Preface

When Jim Holton was making revisions for the Fourth Edition of this book, I served as a consultant on aspects of the material with which I was most familiar. Toward the end of the revision process, Jim asked whether I would like to join him as a coauthor for the next edition. Although I agreed to this wonderful opportunity and looked forward to the collaboration, it vanished when Jim Holton died on March 3, 2004. The shock of his sudden passing lingers in the dynamic meteorology community, where his influence is difficult to exaggerate. That sphere of influence includes this book on dynamic meteorology, which has served as the standard text on the subject for generations of students and practitioners in the atmospheric and related sciences. It was very difficult to take up revisions without Jim's guidance, but the situation also presented an opportunity to bring a fresh perspective to aspects of the material that had become dated, tracing their origin to lecture notes from classes taught at MIT during the 1960s.

This book serves three main communities: undergraduate and graduate students in the atmospheric sciences, practitioners in the field, and those in related physical sciences who want a definitive, and accessible, introduction to the subject matter. In making revisions, I have tried to draw on my experiences with the book as both a student and an instructor, to streamline and modernize aspects of the text to serve these communities. Major structural changes include Chapter 5 (on waves and the perturbation method, formerly Chapter 7), Chapter 7 (on baroclinic development, formerly Chapter 8), and Chapter 8 (on turbulence and the planetary boundary layer, formerly Chapter 5). The material now flows from the introduction of core concepts (Chapters 1–4) to the development of methods needed to understand the application of core concepts (Chapter 5) to understanding extratropical weather systems (Chapters 6 and 7), followed by advanced topics in later chapters.

In addition to numerous minor changes, specific substantial revisions include the following. In Chapter 1, the treatment of viscous effects and noninertial reference frames is streamlined, and a new section on kinematics is introduced. New sections in Chapter 2 are devoted to the Boussinesq approximation and thermodynamics of the moist atmosphere, which are used in several chapters later in the book. Potential vorticity (PV) is given an expanded treatment in Chapter 4, including a derivation of the Ertel PV as a special case of the Kelvin circulation theorem, a discussion of nonconservative effects, and an illustration of the use of PV to construct maps of the dynamical tropopause. Moreover, PV is used to motivate a derivation of the shallow-water and barotropic equations, which are used extensively in later chapters. In Chapter 5, the discussion of basic wave properties is extended to three dimensions, and a general strategy for solving wave problems is outlined. Stationary Rossby wave solutions are now discussed for both shallow-water and stratified atmospheres at rest, providing the reader with a deeper understanding of the basis for the quasi-geostrophic approximation that follows in the next chapter.

Chapter 6 is largely rewritten, with a novel, and simple, derivation of the quasi-geostrophic equations starting from the Ertel PV conservation equation. In contrast to previous editions, here standard height coordinates are used, which liberates the reader from the mental gymnastics associated with pressure coordinates. A MATLAB code for a quasi-geostrophic model is provided, along with a diagnostic package that allows the reader to simulate and diagnose extratropical weather systems; these codes are easily adapted for flow patterns different from those provided. Baroclinic development is covered in Chapter 7; the treatment is largely the same as in previous editions but offers a richer discussion of "generalized stability." Chapter 9 contains updated information on hurricanes, including a full derivation and discussion of potential intensity theory. A new section in Chapter 10 reviews climate sensitivity and feedbacks, which is a subject of increasing interest in the research community. Finally, Chapter 13 has been revised significantly to include a mathematical treatment of data assimilation, building up from simple examples for scalars to many variables. Kalman filters, variational techniques (3DVAR and 4DVAR), and ensemble Kalman filters are discussed. A new section reviews predictability and ensemble forecasting, including the Liouville equation and primary results on the theory of ensemble prediction. For other information about, and teaching aids for, this book, see booksite.academicpress.com/9780123848666.

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