Atmospheric Acoustic Remote Sensing
Stuart Bradley
CRC Press, Boca Raton, FL, (2008),
271 pp., 15 Color & 185 B/W Illustrations,
Hardback, 127.96 USD, ISBN 978-0-8493-3588-4

Sonic detection and ranging (SODAR) systems and radar acoustic sounding systems (RASS) use sound waves to remotely sense and determine the speed and direction of wind, as well as the turbulent quality of the atmosphere. This collected information is used in the qualification and quantification of pollution and other applications, such as monitoring conditions affecting wind energy generation. This book is an interesting and succinct "how it works" book on the design and use of these systems along with insights into each of their strengths and limitations.

As described in the preface, in 2001 Dr. Bradley, a renowned expert in the design and use of SODAR/RASS, delivered with his colleague, Sabine von Hünerbein, a two-day intensive course on the principles of operation and data interpretation of SODAR systems. As a result, Stuart Bradley understood the need to make available a more general description of SODAR and other atmospheric acoustic remote sensing principles for a wider audience. Dr. Bradley provides extensive diagrams throughout the book along with the core mathematics, with the intent of providing a book that explains how it works and "avoid the more abstruse mathematical treatments." The book begins with an extensive symbol list and each chapter ends with extensive references.

Chapter one gives an easy read about the background on remote sensing. This chapter concludes with some exceptional color pictures ranging from the equipment to the output data plots of the SODAR. Chapter two then looks at the atmosphere near the ground, as it relates to remote sensing. Temperature and wind profiles are discussed. The structure of the turbulence is also presented along with standard methods for defining each and their effect on the data.

Chapter three presents the concept of sound in the atmosphere in line with the purpose of understanding how the systems work. This chapter is not intended to be a treatise on the linear and nonlinear aspects of the wave equation, but just the basics. It does go through the fundamentals on sound waves, background noise, reflection, refraction and diffraction. These sections are followed by sections on Doppler shift, scattering and attenuation. Each section includes figures to clarify the content of the section.

Chapter four takes this content of information and discusses it in terms of reception, including wind vectors. Chapter five presents the SODAR systems and signal quality. The critical information on loss of signal in noise and calibration concludes chapter five.

Chapter six presents the signal processing feature of the SODAR hardware. As any signal processing application, the extraction of the valid signal amidst the various noises is a critical aspect of usability of any system. This chapter also examines the various errors and biases that can be part of the data. With this level of deeper understanding of each error or bias type, proper adjustments can be made to the data to provide true comprehension of the data collected.

Chapter seven details RASS Systems. Different systems and measurements that can be made with RASS are discussed. Chapter eight is a review of selected applications. This chapter provides insight to the different conclusions that can be formed with the collected data.

For anyone using these systems, the appendices are invaluable.

Appendix 1: Mathematical Background. This gives sufficient mathematics to understand the required processing.
Appendix 2: Sample Data Sets and Matlab Code. The information provided should help the user easily understand the data input and at a minimum be able to identify background noise and data quality issues, which is a critical aspect of data processing.
Appendix 3: Available Systems. This appendix provides information from wind speed accuracy to averaging interval for various available systems. Additionally, the pictures of the different systems help to understand the dimensions of what will be located and installed.
Appendix 4: Acoustic Travel Time Tomography. The math with the diagram of acoustic travel time will help with the interpretation of the data for anyone who has never performed this calculation before.
Appendix 5: Installation of a SODAR or RASS. This section includes a discussion of the calibration and testing, operating requirements, measurement periods, etc. The section on noise is important for those who are uncertain as to the each type of noise and how to address its inevitability in the findings. Additionally, the section on use of an artificial signal to verify performance is vital.

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