

Preface of the First Edition

The intent of *Introduction to Geophysical Fluid Dynamics* is to introduce readers to this developing field. In the late 1950s, this discipline emerged as a few scientists, building on a miscellaneous heritage of fluid mechanics, meteorology, and oceanography, began to model complex atmospheric and oceanic flows by relatively simple mathematical analysis, thereby unifying atmospheric and oceanic physics. Turning from art to science, the discipline then matured during the 1970s. Appropriately, a first treatise titled *Geophysical Fluid Dynamics* by Joseph Pedlosky (Springer-Verlag) was published in 1979. Since then, several other authoritative textbooks have become available, all aimed at graduate students and researchers dedicated to the physics of the atmosphere and oceans. It is my opinion that the teaching of geophysical fluid dynamics is now making its way into science graduate curricula outside of meteorology and oceanography (e.g., physics and engineering). Simultaneously and in view of today's concerns regarding global change, acid precipitations, sea-level rise, and so forth, there is also a growing desire on the part of biologists, atmospheric chemists, and engineers to understand the rudiments of climate and ocean dynamics. In this perspective, I believe that the time has come for an introductory text aimed at upper-level undergraduate students, graduate students, and researchers in environmental fluid dynamics.

In the hope of fulfilling this need, simplicity and clarity have been the guiding principles in preparing this book. Whenever possible, the physical principles are illustrated with the aid of the simplest existing models, and the terminology and notation have been selected to maximize the physical interpretation of the concepts and equations. For example, the expression *planetary wave* is preferred to *Rossby wave*, and subscripts are avoided whenever not strictly indispensable.

The book is divided in five parts. After the fundamentals have been established in Part I, the effects of rotation and stratification are explored separately in the following two parts. Then, Part IV analyzes the combined effects of rotation and stratification, and the book closes with Part V, on miscellaneous topics of contemporary interest. Each part is divided into short, relatively well-contained chapters to provide flexibility in the choice of materials to be discussed, according to the needs of the curriculum or the reader's interests. Each chapter corresponds to one or two lectures, occasionally three, and the length is deemed suitable for a one-semester course (45 lectures). Although it is also an inevitable reflection of my personal choices, the selection of materials has been guided by the desire to emphasize the physical principles at work behind observed phenomena. Such

emphasis is also much in keeping with the traditional teaching of geophysical fluid dynamics. The scientist interested in the description of atmospheric and oceanic phenomena will find available an abundance of introductory texts in meteorology and oceanography.

Unlike existing texts in geophysical fluid dynamics, this book offers a number of exercises at the end of every chapter. There, the reader/teacher will also find short biographies and suggestions for laboratory demonstrations. Finally, the text ends with an appendix on wave kinematics, for it is my experience that not all students are familiar with the concepts of wavenumber, dispersion relation, and group velocity, whereas these are central to the understanding of geophysical wave phenomena.

A general remark on the notation is appropriate. Because mathematical physics in general and this discipline in particular involve symbols representing variables and constants, with and without dimensions, I believe that clarity is brought to the mathematical description of the subject when certain classes of symbols are reserved for certain types of terms. In that spirit, a systematic effort has been placed to assign the notation according to the following rules: Dimensional variables are denoted by lowercase Roman letters (such as u , v , and w for the velocity components), dimensional constants and parameters use uppercase Roman letters (such as H for the domain depth, L for length scale), and dimensionless quantities are assigned lowercase Greek letters (such as θ for an angle). In keeping with a well-established convention of fluid mechanics, dimensionless numbers credited to particular scientists are denoted by the first two letters of those scientists' names (e.g., Ro for the Rossby number). Of course, conventions breed exceptions (e.g., g for the constant gravitational acceleration, ω for frequency, and ψ for streamfunction).

In closing, I wish to acknowledge inspiration from numerous colleagues from across the globe, too many to permit an exhaustive list here. I am also particularly indebted to my students at Dartmouth College; their thirst for knowledge prompted the present text. Don L. Boyer, Arizona State University, Pijush K. Kundu, Nova University, Peter D. Killworth, Robert Hooke Institute, Fred Lutgens, Central Illinois College, Joseph Pedlosky, Woods Hole Oceanographic Institution, and George Veronis, Yale University, made many detailed and invaluable suggestions, which have improved both the clarity and accuracy of the presentation. Finally, deep gratitude goes to Lori Terino for her expertise and patience in typing the text.

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