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Relationship among monthly averaged Pressure, Temperature and Relative Humidity and their Effect on Tropospheric Scintillations in Indian climate

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Abstract

To estimate and compare the characteristics of Tropospheric atmospheric Pressure, Temperature and Relative Humidity in south India Region. And observe the effect of these parameters on Tropospheric Scintillations and to be compare with the theoretical background and meteorological parameters. New prediction model for the scintillation effect could be develop and need to specify the improvements to existing models.

***Key Words*:**Monthly averaged pressure, Temperature, Relative Humidity and Height, Ka band,Tropospheric scintillations

1 Introduction

Pressure: Pressure units are hectapascal (hPa). One hectapascal is equal to 100 pascale or one millibar called barometric pressure exerted by atmosphere of gravitational attraction consequently exerted upon the "column" of the air lying above in the question point. As with any gas, the pressure exerted by the atmosphere in terms of bombardment by gas molecules; pressure is independent of the orientation of the surface on which it acts. Pressure is a meteorological elements. The most common unit used is the millibar. Unique to the science of meteorology is the use of inches (or millimeters) of mercury, that is, the height of a column of mercury that exactly balances the weight of the column of atmosphere the base of which coincides with that of the mercury column.. Also employed are units of weight per area and units of force per area. A standard atmosphere has been defined in terms of equivalence to each of the above unit systems. They are actual pressure, standard pressure, sea level pressure.

Temperature: Atmospheric Temperature units are Celsius degrees. The Ninth General Conference on Weights and Measures in 1948 replaced the designation "degree centigrade" by "degree Celsius." Originally, Celsius took the boiling point of water at 1000 mb pressure as 0° and the ice point as 100°, which is inverted from the present-day temperature scale compare Fahrenheit temperature scale. The quantity measured by a thermometer. Bodies in thermal equilibrium with each other have the same temperature. In gaseous fluid dynamics, temperature represents molecular Kinetic energy, which is then consistent with the equation of state and with definitions of pressure as the average force of molecular impacts and density as the total mass of molecules in a volume. For an ideal gas, temperature is the ratio of internal energy to the specific hear capacity at constant volume.

Humidity(H) : Humidity is an estimate mean of the relative humidity of the atmosphere between approximately 600 hPa and 300 hPa. UTH is a measure of weighted mean of relative humidity according to the weighting function of the water vapor channel. Therefore, H is more likely a representative mean of the relative humidity around the atmospheric layer where weighting function of water vapour channel peaks.

Tropospheric scintillations Energy from the sun warms the surface of the earth resultant convective activity agitates the boundary layer, results in turbulent mixing of different parts of boundary causing small scale variations in refractive index,when signal encounters a turbulent atmosphere ,the rapid variation in refractive index along path will lead fluctuations in the received signal,these fluctuations fairly mean signal level are called scintillations.Bulk of fluctuations caused within 4kms of the earths surface are referred as tropospheric scintillations, significant at troposphere layer with the communication link at the frequency above 10 GHz.The amplitude scintillation is a significant cause of degradation in several emerging low availability satellite communication systems operating at Ka-Band(30/20 GHz) frequencies and using small aperture antennas.

Components of tropospheric scintillation Due to turbulence developed by convective heating and wind gradients. Due to pure scattering by a random distribution of scatterers. Apparent scintillation caused by temporal variation of rain drop size distribution which produces a rapidly varying signal attenuation.

Why Study the Tropospheric Scintillations The quality of SC Systems can be seriously affected by variable climatic phenomena, causes signal loss on the atmosphere called propagation effects.SC system that operates above 10GHz with low weather margin (e.g.,$<$ 3 to 4 dB) and low elevation angle (e.g., $< 10°$) are may experience more degradation from scintillation than from rain. Tropical climate was known as uniform temperature, high humidity and heavy rain characteristics in which so different with four seasons climate. Scintillation will be occurred in the clear sky condition or cloudy or raining. The prediction and modelling of tropospheric scintillation come to be important for such systems. Scintillation models needed to be accurate in order to designing these types of systems.To improve the prediction of propagation effects, which is essential for SC system design in Earth-space links for SC systems.

Why Study TS in India region Indian is a tropical, hot and humid throughout the year have different scintillation effects to be predict scintillation intensity.It is seasonally dependent, and varies day to day with the local climate.Thus, signal level fluctuations owing to scintillation must be understood for the purpose of correct design of satellite.we need to innovate a new scintillation prediction model that fits with the Indias tropical climate.Hence the need of being taken into account in the communication systems link budget. for Adaptive Link Control systems in particular in Indian Region.Signal degradation is reduced from scintillation.The current trend in fixed and broadcast satellite services and many emerging applications of satellite communications is towards higher frequencies and cheaper earth stations.This situation under which scintillation becomes an important and predominant degradation factor on a sc link.The aspects of scintillation which are of interest to communications system design and remote sensing.

Ka Band Satellite GSAT-14 The Indian communications satellite GSAT-14 is intended to serve as a replacement for GSAT 3 edusat. The spacecraft is configured with 6 Ku- and 6 Extended-C-band transponders providing India coverage beams. In addition, the spacecraft also carries Ka-band beacons transmitting the signals at 20 and 30 GHz, which are planned to be used to carry out studies related to rain and atmospheric effects on Ka-band satellite communication links in Indian region. Fiber optic gyro, active pixel sun sensor, round type bolometer and field programmable gate array based earth sensors and thermal control coating experiments are new technologies to be flown as experiments. The satellite lift-off mass is 1980 kg and generates a power of around 2.6 kW. It is planned to use the existing structure and several mechanical and electrical components procured as spares during earlier projects. GSAT- 14 is planned to be launched by GSLV Mk.2 with indigenous cryogenic upper stage.GSAT-14, actually the 13th GSAT spacecraft to fly, is a Communications Satellite developed and built by the Indian Space Research Organization. The satellite is based on the I-2K satellite bus that has been used for a number of ISRO satellites of the 2,000-Kilogram weight-class.GSAT-14 weighs 2,050kg at liftoff featuring the conventional I-2K bus section with two deployable solar arrays and batteries along with avionics and data handling equipment as well as a propulsion unit and navigation equipment. GSAT-14 is 2 by 2 by 3.6 meters in size featuring a 2-meter and a 2.2-meter shell shaped reflector antennas. The satellite is equipped with a Liquid Apogee Motor. It provides a thrust of 440 Newtons and uses Mixed Oxides of Nitrogen as fuel and Unsymmetrical Dimethylhydrazine as oxidizer. The engine operates and an mixture ratio of 1.65 and has a nozzle ratio of 160.

Dual frequency ,dual polarization 2.4 m Ka Band Beacon Signal Reception facility ,used for conducting Ka Band propagation experiment using GSAT-14

New Prediction Model for Indian region The proposed Tropospheric scintillation prediction model used for calculating the standard deviation of signal fluctuation due to scintillation. This model uses the wet term of earth refractivity wet N, regarding relative humidity and temperature, averaged six months as input. This model is applicable for frequencies ranging from 20GHz to 30 GHz and 3.3 to 10° of elevation angles.The parameter of σ of signal amplitude in dB, referred as scintillation intensity

Antenna Efficiency= η, Elevation angle of Antenna= θ,

Frequency= f,Average monthly Temperature= t,Average relative humidity= H,

Scintillation intensity: The value of es(hPa) the saturation water vapour pressure: es =EF.a.exp[(b-t/d).t/(t+c)]

The wet term and radio refractivity,

Nwet= 3732 H es /(273+t)

The value of ref is the referenced standard deviation of the signal amplitude:

$\sigma_{ref} = 3.6 \times 10^{-3} + 10^{-4} Nwet$,

The value of standard deviation σ: $\sigma = \sigma_{ref} f^{1.1} g(x)/(sin\theta)^{.916}$

where σ is the signal standard deviation for the considered period and propagation path.

The value of antenna averaging factor g(x):

$g(x) = \sqrt{(3.86(x^2+1)^1 1/12.sin(11/6arctan1/x) - 7.08x^5/6)}$

where $x = 1.22Deff^2(f/L)$, The value of the effective antenna diameter Deff:

Deff=$\sqrt{\eta}$.D m

Where D is geometrical diameter,η is antenna efficiency. The value of effective path length L:

$L = 2hL/\sqrt{[\sin^2\theta + 5.5 \times 10^{-4} + \sin\theta]}$,m

Where hL is the height of the turbulent layer=1000m.

The value of a(p):

$a(p) = 0.0061(\log 10p)^3 + 0.072(\log 10p)^2 - 1.71\log 10p + 3.0$

where a(p) is the time percentage factor for time percentage p , $0.01 < p < 50$.

The value of fade depth for time percentage: As(p)=$\sigma(p).\sigma$ dB

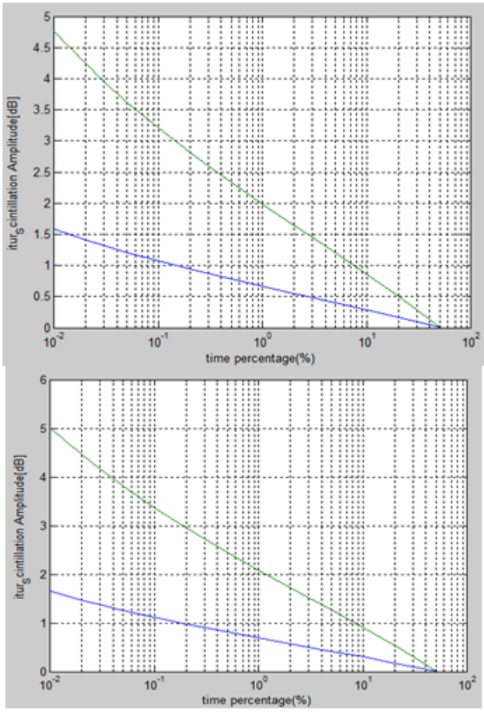

Fig.1.The amplitude scintillations fade depth at 1000m and 1200m of turbulent layers height with 0.01% of time percentage factor

2 Results

The monthly averaged relative humidity is inversely proportional to the monthly averaged temperature .maximum relative humidity noted that 66.86% at temperature 17.55 C in the month of feb2017 and minimum 31.234% at 25.26 C in the month of Dec2016 as shown below figure 1.a,b

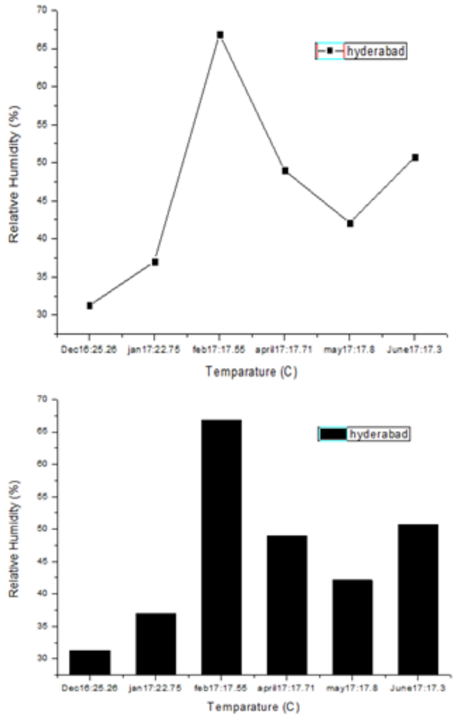

Fig2.The relationship between Relative humidity and Monthly average Temperature

The monthly averaged temperature is inversely proportional to the monthly averaged height of the turbulent layer from the surface of the earth.. maximum temperature noted that 25.26 at 730.54m in the month of may2017 and minimum 17.5C at 893m in the month of June17 as shown below figure 2.a,b

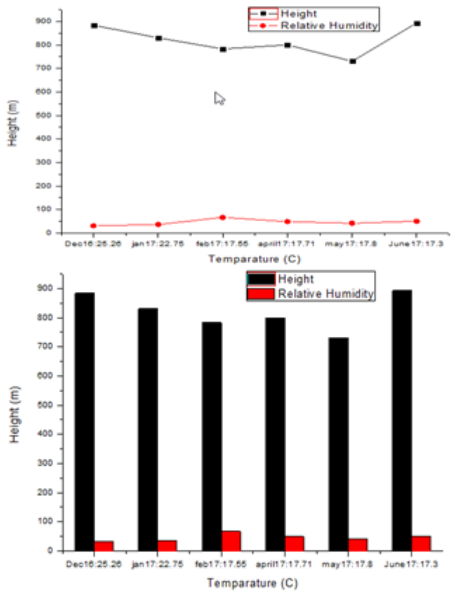

Fig.3.The relationship between averged height and Monthly avg. Temparature.

The temperature is inversely proportional to the average height of the turbulent layer and relative humidity.as shown in fig.3 a,b

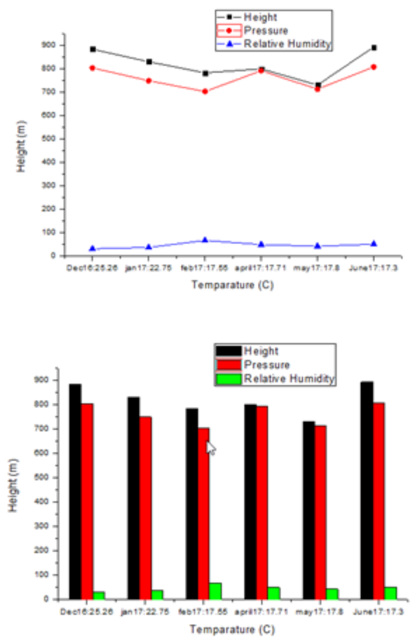

Fig4.the relationship among pressure, Temperature and Height

3 CONCLUSION

The relationship between Relative humidity and monthly average temperature and Pressure characteristics are plotted for six months recorded data the dce2016 to June 2017 in Hyderabad. Relative humidity is Inversely proportional to the temperature.GSAT-14 beacon antenna Situated in NRSC/ISRO, Balanager, Hyderabad with Elevation angle of 7.3°. This Model, compared with the measured scintillation data. The measured fades stretch upto 1.52dB,1.56dB and 4.57dB,5dB at 0.01% of time at 20.2GHz, 30.5GHz of frequencies and 1000m ,1200m of turbulent layers height. The measured enhancements stretch upto 0.04 dB and .43dB at 0.01% of time. This model is new scintillation prediction model that fits with the Indias tropical climate. The scintillation intensity will increase with frequency. This is proven with the simulation. Scintillations statics were estimated at different attenuation levels for Ka band is higher in value. Since the effect of scintillation is strongly frequency dependent, signal with shorter wavelength will encounter more severe variation. It can be said that Ka band communication link are more affected by scintillation phenomenon in communication link.

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