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Scintillation on non Standard Atmosphere

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ABSTRACT

There are several methods to measure the magnitude of scintillation. Most of which their equations do not include meteorological element .In meantime we can not measure the magnitude of scintillation with elevation angle 5°-10° .A prediction method is suggested to measure tropospheric scintillation on earth –space path. This method avoids all the problems in their methods.It would apply this method in Basrah atmosphere in the case of non-standard atmosphere and we studied the effect of meteorological conditions, frequency, antenna diameter, elevation angle and altitude above sea level, on the magnitude of scintillation.

Introduction.

Atmospheric refraction can, under certain conditions, cause the microwave beam to be trapped in an atmospheric layer called a duct, resulting in severe transmission disruption. Ducting is usually caused by low –altitude high-density atmospheric layers most frequently occurring near or over large expanses of water or in climates where temperature or humidity inversions occur [1].When the beam enters the duct and it reaches the other interface between the two different density layers, the critical angle is exceeded so that internal reflection occurs. Subsequently, the beam bounees back and forth as it travels along the duct, and the receiving antenna loses the signal [2].

Refractive Index Model.

Modeling of the duct

A simple analytical expression is used for modeling, which is [3],

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$$N = NO + Kh + \frac{\Delta N}{\pi} \tan^{-1} \frac{12.63(h-h_0)}{\Delta h} \qquad (1)$$

$$\frac{dN}{dh} = K + \frac{No}{\pi} \cdot \frac{12.63\Delta h}{\Delta h + [12.63(h-h_0)^2} \qquad (2)$$

where; K , the basic under lying gradient assuming earth radius K = 4/3.

h0 = the height at the center of the change.

ΔN = The total change in refractivity, h = the height above the surface of the earth.

Δh = The height range between points at which the change has go percent of its final value.

Predication method to estimate the magnitude of scintillation (rms fluctuation) in non standard atmosphere.

A few papers lately have studied the effect of scintillation on microwave propagation in non standard atmosphere, most of them treated the subject theoretically using the same theories, and only few workers treated the subject by measurement on microwave links [4].

It is difficult now to get meteorological data about Iraq, there fore we analyze figure (1) that shows the relationship between the modified refractivity in

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(M–unit) and the height in (m) in Basrah in the Oct 1987 [5].

The meteorological data analysis in Basrah showed that ducting of Microwave signal is a common phenomenon in the lower layers of the atmosphere.

It is important to study the relationship between meteorological data and fading. After analyzing this curves, we can get meteorological data of non standard atmosphere in Basrah in this month by using equation (3) .

N	**H**
319	**100**
321.5	**200**
327.25	**300**
323	**400**
317	**500**

M = N + (h / a) 106 (3)

We can get the refractivity for each height of duct, table (1) gives a sample of these values.

$$\sigma_x = 0.0228\,\sigma_{x,ref}\, f^{0.45} \csc^{1.3}\theta\, (Q(D_a))^{0.5} \qquad (dB) \qquad (7)$$

The temperature as a function of refractivity and humidity given in equation (4).

$$t = (3730 * U * 6.11 \exp(19.7t/(t+273)/N)^{\frac{1}{2}} - 273 \quad (4)$$

This relation imply different relative humidity.For this reasons we solve this relation using Newton's rafson method, we can find the temperature for each refractivity.) Equations (5-6) gives a three formula used to estimate the rms fluctuation when elevation angel above 5°,[6].

$$\sigma xref = 0.15 + 5.2 \times 10^{-3} N \qquad [dB] \qquad (5)$$

$$Q(R) = 1.0 - 1.4\,(\frac{R}{\sqrt{\lambda L}}) \quad for \quad 0 \le \frac{R}{\sqrt{\lambda L}} \le 0.5 \qquad (6)$$

Where

R: - effective radius of circular antenna aperture (m) given by R = 0.75(D_a /2)

$D_{a:}$ - diameter of reflector (m).

λ : - Operating wavelength (m)

L: -Slant distance to height of a horizontal thin turbulent layer given by:

$$L = \frac{2h}{\sqrt{\sin^2\theta + \frac{2h}{Re}} + \sin\theta}$$

Where N is the refractive index given by, $N = 3730 Ues/(t+273)^2$.

We calculated rms fluctuation when elevation angle is equal to 5° . Given by equation (8)[6].

$$\sigma_x = \sigma_{x,ref}\, \eta_f \,.\eta_\theta\, \eta_{Da} \qquad [dB] \qquad (8)$$

We compensate equation (1) in equation (5), we find the magnitude of scintillation model as a function of refractivity given in equation (9).

$$\sigma xref = 0.15 + 5.2 * 10^{-3} * (No + Kh + \frac{\Delta N}{\pi} \arctan \frac{12.63}{\Delta h}(h_0 - h_0) \qquad (9)$$

Estimation the magnitude of scintillation in non-standard atmosphere with elevation angles above 5º.

Frequencies effect on magnitude of scintillation (rms fluctuation)

Figure (2) represents the frequenccies effect in magnitude of scintillation (rms fluctuation). It shows the calculated rms fluctuation due to the scintillation as a function of temperature and relative humidity 60% at a frequency of 14/11 GHz,the elevation angle equals 7^o and the antenna diameter equals 5 meter.

Antenna diameter effect on magnitude of scintillation (rms fluctuation).

Figure (3) represents the antenna diameter effect in magnitude of scintillation (rms fluctuation). It shows the relationship between rms fluctuation and temperature with relative humidity 60% at a frequency of 12 GHz,the elevation angle equals 7° and the antenna diameter equals 3,5.7,9 meter.

Estimation the magnitude of scintillation in non standard atmosphere with elevation angle equal 5°.

Frequencies effect on magnitude of scintillation (rms fluctuation)

Figure (4) represents the frequencies effect in magnitude of scintillation (rms fluctuation). It shows relationship between rms fluctuation and temperature with relative humidity 60% at a frequency of 11 GHz, and the antenna diameter equals 5 meter.

Antenna diameter effect on magnitude of scintillation (rms fluctuation)

Figure (5) represents the antenna diameter effect in magnitude of scintillation. It is show calculated rms fluctuation due to the scintillation as a function of temperature and relative humidity 60% at a frequency of 12 GHz and the antenna diameter equals 3,5,7,and 9 meter.

Elevation angle effect on magnitude of scintillation (rms fluctuation).

Figures (6),(7),(8),(9) represent the elevation angles effect in magnitude of scintillation (rms fluctuation).

It shows the calculated rms fluctuation due to the scintillation as a function of temperature and relative humidity 60% at a frequency of 12 GHz,the elevation angle equals 5°,7°,12°and 20° and the antenna diameter equals 3 meter.

Conclusion.

We propose a model of scintillation on non standard atmosphere, occurring on earth-space paths, with low elevation angles, in ku frequency band. we applied the model on Iraq environment. The estimated values shows a range of parameters dependent, and how these can have effects on scintillation. The magnitude of scintillation (rms fluctuation) would increase with increasing of frequencies. The magnitudes of scintillation becomes peak at temperature near 40°.The magnitude of scintillation would be decreased with increasing of antenna diameter. The magnitude of scintillation would decrease with increasing of elevation angles. The magnitude of scintillation would increase with increasing of frequencies 11/14 GHz.

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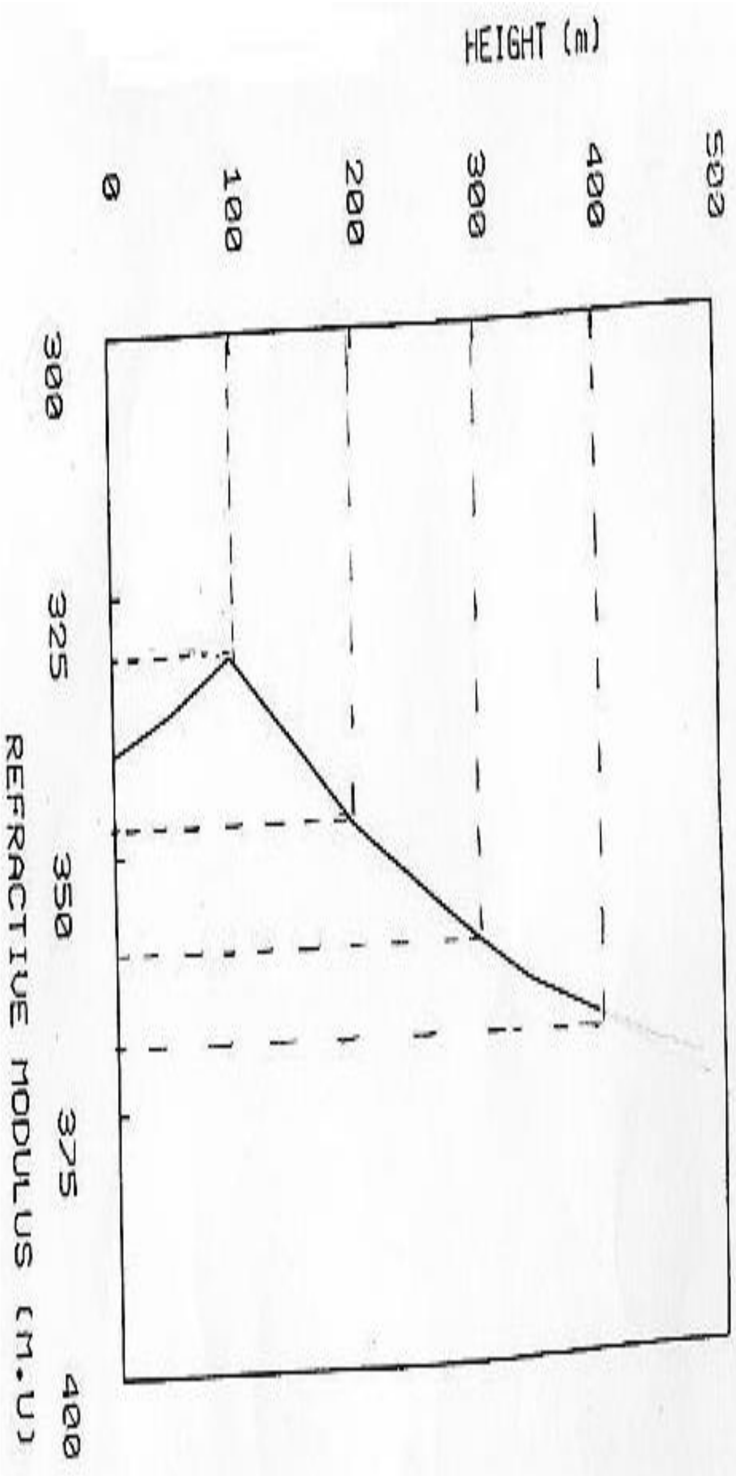

Figure (1) elevated duct for Basrah Oct. 1988 [1]

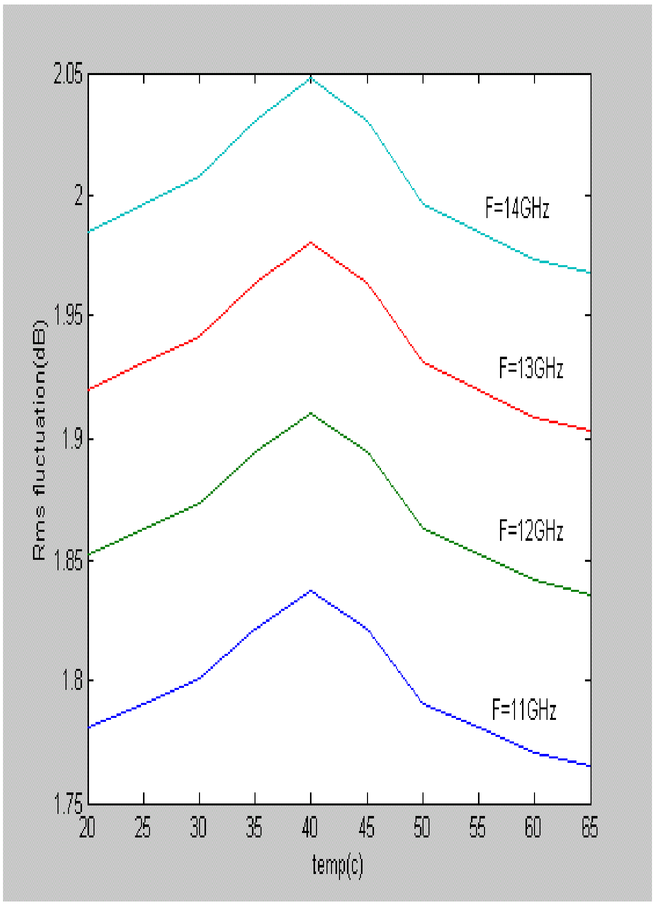

Fig (2) frequencies effect in magnitude of scintillation (rms fluctuation)

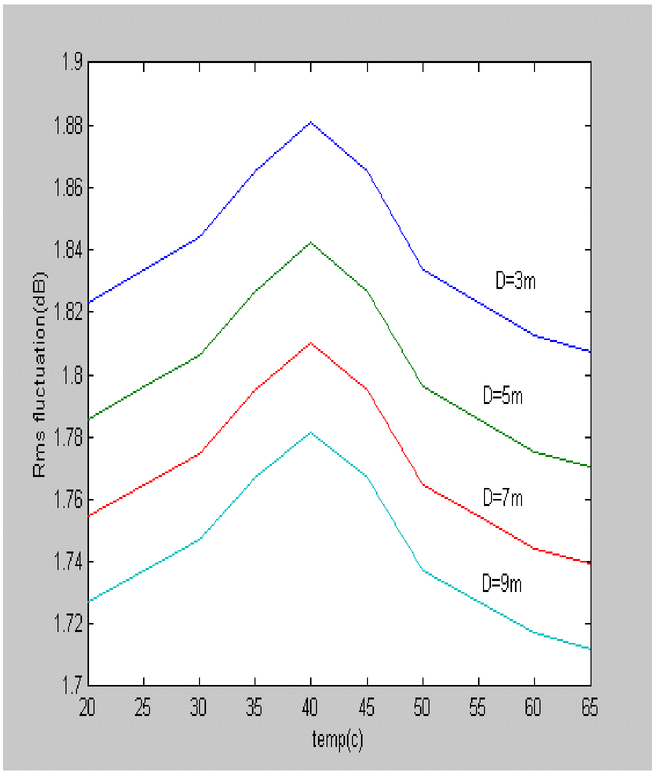

Fig (3) Antenna diameter effect in magnitude of scintillation (rms fluctuation)

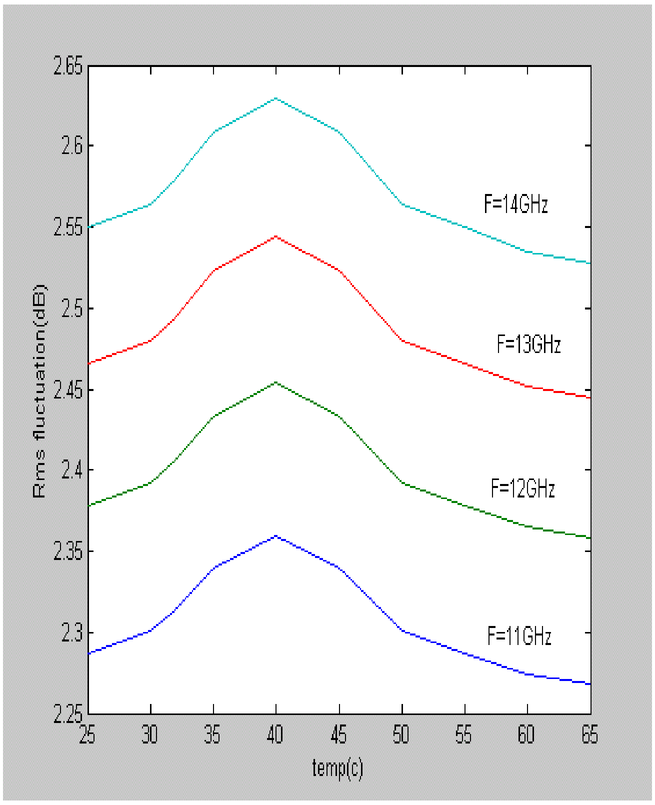

Fig (4) The frequencies effect in magnitude of scintillation

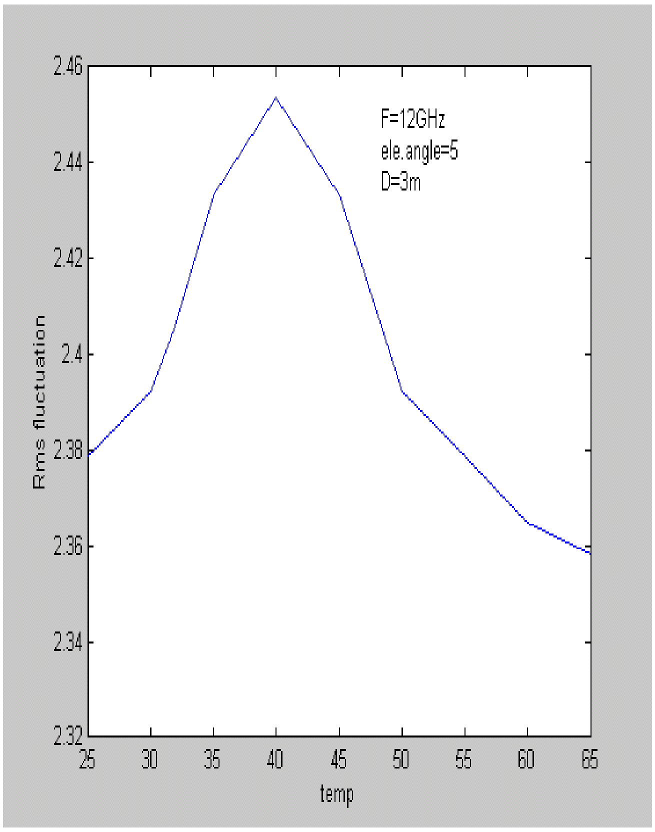

Fig (6) Relationship between temp. and rms fluctuation

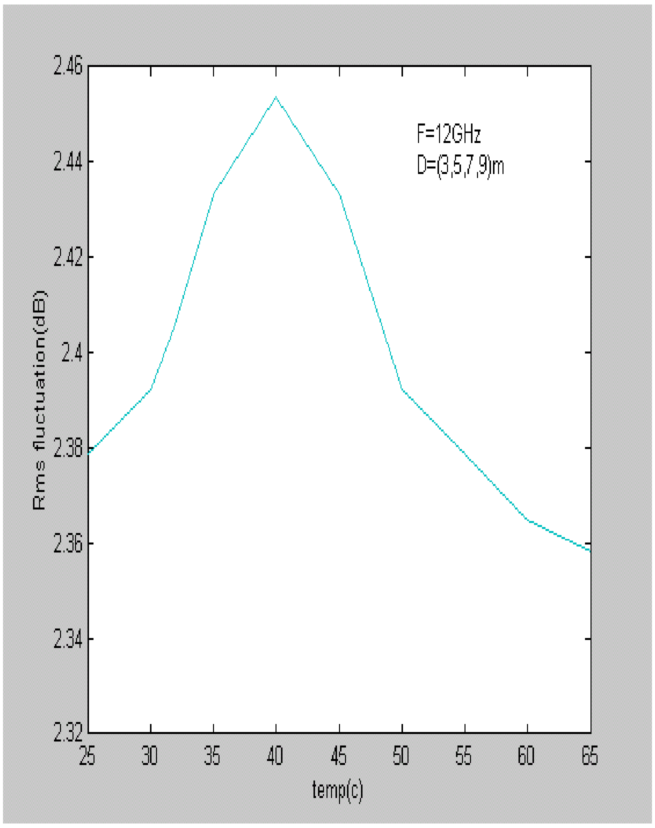

Fig.(5) Antenna diameter effect in magnitude of scintillation

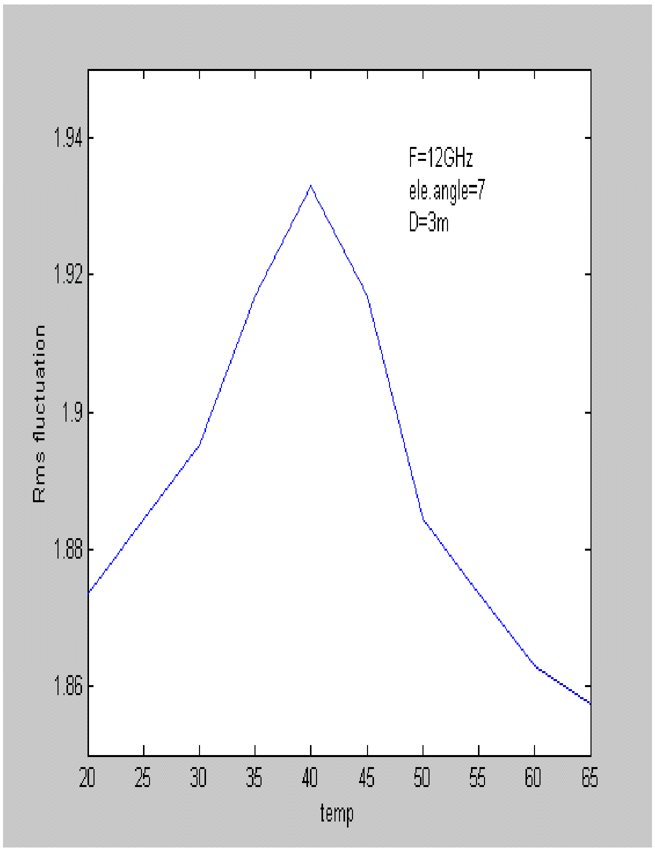

Fig (7) Relationship between temp. and rms fluctuation

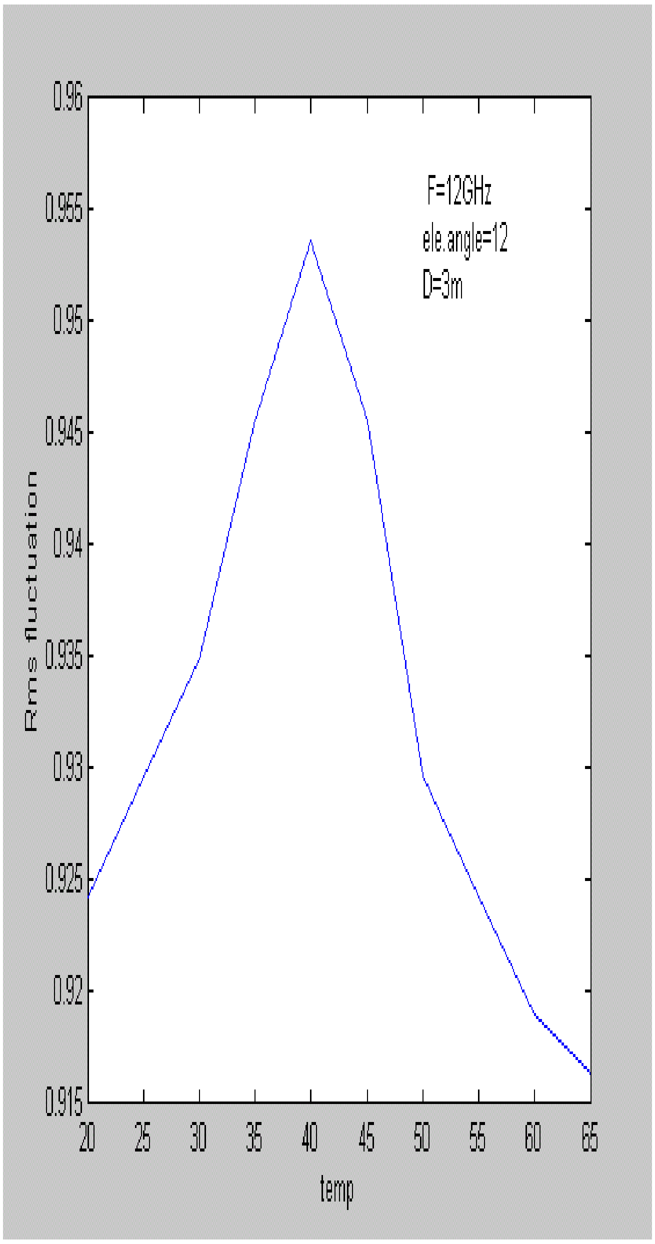

Fig (8) Relationship between temp. and rms fluctuation

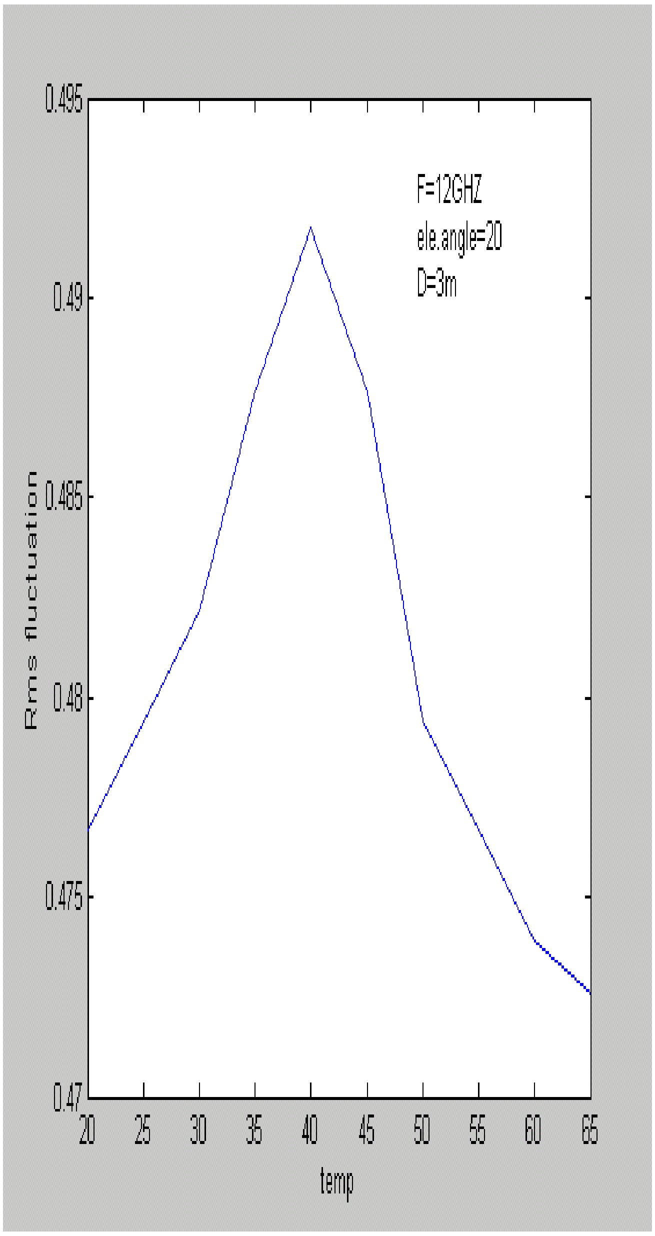

Fig (9) Relationship between temp. and rms fluctuation

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التألق في الجو غير القياسي

احمد نوري رشيد

الخلاصة

انتشار الموجات الراديوية خلال الجو يقسم إلى صنفين قياسي وغير قياسي. في اتصالات الأقمار الصناعية بالترددات فوق ١٠كيكا هرتز المشاكل الرئيسة في انتشار الموجات هي توهين مستوى الإشارة المسبب بواسطة التألق التروبوسفيري بالأضافه إلى توهين مستوى الإشارة بواسطة المطر .تم اقتراح طريقه منتخبه لقياس التألق في طبقة التروبوسفيري على طريق فضاء الأرض. ولقد تجاوزت هذه الطريقة اغلب المشاكل الموجودة في الطرق الأخرى المشابهة. لقد طبقنا هذه الطريقة في العراق في حالة الجوغير القياسي وقمنا بدراسة تأثير العناصر الرصديه والتردد وقطر الهوائي وزاوية الارتفاع والارتفاع فوق مستوى سطح البحر على مقدار التألق.