Preface

What is 'rotating hydraulics' and why would anyone wish to read a book on the subject? Over the past three decades, the term has come to describe the physics of overflows and other choked flows, common in the ocean and atmosphere, that exhibit high speeds, subcritical-to-supercritical transitions, jumps, and other features familiar to open-channel or aeronautical engineers, and that are strongly influenced by the earth's rotation. Bores, intrusions, steepening waveforms and separation phenomena are included because they tend to arise within these flows. Interest in the field is often excited by the dramatic and strongly nonlinear character of the features in question. The subject is also important in terms of the special opportunities for observation and long term monitoring made possible as a result of the choking effect.

This book is concerned primarily with the theory of rotating hydraulics. However, the Introduction contains a overview of the observations that have motivated much of the theoretical development, and more detailed case studies appear later in the book. Though both the atmosphere and ocean are covered, the latter is the source of the most numerous known examples. Laboratory experiments have played a fundamental role in the development of the field and many of these are described as well. Our intent is to provide the reader with the material necessary to develop a solid grasp of the fundamental ideas and physical processes as well as a general familiarity with geophysical applications. We will also introduce the reader to a range of mathematical techniques that have proved useful within the field to solve nonlinear problems.

An introduction and review of classical hydraulics appears in Chapter 1. The prospective reader should have a good understanding of basic fluid dynamics and be familiar with the shallow water equations and the approximations behind them. A grasp of the basics of linear wave propagation in fluids, including the concepts of phase speed and group speed, is also desirable. Beginning with Chapter 2, where the effects of rotation are first discussed, the reader will need to know about Coriolis acceleration and geostrophic flow. Thorough discussions of these topics appear in the texts of Gill (1982), Pedlosky (1987), Cushman-Roisin (1994) and Salmon (1998).

The notation and conventions used in this book are largely standard for geophysical fluid dynamics. However there are two departures worth mentioning. The first is the use of y, in place of the more common x, to denote the predominant direction of flow. This convention stems from early models of flow in deep ocean straits and along coasts, both or which tend to be aligned in the north-south (y-) direction. The second matter concerns the representation of dimensional vs. dimensionless variables. Most of the book (Chapters 2-6) makes use of a common convention in which a star (*) superscript signifies a dimensional quantity while quantities lacking a star are nondimensional. (Exceptions are made where the context makes the meaning clear.) However, the vast majority of mathematical text in Chapter 1 is dimensional and it would have been cumbersome to use stars on every such variable. The star notation is therefore not used in that Chapter. We have tried to avoid any confusion by placing reminders where ambiguities might arise. Should questions arise concerning the meaning of a particular variable, the list of notation (**Appendix A**) can be consulted.

A number of texts explore the hydraulics of nonrotating fluids in much more depth than is present here. At the time of this printing, the most scientific and up-to-date book is Baines' *Topographic Effects in Stratified Flows.* Treatments of linear and nonlinear waves in shallow water systems can also be found in Stoker's *Water Waves* and Whitham's *Linear and Nonlinear Waves.* Engineering texts such as Chow's *Open Channel Hydraulics* and Henderson's *Open Channel Flow* present the traditional engineering perspective.