Cross Polarization on Line-of-Sight Links in a Tropical Location: Effects of the Variation in Canting Angle and Rain Dropsize Distributions

Moses Oludare Ajewole, Lawrence Babatope Kolawole, and Gabriel Olalere Ajayi

***Abstract*—The effects of the variation in canting angle of falling raindrops and the distribution of raindrop sizes in different types of rain on cross-polarization discrimination (XPD) on line-of-sight propagation paths in a tropical location in the frequency range 1–50 GHz are investigated. The dropsize distribution (DSD) model of [1] has been used. Although, some previous studies of XPD assumed equi-orientation of the raindrops along the propagation paths, the present study employs the more realistic distribution of canting angles along the path. The results obtained show that the XPD improves by about 4–7 dB over those based on the equi-orientation model. It is also shown that for the same copolar fade and for frequencies greater than about 10 GHz, the variation of the XPD with copolar attenuation (CPA) is relatively insensitive to the assumed DSD in rain and that the deterioration in signal quality or outage will be influenced more by the signal attenuation rather than by the cross-polarization interference.**

***Index Terms*—Canting angle, cross-polarization discrimination, differential attenuation, differential phase shift, dropsize distribution, tropical path.**

I. Introduction

THE frequency reuse is a technique often employed to minimize frequency separation and to increase spectrum capacity without increasing spectrum occupancy. The rapid congestion of the frequency band lower than 10 GHz used by many terrestrial line-of-sight communication links and the need to accommodate the new high-speed digital data transmission systems necessitated the use of higher frequency bands. The use of orthogonal polarization systems in these frequency bands has to contend with rain attenuation along the propagation path. The occurrence of heavy tropical rain over a propagation path will severely limit the reliability of system performance since rain induces cross-polarization interference, which tends to reduce the cross-polarization isolation between orthogonal channels along the propagation path as rain attenuation is polarization dependent.

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Both theory and experiments on terrestrial links, especially in the mid and high latitude regions, have shown that rain is the most important hydrometeor responsible for the reduction in the cross-polarization discrimination (XPD) on terrestrial path, especially for the high availability time requirements [2]. It is also clearly understood now that rain depolarization occurs due to: 1) the nonsphericity of the falling raindrops, thus making the specific attenuation polarization dependent and 2) the tendency for raindrops to align in a particular direction at a time (canting angle). It is therefore essential to have adequate information on the raindrop shape, raindrop size distributions, orientation of raindrops along the path, and so on, in order to study the cross polarization due to rain. The present study deals with the latter two points.

The reasons for the present study are, therefore, as follows.

1) The previous studies of the problem using tropical data [3]–[5] assumed equi-orientation of the raindrops along the propagation path. Studies have, however, shown that the orientation of the raindrops varies along the path. The raindrop orientation tends to be approximately Gaussian distributed along a terrestrial path [2], [6]. Therefore, the previous studies tend to produce poor levels of cross-polarization isolation.
2) The previous studies also employed a generalized dropsize distribution (DSD) at all rain rates (e.g., [7]). The studies of [8] and [9] on the measurement of differential phase shift at 36.5 GHz showed that the differential phase shift is very sensitive to DSD in rain as only the Joss thunderstorm distribution as modified by [10] described accurately their results in contrast to the often-assumed DSD model of [11]. Since the differential phase shift is important in estimating the XPD at the lower frequencies, the prediction of XPD based on the variation of the DSD in rain will be essential. In this respect, it will be adequate to use the recent DSD of [1], which classified tropical rain into drizzle, widespread, shower, and thunderstorm with distinct DSD to predict the XPD levels on tropical terrestrial links.

For the purpose of comparison, the specific attenuation and phase-shift data based on the DSD of [11] have been taken from [12], while those based on [7] have been taken from

[13]. The XPD derived for equi-oriented raindrops is based on [3]. This study is, therefore, intended to provide improved XPD statistics over those derived for the constant canting angle model for tropical paths. As the present results represent more realistic statistics, it can form the basis for a reliable future XPD data base for terrestrial tropical applications involving the variation in rain DSD.

II. Computational Method

Using small argument approximations based on an assumption by [6] that the propagation constants associated with the two characteristic polarizations propagated through a rain medium without depolarization are approximately equal, [2] simplified the semiempirical model of XPD prediction from which the theory is derived. The XPD and CPA are thus approximated by

$$\text{XPD} \approx -20\log(l\cos^2\varepsilon|\Delta k|e^{-2\sigma^2}\sin|\phi-\tau|/2) \quad (1)$$

and

$$\text{CPA} \approx [A_H + A_V + (A_H - A_V)\cos^2\varepsilon e^{-2\sigma^2} \cdot \cos 2(\phi-\tau)] \times \frac{l}{2} \quad (2)$$

where A_H and A_V represent the specific attenuations associated with the principal planes of the raindrop axes (major and minor axes of the raindrop) where

$$|\Delta k| = |k_H - k_V| = (\Delta\alpha^2 + \Delta\beta^2)^{1/2} \quad (3)$$

with $\Delta\alpha$ and $\Delta\beta$ representing the differential attenuation and phase shift, respectively. ϕ defines the effective canting angle τ is the polarization tilt angle ($\tau = 0$ for horizontal polarization and $\pi/2$ for the vertical polarization), σ is the effective standard deviation of the canting angle distribution, ε represents the path elevation angle ($\varepsilon = 0$ for terrestrial propagation path), and l is a measure of the pathlength through uniform rain.

This study utilized the specific attenuation and phase shift computed by [14] in which the forward scattering amplitude functions were computed by the least square method for oblate spheroidal raindrops at a water temperature of 20° with the complex refractive index obtained using Ray's method [15] in order to estimate XPD for an effective canting angle of 10° with a standard deviation of 19° over a propagation path of 1 km. The recent DSD models of [1] were utilized to compute the number of raindrops per diameter interval in each rain type over the applicable rain rates. Comparison was made with the results based on the Laws–Parsons and Ajayi–Olsen [13] generalized DSD models. Reported computed specific attenuation and phase shift using these models used forward-scattering amplitude functions obtained from point-matching method, which is less efficient when applied to large distorted raindrops such as are prevalent in the tropical regions. A comparison of the frequency characteristics of the differences between the specific attenuation obtained using the model of [1] and the other models has been shown in [16].

Also in the reference are the comparisons of the phase shift for the rain types. Some typical results of the variation of XPD with path length obtained at some frequencies are presented. Since the measured XPD data became available only recently, especially from the mid and high latitude regions of the world for frequencies up to about 50 GHz [17], [18] and because of the interest in the utilization of these frequency bands for new services such as digital high-speed data transmission and application to satellite systems, our comparisons are limited to these frequency ranges.

III. Results

A. Differential Attenuation and Differential Phase Shift

The differential attenuation and differential phase shift are two important parameters required to compute the XPD as defined in (3). The normalized differential phase shift per decibel of vertical attenuation when computed, is one parameter that shows the frequency range over which the differential phase shift is the dominant contributor to XPD. The detailed results of the differential attenuation and differential phase shift obtained for Nigeria are available in [3] and [14], while the results of the normalized differential phase shift per decibel of vertical attenuation obtained by [16] show that it is the dominant contributor at frequencies lower than 10 GHz. It is important to mention that the results in [3] and [14] show that the differential phase shift decreases to negative values at frequencies greater than 30 GHz. This has been attributed to the real part of the forward scattering amplitude for vertical polarization reaching a maximum at a raindrop size, which is much larger than the drop size over which the maximum occurs for horizontal polarization. The results also show that the frequency of cross over was bounded in the range of 30–50 GHz in all the cases considered.

B. Variation of XPD with Frequency

1) Effect of Canting Angle and Dropsize Distribution: Fig. 1 shows the comparison of the frequency characteristics of the XPD obtained for thunderstorm rain using a distribution of canting angles of 10° with a standard deviation of 19° with the earlier results of [3] for equi-oriented raindrops for a constant canting angle of 10° at rain rates of 50 and 150 mm/h. The results show that the XPD improves by about 7 dB over those of the equi-orientation model. Also computing the XPD using the generalized DSD model of [7] but utilizing a distribution of canting angles of 10° with a standard deviation of 19° and comparing the results with those obtained by [3] for constant canting angle of 10°, an improvement of 7 dB in the XPD is also noticed over the constant canting angle.

2) Effect of Variation in Dropsize Distribution in Rain: Figs. 2 and 3 show the frequency characteristics of the variation of XPD due to the variation in rain DSD in widespread and thunderstorm rain types, respectively, at frequencies from 1 to 50 GHz, varying rain rates, path length of 1 km in rain, and canting angle distribution of 10° with standard deviation of 19°. In Fig. 2, for the widespread rain type, the similarity in the prediction of the XPD between the models of [1], [11]

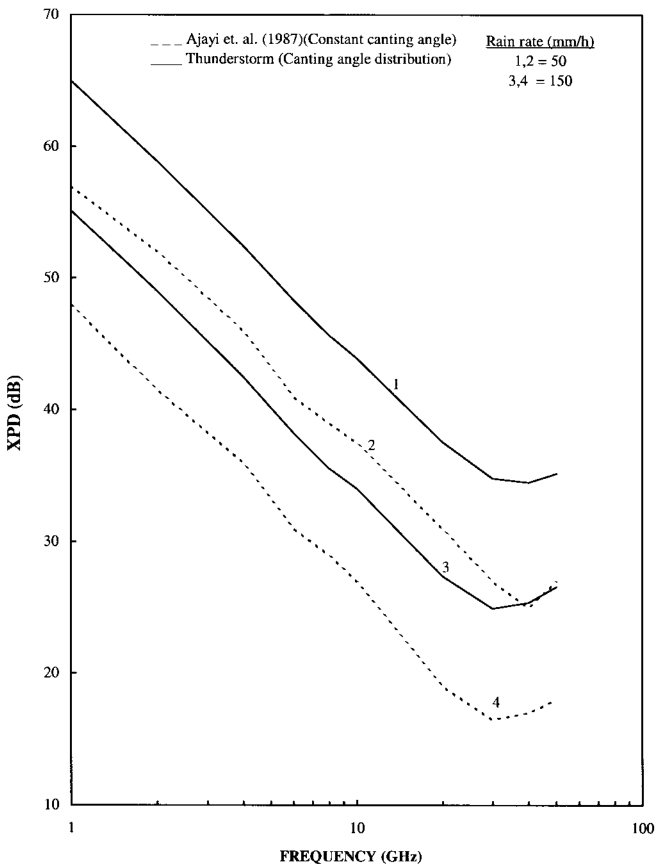

Fig. 1. Comparison of the frequency characteristics of horizontal XPD for the Ajayi *et al.* (1987) equi-orientation model with the *tropical thunderstorm* model using effective canting angle $\phi = 10^\circ$ and standard deviation $\sigma = 19^\circ$ for rain rates of 50 and 150 mm/h.

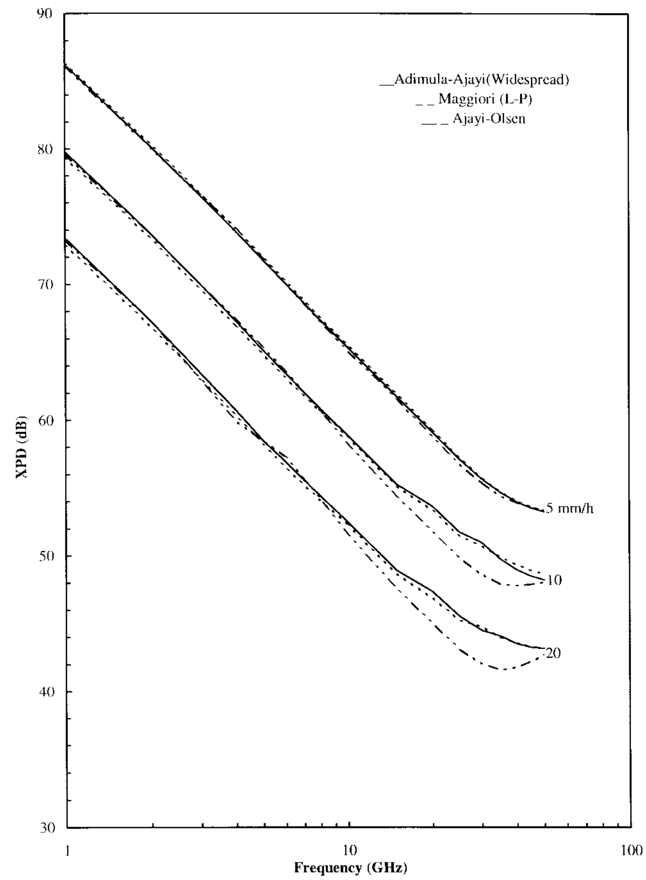

Fig. 2. Comparison of the frequency characteristics of horizontal XPD for *widespread rain* with the models of Maggiori (L–P) and Ajayi (Ajayi–Olsen) for a pathlength of 1 km and effective canting angle $\phi = 10^\circ$ and standard deviation $\sigma = 19^\circ$.

is a consequence of the similarity in the specific attenuation of these models arising from the similarity in number density of raindrops in the attenuation integral. Also, the similarity in the XPD at the low frequencies is a result of the comparable phase shift predicted by the three models at frequencies lower than 20 GHz [16]. However, at frequencies higher than 10 GHz and rain rate in excess of 5 mm/h, the DSD model of [7] predicts the XPD's that are poorer by about 2–4 dB because it overestimates specific attenuation under these conditions. In Fig. 3, however, the results utilizing [7] show comparable XPD values with those due to thunderstorm rain type at rain rates higher than 50 mm/h and frequencies slightly lower than 50 GHz. However, because of the higher attenuation predicted by this model at frequencies between about 10–30 GHz and rain rates lower than about 100 mm/h, lower values of the XPD are predicted for these conditions. The higher XPD predicted by [11] at frequencies higher than 20 GHz and at all rain rates is a consequence of the underestimation of rain attenuation due to tropical convective thunderstorm rain by this model. Similar results were obtained for convective shower rain and the magnitude of the difference in each case is about 2–3 dB.

Fig. 4 shows the frequency characteristics of XPD for horizontal and vertical polarizations for the shower rain type at some rain rates. As an improvement over the earlier results of [3] which utilized constant canting angle and in which the XPD level was virtually the same at all rain rates and outside the frequency window of 20–100 GHz, the present study shows that the XPD is poorer by about 1 dB in the horizontal polarization at all frequencies and rain rates. This is quite significant in choosing the polarization to be transmitted over a given path.

C. Variation of XPD with Copolar Attenuation

Figs. 5 and 6 show the comparison with the other models of the variation of XPD with copolar attenuation (CPA) at frequencies of 4, 6, 10, 20, 30, and 50 GHz derived for the shower and thunderstorm rain types. A distribution of canting angles is assumed along the propagation path. The results show that at the low-frequency end (4–10 GHz), the models utilizing DSD due to [7] and [11] yielded slightly higher XPD for the 4-GHz frequency at all fade levels, at about 0.1–1 dB for the 6 GHz, and at about 2–5 dB fade levels for the 10-GHz frequency in the two cases presented. At the higher frequencies, the variation of the XPD with copolar attenuation CPA seems to be insensitive to the assumed DSD. For a system with a designed outage margin of about 20 dB, the distortion of the purity of the signal in a channel and/or signal outage at frequencies higher than 10 GHz will be due more to the signal attenuation on the link than due to the cross-polarization interference. This can be deduced from the diagrams since the

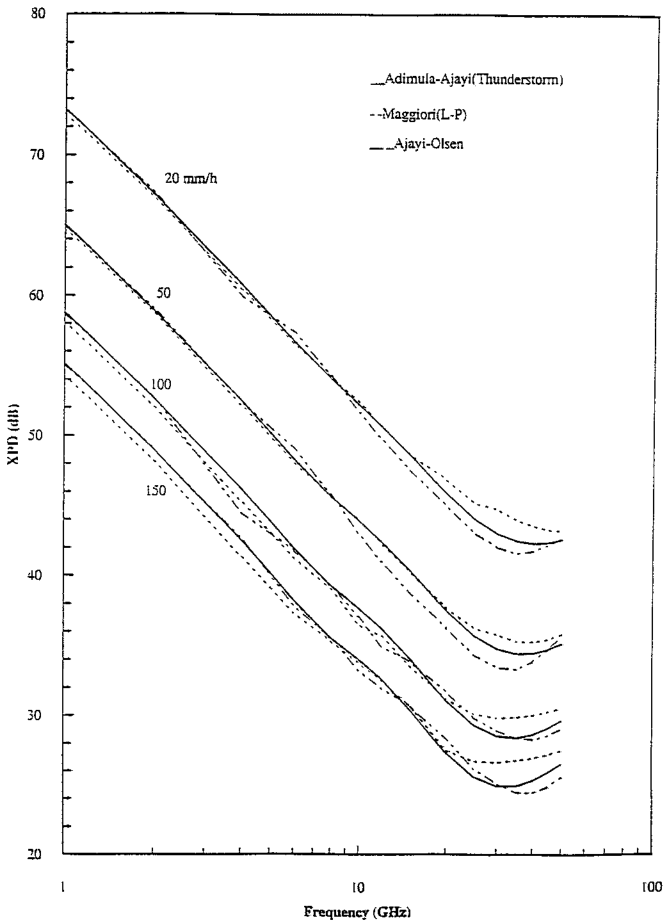

Fig. 3. Comparison of frequency characteristics of the XPD for *thunderstorm rain* (Adimula–Ajayi) with the models of Maggiori (L–P) and Ajayi–Olsen at some rain rates for a terrestrial path length of 1 km and effective canting angle $\phi = 10°$ and standard deviation $\sigma = 19°$.

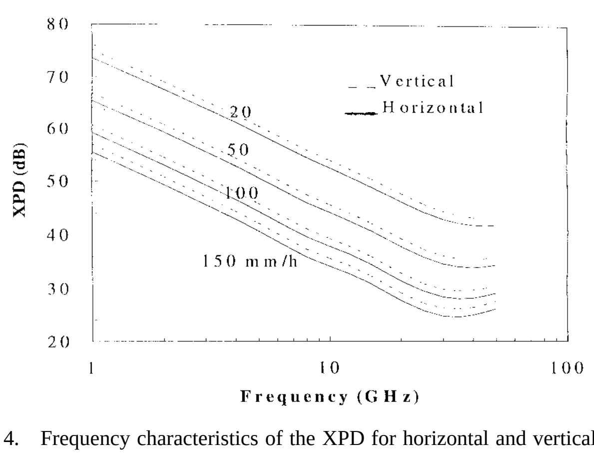

Fig. 4. Frequency characteristics of the XPD for horizontal and vertical polarization for *shower rain* (Adimula–Ajayi) at some rain rates using effective canting angle $\phi = 10°$ and standard deviation $\sigma = 19°$.

worst discrimination even at a fade level of about 45 dB is around 25 dB, a margin that can be fairly supported by most line-of-sight systems regardless of the type of convective rain that is responsible for the degradation of the signals. The above observation is also an important parameter that will be useful in locating repeater stations for line-of-sight communication links in the tropical regions. The typical result of the variation

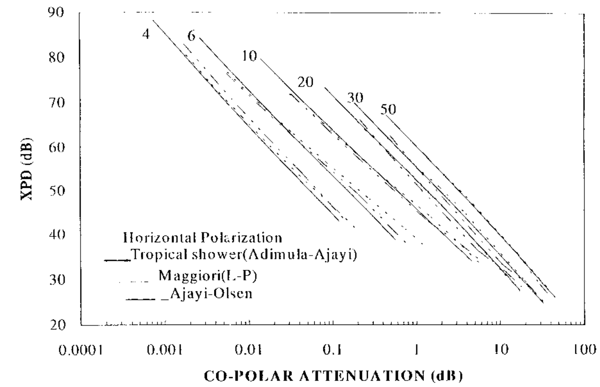

Fig. 5. Comparison of the variation of XPD with CPA in *shower rain* for horizontal polarization with the three DSD models at some frequencies.

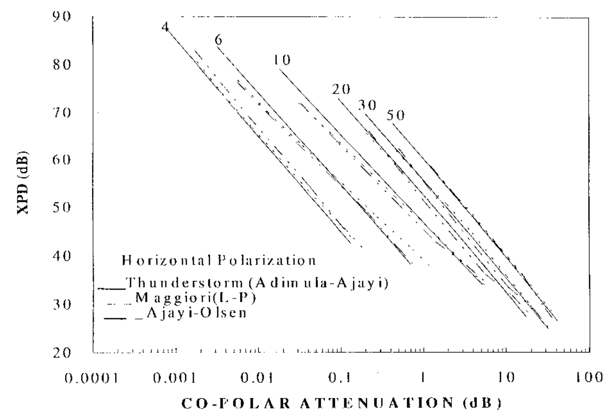

Fig. 6. Comparison of the variation of the XPD with CPA in *thunderstorm rain* for horizontal polarization with the three DSD models at some frequencies.

of the XPD with CPA for two polarization states (horizontal and vertical) shows that the XPD is better in the vertical by about 0.5 dB at all frequencies. This is also an improvement over [3].

D. Variation of XPD with Pathlength

An example of the variation of the XPD with path length at frequencies of 4, 6, 10, 20, and 30 GHz for horizontal and vertical polarizations is shown in Fig. 7 for thunderstorm rain type at a rain rate of 100 mm/h. Similar results were obtained for the shower rain type, while the degree of the deterioration of the XPD is insignificant in the low-intensity stratiform rain type because the rain drops are almost spherical and since most operating systems have more than enough allowable margin to cope with any likely degradation or outage. Fig. 7, however, shows that, at frequencies higher than 10 GHz, the XPD will deteriorate to levels lower than 20 dB, implying extremely very poor cross-polarization isolation in orthogonal channels at path lengths longer than about 2 km with a thunderstorm rain envelope along the path. In order to maintain a reasonable level of cross-polar isolation in the channels, repeater stations may have to be closely spaced so as to reduce the significant incidence of fading, in addition to allowing for the margins which could be poorer than say 15 dB along the path. Nevertheless, the XPD may be responsible for

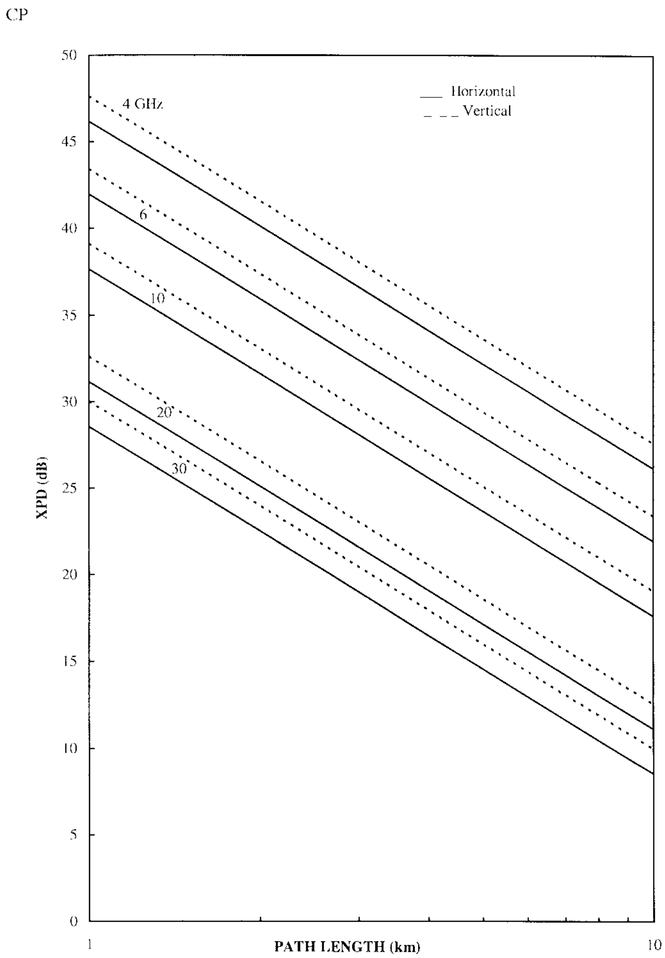

Fig. 7. Variation of XPD with pathlength for *thunderstorm rain* at some frequencies and rain rate of 100 mm/h using effective canting angle $\phi = 10°$ and standard deviation $\sigma = 19°$.

the degradation in the quality of signals in the low-frequency region in terrestrial line-of-sight systems since the copolar attenuation is small in the low-frequency region.

IV. Conclusions

This study has shown, to some extent, the deficiencies in the assumption of an all equally oriented raindrops model for the prediction of XPD for linear polarization on terrestrial tropical microwave paths. For instance, the distribution of the canting angles over a propagation path has shown that there can be improvement of nearly 7 dB in the XPD over those of the constant canting angle model on the same path.

Subject to the same canting angle distribution on the path of a terrestrial microwave relay system in the tropics, models utilizing the lognormal DSD [1], [7] and convective rain types appear to yield comparable XPD values at high rain rates. The attenuation and phase-shift characteristics of these models were earlier shown to be comparable for these conditions [16]. The DSD model of [11] will overestimate the XPD under these conditions on the tropical path, whereas the system may in reality be subject to a lower XPD than will be predicted by this model. Using the DSD model of [7] for the low-intensity widespread rainfall will result in poorer cross-polarization isolation prediction between the orthogonal channels at frequencies higher than 20 GHz, whereas [1] and [11] will provide reliable results for widespread rainfall. The frequency characteristics of the XPD for a given rain rate and frequency appear to be sensitive to the distribution of raindrop sizes in the rain storm, whereas the variation of XPD with copolar attenuation at high frequencies seems to be insensitive to the DSD. However, there are no experimental data from tropical regions available to the authors for comparing the theoretical with measured data.

The present study has also shown that XPD could be poorer by up to 1 dB in the horizontal polarization compared with the vertical polarization at all rain rates and frequencies in modification to the results of [3].

The degradation in the quality of the signals transmitted with a defined polarization due to cross polarization interference from an orthogonal channel will be as a result of cross polarization interference from an adjacent channel at low frequencies over long paths, while at high frequencies, degradation in the purity of signals in the wanted polarization or complete outage will be due more to the substantial signal attenuation along the propagation path.

The dependence of XPD on raindrop shape using models of raindrop shape in [19] and [20], which represent more recent but realistic raindrop shape models should be employed in the investigation of dependence of the XPD on raindrop shape. In such a study, suitable scaling relationships between the XPD and the CPA will be derived for each tropical rain type.

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References

[1] I. A. Adimula and G. O. Ajayi, "Variations in raindrop size distribution and specific attenuation due to rain in Nigeria," *Ann. Telecomm.*, vol. 51, nos. 1/2, pp. 87–93, 1996.
[2] R. L. Olsen, "Cross polarization during precipitation on terrestrial links: A review," *Radio Sci.*, vol. 16, no. 5, pp. 761–779, 1981.
[3] G. O. Ajayi, I. E. Owolabi, and I. A Adimula, "Rain induced depolarization from 1 GHz to 300 GHz in a tropical environment," *Int. J. Infrared Millimeter Waves*, vol. 8, no. 2, pp. 177–197, 1987.
[4] G. O. Ajayi, "Some aspects of tropical rainfall and their effect on microwave propagation," *Int. J. Satellite Commun.*, vol. 8, pp. 163–172, 1990.
[5] S. O. Ajose, M. N. O. Sadiku, and U. Goni, "Computation of attenuation, phase rotation, and cross polarization of radio waves due to rainfall in tropical regions," *IEEE Trans. Antennas Propagat.* vol. 43, pp. 1–5, Jan. 1995.
[6] T. Oguchi, "Scattering properties of Pruppacher-and-Pitter form raindrops and cross polarization due to rain: Calculations at 11, 13, 19.3, and 34.8 GHz," *Radio Sci.*, vol. 12, no. 1, pp. 41–51, 1977.
[7] G. O. Ajayi and R. L. Olsen, "Modeling of a raindrop size distribution for microwave and millimeter wave applications," *Radio Sci.*, vol. 20, no. 2, pp. 193–202, 1985.

[8] P. A. Watson, G. Papaioannou, and J. C. Neves, "Attenuation and cross polarization measurements at 36 GHz on a terrestrial link," in *Proc. URSI Comm. F Open Symp. Propagat. Nonionized Media.,* La Baule, France, Apr. 28–May 6, 1977, pp. 283–287.

[9] J. C. Neves and P. A. Watson, "Cross polarization, differential attenuation and differential phase shift measured on a 36.5 GHz terrestrial link," in *URSI Comm. F Open Symp. Effects Lower Atmosphere Radio Propagat. Freq. Above 1 GHz,"* Lennoxville, Canada, 1980, vol. 5.1.1–5.1.6 (preprints).

[10] R. L. Olsen, D. V. Rogers, and D. B. Hodge, "The aR^b relation in the calculation of rain attenuation," *IEEE Trans. Antennas Propagat.* vol. AP-26, no. 2, pp. 318–329, Mar. 1978.

[11] J. D. Laws and D. A. Parsons, "The relation of rain dropsize to intensity," *Trans. Amer. Geophys. Union*, vol. 24, pp. 452–460, 1943.

[12] D. Maggiori, "Computed transmission through rain in the 1–400 GHz frequency range for spherical and elliptical drops and any polarization," FUB Rep. IC 379 Alta Freq., 1981, vol. 1, pp. 262–273.

[13] G. O. Ajayi, "Characteristics of rain induced attenuation and phase shift at centimeter and millimeter wavelengths using a tropical raindrop size distribution model," *Int. J. Infrared Millimeter Waves*, vol. 6, pp. 771–806, 1985.

[14] M. O. Ajewole, "Scattering and attenuation of centimeter and millimeter radio signals by tropical rainfall," Ph.D. dissertation, Federal Univ. Technol., Akure, Nigeria, 1997.

[15] P. S. Ray, "Broadband complex refractive indices of ice and water," *Appl. Opt.*, vol. 11, no. 8, pp. 1836–1844, 1972.

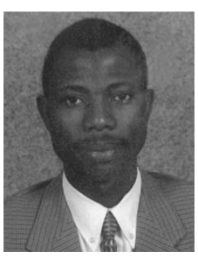
[16] M. O. Ajewole and L. B. Kolawole, "Millimeter and microwave signal degradation by rain in Nigeria," *Nigerian J. Sci.*, to be published.

[17] A. Paraboni, A. Martellucci, A. Aresu, E. Damosso, L. Ordano, and R. Polonio, "Depolarization of electromagnetic waves due to rain and ice: Theory and experimental results," *Alta Freq.,* vol. 6, no. 6, pp. 70–75, 1994.

[18] A. Paraboni, A. Martellucci, and R. Polonio, "Statistical modeling of depolarization due to rain and ice during thunderstorms based on the ITALSAT and OLYMPUS measurements," in *Proc. 8th. URSI Comm. F Symp. Wave Propagat. Remote Sensing,* Aveiro, Portugal, Sept. 1998, pp. 288–290.

[19] K. V. Beard and C. Chuang, "A new model for the equilibrium shape of raindrops," *J. Atmosph. Sci.*, vol. 44, no. 11, pp. 1509–1524, 1987.

[20] J. W. F. Goddard, J. D. Eastman, and J. Tan, "Self-consistent measurement of differential phase and differential reflectivity in rain," in *Proc. Int. Geosci. Remote Sensing, Symp.,* Pasadena, CA, invited paper, Aug. 1994, pp. 369–371.



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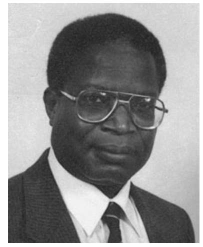

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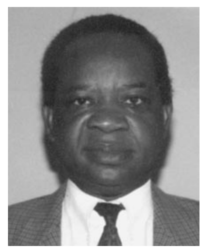

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