dust and rain.

Formulation for Estimation of Attenuation and Rain Height

The output voltage from radiometer is recorded for calculating the attenuation. This voltage is converted into equivalent sky noise temperature (T_{sky}) using calibration table. The relation between attenuation and sky noise temp is

$$T_{sky} = (T_c/A_t) + (1\text{-}1A_t)^* \, T_{med} \qquad .. (1)$$

Where, T_c = Cosmic background temperature (2.7^o), A_t = Attenuation in dB, T_{med} = Medium Temperature

The vertical path attenuation due to rain is estimated by subtracting clear sky attenuation (free space) from excess attenuation (rainy medium) due to rain. The slant path attenuation can be calculated using the rain height (H_e). The rain rate remains invariant with rain height is assumed. The rain height H_G can be calculated as:

$$(H_G = (A_H / \alpha)km \qquad \ldots (2)$$

Where A_H is the total zenith attenuation and α is specific attenuation

The path reduction factor is related to the horizontal path length. The horizontal path length is defined as "That path length where a uniform rain measured at a point of reference to measure to produce attenuation equivalent to the attenuation measured on the link." In LOS link two receivers are used. One receiver receives coplanar signal and the cross polar signal is received on cross-polar receiver. The reduction in signal strength due to presence of rain or dust particles, as compared to clear sky condition gives attenuation due to rain, or dust particles and in two receivers the effect of tilt in axis of drop is monitored by co-polar and cross polar signals. The effective path length is computed using the attenuation in signal in copolar receiver and rain rate.

3. Conclusion

In this work the slant path attenuation measurement at 35 GHz and the system design of equipments required for Vertical height attenuation measurement, which is done by radiometers and Horizontal path attenuation measurement is done by Line of Sight Link is described. The experimental for determination of slant path attenuation at 35 GHz is also presented. Than we feels that the effect of precipitation on propagation at 35 GHz must be undertaken urgently in our country.

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