

RECOMMENDATION ITU-R P.838-3

Specific attenuation model for rain for use in prediction methods

(Question ITU-R 201/3)

(1992-1999-2003-2005)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to calculate the attenuation due to rain from a knowledge of rain rates,

recommends

1 that the following procedure be used.

The specific attenuation γ_R (dB/km) is obtained from the rain rate R (mm/h) using the power-law relationship:

$$\gamma_R = kR^\alpha \quad (1)$$

Values for the coefficients k and α are determined as functions of frequency, f (GHz), in the range from 1 to 1 000 GHz, from the following equations, which have been developed from curve-fitting to power-law coefficients derived from scattering calculations:

$$\log_{10} k = \sum_{j=1}^4 a_j \exp \left[- \left(\frac{\log_{10} f - b_j}{c_j} \right)^2 \right] + m_k \log_{10} f + c_k \quad (2)$$

$$\alpha = \sum_{j=1}^5 a_j \exp \left[- \left(\frac{\log_{10} f - b_j}{c_j} \right)^2 \right] + m_\alpha \log_{10} f + c_\alpha \quad (3)$$

where:

f : frequency (GHz)

k : either k_H or k_V

α : either α_H or α_V .

Values for the constants for the coefficient k_H for horizontal polarization are given in Table 1 and for the coefficient k_V for vertical polarization in Table 2. Table 3 gives the values for the constants for the coefficient α_H for horizontal polarization, and Table 4 gives the values for the constants for the coefficient α_V for vertical polarization.

TABLE 1
Coefficients for k_H

j	a_j	b_j	c_j	m_k	c_k
1	−5.33980	−0.10008	1.13098	−0.18961	0.71147
2	−0.35351	1.26970	0.45400		
3	−0.23789	0.86036	0.15354		
4	−0.94158	0.64552	0.16817		

TABLE 2
Coefficients for k_V

j	a_j	b_j	c_j	m_k	c_k
1	−3.80595	0.56934	0.81061	−0.16398	0.63297
2	−3.44965	−0.22911	0.51059		
3	−0.39902	0.73042	0.11899		
4	0.50167	1.07319	0.27195		

TABLE 3
Coefficients for α_H

j	a_j	b_j	c_j	m_α	c_α
1	−0.14318	1.82442	−0.55187	0.67849	−1.95537
2	0.29591	0.77564	0.19822		
3	0.32177	0.63773	0.13164		
4	−5.37610	−0.96230	1.47828		
5	16.1721	−3.29980	3.43990		

TABLE 4
Coefficients for α_V

j	a_j	b_j	c_j	m_α	c_α
1	−0.07771	2.33840	−0.76284	−0.053739	0.83433
2	0.56727	0.95545	0.54039		
3	−0.20238	1.14520	0.26809		
4	−48.2991	0.791669	0.116226		
5	48.5833	0.791459	0.116479		

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For linear and circular polarization, and for all path geometries, the coefficients in equation (1) can be calculated from the values given by equations (2) and (3) using the following equations:

$$k = [k_H + k_V + (k_H - k_V) \cos^2 \theta \cos 2 \tau] / 2 \quad (4)$$

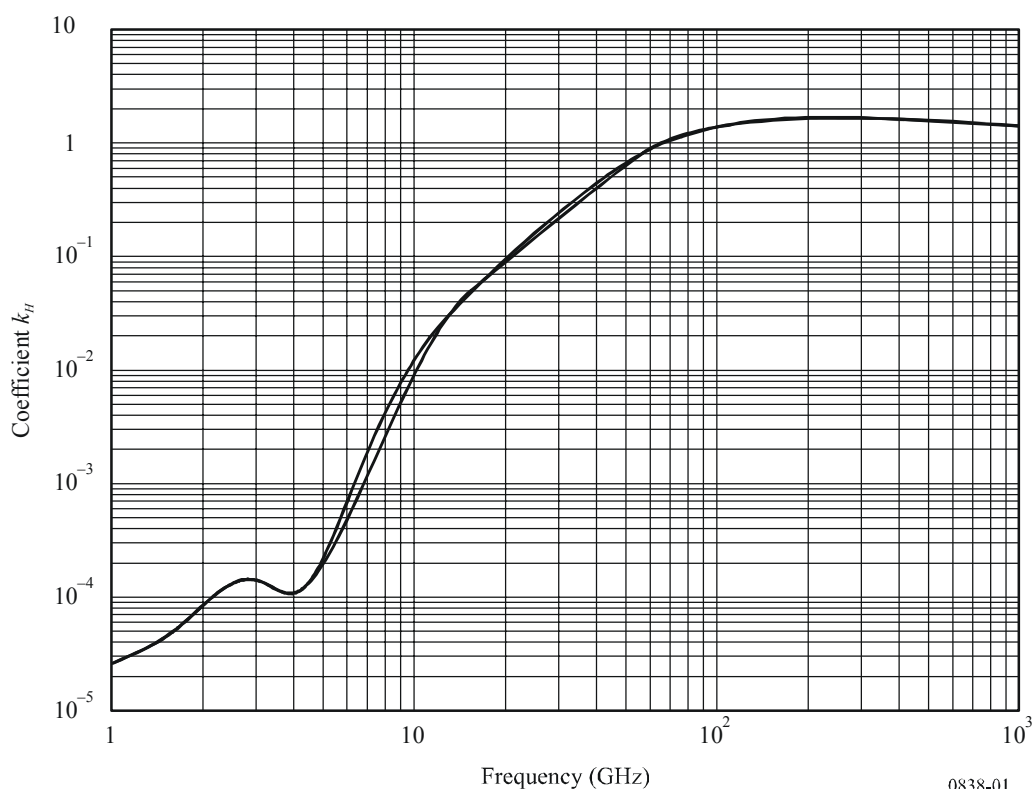
$$\alpha = [k_H \alpha_H + k_V \alpha_V + (k_H \alpha_H - k_V \alpha_V) \cos^2 \theta \cos 2 \tau] / 2k \quad (5)$$

where θ is the path elevation angle and τ is the polarization tilt angle relative to the horizontal ($\tau = 45^\circ$ for circular polarization).

For quick reference, the coefficients k and α are shown graphically in Figs. 1 to 4, and Table 5 lists numerical values for the coefficients at given frequencies.

FIGURE 1

k coefficient for horizontal polarization



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