MODELLING OF DROP SIZE DISTRIBUTION OF RAIN FROM RAIN RATE AND ATTENUATION MEASUREMENTS AT MILLIMETER AND OPTICAL WAVELENGTHS

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Abstract

This paper describes a technique for modelling of rain drop size distributions at Calcutta in terms of negative exponential function, from the measurements of rain rate and attenuation over a dual wavelength LOS link at millimeter and optical frequencies. The DSD model obtained is then used to determine the attenuation at 94 GHz, for comparison with experimentally obtained attenuation at 94 GHz. This is also compared with the attenuation calculated by considering other experimentally obtained DSD models. The best fit negative exponential distribution function (modified M-P model) is presented along with some other experimentally obtained and reference models.

Key words: Rain drop size distribution, rain attenuation, theoretical model.
1. Introduction

The atmosphere which introduces attenuation, scattering, scintillation, depolarization etc., plays a major role in determining the performance of microwave and millimeterwave communication links. All these atmospheric phenomena actually degrades the link performance. In recent days, there is an increasing use of high frequency (mm and sub-mm frequency) as it provides larger bandwidth, narrower beamwidth, good resolution and smaller component size. At millimeter and optical frequencies, rain plays a significant role. So the feedback information about the actual value of rain attenuation is very important in determining the design parameters of a high frequency communication link. In predicting the rain attenuation, the knowledge about the drop size distribution (DSD) is essential. The DSD is also important to know the microstructure of rain.

The DSD, which is highly variable with location, has been obtained using a number of techniques. Among these, Laws and Parsons (L-P) [1] (1943) DSD model is most widely used. This model was obtained by measuring the number of dough balls of a particular radius formed by the rain drops falling on a flour tray. Another very popular DSD model is that of Marshall and Palmer (M-P) [2] (1948) which is a negative exponential function. This model was obtained from dyed filter papers. Joss et al. [3] (1968) obtained the DSD from electromechanical distrometer. The L-P and M-P models are very much used in the temperature climatic zones. Actually many random multiplicative processes affects the natural DSD. So, in recent days, more complex distributions have been considered by many workers. Among these complex models, Log normal distribution and Gamma distribution becomes much popular. In some places of tropical region, the log normal distribution was found more suitable by Mason [4] (1971), Ajay and Olsen [5] (1983) and Kozu [6] (1991). Also the log normal distribution was fitted to distrometer data obtained at slough by Harden et. al [7] (1979).

The path averaged DSD, which is more practical was obtained by Ihara et al [8] (1984). Using multifrequency measurements, they obtained the negative exponential function for path averaged DSD.