

2000. 12.

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2001. 1. 18.

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		1	2	3	4	5	6	7	8	9	10	11	12	
o ITU-R		→												
o				→										
- S/W														
-														
o					→									
-														
-														
o					→									
- ITU-R, Crane- Global,														
- DAH														
-														
-														
o											→			
o											→			
o													→	
(%)		20			40			80			100			

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1)

- o IEEE
- o NASA Refernce Publication

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- o S/W
- o (7)

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- o ITU - R, Crane - Global
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SUMMARY

In this study, we calculated the rain intensity distribution parameter u by using existing rain intensity distribution values, in the two cases which are the temperate region($u=0.01149$) and the sub-tropical region($u=0.199$). In the temperate region and the sub-tropical region, the rain intensity distribution parameters are improved to -0.00072 and $+0.003$ respectively.

Applying the estimated values of the rain intensity distribution parameter, we calculated the rain attenuation models and improved the values to 0.188% on an average. As a result, we know that the control powers of satellite link margins on the Ka-band(up/down : $28.95/19.15$ GHz) were not improved.

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1	Moupfouma New Model.....
2	Moupfouma
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4- 3		
4- 4	ITU-R	

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1 Moupfouma New Model^[2]

Moupfouma^[1],

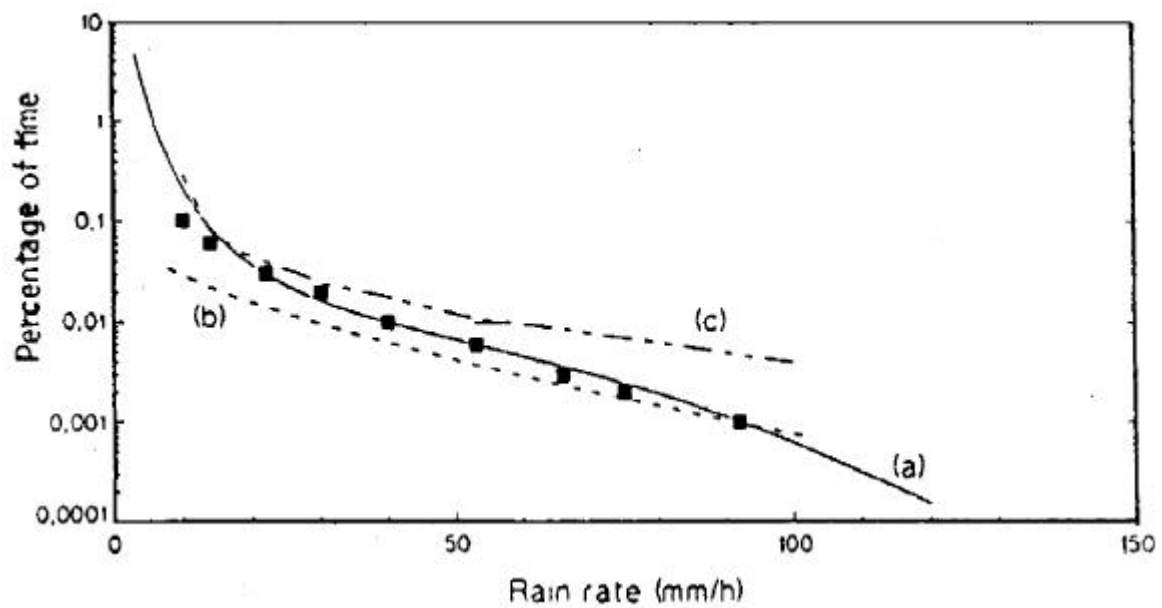
가 .
가 Moupfouma New Model

[4]

Moupfouma

^{[1][2]} 2- 1 가

2- 1 Dijong



$$P(R \geq r) = \left(\frac{R_p + 1}{r + 1} \right)^b e^{-u(R_p - r) + \log_e[P(R_p)]} \quad (2-1)$$

$$u = \quad ,$$

(a)

$$u(r) = - \frac{\log_e[P(R_p)]}{R_p} \frac{1}{1 + \eta \left(\frac{r}{R_p} \right)^\beta} \quad (2-2)$$

(b)

$$u(r) = - \frac{\log_e[P(R_p)]}{R_p} \exp \left(- \lambda \left(\frac{r}{R_p} \right)^\gamma \right),$$
$$\lambda, \gamma > 0 \quad (2-3)$$

ITU-R 1 0.01% $R_{0.01}(\text{mm})$
/h) , 1 $R_p = R_{0.01}$
(a), (b) $\eta, \beta, \lambda, \gamma$.

$$\begin{aligned} \eta &= 4.56 \\ \beta &= 1.03 \\ \lambda &= 1.066 \\ \gamma &= 0.214 \end{aligned} \quad (2-4)$$

2 Moupfouma ^[2]

(1 min)
0.01% $R(\tau \text{ min.})_{0.01}$,
1 0.01% $R(1 \text{ min.})_{0.01}$
가 .
1 min. $\leq \tau \leq$ 1 hour ,

$$R(\tau \text{ min.})_{0.01} = (R(\tau \text{ min.})_{0.01}) \quad (2-5)$$

$$\alpha = 0.987(\tau(\text{min.}))^{0.061} \quad (2-6)$$

가 .

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, , , , ,) 1 10
(, , : 1987 1996, , , : 1988 1997, 1
) 2- 1 .
Moupfouma 1 1
, 2- 2 , 1, 0.1,
0.01, 0.001% 2- 2 .

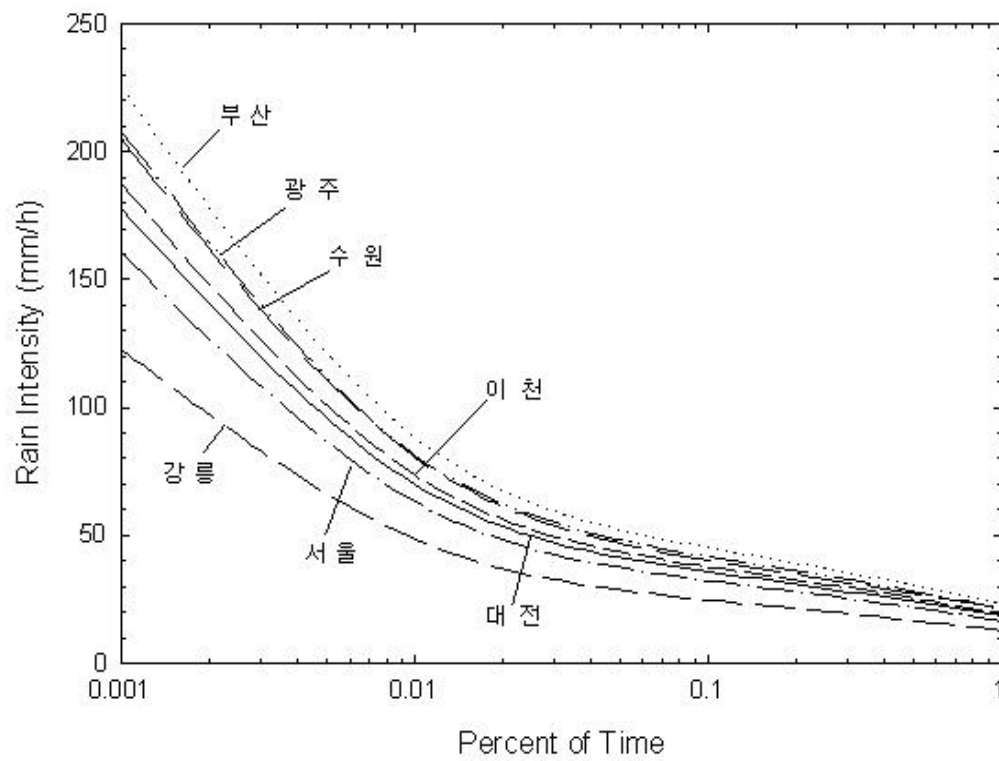
2- 1. , , ^[6]

(°)	(°)	(m)
37.75	128.90	26.0
37.57	126.97	85.5
37.27	126.98	36.9
37.25	127.48	68.5
36.37	127.37	67.2
35.17	126.88	70.3
35.10	129.03	69.2

2-2.

(: mm/h)^[6]

(%)							
0.001	177.7	225.1	187.4	207.9	205.1	160.6	122.8
0.01	69.6	88.1	73.3	81.3	80.3	62.8	48.1
0.1	35.6	45.1	37.5	41.6	40.0	32.1	24.6
1	18.3	23.2	19.3	21.4	21.1	16.5	12.6



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[6]

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3- 1 2- 2 1997 7
 1998 6 . 0.001%
 100mm/h
 가 ,
 1% 10
 1
 . 0.01 0.1%
 2 0.01%
 u
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(%)	(mm/h)	(mm/h) ^[5]	(%)
0.001	187.4	99.0	-
0.01	73.3	72.8	0.6
0.1	37.5	33.1	13.3
1	19.3	6.0	-

2

u (2- 2) (2- 3)

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가

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u

(2- 2) (2- 3),

(2-4)

3- 1

0.01%

3- 2

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3- 2.

<i>u</i>		
0.01149	- 0.00072	
0.01221		
0.199	+0.003	
0.196		

4

1

ITU-R Crane-Global , ITU-R
0
.
ITU-R
Crane- Global [3]
ITU-R 0.01%
, R_p . $A_{0.01}$
 $A_{0.01}$ (4- 1) (4- 2) .

$$A_p = A_{0.01} \cdot 0.12 \cdot P^{-(0.546 + 0.043 \log P)} \quad (4- 1)$$

$$A_p = C \cdot A_{0.01} (P/0.01)^a \quad (4- 2)$$

$$C = 1.0, a = 0.33 \quad ; 0.001 \leq P \leq 0.01$$

$$C = 1.0, a = 0.41 \quad ; 0.01 < P \leq 0.1$$

$$C = 1.0, a = 0.33 \quad ; 0.1 < P \leq 1.0$$

Crane- Global

가

가

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가

R_p

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,

0

가

가

0

A

.

$$A = \left(\frac{H_o}{\sin}\right) \cdot a(f) \cdot r(D) \cdot R_p^{b(f) - \delta(D)} \tag{4-3}$$

$$H_o \quad : 0 \hspace{10em} (\text{km})$$

$$\hspace{10em} : \hspace{1em} (>10^\circ)$$

$$R_p \quad : \hspace{10em} (\text{mm/h})$$

$$D \quad : \hspace{10em} (\text{km})$$

$$r(D), \hspace{0.5em} \delta(D) \hspace{0.5em} : D$$

$$a(f), \hspace{0.5em} b(f) \hspace{0.5em} :$$

$$\text{가} \hspace{10em} A \hspace{0.5em} D \hspace{0.5em} Z, \hspace{1em} 10^\circ$$

,

$$A = \frac{a \hspace{0.5em} R_p^b}{\cos} \left[\frac{e^{UZb} - 1}{Ub} - \frac{X^b e^{YZb}}{Yb} + \frac{X^b e^{YDb}}{Yb} \right] \tag{4-4}$$

$$U = (Z^{-1})[\ln(X \cdot \exp(Y \cdot Z))]\tag{4-5}$$

$$X = 2.3 \cdot R_p^{-0.17}$$

$$Y = 0.026 - 0.03 \cdot \ln R_p \tag{4-6}$$

$$Z = 3.8 - 0.6 \cdot \ln R_p$$

$$<10^\circ \hspace{1em},$$

$$A = \frac{L}{D} \hspace{0.5em} a \hspace{0.5em} R_p^b \left[\frac{e^{UZb} - 1}{Ub} - \frac{X^b e^{YZb}}{Yb} + \frac{X^b e^{YDb}}{Yb} \right] \tag{4-7}$$

$$D<Z$$

$$A = \frac{a R_p^b}{\cos} \left[\frac{e^{UbD} - 1}{Ub} \right] \quad (4-8)$$

, $D=0$, $=90^\circ$ A (4-14) .

$$A = (H_o - H_g)(aR_p^b) \quad (4-9)$$

H_g : (km)

2

ITU-R Crane-Global 3-2

. ITU-R
가 , , 0
(ITU-R1) (ITU-R2)
.
Ka (/ : 28.95/ 19.15GHz) 4-1
.
0.188% .

3

/ 28.95/ 19.15GHz Ka 4-2
가 .
4-3 . 가 4-3
/ .
4-1 .
가 99.0% /year 가 ,
ITU-R 가
4-4 . 4-3 6.43dB ,

4- 1.

(dB)

(%)										
			0.001	0.01	0.1	1	0.001	0.01	0.1	1
	Crane- Global		88.2/ 177.9	34.4/ 72.2	15.7/ 34.0	6.7/ 15.3	88.0/ 177.6	34.3/ 72.0	15.7/ 33.9	6.7/ 15.3
	IT U - R	1	70.7/ 129.3	28.8/ 52.7	13.3/ 24.4	4.3/ 7.9	70.6/ 129.1	28.7/ 52.6	13.3/ 24.4	4.3/ 7.9
		2	63.1/ 115.4	25.9/ 47.4	11.1/ 20.3	3.5/ 6.5	63.0/ 115.2	25.9/ 47.3	11.1/ 20.3	3.5/ 6.5
	Crane- Global		109.7/ 219.0	43.6/ 90.6	20.6/ 44.1	9.2/ 20.6	109.5/ 218.6	43.5/ 90.4	20.6/ 44.0	9.2/ 20.6
	IT U - R	1	85.8/ 154.2	35.0/ 62.8	16.2/ 29.1	5.2/ 9.4	85.6/ 153.9	34.9/ 62.7	16.2/ 29.0	5.2/ 9.4
		2	77.5/ 139.2	31.8/ 57.2	13.6/ 24.2	4.4/ 7.8	77.4/ 138.9	31.7/ 57.1	13.6/ 24.2	4.4/ 7.8
	Crane- Global		92.9/ 187.1	36.5/ 76.4	16.9/ 36.5	7.4/ 16.8	92.7/ 186.7	36.4/ 76.3	16.9/ 36.4	7.4/ 16.8
	IT U - R	1	72.6/ 132.2	29.6/ 53.9	13.7/ 24.9	4.4/ 8.0	72.5/ 131.9	29.5/ 53.8	13.7/ 24.9	4.4/ 8.0
		2	66.7/ 121.4	27.4/ 49.9	11.7/ 21.3	3.7/ 6.8	66.6/ 121.2	27.3/ 49.8	11.7/ 21.3	3.7/ 6.8
	Crane- Global		101.9/ 204.2	40.3/ 84.0	19.0/ 40.7	8.4/ 19.0	101.7/ 203.8	40.2/ 83.8	19.0/ 40.6	8.4/ 19.0
	IT U - R	1	78.2/ 141.3	31.9/ 57.6	14.7/ 26.6	4.8/ 11.3	78.1/ 141.0	31.8/ 57.5	14.7/ 26.6	4.8/ 11.3
		2	72.8/ 131.5	29.9/ 54.0	12.8/ 23.1	4.1/ 7.4	72.7/ 131.3	29.8/ 53.9	12.8/ 23.1	4.1/ 7.4
	Crane- Global		64.5/ 132.3	25.0/ 53.3	11.4/ 25.2	4.8/ 11.3	64.4/ 132.1	25.0/ 53.2	11.4/ 25.2	4.8/ 11.3
	IT U - R	1	48.4/ 91.0	19.7/ 37.1	9.1/ 17.2	3.0/ 5.5	48.3/ 90.8	19.7/ 37.0	9.1/ 17.2	3.0/ 5.5
		2	46.1/ 86.5	18.9/ 35.5	8.1/ 15.2	2.6/ 4.9	46.0/ 86.3	18.9/ 35.4	8.1/ 15.2	2.6/ 4.9
	Crane- Global		100.7/ 202.0	39.6/ 82.6	18.3/ 39.2	7.9/ 17.7	100.3/ 201.6	39.4/ 82.2	18.3/ 39.0	7.9/ 17.7
	IT U - R	1	82.8/ 149.8	33.7/ 61.0	15.6/ 28.2	5.0/ 9.1	82.8/ 149.8	33.7/ 61.0	15.6/ 28.1	5.0/ 9.1
		2	71.4/ 129.2	29.3/ 53.1	12.5/ 22.7	4.0/ 7.3	71.3/ 129.0	29.2/ 53.0	12.5/ 22.7	4.0/ 7.3
	Crane- Global		81.0/ 164.2	31.5/ 66.5	14.4/ 31.3	6.2/ 14.2	80.8/ 163.9	31.4/ 66.4	14.4/ 31.2	6.2/ 14.2
	IT U - R	1	62.9/ 116.0	25.7/ 47.3	11.9/ 21.9	3.8/ 7.1	62.8/ 115.8	25.7/ 47.1	11.9/ 21.9	3.8/ 7.1
		2	58.2/ 107.2	23.9/ 44.0	10.2/ 18.8	3.3/ 6.0	58.1/ 107.0	23.9/ 43.9	10.2/ 18.8	3.3/ 6.0

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가

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가

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[6]

가			
EIRP	dBW	44.40	
	m	5.00	
G/T	dB/ K	27.40	
	m	3.00	
EIRP	dBW	17.60	
G/T	dB/ K	4.80	
	kbps	32.00	

4- 3.

[6]

BER		10^{-3}	
$(C/N_o)_L$	dB · Hz	54.26	
$(C/N_o)_D$	dB · Hz	63.80	
$(C/N_o)_U$	dB · Hz	63.11	
$(C/N_o)_T$	dB · Hz	60.43	
$(C/N_o)_{LU}$	dB · Hz	55.49	
$(C/N_o)_{LD}$	dB · Hz	55.56	
	K	260.00	
+	K	63.90	
	dB	0.20	
	K	290.00	
LNA	K	300.00	
	dB	4.05	
	dB	6.43	

ITU-R							
1	0.45%	0.66%	0.47%	0.55%	0.21%	0.61%	0.35%
	/	/	/	/	/	/	/
	0.55%	0.34%	0.53%	0.45%	0.79%	0.39%	0.65%
P_c (dB)	(10.60)	(16.08)	(11.04)	(12.81)	(6.22)	(14.58)	(8.75)
	6.55	12.03	6.99	8.76	2.17	10.53	4.70
2	0.32%	0.48%	0.36%	0.43%	0.17%	0.41%	0.27%
	/	/	/	/	/	/	/
	0.68%	0.52%	0.64%	0.57%	0.83%	0.59%	0.73%
P_c (dB)	(7.97)	(11.08)	(8.66)	(9.97)	(5.37)	(9.62)	(7.13)
	3.92	7.03	4.61	5.92	1.32	5.57	3.08

가

가

가

ITU-R1

(6.43dB)

, , 가 0.45%/year가 , 가

0.55%/year

0.55%/year 10.60dB ,

4.05dB 6.55dB가 . ,

P_c

5

 $(u=0.01149)$

($u=0.199$)

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- 0.00072

+0.003

•

0.188%

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Ka

(/

: 28.95/ 19.15GHz)

가

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