KA-BAND RAIN ATTENUTION OVER MAJOR INDIAN CITIES

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ABSTRACT:

Rain attenuation is a major cause of signal degradation for earth-space communication systems operating at centimeter and millimeter waves in the tropical environment, where high intensity rainfall exists. Rain attenuation is also the most critical impairment to counteract, especially for high-availability systems.

Presently ITU-R Model gives global rainfall statistic, which provides only course data for Indian stations. This will be quite inadequate for calculation of rain attenuation statistics from point rainfall rate. In the present work rain zones have been modified by using available metro logical data and Ka-band rain attenuation is calculated over major Indian cities.

KEY WORDS: Rain attenuation, Indian Stations, Ka band

INTRODUCTION:

The demand of higher frequency band increases rapidly due to the requirement of high data rate transmission for various multimedia applications, such as videoconferencing and broadcast, bandwidth on demand, data broadcast, intranet works and telemedicine. Rain attenuation is an important propagation effect, which must be considered in the design of ka-band satellite systems.

RAIN ATTENUTION:

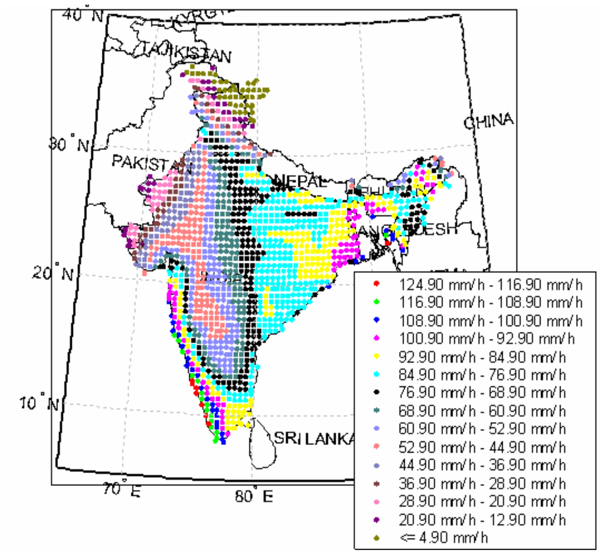
In Indian region climatic condition are varied, so locations have been selected over Indian regions based upon different climatic condition and rainfall rate. Table 1 shows different locations with rainfall rate and moisture name [1].

Table 1.List of locations with rainfall rate and moisture name

Station name	Rain rate (mm/hr)	Moisture name
Amritsar	69.1	Arid
Jodhpur	38.5	Arid
Pune	93	Semi arid
Rajkot	42.8	Semi arid
Srinagar	46.2	Dry sub humid
Solapur	50.6	Semi arid
Hyderabad	57.9	Semi arid
Bangalore	73.1	Semi arid and dry sub humid
Nagpur	71.9	Semi arid and dry sub humid
Vizag	79.8	Semi arid and dry sub humid
Chennai	80.3	Semi arid and dry sub humid
Delhi	67.6	Semi arid and dry sub humid
Patna	77.5	Dry sub humid
Mumbai	103.6	Moist sub humid and humid
Kolkatta	98.7	Moist sub humid and humid
Mangalore	122.4	Per humid
Ahmedabad	51	Semi arid
Hasan	83.6	Semi arid
Kolhapur	87	Per humid

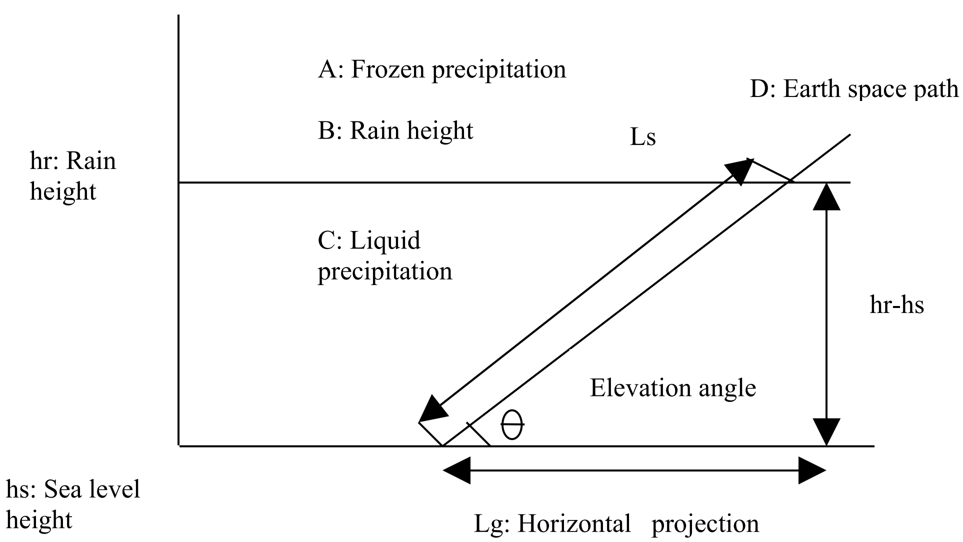
Figure 1 shows refined rain zones map over Indian region. The rain zones have been modified by using available metro logical data.

Figure 1: Refined rain zones map over Indian region.



CALCULATION OF RAIN ATTENUATION:

The long-term statistics of the slant path rain attenuation at a given location is calculated by using ITU-DAH model [2]. The attenuation value depends upon station rainfall rate and elevation angle.



Step 1.To calculates slant path length (km).

$$Ls = (hr - hs) / \sin\theta \quad (1)$$

Step 2.To calculates horizontal polarization (km).

$$Lg = Ls * \cos\theta \quad (2)$$

Step 3.To calculates specific attenuation (dB/km), where k and α are frequency dependent term.

$$\gamma R = k * (R_{0.01})^{\alpha} \quad (3)$$

Step 4.To calculates horizontal reduction factor.

$$r0.01 = 1/(1+0.78\sqrt{Lg*\gamma R/f} - 0.38(1-e^{-2Lg})) \tag{4}$$

Step 5.To calculates vertical adjustment factor.

$$Lr = (Lg*r0.01)/\cos\theta \tag{5}$$

$$v0.01 = 1/(1+\sqrt{\sin\theta}\,(31(1-e^{-(\theta/(1+\chi))})*\sqrt{Lr*\gamma R/f^2} - 0.45))$$

Where, $\chi = 36 - |\zeta|$

Step 6.To calculates effective path length.

$$Le = Lr*v0.01 \tag{6}$$

Step 7.The predicted attenuation for 0.01% of the year.

$$A_{0.01} = \gamma R*Le \tag{7}$$

Step 8.Total attenuation in the range 0.01% to the 5% of the year.

$$Ap = A0.01(p/0.01)^{-(0.655+0.033In(p)-0.045In(A0.01)-\beta(1-p)\sin\theta)} \tag{8}$$

Where,

$If\ p \geq 1\%\ or\ |\zeta| \geq 36^0;$ $\quad \beta = 0$

$If\ p \langle 1\%\ and\ |\zeta| \langle 36^0\ and\ \theta \geq 25^0;$ $\quad \beta = -0.005(|\zeta|-36);$

$Otherwise:$ $\quad \beta = -0.005(|\zeta|-36)+1.8-4.25\sin\theta$

Figure 2 shows rain attenuation in 30 GHz (horizontal polarization) at different locations for a satellite location 83 degree E, which is India's future Ka-band satellite location. The maximum value of attenuation goes up to 30.8 dB for 99.7% annual availability, which corresponds to worst month availability of 99% [3].

Figure 2: Rain attenuation in 30 GHz at different location

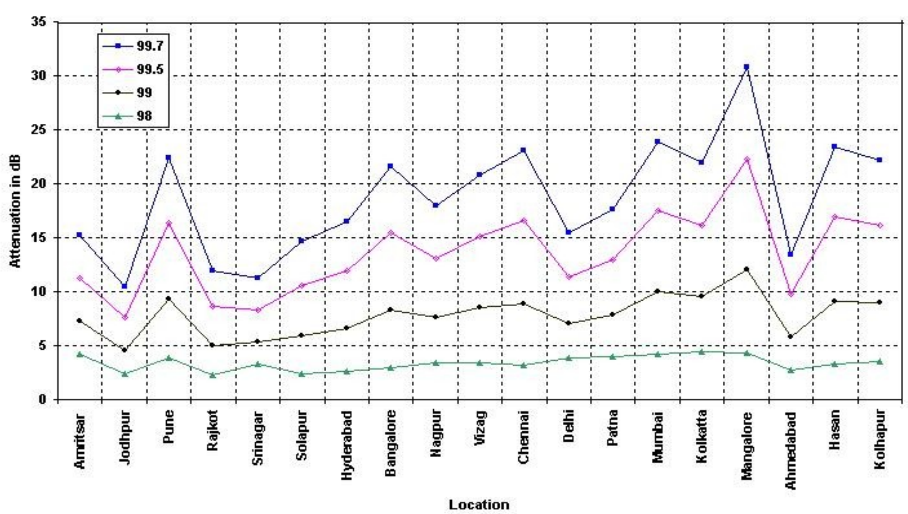
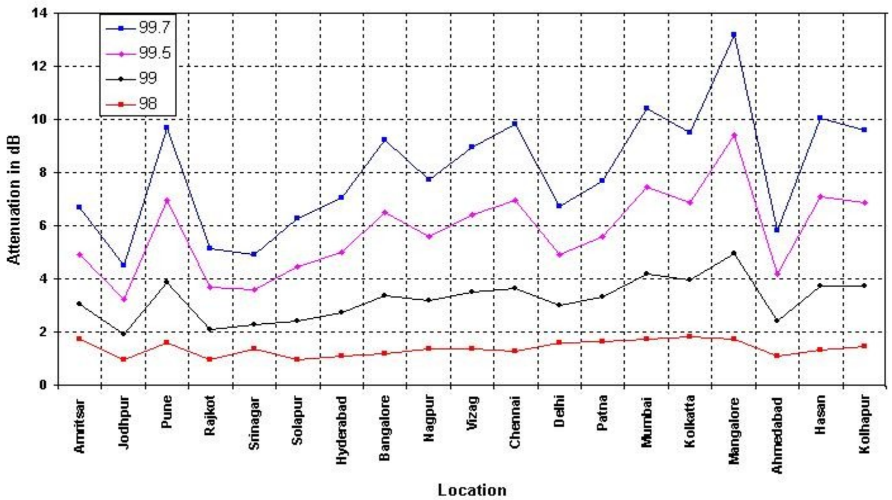


Figure 3 shows rain attenuation in 20GHz (horizontal polarization) at different locations for a satellite location 83-degree E .The maximum value of attenuation goes up to 13.2 dB for annual average availability 99.7%, which corresponds to worst month availability of 99%

Figure 3: Rain attenuation in 20 GHz at different location



CONCLUSION:

The values of attenuation vary significantly at different locations. In present study Ka band rain attenuation is calculated using available rainfall data. It is found that the available rainfall data is not sufficient for accurate prediction of attenuation. Long-term rain data measurement is required for further refinement in attenuation prediction

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