TRYING TO BETTER UNDERSTAND RAIN ATTENUATION DISTRIBUTIONS MEASURED AT 19 GHz AND 38 GHz

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1. Introduction

TESTCOM has measured attenuation due to hydrometeors (rain, hail, fog, snow) at 19 GHz on V polarisation on the path Kladno – TV Tower Prague (path A) since March 1995, at 38 GHz on V polarisation on the path Strahov – TESTCOM (path B) since July 1995 and on the path Uvaly – TESTCOM (path C) since December 1999 [1].

The length of the path A is 27.1 km. The transmitter is situated in the town Kladno, altitude 51 m above ground. The receiver is at TV Tower Prague, altitude 121 m above ground. The transmitter power is + 23 dBm, working frequency is 19 480 MHz. Antennas having diameter of 1.2 m have been used. The recording margin is 50 dB.

The length of the path B is 9.3 km. The transmitter is situated in Prague at Strahov (394 m a. s. l.), altitude 39 m above ground. The receiver is at TESTCOM, altitude 27 m above ground. The transmitter power is + 16 dBm, working frequency is 38 319.75 MHz. Antennas having diameter of 0.6 m have been used. The recording margin is 52 dB.

The length of the path C is 15.2 km. The transmitter is situated in Prague at Uvaly, altitude 26 m above ground. The receiver is at TESTCOM, altitude 27 m above ground. The transmitter power is + 18 dBm, working frequency is 38 491.25 MHz. Antennas having diameter of 0.6 m have been used. The recording margin is 60 dB.

The obtained records of received signal level on the above mentioned paths were processed statistically and monthly cumulative distributions of attenuation due to hydrometeors were obtained. From these distributions, cumulative distributions of attenuation due to hydrometeors for both the average worst month and the average year over different periods were obtained.

Rain intensities have been measured at TESTCOM by means of a heated siphon raingauge over full years. Rain intensities have been also measured at meteorological station Prague-Klementinum (about 2.6 km far from TV Tower Prague) by means of a siphon raingauge always from May to October. The cumulative distributions of average 1-minute rain intensities for both the average worst month and the average year were obtained for the same periods as cumulative distributions of attenuation due to hydrometeors.

The obtained cumulative distributions of attenuation due to hydrometeors for both the average year and the average worst month are presented. These distributions are compared with the distributions calculated in accordance with ITU-R Recommendations, and differences are discussed.

2. Obtained results and discussion

The geographical location of the experimental paths A, B, and C is shown in Fig. 1.

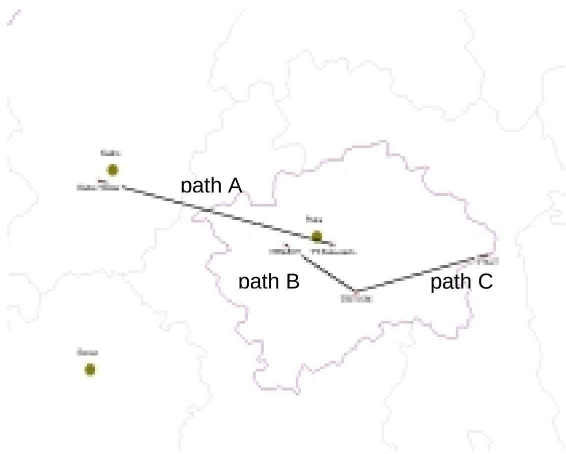

Fig. 1. Geographical location of experimental paths

The cumulative distributions of attenuation due to hydrometeors for both the average year (AY) and the average worst month (AWM) were obtained for both the path A and B from 5 year period of observation (path A: April 1995 – March 2000, path B: July 1995 – June 1998, August 1999 – July 2001), and for the path C from 2 year period of observation (December 1999 – November 2001). The results obtained are given in Fig. 2. The calculated cumulative distributions of attenuation due to rain for both the average worst month and the average year in accordance with [2] are shown in Fig. 3. The used rain intensities with the integration time of 1 minute exceeded for 0.01% of the time were obtained from the measured cumulative distribution of rain intensities at TESTCOM and Prague-Klementinum. The rain intensity $R_{0.01}(1)$ = 28.4 mm/h used for the path A was measured at Prague-Klementinum. The rain intensity $R_{0.01}(1)$ = 25.2 mm/h was used for the path B, and the rain intensity $R_{0.01}(1)$ = 23.6 mm/h was used for the path C. These rain intensities were measured at TESTCOM. The rain intensity with the integration time of 1 minute exceeded for 0.01% of the average year $R_{0.01}(1)$ = 26 mm/h was calculated in accordance with [3]. It can be said that there is no great difference among these rain intensities.

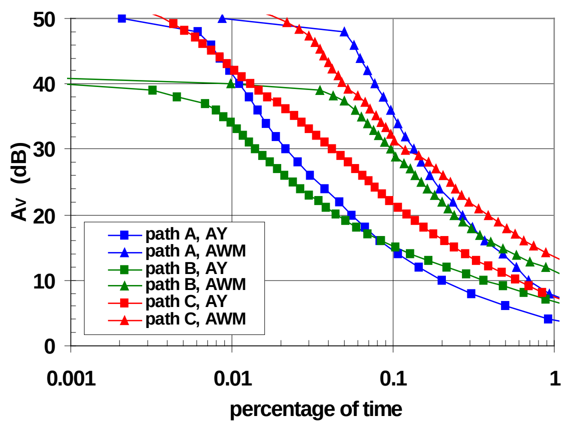

Fig. 2. Measured cumulative distributions of attenuation due to hydrometeors

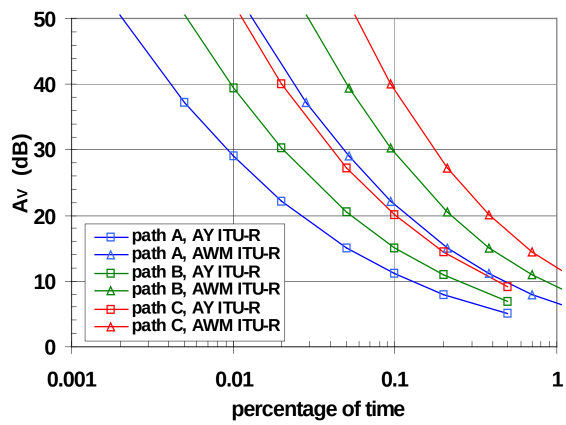

Fig. 3. Calculated cumulative distributions of attenuation due to rain

A comparison of both the measured and the calculated distributions for the individual paths is given in Figs. 4 - 6.

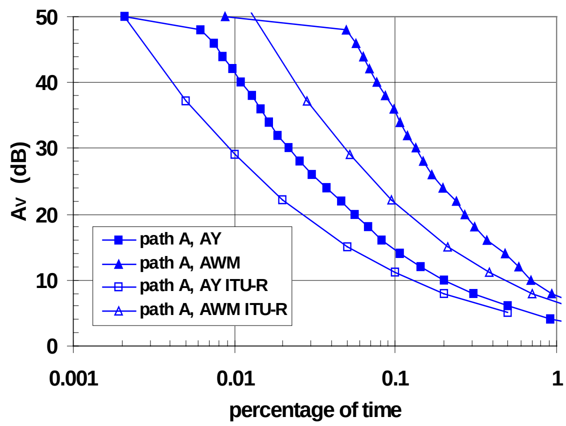

Fig. 4. Comparison of measured and calculated distributions for path A

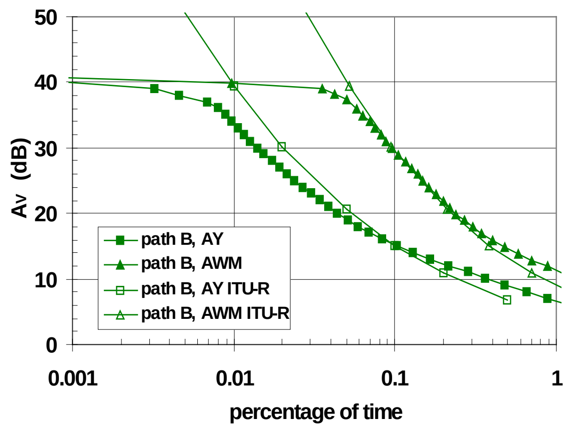

Fig. 5. Comparison of measured and calculated distributions for path B

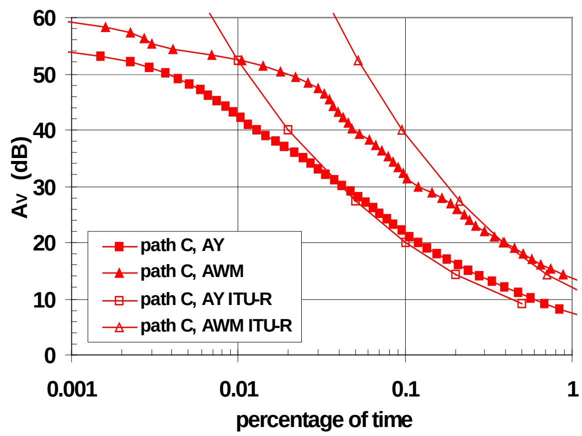

Fig. 6. Comparison of measured and calculated distributions for path C

A very good agreement between the measured cumulative distributions and the calculated ones was only found for the worst month distribution for the percentage of time greater than 0.1% for the path B as well as for the average year distribution for the percentage of time greater than 0.04% for the path C.

The greatest differences between the measured attenuation and the calculated one occurs for the longest path A. The measured attenuation is much greater than the calculated one. It could be due to the fact that the path A lies in the direction of the prevailing winds. These winds might bring showers moving along the path and therefore the duration of attenuation is greater. The further reason might be that rain cells with great rain intensities occurred at the path but they missed the raingauge at Prague-Klementinum. It would mean that the cumulative distributions of attenuation due to rain could be depended on the direction of the prevailing winds and consequently on their geographical orientation. Hails that have much greater specific attenuation might also occurred on this path. Last but not least reason might be that more than one rain cell occurred frequently along the path A.

For the shorter paths B and C, the measured attenuation is smaller than the calculated one. Concerning the path B, there is a very good agreement between the measured distribution and the calculated one for the average worst month. For the average year, the measured attenuation is greater than the calculated one for the percentage of time greater than 0.1%, but it is smaller for the percentage of time smaller than 0.1%. The obtained differences are not too great and they might be also caused by local meteorological conditions. The greater differences for the path C may be explained by the year-to-year variability of these distributions obtained from only 2-year measurement.

3. Conclusions

The above mentioned results were obtained within the framework of our research focused on obtaining a long term radio and radio-meteorological data in our climatic conditions. The obtained data will be used for draft cumulative distributions of attenuation due to hydrometeors for the average year and the average worst month that will be applied to calculations of transmission quality and reliability of terrestrial fixed systems in the Czech Republic.

4. Acknowledgements

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References

[1] V. Kvicera, M. Grabner, “Theoretical and Experimental Testing of Possibilities to Advanced Utilisation of Higher Frequency Bands under Radio Wave Propagation Conditions in the Climate of the Czech Republic,” Annual Report, Task No. 9331-1212, TESTCOM, Prague, December, 2001.

[2] Rec. ITU-R P.530-9, “Propagation data and prediction methods required for the design of terrestrial line-of-sight systems,“ ITU-R Recommendations, P Series, ITU, Geneva, September 2001.

[3] Rec. ITU-R P.837-3, “Characteristics of precipitation for propagation modelling,“ ITU-R Recommendations, P Series, ITU, Geneva, March 2002.