



STATISTICAL ANALYSIS OF VHF SIGNAL  
TRANSMISSION IN EGYPT AND ACROSS RED SEA

BY

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ABSTRACT

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The propagation of VHF and UHF signals depends, mainly, on the propagation media. Measurements had been done, in Egypt, in two paths and at some individual points. The first path was a propagating of TV VHF signal across cultivated land (in Delta region). The second path was carried out for an FM VHF signal propagated across the Red sea. The recorded signals, for the two paths, were statistically analyzed and the probability of the signal reception, the probability distribution, and the signal correlation are noted.

The individual points were selected in different regions in Egypt, during different seasons, where the field strengths, from different TV transmitters, were measured. The field strengths were normalized and plotted on standard curves to be compared to the appropriate standard curves. There are noticeable differences in the results for standard media and different seasons (1,2,3).

INTRODUCTION

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The nature of Egypt land with respect to VHF and UHF propagation varies from region to region. In the north, there is cultivated land, in the south, there are desert except the region of the river valley. Also there are two important regions, the Mediterranean sea coast and the Red sea coast.

The first path experiment was carried out in the cultivated land in the Delta region. In this experiment, a TV signal (in VHF band) transmitted from Mahalla TV centre (Fig.1) was received and recorded at Cairo. The distance between Mahalla and Cairo is about 100 km.

The second path experiment was carried out across the Red sea. An FM signal transmitted from Jeddah (in Saudi Arabia) was received and recorded at Qusair (in Egypt). The distance between Jeddah and Qusair is about 700 km.

In addition to these two experiments, field strength measurements were carried out at many points, in the Delta region, on the Red sea coast, on Suez and Aqaba Gulves, and on the mediterranean sea.

The transmitters, of which the field strength were measured are in Egypt, Saudia Arabia, Jordan, Syria, Jerusalem, Haifa, and Tobruk.

## RESULTS

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(i) The probability of the field strength levels exceeded for 1%, 5%, 10%, 50%, and 90% .

The recorded received signals of Mahalla-Cairo and Jeddah-Qusair experiments were analyzed to calculate the probability of the field strength levels exceeded for 1%, 5%, 10%, 50%, and 90% . Unfortunately, the time of the recording was not too long due to unavailability of the equipment at that time. The probability of the received signal levels exceeded for the named percentages are estimated and plotted day by day. Fig.2 shows the results for Mahalla-Cairo experiments, and Fig.3 shows the results for Jeddah-Qusair experiment. Table 1 summarizes the results obtained from Figs. 2 & 3.

Time Percentages	Probability for Mahalla-Cairo	Probability for Jeddah-Qusair
1%	1	.7 to 1
5%	1	.33 to 0.94
10%	.89 to 1	.27 to 0.9
50%	.19 to 0.48	.02 to 0.58
90%	.04 to 0.08	0 to 0.33

Table 1: Probabilities of received signals for Mahalla-Cairo and Jeddah-Qusair of levels exceeded 1, 5, 10, 50 & 90% .

From the table, it is clear that for Mahalla-Cairo, the probabilities for 1% and 5% are 1, and for 10% is close to 1, but on the contrary, for Jeddah-Qusair the probabilities are lower. Also, the ranges of variation in each percentages, for Jeddah-Qusair, are larger than that for Mahalla-Cairo. Figs. 4 and 5 show parts of the recorded charts for the two experiments.

(ii) The Probability Distribution Functions

The recorded received signals for Mahalla-Cairo and Jeddah-Qusair are sampled in order to estimate the probability distribution functions. Fig. 6 represents the function for Mahalla-Cairo, and Fig. 7 represents Jeddah-Qusair function.

For Mahalla-Cairo the function shown in Fig. 6, can be compared with normal distribution. For Jeddah-Qusair ( Fig. 7 ), the distribution concentrates near zero level and has appreciable values up to 50% of the recorded signal level.

(iii) VHF Signal Correlation

The correlation between waveforms is a measure of the similarity or relatedness between the waveforms. The autocorrelation of a waveform is the correlation of this waveform with itself.

In the experiments, the autocorrelation of samples of the received signals is calculated. Fig. 8 shows the correlation of Mahalla-Cairo signal, and Fig. 9 for Jeddah-Qusair signal. From the figures, it is clear that the correlation for the first path is stronger.

(iv) The Field Strength Measurements

In order to compare the VHF TV signal propagation across different media during different seasons, some points, represent different paths, were selected in different regions in Egypt. Each path may be totally across sea, totally across land, or part sea and part land.

The values of the measured field strength are normalized to 1 kW effective radiated power, and plotted on appropriate curves ( according to the path and the transmitter effective antenna height ).

The curves for free space, 50%, and 1% of time are shown for references. Figs. 10 to 13 show the results of the measured field strength values. The curves are ordered from total land path, mixed path, then total sea paths. Fig. 1 shows a map having the different paths according to each figure. These curves are classified into three groups. The first group, Fig. 10, represent paths across land like Delta region. As shown, from this figure, the normalized field strength values are less than the 50% and the 1% time percentages.

The second group, Fig. 12, represents the signal propagation across mixed paths. The third group, fig. 13, represent the signal propagation across gulf and sea.

It is clear that the field strength values are higher for sea and gulf paths than mixed paths than land paths. For sea path the values can reach the free space curve. Also, for months of summer season, the values are higher than the winter season.

#### CONCLUSION

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The propagation of VHF signal through short path differs than long path. In the short path ( as Mehalla-Cairo ), the received signal level is smooth and has no severe fading. The probability distribution function can be compared to the normal distribution function. Also correlation coefficient of the received signal is high.

In the long path ( Jeddah-Qusair ), the received signal has many severe fading. This is due to the long path or due to the propagation media ( sea ). The probability distribution function cannot be compared with the known distribution. The correlation coefficient of the received signal is small.

The individual field strength measurements show that the values are higher for sea and gulf paths than mixed paths than land paths as expected. For sea path, the values can reach and exceed the free space curve. Also, for summer seasons, the values are higher than the winter season.

Data acquisition system is now prepared and equipped to analyze different paths. The analysis, using the microcomputer system, will lead to versatile results.

#### REFERENCES

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- (1) CCIR, "RECOMMENDATIONS AND REPORTS OF THE CCIR ON PROPAGATION IN NON-IONIZED MEDIA", Vol. V, 1986.
- (2) EBU, "IONOSPHERIC PROPAGATION IN EUROPE IN VHF TELEVISION BAND I", No. 3214, Vol. I, Feb. 1976.
- (3) EBU, "IONOSPHERIC PROPAGATION IN EUROPE IN VHF TELEVISION BAND I", No. 3214, Vol. II, Feb. 1976.

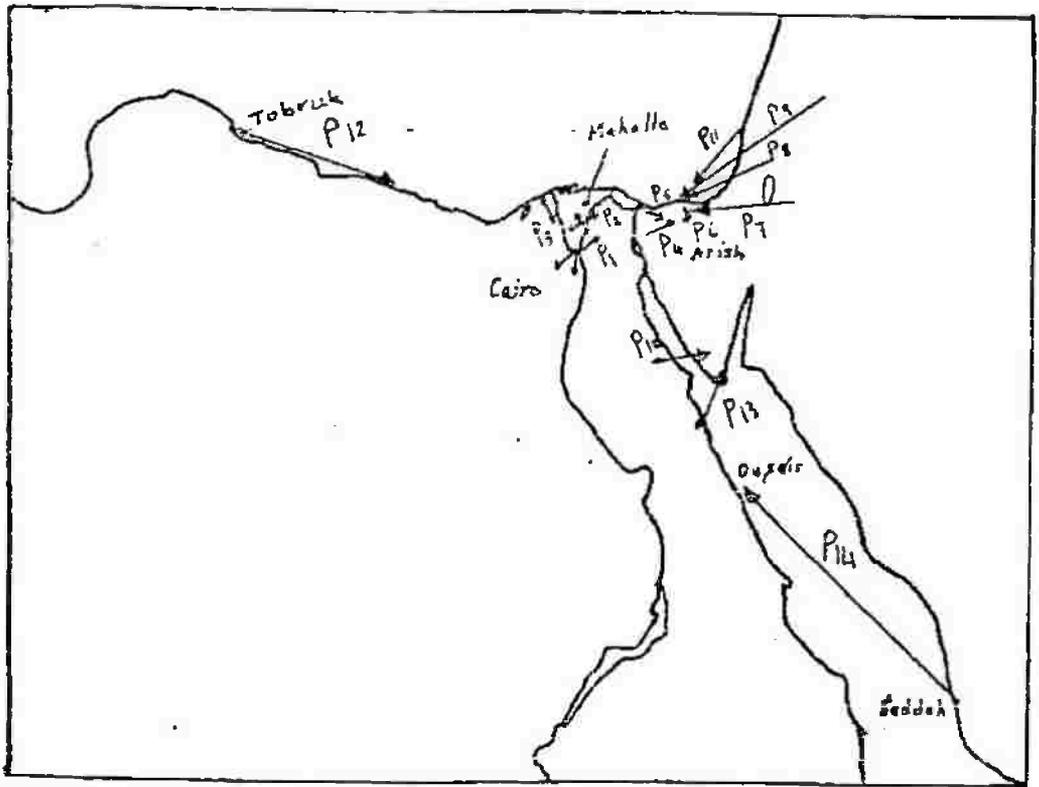


Fig. ( 1 ) Map of EGYPT.

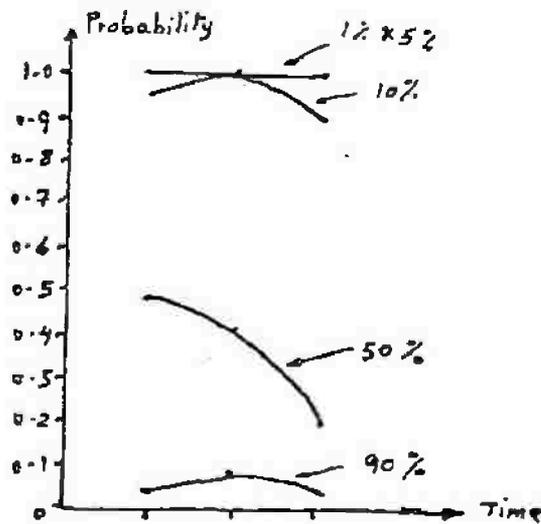
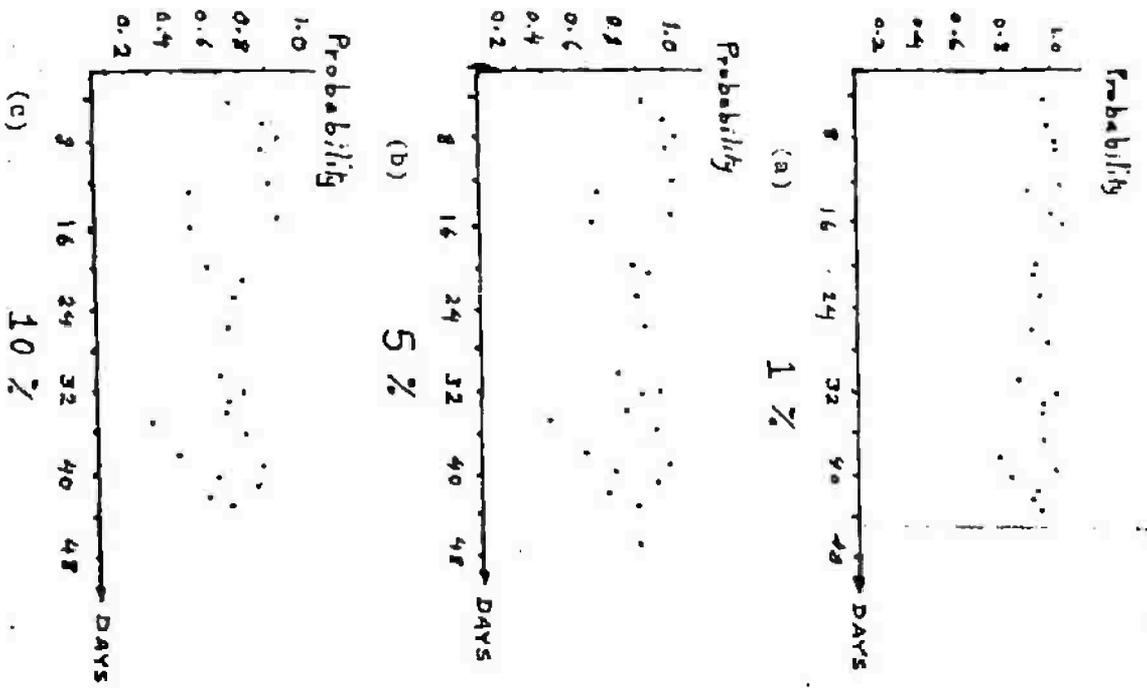
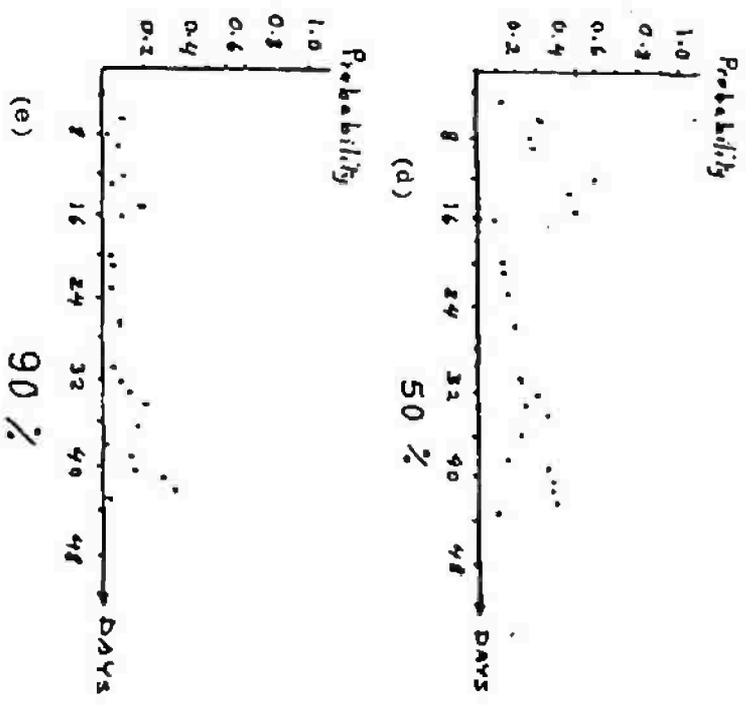


Fig. ( 2 ) Probability of received signal levels exceeded 1 %, 5 %, 10 % and 90 % for Mahalla-Cairo experiment.



Figs( 3 ) Probability of received signal levels exceeded 1 %, 5 %, 10 % and 90 %.

- FM Transmitter at Jeddah(Saudia Arabia)
- Received point at Qusair (Egypt).
- Distance Jeddah-Qusair = 700 Km.



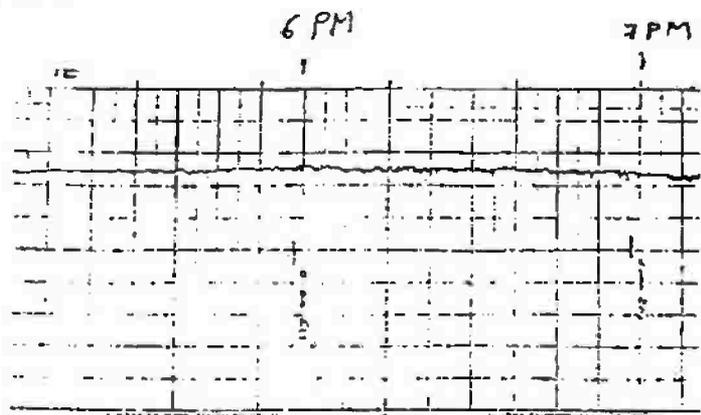


Fig.( 4 ) Part of the recorded signal for Mahalla-Cairo experiment.

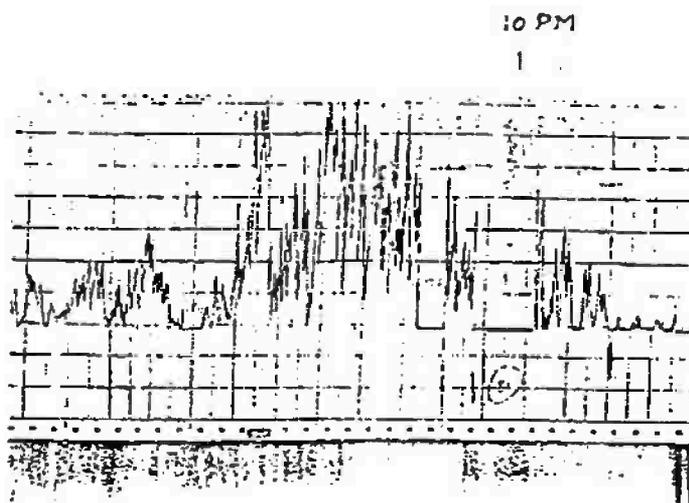


Fig.( 5 ) Part of the recorded signal for Jeddah-Qusair experiment.

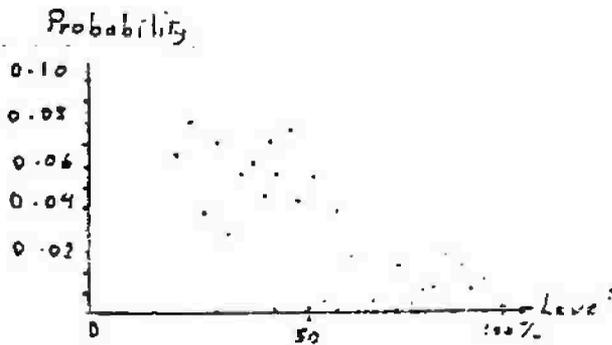


Fig. ( 6 ) Probability distribution function  
for Mahalla-Cairo experiment.

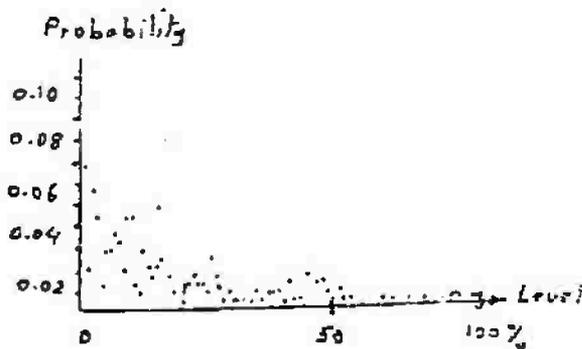


Fig. ( 7 ) Probability distribution function  
for Jeddah-Qusair experiment.

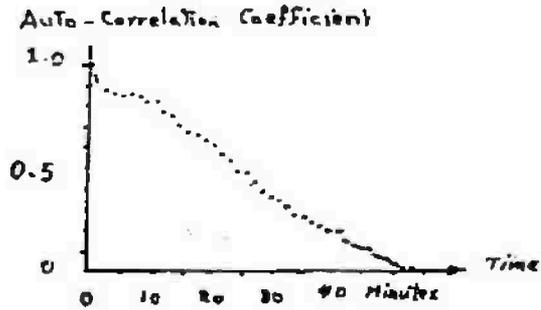


Fig. ( 8 ) The autocorrelation of Mahalla-Cairo signal.

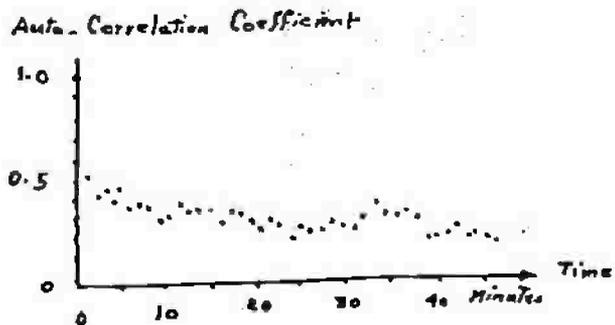
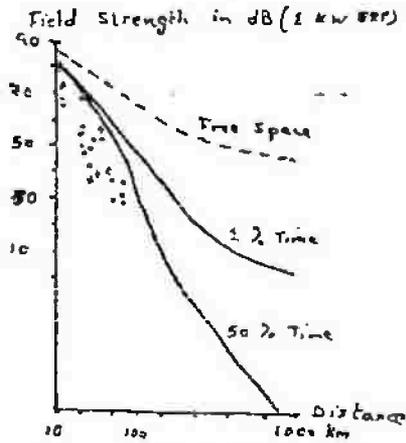
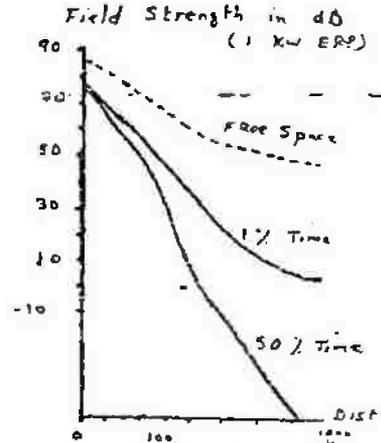


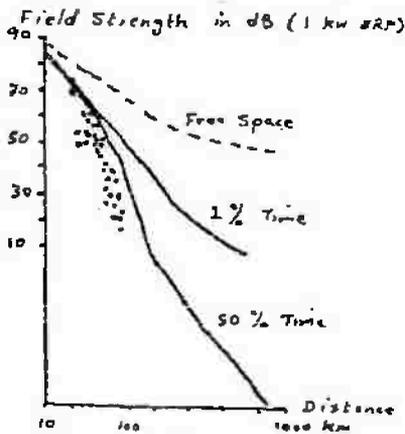
Fig. ( 9 ) The autocorrelation of Jeddah-Qusair signal.



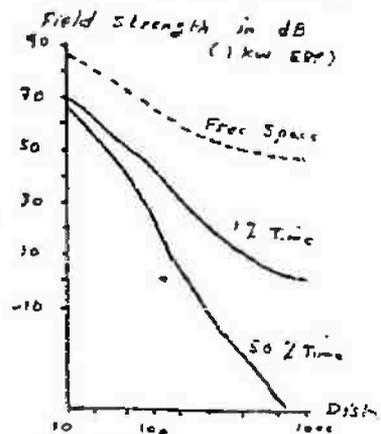
(a) Path 1 (Makattam)



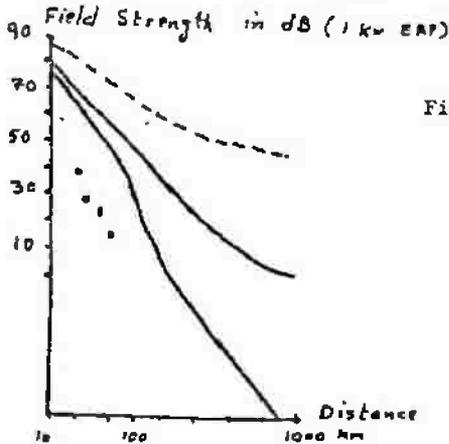
(d) Path 4 (Ismailia)



(b) Path 2 (Mahalla)



(e) Path 5 (Port Said)



(c) Path 3 (Alex)

Figs. ( 10 ) The field strength in dB (relative to 1 kW ERP) for different Tv transmitter (lund path

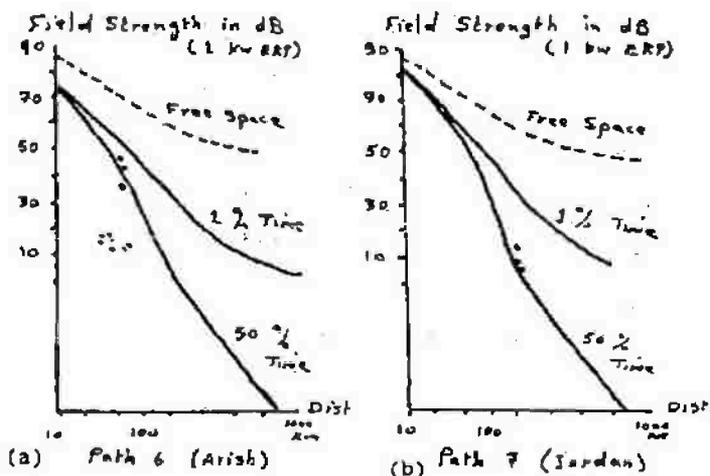


Fig:( 11 ) The measured field strength in dB (1 Kw ERP)  
(land path)

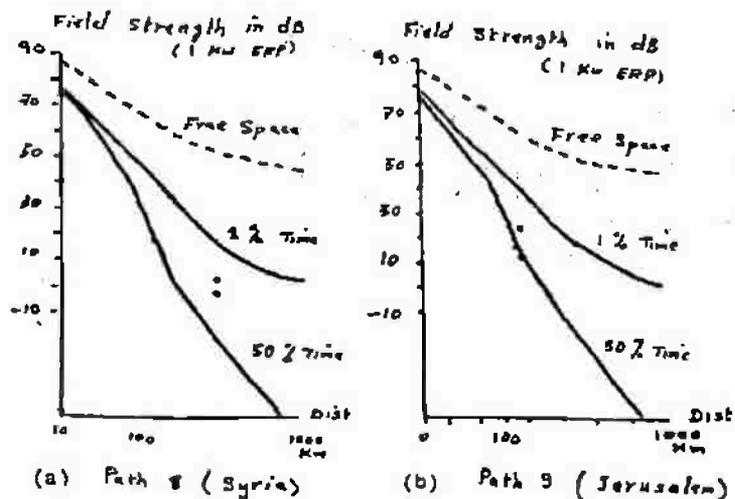
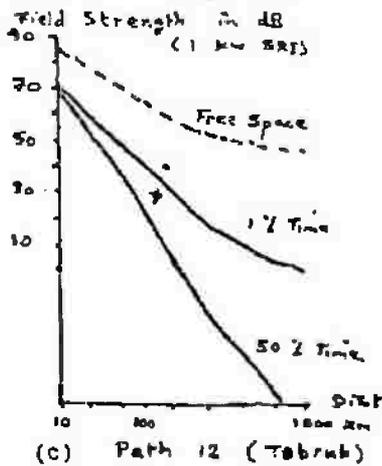
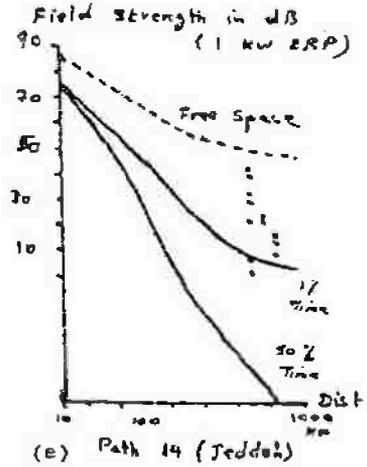
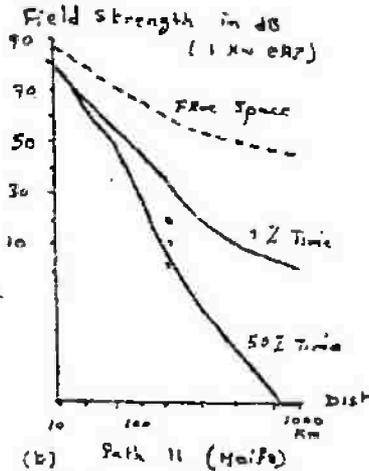
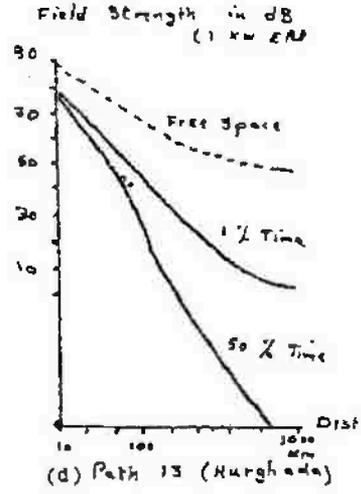
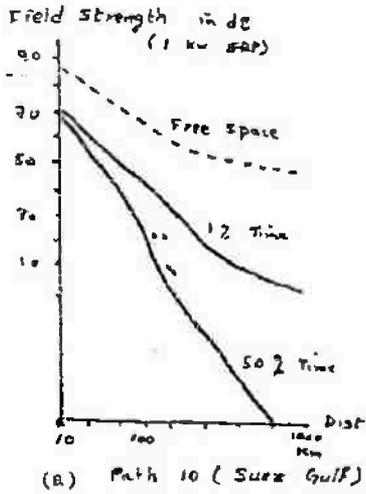


Fig:( 12 ) The measured field strength in dB (1 Kw ERP)  
(mixed path).



Figs. (13) The measured field str  
in dB (1 Kw ERP) total  
sea path.