Preface to the First Edition

Many university departments of meteorology or atmospheric sciences offer a course in micrometeorology as a part of their undergraduate curricula. Some graduate programs also include an introductory course in micrometeorology or environmental fluid mechanics, in addition to more advanced courses on planetary boundary layer (PBL) and turbulence. While there are a number of excellent textbooks and monographs available for advanced graduate courses, there is no suitable text for an introductory undergraduate or graduate course in micrometeorology. My colleagues and I have faced this problem for more than ten years, and we suspect that other instructors of introductory micrometeorology courses have faced the same problem – lack of a suitable textbook. At first, we tried to use R.E. Munn's 'Descriptive Micrometeorology,' but soon found it to be much out-of-date. There has been almost an explosive development of the field during the past two decades, as a result of increased interest in micrometeorological problems and advances in computational and observational facilities. When Academic Press approached me to write a textbook, I immediately saw an opportunity for filling a void and satisfying an acutely felt need for an introductory text, particularly for undergraduate students and instructors. I also had in mind some incoming graduate students having no background in micrometeorology or fluid mechanics. Instructors may also find the latter half of the book suitable for an introductory or first graduate course in atmospheric boundary layer and turbulence. Finally, it may serve as an information source for boundary-layer meteorologists, air pollution meteorologists, agricultural and forest micrometeorologists, and environmental scientists and engineers.

Keeping in mind my primary readership, I have tried to introduce the various topics at a sufficiently elementary level, starting from the basic thermodynamic and fluid dynamic laws and concepts. I have also given qualitative descriptions based on observations before introducing more complex theoretical concepts and quantitative relations. Mathematical treatment is deliberately kept simple, presuming only a minimal mathematical background of upper-division science majors. Uniform notation and symbols are used throughout the text, although certain symbols do represent different things in

different contexts. The list of symbols should be helpful to the reader. Sample problems and exercises given at the end of each chapter should be useful to students, as well as to instructors. Many of these were given in homework assignments, tests, and examinations for our undergraduate course in micrometeorology.

The book is organized in the form of fifteen chapters, arranged in order of increasing complexity and what I considered to be a natural order of the topics covered in the book. The scope and importance of micrometeorology and turbulent exchange processes in the PBL are introduced in Chapter 1. The next three chapters describe the energy budget near the surface and its components, such as radiative, conductive, and convective heat fluxes. Chapter 5 reviews basic thermodynamic relations and presents typical temperature and humidity distributions in the PBL. Wind distribution in the PBL and simple dynamics, including the balance of forces on an air parcel in the PBL, are discussed in Chapter 6. The emphasis, thus far, is on observations, and very little theory is used in these early chapters. The viscous flow theory, fundamentals of turbulence, and classical semiempirical theories of turbulence, which are widely used in micrometeorology and fluid mechanics, are introduced in Chapters 7, 8, and 9. Instructors of undergraduate courses may like to skip some of the material presented here, particularly the Reynolds-averaged equations for turbulent motion. Chapters 10–12 present the surface-layer similarity theory and micrometeorological methods and observations using the similarity framework. These three chapters would constitute the core of any course in micrometeorology. The last three chapters cover the more specialized topics of the marine atmospheric boundary layer, nonhomogeneous boundary layers, and micrometeorology of vegetated surfaces. Since these topics are still hotly pursued by researchers, the reader will find much new information taken from recent journal articles. The instructor should be selective in what might be included in an undergraduate course. Chapters 7–15 should also be suitable for a first graduate course in micrometeorology or PBL.

Finally, I would like to acknowledge the contribution of my colleagues, Jerry Davis, Al Riordan, and Sethu Raman, and of my students for reviewing certain parts of the manuscript and pointing out many errors and omissions. I am most grateful to Professor Robert Fleagle for his thorough and timely review of each chapter, without the benefit of the figures and illustrations. His comments and suggestions were extremely helpful in preparing the final draft. I would also like to thank the publishers and authors of many journal articles, books, and monographs for their permission to reproduce many figures and tables in this book. The original sources are acknowledged in figure legends, whenever applicable. Still, many ideas, explanations, and discussions in the text are presented without specific acknowledgments of the original sources, because, in many cases, the original sources were not known and also because, I thought,

giving too many references in the text would actually distract the reader. In the end, I wish to acknowledge the help of Brenda Batts and Dava House for typing the manuscript and Pat Bowers and LuAnn Salzillo for drafting figures and illustrations.