Kodaikanal Obs. Bull. (1997) 13, 217-220

Microwave Propagation and Troposphere : Eclipse Time Observation

U. Mishra, S. Sen, S. Sharma, A.K. Barbara and M. Devi
Department of Physics, Gauhati University, Guwahati - 781 014

Abstract

The effects of 24th October 1995 solar eclipse were studied on the reception of Laitkor-Shillong and Nongpiur-Shillong links both operating at a frequency of 11GHz. The surface temperature, pressure and humidity were continuously recorded and the radio sonde and SODAR observations are available during that period. These links (generally stable) showed an attenuation of 8dB during the maximum solar obscuration period (82%). The radio refractive index gradient maintained a normal lapse rate during the initial phase of the eclipse, but with the progress of eclipse and during the maximum obscuration period, the gradient reflected development of sub-refractive conditions. The paper discusses the effects of refractive fading on microwave signal by eclipse induced sub-refractive situation through a simple ray tracing model over the link path.

Key Words : Solar eclipse, Microwave propagation, Radio refractive index

Introduction

The October 24, 1995 solar eclipse touched Guwahati at 07:33 IST with maximum obscuration of 82% at 08:55 IST. The recovery phase started after that and the eclipse ended at 10:20 IST. During this period the propagation character of the two 11 GHz Microwave links viz. Laitkor - Shillong (3.2 Km) and Nongpiur - Shillong (5.65 km) were studied. The observation on meteorological variabilities like radio refractive index (RRI), RRI gradient and solar echograms are also available during this period.

Observation

The cooling of the atmosphere was observed 15 minutes after the commencement of the eclipse and the temperature went down by 2° (from the commencement time) during the maximum obscuration period. Along with the earth's cooling effect, the 11 GHz links showed attenuation by 10 db. The attenuation of the signal too low compared to the blackout

conditions, is significant because of the presence of feedback control system which corrects the signal level for moderate variations. The temporal changes in signal amplitude of the two links (Fig. 1) maintained fair similarity with significant attenuation during the maximum obscuration period. However while Laitkor fades were abrupt, the Nongplur attenuation reflected gradual increase to reach the maximum during the totality.

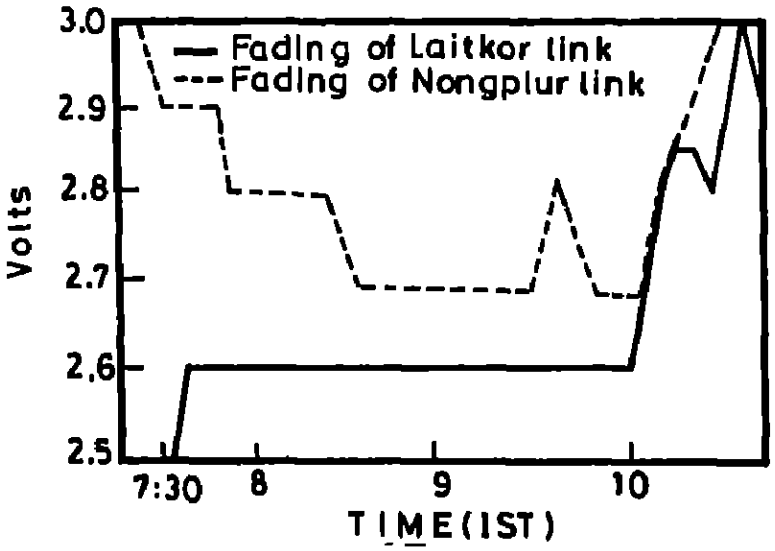

Figure 1 : Fading of the links on the eclipse day.

On examination of RRI and RRI gradient received through radio sonde observations in this context (Fig. 2) indicates development of subrefractive condition after 10 - 15 mins. of the commencement of the eclipse. The drifting of balloon to higher altitude would however make an altitude effect, but during normal days, RRI gradient does not reflect such situation (when altitude effects are also present). Average PRL gradient variation pattern for the normal days is also presented with the RRI gradient of the eclipse day. The development of sub-refractive condition during eclipse are clearly seen from this figure. The sodar echogram taken over Guwahati also reflects the increase of inversion layer heights during the maximum obscuration period.

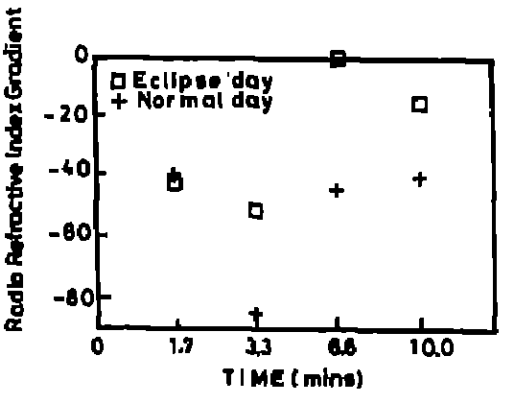

Figure 2 : Radio refractive index profile of eclipse day and normal day.

Discussion

The basic factors that may be responsible for development of attenuation over the two 11GHz links are difficult to define without multiple observations of eclipse time tropospheric variabilities over the link path. However, the effect of sub-refractive condition in the atmosphere cannot be ruled out for the observed attenuation in microwave propagation. Our past study shows that the microwave fadings are rarely observed during the normal atmosphere while RRI gradient varies between - 40N to - 100N, (where N is the refractivity), a sub refractive situation in the atmosphere triggers attenuation in microwave signals. The attenuation in sub-refractive state is caused either by obstruction of the first Fresnel zone by earth's bulge (over a large hop) or through generation of surface or elevated inversion. In the short hops, obstruction by first Fresnel zone cannot be expected. However refractive bending of signal during such situation cannot be ruled out. Examination of the terrain features of the studied link (viz. Laitkor link) (Fig. 3) clearly shows that LOS path is free from earth's obstruction for both normal and worst atmospheric situation. However sub-refractive condition generated in the atmosphere, (in the worst clearance position) may deviate the beam causing fading or attenuation. A simple ray tracing model is applied assuming presence of a strong sub refractive condition (reflected by the RRI) of depth 50 meters in the atmosphere at a distance of 1 km from the transmitting end. The computation shows that in such a condition the signal will bend by 0.02° defocussing a part of energy at the receiving antenna. The microwave signal is likely to suffer attenuation in such a condition.

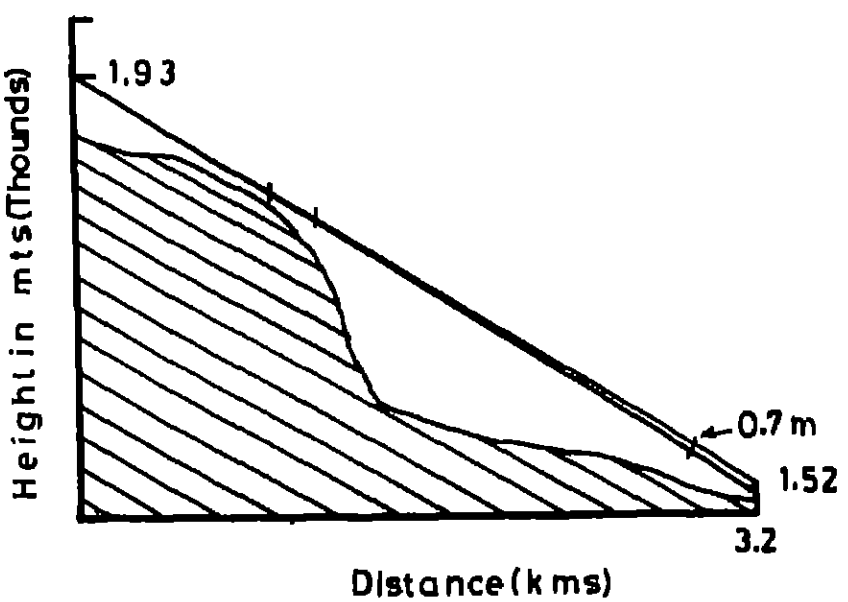

Figure 3 : Raytracing of Laitkor path during the eclipse period.

Conclusion

The analysis shows that microwave suffers attenuation during eclipse condition. The analysis of meteorological parameters suggest development of sub-refractive situation. A simple ray tracing model indicates that refractive bending of ray because of sub-refractive situation developed by the eclipse may lead to the observed attenuation.

Acknowledgement

The authors wish to express their thanks to the P & T Department and the IMD Guwahati for their kind co-operation.