PROPAGATION OF VHF WAVES IN SEMI ARID CONDITIONS

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Introduction: In this paper some observations on a LOS (Line of Sight) VHF link within the city of Khartoum will be revealed. Khartoum, the Capital of Sudan, lies in a semi desert region where the Blue and White Niles join to form the main Nile. The climate is characterized by being hot and dry over more than 80% of the year. In summer days are in general very hot with maximum temperatures that may exceed 45° C, while nights are relatively cool with minimum temperatures ranging between 25 to 35° C. In winter the maximum and minimum temperatures are 25 and 14° C respectively. These figures, however, vary considerably from year to another. Humidities, on the other hand are less than 30% over the whole year except during the rainy season that lasts for less than two months. To investigate the effects of these climatic conditions on the propagation of very high frequency waves over short distances, a 5 kilometer test link was used and was operated at a frequency of 100 MHz.

The transmitting antenna was installed on the roof of the Faculty of Engineering, University of Khartoum, which is a six story building of 27 meters height. The receiving antenna, on the other hand, was placed on the roof of a two story building some 5 kilometers south of the transmitter. It is worth noting that the Faculty of Engineering is less than a 100 meters south of the Blue Nile. Thus the radio path does not cross either of the Niles.

The received signal level was recorded around the clock for several months. In this paper some of the salient observations made in this study will be revealed.

Diurnal Signal Variations: The general features of signal variations over the day are as follows: During night time the received signal level is relatively high with a low level of scintillations The maximum signal level is reached at dawn. During day the level starts to drop reaching a minimum at sun set. Scintillations may exceed 10 dB between peaks. The difference between the maximum level at dawn and the minimum at sun set is around 6 dB on the average. Differences exceeding 20 dB were observed, however. Fig. 1 shows the diurnal variation of received signal level relative to the free space level as observed on the 18th and 19th of February 1989. The high level of scintillations during day time is attributed to air turbulences brought about by convection. Fig. 2 shows how the level of scintillations increases during day time as compared with night time.

Surface Ducts: Surface ducts occur, in Khartoum, very frequently after sun set. These occur as a result of the formation of a temperature inversion at a relatively low height above the ground. During day time the ground becomes very hot due to solar radiations. Hot air rises by convections and a stable layer of hot air is formed several tens of meters above the ground. During night the ground cools and so does the air close to the surface while at some 50 meters above the ground air remains hot thus forming the duct(1). It is the vast temperature difference between day and night that helps in the formation of these surface ducts despite the low level of vapor pressure. In general the effect of variations of vapor pressure with height is negligible except during the rainy season.

The influence of surface ducts on microwave propagation at 2 GHz was observed to cause multipath propagation with fades ranging between +6 and -25 dB (2). At 100 MHz multipath fades have been observed a number of times. The effect, however, is less pronounced than at 2 GHz. Also the frequency of occurence is lower than that encountered at microwave frequencies. The deepest multipath fade observed, as yet, is less than -20 dB. An important feature of these fades is that they occur suddenly, continue for some period (ranging from a few minutes to over an hour) and disappear as suddenly as they appeared. Fig. 3 shows a typical multipath event that took place on the evening of the 15th of January 1989. From this recording it is seen that multipath fade appear like a rectangular pulse. This is different from that observed at 2 GHz which assumes random shapes and looks like noise.

Conclusions: Observations of the signal level on a 5 Km VHF link operating in Khartoum confirms the existence of a diurnal cycle with maximum signal level occuring before sun rise and minimum level around sun set. Due to surface ducts multipath fades are encountered in the evenings. These usually appear in the signal level recrdings as rectangular pulses.

References

(1) D E Kerr (ed):"Propagation of short radio waves", Chapter 3 McGraw Hill Book Co,Inc. 1951.

(2) S I Ghobrial and M A Hemeidi:"Microwave propagation in semi desert conditions" International Wroclaw Symposium on Electromagnetic compatibility, 24-26 June 1986, Wroclaw, Poland.

Figure Captions

1- Diurnal variation of signal level.

2- Night and morning scintillations.

3- A multipath event that took place on the evening of Jan. 15th 1989.

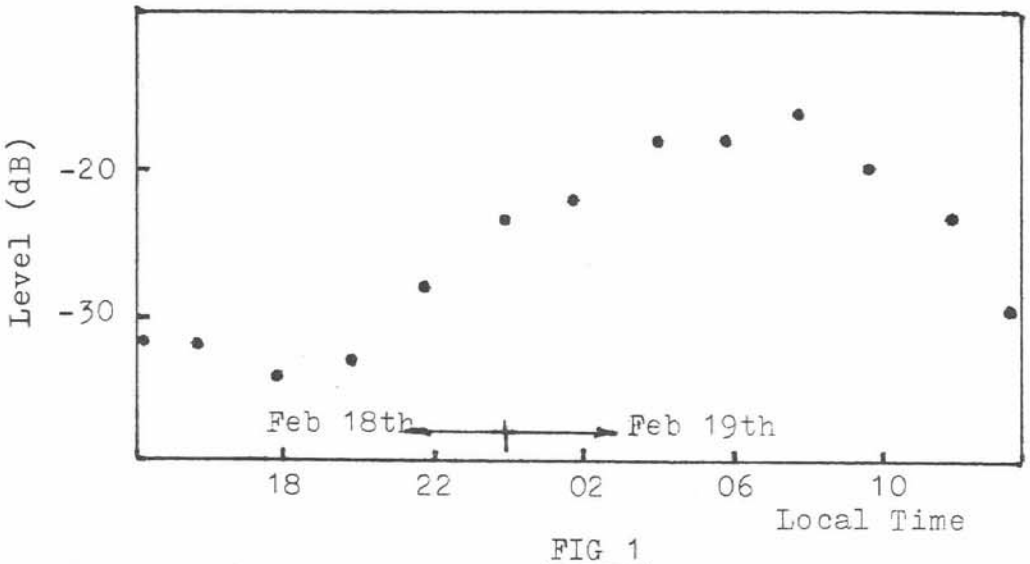

FIG 1

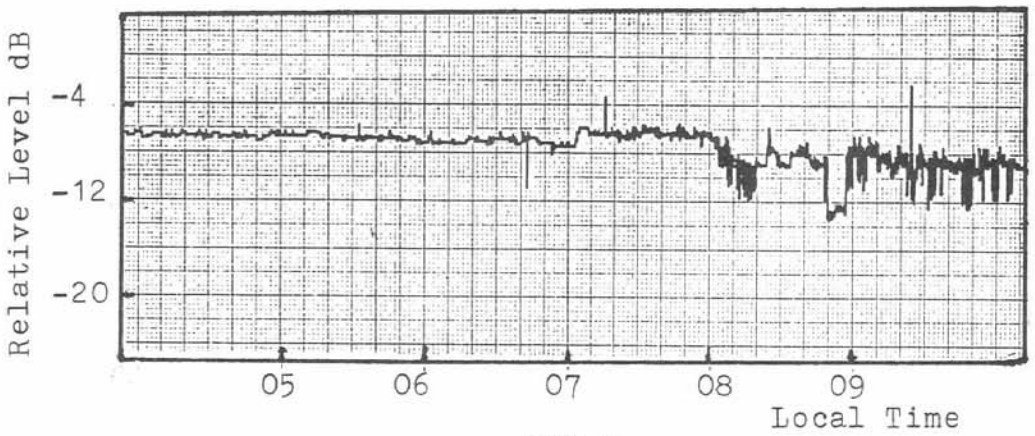

FIG 2

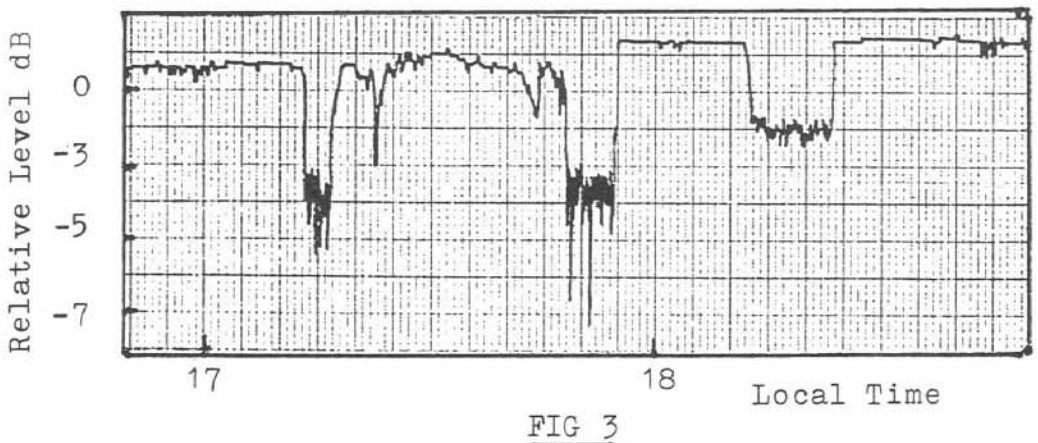

FIG 3