

Diurnal Behaviour of Tropospheric Scintillations at Ka band Frequencies for Indian Climate Conditions

Rapaka Prabhakar, Abhishaktha Varma Teppala, T.Venkataramana

Abstract: In this to study the diurnal behavior of scintillations at ka band frequencies for Indian tropical climate conditions. Scintillations are the most significant important propagation impairment at ka band frequency. To minimize this effect need to study the complete behavior of scintillations. Because the scintillations are vary with respect time(day and night),the metrological parameters temperature and relative humidity are more effected on the scintillation variations.

Keywords :Diurnal behavior, Scintillations, Ka band frequency, Temperature and relative humidity.

I. INTRODUCTION

Due to the solar radiation, the ground surface heated up and the boundary layer of atmosphere exited at the boundary of turbulent layer, due to convective activity small scale variations signal fluctuations are occurred in received signals, when these signal are passing through turbulent layer mixed-up and rapid signal variations occurred in signal amplitude and angle ,these mean level signal are called scintillations. These are more significant at low elevation angle and ka band frequency. India is a tropical country and very hot and cloudy thought the year. Scintillations are more significant at long term uniform temperature and relative humidity. And the scintillations are function of refractive index and refractive index is function of radio refractivity. Radio refractivity is a function of temperature and relative humidity.

II. DIURNAL BEHAVIOUR DUE TO TEMPERATURE

The measured raw data collected for four years from 2014 to 2018 for the study of long term troposphere scintillations in Indian climatic conditions .Here temperature t1 indicates the day time that is 12 am at 00z hour. And t2 indicates the night time that is 12pm at 12z. And considered averaged data for each month of four years of measured data. The graphical representation shown in figure 1. gives the monthly averaged temperature behaviour for the four years. Night time temperature effect is more than day time temperature thought the average year except the December month.

Table1.temperature at day and night times

Long Name	MONTH	temp_12pm(0	temp_12am(12Z)	avg temp
Units		C		
1	jan	21.32	19.479	20.3995
2	feb	22.6	21.8065	22.20325
3	mar	32.725	25.0865	28.90575
4	apr	33.373	25.10225	29.23763
5	may	34.22	26.2005	30.21025
6	jun	27.1	23.8535	25.47675
7	jul	25.65	21.2575	23.45375
8	aug	24.832	21.2326	23.0323
9	sep	26.65	21.3025	23.97625
10	oct	26.04	22.8865	24.46325
11	nov	24.434	20.778	22.606
12	dec	21.45	19.99	20.72

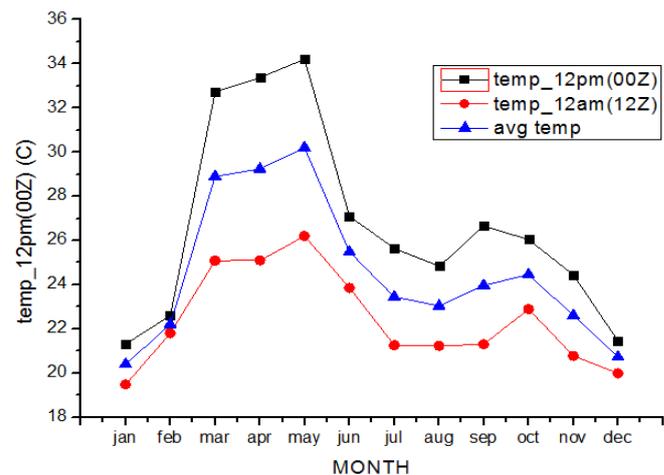


Fig1. Temperature behaviour at day and night times

III. DIURNAL BEHAVIOUR DUE TO RELATIVE HUMIDITY

Here Rh1 relative humidity indicates the night time that is 12 pm at 12z hour. And Rh2 indicates the day time that is 12am at 00z. And considered averaged data for each month of four years of measured data. The graphical representation shown in figure 2. gives the monthly averaged relative humidity behaviour for the four years. Day time relative humidity effect is more than night time relative humidity thought the average year except the February and December months.

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Table2: Relative humidity at day and night times

Long Name	MONTH	RH1_12P	RH2_12A	AVG RH
Units		%		
1	jan	52.981	44	48.4905
2	feb	48.63525	55.125	51.88013
3	mar	44.6172	28.916	36.7666
4	apr	47.593	33.2	40.3965
5	may	54.87325	39	46.93662
6	jun	76.651	61.17	68.9105
7	jul	86.9955	75	80.99775
8	aug	87.73325	82.6843	85.20878
9	sep	86.13225	58.25	72.19113
10	oct	66.194	39.4	52.797
11	nov	52.8615	53.334	53.09775
12	dec	53.696	58.324	56.01

Long Name	MONTH	Nwet	sigma ref
Units		ppm	dB
Comments			
1	Jan	53.8257	0.0022
2	Feb	64.8335	0.0025
3	Mar	58.0788	0.0023
4	Apr	50.4832	0.0021
5	May	84.5053	0.003
6	Jun	93.1948	0.0032
7	Jul	104.0617	0.0035
8	Aug	93.2291	0.0032
9	Sep	85.2554	0.003
10	Oct	55.8203	0.0022
11	Nov	68.3113	0.0026
12	Dec	64.4019	0.0024

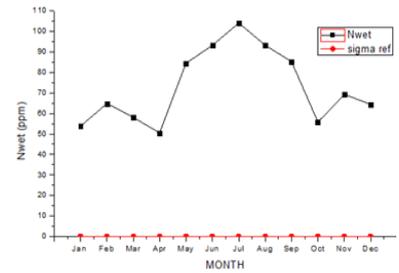


Fig4.behaviour of ref.standard deviation w.r.t Radio refractivity at day time

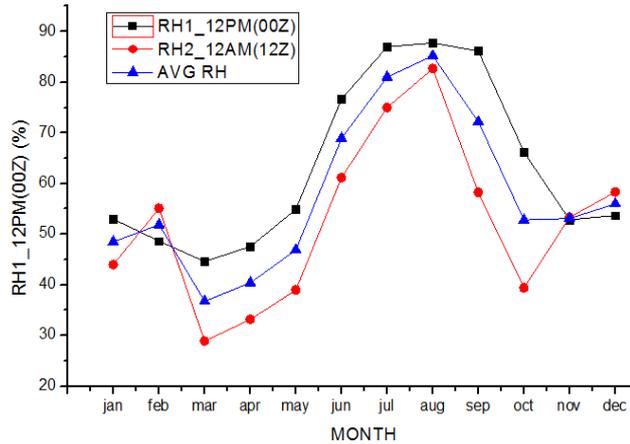


Fig2. Graph of Relative Humidity behaviour at day and night times

Table3: Temperature and Relative humidity at day and night times

Long Name	MONTH	temp_12pm(0)	temp_12am(12Z)	avg temp	RH1_12P	RH2_12A	AVG RH
Units		C			%		
1	jan	21.32	19.479	20.3995	52.981	44	48.4905
2	feb	22.6	21.8065	22.20325	48.63525	55.125	51.88013
3	mar	32.725	25.0865	28.90575	44.6172	28.916	36.7666
4	apr	33.373	25.10225	29.23763	47.593	33.2	40.3965
5	may	34.22	26.2005	30.21025	54.87325	39	46.93662
6	jun	27.1	23.8535	25.47675	76.651	61.17	68.9105
7	jul	25.65	21.2575	23.45375	86.9955	75	80.99775
8	aug	24.832	21.2326	23.0323	87.73325	82.6843	85.20878
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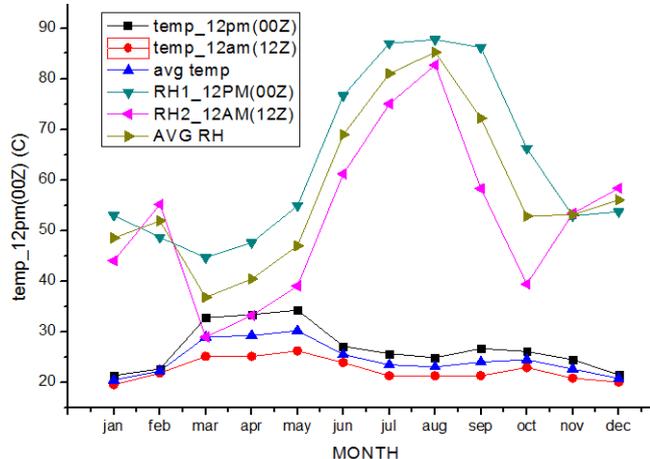


Fig.3.relationship between temp and relative humidity

IV. RESULTS

Scintillation Fade depth

$$a_s(p) = a(p) \cdot \sigma \text{-----(3)}$$

where

$$\sigma = \sigma_{ref} \cdot [f^{1.2} \cdot (\sin \Theta)^{0.55} \cdot g(x)] \text{-----(4)}$$

where

$$g(x) = \sqrt{[(3.86(x^2+1))^{11/12} \cdot \sin(11/6 \arctan(1/x)) - 7.08x^{5/6}]} \text{-----(5)}$$

where $x = 0.22 \text{Def}^2 (f/L)$,

f in GHz Carrier frequency

Table4: Estimated Nwet and Scintillation Intensity using Proposed model

att(dB) predicted	Nwet(ppm) Predicted
0.0022	52.27
0.00225	54.74
0.00236	59.52
0.00249	62.43
0.00276	72.82
0.003385	96.18
0.00338	94.97
0.00336	95.69
0.00333	93.94
0.00335	78.87
0.00231	56.04
0.00254	64.06

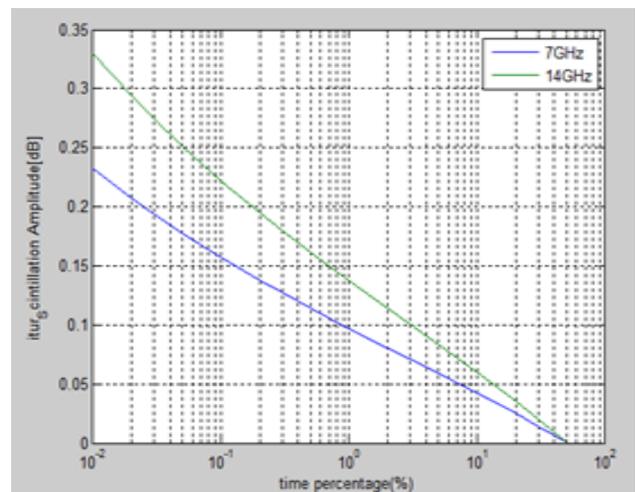


Fig.5.Scintillation fade depth using ITUR Model for 7GHz and 14GHz Frequencies

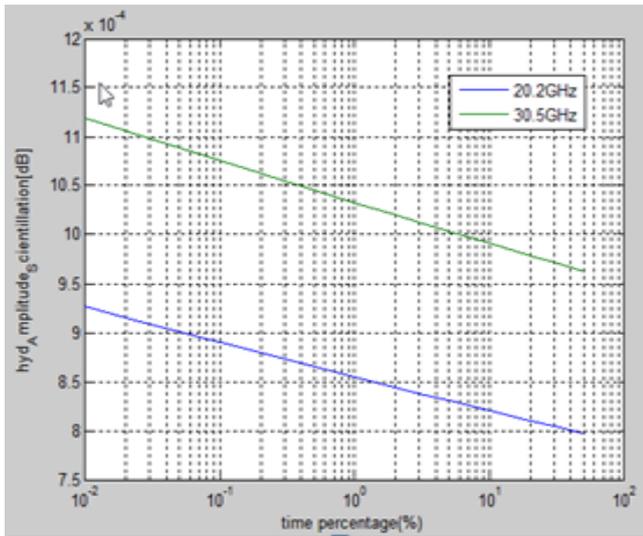


Fig6.Scintillation effects at 30.5GHz and 20.2GHz.

V. CONCLUSION

The measurements are done at 1 km of turbulent height, Relative humidity is directly proportional to the wet term radio refractivity and inversely proportional to the temperature. The measured scintillations fade depth stretch up to 0.00115dB at time 0.01% at 30.5GHz and 0.0009dB at 20.2GHz and standard error is 1.47952dB

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