



Space Dependence of Fog Visibility and Its Influence on Availability of Free Space Optical Links

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INTRODUCTION

A free space optical (FSO) communication systems can be used as high bandwidth solutions for terrestrial last mile broadband access, Earth-space communication (between Earth station and High Altitude Platform situated in troposphere or between Earth station and satellite), and inter-satellite communication. However, dense fog events which occur on the Earth surface can cause serious attenuation of optical waves or even the total outage of optical communication. Fog seems to be the most important impairment factor for terrestrial and Earth-space FSO communication links. Therefore, the availability performances of FSO links are seriously affected by lower atmospheric visibility. However, the detailed data about fog characteristics is very rare.

Experimental research in the Department of Frequency Engineering in the Czech Metrology Institute in Praha, the Czech Republic, is focused on stability of received signal on terrestrial radio and optical communication links. Therefore, our experimental research is also focused on processing meteorological data to obtain basic information for the assessment of availability performances of FSO links. The fog visibility data is measured and stored in meteorological stations or airports. The data can be used for the calculation of attenuation due to fog in accordance with the relevant ITU-R Recommendation. The results obtained provide a good estimate for the assessment of the availability performance of FSO links situated in the similar climatic conditions.

RESULTS OBTAINED

Fog visibility data obtained by the Vaisala transmissometer at both the Praha-Ruzyně airport and the Czech Metrology Institute (CMI) in Praha, the Czech Republic, was statistically processed from January 2004 to December 2008 (5 years of observation). The distance between the Praha-Ruzyně airport and the CMI is about 20 km. The cumulative distributions (CDs) of fog visibilities over the whole period of processing were obtained for both sites. A site dependence as well as great year-to-year variabilities of these distributions were observed. For both sites, fog events occurred most frequently in November and January, sporadically during the spring and summer months. The reduced fog visibility most frequently occurred during the sunrise due to the fact that the radiation caused dense fog events.

The CDs of fog visibility for the average year over the entire 5-year period of processing obtained at two sites were converted to the CDs of specific attenuation due to fog by the Al Naboulsi method for the convection (radiation) fog events. It was found that significant differences between the obtained CDs of specific attenuation due to fog occur for both sites.

CONCLUSIONS

The calculated CDs of specific attenuation due to fog for the average year can be used for the assessment of availability performances of the FSO communication links situated in the both sites where fog visibilities were measured.

ACKNOWLEDGEMENTS

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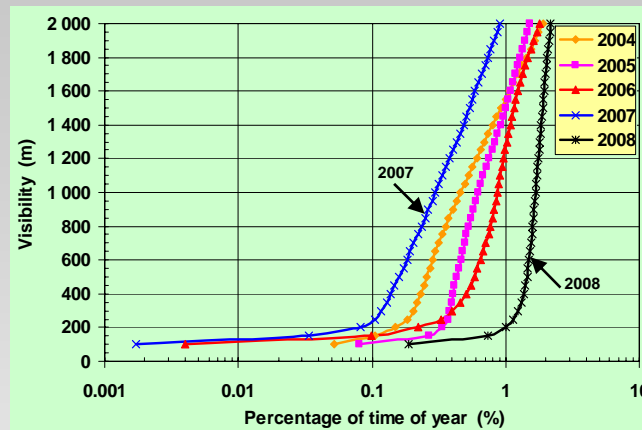


Fig. 1. Obtained CDs of visibility for individual years at CMI

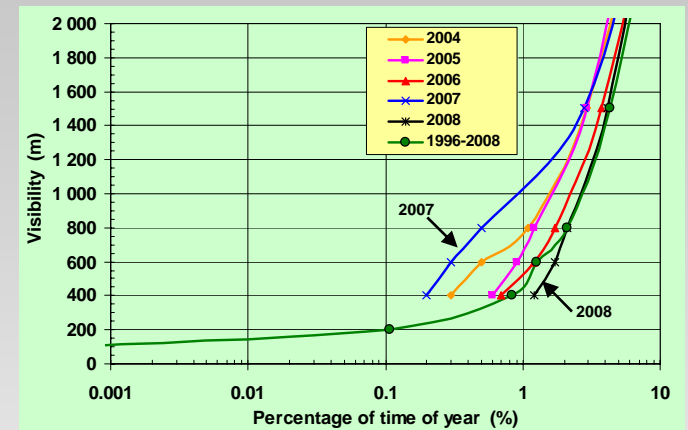


Fig. 2. Obtained CDs of visibility for individual years at Praha-Ruzyně Airport

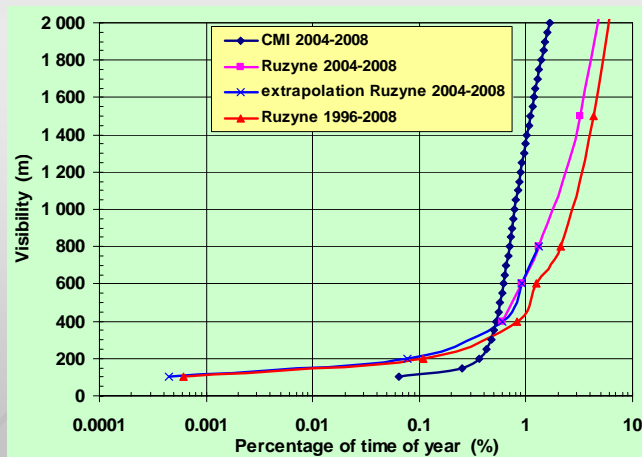


Fig. 3. Comparison of CDs of visibility for the average year over the 5-year period obtained at CMI and Praha-Ruzyně Airport

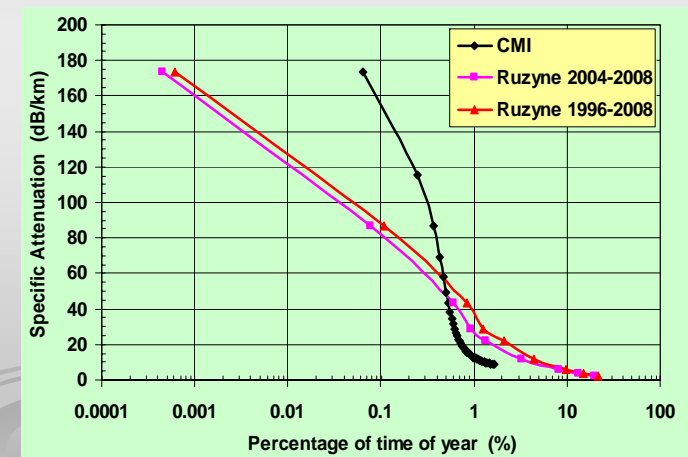


Fig. 4. Calculated CDs of specific attenuation due to fog for the average year over the 5-year period for CMI and Praha-Ruzyně Airport