AN INTRODUCTION TO BOUNDARY LAYER METEOROLOGY

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Preface

Part of the excitement of boundary-layer meteorology is the challenge in studying and understanding turbulent flow — one of the unsolved problems of classical physics. Additional excitement stems from the rich diversity of topics and research methods that we collect under the umbrella of boundary-layer meteorology. That we live our lives within the boundary layer makes it a subject that touches us, and allows us to touch it. I've tried to capture some of the excitement, challenges and diversity within this book.

I wrote this book with a variety of goals in mind. First and foremost, this book is designed as a ***textbook***. Fundamental concepts and mathematics are presented prior to their use, physical interpretations of equation terms are given, sample data is shown, examples are solved, and exercises are included. Second, the book is organized as a ***reference***, with tables of parameterizations, procedures, field experiments, useful constants, and graphs of various phenomena in a variety of conditions. Third, the last several chapters are presented as a ***literature review*** of the current ideas and methods in boundary layer meteorology.

It is assumed that this book will be used at the beginning graduate level for students with an undergraduate background in meteorology. However, a diversity in the background of the readers is anticipated. Those with a strong mathematical background can skip portions of Chapter 2 on statistics, and those with experience with time series can skip Chapter 8. These two mathematics chapters were separated to offer the reader a chance to apply the first dose of statistics to boundary layer applications before delving back into more math. Some students might have had a course on geophysical turbulence or statistical fluid mechanics, and can skim through the first 5 chapters to get to the boundary-layer applications. By excluding a few chapters, instructors can easily fit the remaining material into a one-semester course. With supplemental readings, the book can serve as a two-semester sequence in atmospheric turbulence and boundary-layer meteorology.

Notational diversity proved to be the greatest difficulty. Each subdiscipline appeared to have its own set of notation, which often conflicted with the notation of other subdisciplines. To use the published notation would have lead to confusion. I was therefore forced to select a consistent set of notation to use throughout the book. In most cases I've tried to retain the notation most frequently used in the literature, or to add subscripts or make logical extensions to existing notation. In other cases, I had to depart from previously published notation. Readers are referred to Appendix B for a comprehensive list of notation.

I certainly cannot claim to be an expert in all the myriad subdisciplines of boundary-layer meteorology, yet I knew the book should be comprehensive to be useful. My interest and enthusiasm in writing this book motivated many trips to the library, and stimulated my analysis of many research papers to learn the underlying themes and common tools used in the diverse areas of boundary layer meteorology. Unfortunately, the limited space within this book necessitated some difficult decisions regarding the amount and level of material to include. Hopefully I've presented sufficient background to lay the building blocks upon which more advanced concepts can be built by other instructors and researchers. Certain topics such as atmospheric dispersion and agricultural micrometeorology are not covered here, because there are other excellent books on these subjects.

Many colleagues and friends helped with this book and contributed significantly to its final form and quality. Michelle Vandall deserves special recognition and thanks for drawing most of the figures, designing the page and chapter headers, and for her overall dedication to this project. Colleagues Steve Stage, Larry Mahrt, George Young, Jacq Schols, Chandran Kaimal, Steve Silberberg, Beth Ebert, and Bruce Albrecht reviewed various chapters and provided valuable suggestions. Information regarding field experiments was provided by Anton Beljaars, Ad Driedonks, Jean-Claude André, Jean-Paul Goutorbe, Anne Jochum, Steve Nelson, Bob Murphy, Ruwim Berkowicz, Peter Hildebrand, Don Lenschow, and others. Eric Nelson proofread the manuscript, and helped with the list of notation. Sam Zhang compiled the index. Some of the equations were typeset by Camille Riner and Michelle Vandall (her name keeps reappearing). Four years of students in my micrometeorology courses at Wisconsin graciously tolerated various unfinished drafts of the book, and caught many mistakes. The patient editors of Kluwer Academic Publishers (formerly D. Reidel) provided constant encouragement, and are to be congratulated for their foresight and advice. The American Meteorological Society is acknowledged for permission to reproduce figures 10.7, 12.10 and 12.19. To all of these people and the many more to whom I apologize for not naming here, I thank you.

To my wife, Linda, I give my gratitude for her devotion during this exciting and exhausting episode of my life.

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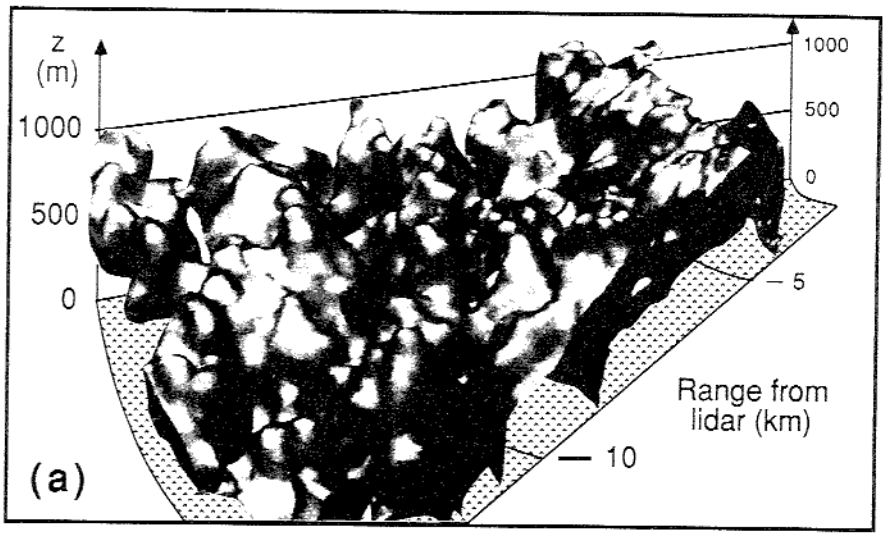

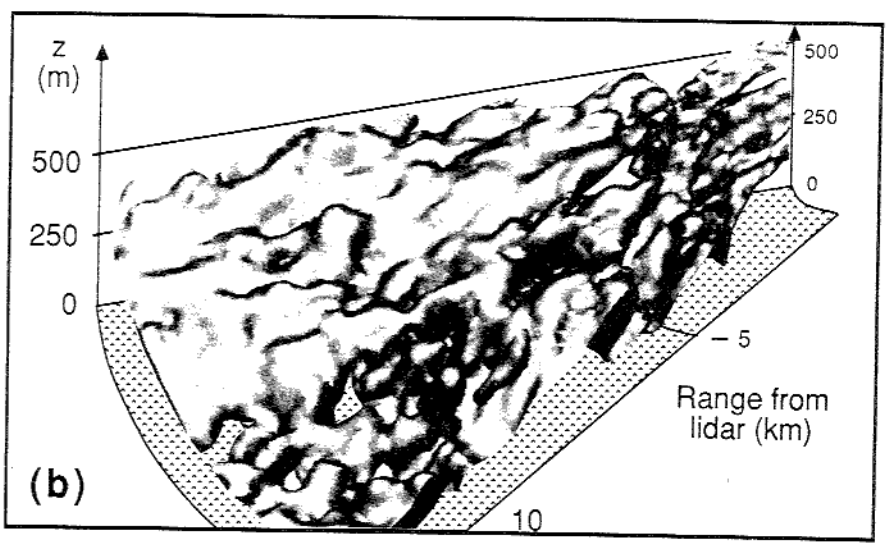

Frontispiece Lidar images of the aerosol-laden boundary layer, obtained during the FIFE field experiment in Kansas. (a) Convective mixed layer observed at 1030 local time on 1 July 1987, when winds were generally less than 2 m/s. (b) Slightly-stable boundary layer with shear-generated turbulence, observed at 530 local time on 7 July 1987. Winds ranged from 5 m/s near the surface to 15 m/s near the top of the boundary layer. Photographs from the Univ. of Wisconsin lidar are courtesy of E. Eloranta, Boundary Layer Research Team.