Analysis and Modeling of Radio Wave Propagation

With this comprehensive guide you will understand the theory and learn the techniques needed to analyze and model radio wave propagation in complex environments. All of the essential topics are covered, from the fundamental concepts of radio systems to complex propagation phenomena. These topics include diffraction, ray tracing, scattering, atmospheric ducting, ionospheric ducting, scintillation and propagation through both urban and non-urban environments. Emphasis is placed on practical procedures, with detailed discussion of numerical and mathematical methods, providing you with the necessary skills to build your own propagation models and develop your own techniques. MATLAB functions illustrating key modeling ideas are available online.

This is an invaluable resource for anyone wanting to use propagation models to understand the performance of radio systems for navigation, radar, communications or broadcasting.

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Preface

The aim of this book is to provide the reader with the techniques and theory that are required for the analysis and modeling of radio wave propagation in complex environments. It is designed for the reader who might need to model propagation in order to understand the performance of radio systems for navigation, radar, communications or broadcasting. The book brings together a range of topics that are often treated separately, but all of which are important in the comprehensive modeling of a radio system. In particular, the book includes an extensive discussion of propagation through irregularity, of importance to systems that suffer from scintillation. The book is not intended to be just a cookbook of propagation formulae, but rather to provide readers with sufficient insight to enable them to produce their own specialized theory and techniques when required. It is my experience that many propagation problems are not amenable to off-the-shelf black box solutions. A black box will often only provide part of the solution and the modeler will need to modify and/or add capability. To do this successfully, the modeler will need to have some insight into the basis of the black box in order to effectively incorporate his/her own modifications. It is the intention of the author to provide the reader with such insight. The book leverages on my experience, over several decades, in the development of techniques for the analysis and modeling of propagation in a variety of radar and communication systems. In writing this book, I have been heavily influenced by the work of Professor James Wait, Dr. G.D. Monteath, Dr. Jenifer Haselgrove, and Dr. Kenneth Davies. In particular, the reciprocity ideas that have been developed by Dr. Monteath have proven invaluable in the development of many propagation modeling techniques.

The book is designed to take the reader from very basic ideas concerning radio systems to advanced propagation modeling. The first chapter will be useful to someone new to radio systems and provide them with an idea of the technology and the challenges that radio wave propagation imposes. Obviously, this chapter can be skipped by those readers who are already familiar with radio technology. Chapters 2 and 3 introduce some important electromagnetic ideas that are used in the rest of the book. Readers specifically interested in ionospheric propagation will find Chapters 5 and 8 of most use, while those interested in scintillation will find Chapters 6 and 10 of relevance. For those interested in propagation across terrain and through the lower atmosphere, Chapters 4, 7 and 9 are of greatest relevance. The appendices contain extensive notes

on mathematics and numerical techniques that are used throughout the text. In addition, there are appendices in which important canonical solutions are derived.

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