Abstract

The objective of this thesis is to develop statistical methods for the evaluation and prediction of the effects of atmospheric hydrometeors on earth-satellite links, as required for designing purposes. Attenuation in the 10-30 GHz band is dealt with in some detail in terms of its dependence on a number of meteorological parameters, hereafter called propagation factors, such as:

- distribution of point rainfall intensity, i.e, the probability of rain intensity exceeding given thresholds on an average year;

- probability of occurrence of rainfall types;

- hydrometeor phases and size distributions;

- horizontal profiles of rainfall rate ;

- height of the $0^{O}C$ isotherm (freezing height), which roughly determines the vertical extent of the water phase.

Attenuation predictions are based on the statistical properties of the above propagation factors as obtained from direct meteorological measurements, especially from a dual linearly polarised radar.

The period of research spans from the end of 1981 until the end of 1984. The presentation of the material is organized as follows.

In Chapter II, we start by critically reviewing existing procedures for the estimation of attenuation statistics from meteorological data. We then present some initial considerations about the development of a new attenuation prediction method based on knowledge of the microphysical structure of precipitation. We stress the need to account for the climatic dependence of propagation factors within the technique. We also explain how equi-probable relationships between cumulative dlstributions of rainfall intensity and slant path attenuation can be used in various climates and discuss the meteorological data required for the application of the prediction method.

Chapter III can be considered as a self-contained part of this work. A new radar technique which uses two linear, orthogonal polarisations is discussed in detail, and its capabilities and limitations are evaluated. We were fortunate to be able to use the Chilbolton dual-polarisation radar, which was the first of its type and is still the one which offers best accuracy with high volumetric resolution. Using data from this radar, we investigate techniques for hydrometeor Identification and classification of rainfall types. Comparisons of OTS beacon attenuation data with radar predictions are described.

Chapters IV and V are essentially dedicated to the development of the attenuation prediction method, although many of the results are also useful for other areas of propagation research. Chapter IV deals with the characterisation of precipitation using radar data, which leads to the establishment of equi-probable relationships between point rainfall intensity and slant path attenuation for two rainfall types - widespread and showery rain. Effects of frequency, wave polarisation and path elevation dependence, as well as melting band and variation in rain height are included. The objective of Chapter V is the

climatic characterization of rainfall types and freezing heights, including the seasonal dependences of rain intensity and rain height. A new method of determining freezing heights during rainfall is proposed.

In Chapter VI we apply the new attenuation prediction technique in the European region and test the estimates against direct beacon and radiometrlc data collected within the framework of the current Project COST 205, an European research venture under the auspices of the EEC Commission. We note that the COST 205 data have not been released for publication yet, so the comparisons are confidential until general release due in June/July 1985.

Chapter VII summarizes the most outstandlng conclusions.

The Appendices contain the relevant publications of the author, colour photographs of scans taken with the Chilbolton radar and several FORTRAN programs for the implementation of the new prediction rnethod.