

Preface

The following notes have been used in one form or another for over 20 years. I am making them available as a pdf file in order to better allow changes and corrections to be made. Much has changed in 20 years, though the basic aspects of dynamics remain basic. That said, dynamics itself has, in many places been deemphasized with respect to modeling. This is, in my opinion, unfortunate. Dynamics is crucial as a framework for modeling. It provides both fundamental insights into otherwise difficult to interpret behavior, and, more generally, an interpretive context for modeling.

Although the notes are meant to be self-contained and introductory, many of the topics covered are somewhat advanced for an introductory course. There are several reasons why they have been included (and why other more traditional topics have been neglected). First, I feel that many topics are considered ‘advanced’ or ‘elementary’ for historical reasons and not because they are particularly difficult or easy. The topics I have included do not call on especially advanced mathematical skills (relatively elementary familiarity with ordinary and partial differential equations and fourier series is expected); they are, moreover, topics which I believe to be basic to the contemporary study of atmospheric dynamics (*wave-mean flow interaction*, for example). Second, this course has, as a prerequisite, 12.800, which covers much of the traditional introductory material. That said, the material in these notes is in many instances conceptually demanding, and students should not feel discouraged if they have difficulty following it. Some topics may require considerable effort.

Because most of the students have already been introduced to the equations of motion, I have adopted a somewhat unusual approach to the derivation of the equations in Chapter 6. The derivation (which was used by L.N. Howard in his 1960 Woods Hole Lectures on Geophysical Fluid Dynamics—lectures which helped to introduce me to this field) is, I believe, due to Serrin (1958), and, personally, I have always found it thought provoking as well as elegant.

The fact that the equations of motion are not derived until Chapter 6 is discussed in Chapter 1, the Introduction. Three of the early chapters (2, 3, and 5) are meant to provide some motivation for the study of dynamics.

Chapter 2 offers a simple example of modeling (of the role of the ice-albedo feedback in climate stability) wherein the role of dynamics is crucial but where the treatment of the dynamics is via parameterization. Chapter 3 introduces a very simple model for the distribution of ozone where, again, dynamics plays a remarkable role, and where this role can be identified without detailed treatment of the dynamics. Chapter 5 deals with observations (much too briefly). Ultimately, the study of dynamical meteorology has to be motivated by observed phenomena. Chapter 4 differs from the other 3 chapters we have just discussed. It introduces some (essentially static) force balances (namely, hydrostaticity and geostrophy) which are so intrinsic to the subject that they are actually needed in order to discuss observations.

Only after describing the observations are the dynamical equations derived. Apart from the above reasons for this ordering, I also feel that it serves to emphasize the important fact that atmospheric dynamics is not simply the derivation and application of equations. Rather, one should begin by thinking about nature itself. Consistent with this attitude, I have at two points in these notes (namely, in Chapter 7 on the Hadley circulation and in Chapter 10 on tides) devoted considerable attention to the history of the subject. Hopefully, this will give the student some idea of the context within which certain questions were asked and certain solutions proposed. Stated somewhat differently, some attempt is made to help the student understand why we attempt to solve the problems we do.

It should be stressed that this volume consists in lecture notes for a particular course. As such, the material covered is limited by the time available for that course; the notes are not meant to be a comprehensive text or reference. Although this version of the notes does not have an index, the table of contents is sufficiently detailed to permit the reader to find most topics quickly.

Finally, I wish to thank the various students, secretaries, and colleagues who have contributed to the preparation of these notes over the years.