Project	**IEEE 802.16 Broadband Wireless Access Working Group**
Title	**Recommendation: Use of Various Raindrop Size Distributions for Different Geographical Locations in Calculating the Rain Specific Attenuation**
Date Submitted	**1999-12-29**
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Re:	Call for Contributions (posted 17 December 1999), Specific Area: Propagation Model
Abstract	We recommend the usage of an expanded set of power-law parameters in calculating the rain specific attenuation. We believe that this expansion is needed to accommodate an expanded set of raindrop size distributions, because the raindrop size distribution changes with geographical location and can strongly influence rain attenuation. Generally, the power-law parameters for Laws and Parsons (L-P) and Marshall and Palmer (M-P) distributions are used for estimating rain specific attenuation. We suggest, however, that it is more reasonable to use a gamma raindrop size distribution for high latitude locations and a lognormal raindrop size distribution for tropical regions. We further show that the specific attenuation for L-P raindrop size distribution is nearly the same as the specific attenuation obtained from power-law parameters of the ITU-R model.
Purpose	To provide an input to the specific area ‘‘Propagation Model’’.
Notice	
Release	
IEEE Patent Policy	

Recommendation: Use of Various Raindrop Size Distributions for Different Geographical Locations in Calculating the Rain Specific Attenuation

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Introduction

A specific attenuation model for rain for use in prediction methods has been recommended by ITU-R [1]. The specific attenuation γ_R (dB/km) for rain was recommended to be obtained from the power-law relationship

$$\gamma_R = k \cdot R^{\alpha} \qquad (1)$$

where k and α are power-law parameters, and R is the rain rate in mm/h. The parameters k and α were listed [1] for one raindrop size distribution over the frequency range of 1-400 GHz. The values of k and α were tested and found to be sufficiently accurate for predicting the attenuation for frequencies up to 55 GHz.

More choices for k and α parameters for four different raindrop size distributions at a rain temperature of 0 C over the frequency range of 5-100 GHz were obtained and listed in [2]. They are derived from the computations of the adjusted and improved point-matching technique [3] for non-spherical raindrop shapes. The maximum relative error between the power-law relationship and the point-matching technique computation is less than 11 % [2].

Recommendation and Comparisons

It is recommended that parameters k and α of [2] be used in the calculation of γ_R, because raindrop size distribution can change significantly with the geographical location.

Figure 1 shows a comparison of γ_R using k and α of [2] for horizontal polarization and a horizontal propagation path. The results calculated by using k and α listed in [1] are included in Fig. 1 by the circle "$\circ$" marks. Parameters k and α of ITU-R [1] and k and α of [2] for Laws and Parsons (L-P) raindrop size distribution [4], [5] produce almost identical results. It is seen that γ_R for gamma raindrop distribution [6], [7] is lower than γ_R for L-P distribution at 25 GHz, but it becomes significantly higher than γ_R for L-P distribution at 45 GHz. Similarly, γ_R for Marshall and Palmer (M-P) raindrop distribution [8], [9] is lower than γ_R for lognormal raindrop distribution [10] at 25 GHz, but it becomes higher than γ_R for lognormal distribution at 45 GHz.

In general, k and α of L-P and M-P distributions apply to the estimation of γ_R, as well as k and α of ITU-R [1]. It is more reasonable to use gamma raindrop size distribution for high latitude locations, while lognormal raindrop size distribution should be more appropriate for tropical regions.

Regarding the total rain attenuation, the difference between different climates can be calculated by using the same rain attenuation model with different raindrop size distributions.

Summary

Considering that raindrop size distribution changes with geographical location and it can strongly influence rain specific attenuation and, consequently, total rain attenuation, we recommend the usage of an expanded set of power-law parameters for various raindrop size distributions in calculating the specific attenuation.

The parameters for L-P and M-P distributions generally apply to the estimation of rain specific attenuation. While the gamma raindrop size distribution is more reasonable for high altitude geographical locations, the lognormal raindrop size distribution should be more appropriate for tropical regions.

The specific attenuation for L-P raindrop size distribution is nearly the same as the rain specific attenuation obtained from power-law parameters of ITU-R [1].

References

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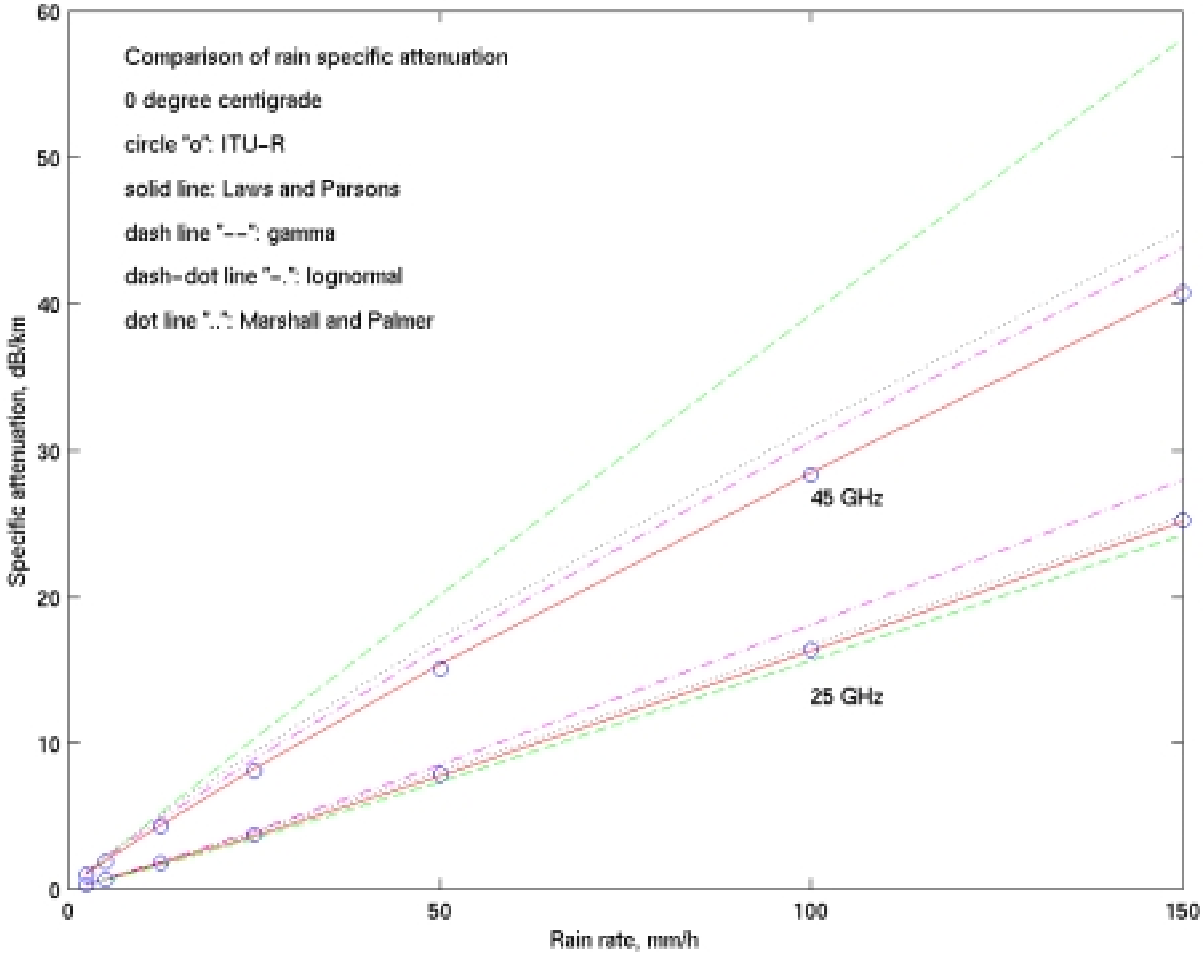

Fig. 1. Comparison of rain specific attenuation obtained from power-law relationship.