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Prediction and Estimation of Rain attenuation of Ka-Band signals

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Ka Band is being used for advanced communication satellite systems to provide data with high throughput to smaller terminals, thus catering to the needs of the time. However, as these high frequency Ka band signals are strongly impaired by various impediment, especially the attenuation due to rain is the most severe degradation. Rain attenuation leads to degradation in the received strength (C/No) of a signal and in turn deteriorates the performance of the system. Therefore, it is necessary to estimate the expected rain attenuations accurately to design a satellite link in this band. To study the impairment in rain attenuation, six different ground stations all over India have been set up across India which measures the rain rate and drop size distribution (DSD) along with the received signal level transmitted from a 20.2 and 30.5 GHz beacon, currently on board GSAT-14 satellite

Rain attenuation occurs mainly due to the scattering and absorption of the signals by the individual raindrops which is a function of frequency and the drop diameter. The Specific Attenuation, which is the total scattering and absorption summed over all individual drops over the range of diameters, can be calculated from the rain Drop Size Distribution (DSD). This DSD again varies with the rain rate, R.
The specific attenuation is expressed as

$\boldsymbol{\alpha = a R^{b}}$ here, R is the rain rate, a and b are frequency dependent constants [1,2]

It has been reported in literature that the rain drop size distribution at the tropical region is different from those in the temperate zone, mainly due to the difference in the nature of the rains [3]
GSAT-14 has two onboard Ka band Beacons – 20.2 GHz and 30.5 GHz and the beacon receiver measures the level of beacons using a 2.4 m antenna. Considerable amounts of attenuation were observed during the rainy periods, especially during the monsoon season. The received data were preprocessed in which the beacon data and disdrometer data were synchronized with proper time stamps. The clear sky reference data were defined after and before the rainy days using averaging method. Data from the site at Delhi and Ahmedabad for the year 2016 to 2017 are used for the study here. From the beacon level measurements, the measured attenuation was calculated. The predicted attenuation was calculated using DSD derived Specific attenuation. The plots represent the measured and predicted attenuation in ka band beacons 20.2 GHz (Figure 1). The prediction and scaling algorithm is combined to see the attenuation at other beacon frequency (30.5 GHz) and the result obtained was compared with measured attenuation of 30.5 GHz beacon (Figure 2). The study shows a standard deviation 2.2 dB prediction error

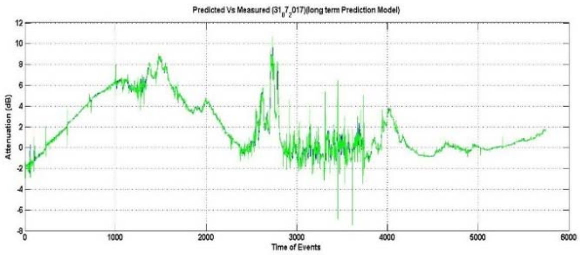

Figure1: Predicted Vs Measured Attenuation

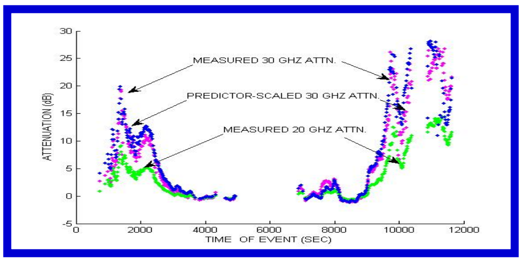

Figure 2: Predicted –Scaled (Combined)

1. ITU-R P.838, 2005. Recommendation ITU-R P.838-3, “Specific attenuation model for rain for use in prediction methods”. ITU.
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3. Das, S., Maitra, A., Shukla, A., 2010. “Rain Attenuation Modelling in the 10 – 100 GHz frequency using drop size distribution for different climatic zones in tropical India”, *Progress in Electromagnetics Research* B, 25, 211–224 4