Prediction Model of Fade Duration Statistics for Satellite Communications at Ka and Q bands

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With the transition of satellite communications to higher frequencies, such as the Ka and Q bands, atmospheric phenomena, in particular rain, have a significant influence on earth-satellite signal propagation, manifested as signal fades that limit the availability and reliability of links. To mitigate signal fades, properly design and operate such a high frequency system, the statistical information of fade durations is inevitably needed.

This paper presents a new model for predicting the fade duration statistics in earth-satellite communications in the Ka and Q bands. It is shown empirically that the Gaussian copula function is the most appropriate function. Thus, a prediction model for the fade duration statistics of single site and site diversity systems based on the Gaussian copula function, which is referred to as the GCM, is proposed.

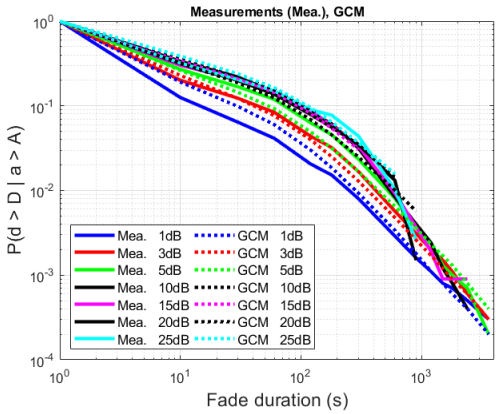

Fig. 1. Fade duration statistics predicted by the GCM compared to the measured distributions of the Q band at Ljubljana.

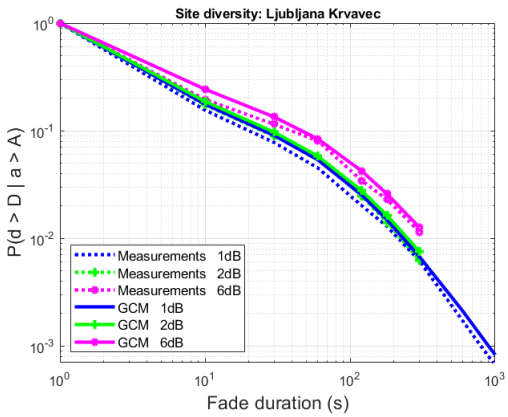

Fig. 2. Examples of the fade duration statistics for the site diversity system with stations in Ljubljana and Krvavec that were predicted by the GCM compared to the measured distributions.

For model development and evaluation, experimental data from 21 single site experiments and 10 site diversity experiments were included in the study. The performance of the new model for single site was compared to that of the ITU-R P. 1623 model and the Cheffena Amaya model. The proposed model is notably more accurate and easier to apply that the other models. The new fade duration prediction model also performs well for site diversity systems and is believed to be the first model of its type in the field.

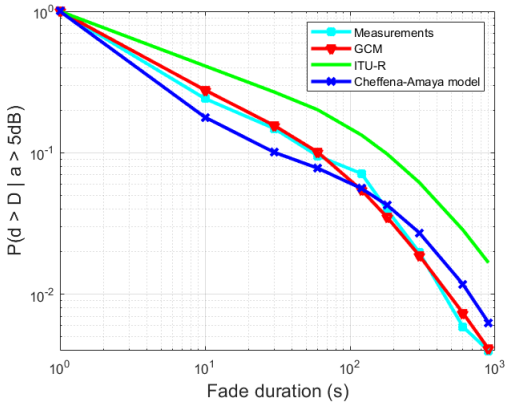

Fig. 3. Probability of the occurrences of a fade duration for a > 5 dB at Aire-sur-l'Adour, France, obtained from the measurements and from the three compared models.