BOOK REVIEW : Acoustics in Moving Inhomogeneous Media (Second Edition) by V. E. Ostashev and D. K. Wilson

The book deals with sound propagation and scattering in moving inhomogeneous media. Although the theories presented in this book are much broader in scope, the main interest lies in sound propagation in the atmospheric boundary layer. Some sections are devoted to particularities of underwater sound propagation. The book can be roughly divided in 3 parts. In a first part, the fundamentals of acoustics in moving media with deterministic inhomogeneities (such as temperature profiles) are discussed. The second part adds the effects of propagation medium randomness (turbulence). A last part deals with numerical approaches to implement some of the presented equations and theories.

The authors wrote in their preface that “they have endeavored to derive results systematically from first principles”. This is truly an accomplishment as this basic idea is successfully maintained throughout the full book. The consistency in notation between chapters and the fact that chapters build upon each other makes this book highly suitable for instructional purposes. However, this also implies that the reader needs a solid mathematical background in order to fully benefit from this work. This book contrasts to many other works nowadays that are too often just a bundling of journal papers. The authors show their in-depth understanding of the topic, and allow positioning the various methods appearing in literature within their solid and fundamental framework.

The main difference, relative to the first edition, are the chapters related to numerical methods for predicting sound propagation in moving inhomogeneous media, more precisely ray acoustics, wave-based frequency-domain techniques, and wave-based time-domain techniques. Wave-based numerical methods, which gained popularity in outdoor sound propagation in the recent two decades, are discussed in two Chapters (of 13 in total). Frequency-domain techniques that are dealt with are the Fast Field Program (indicated by the more general name “Wavenumber Integration” method) and the Parabolic Equation, limited to the narrow-angle and wide-angle Crank-Nicholson solution. Interestingly, implementations of the ray approach and the spectral wave-based techniques are made accessible to the readers by means of a “Matlab App”. An easy-to-use interface allows predicting transmission loss based on a given source-receiver geometry, ground parameters, and a set of (standard) meteorological conditions. The chapter on time-domain techniques focuses on the finite-difference time-domain (FDTD) method applied to a moving medium. As an example, discretised equations for a single temporal and spatial stencil have been presented and discussed. The topic of modelling interactions of sound waves with natural grounds is considered too in this work, and this topic has been touched as well with respect to time-domain modelling.

The book finishes with a timely and interesting chapter on quantitatively assessing uncertainties in predicting atmospheric sound propagation. Such uncertainties in predictions are inevitably as a consequence of the many approximations made when developing models and the myriad of parameters to be chosen when representing outdoor grounds, wind and temperature profiles, and turbulence characteristics.

In brief, this book is a must-have for experts in the field of outdoor sound propagation seeking for a rigorous reference work. An extended overview of theories and their approximations is provided for predicting sound propagation in moving inhomogeneous media, starting from basic fluid dynamic equations. In addition, a number of relevant numerical techniques for such applications are discussed.

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