REFRACTIVITY GRADIENTS IN THE NORTHERN HEMISPHERE

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The continued expansion of microwave radio links and the resulting congestion have increased the need for better performance estimates. In the evaluation of refractivity effects, the designer may wish to consider the average gradients at specific locations for different seasons, as well as diurnal changes. This report presents graphs showing the cumulative probability distributions of the atmospheric radio refractivity gradients in the ground-based 100-m layer for 87 stations in the Northern Hemisphere. These are based on climatological data from radiosonde observations, and show the average conditions in one month of each season. A limited number of diurnal comparisons are included, as well as information on the climate of each site.

Key words: Refractivity gradients, radiosonde data

1. INTRODUCTION

The increasing demand for radio services, particularly those requiring wide bandwidths, is a universal problem. In the United States, for example, there has been rapid development in recent years of the specialized common carrier industry and increased utilization of CARS** microwave links. Because of frequency congestion, many new systems are using frequencies above 10 GHz, which are more susceptible to various atmospheric effects than the lower microwave frequencies.

One of the most important influences on system performance is the bending of the radio beam caused by variations in the vertical refractivity gradient. This is a factor in the determination of the maximum feasible path length, the probability of multipath fading or ducting, and the ultimate reliability of a given link and system. The

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radio path of most terrestrial line-of-sight microwave links is relatively close to the surface, and the gradients in the lowest 100-m layer are therefore more suitable for propagation estimates than the gradients over the lowest 1 km. Microwaves may be affected by atmospheric layers of rather limited vertical extent, and 1-km layer statistics tend to smooth out many of the extreme gradients.

Information on the refractivity gradients to be expected in any part of the world is available in the "World Atlas of Atmospheric Radio Refractivity" (Bean et al., 1966). This Atlas contains maps showing the 100-m gradients exceeded for selected percentages of time. For application to the design of radio links, many engineers prefer a complete cumulative time probability distribution of the gradients at specific locations. The Atlas contains such distributions of the 50-m gradients at 22 stations worldwide; the present report supplements the Atlas by providing distributions of 100-m gradients at 87 stations in the Northern Hemisphere (see map, figure 1, and station index, Appendix C). Data for four months of the year are shown on the same graph to facilitate seasonal comparisons. Accompanying each graph is information on the length of record analyzed, the hours at which observations were taken, and general climatic and topographic details in the vicinity of the station.

2. SOURCE OF DATA

Refractivity gradients can be calculated from the radiosonde observations (RAOBs) made by national meteorological services in the various countries (see Appendix A). Although these observations of the vertical changes in temperature, pressure, and humidity do not provide as much detail and accuracy as is desirable for studies of radio refractivity, they are the only available source of worldwide, long-term, upper-air data.

Climatological RAOB data for the U.S. and many foreign locations are on file at the National Climatic Center in Asheville, N.C. The analysis of these data to obtain refractivity statistics requires that the refractive index be calculated for the individual data points on