1. Introduction

This is an introductory course in geophysical fluid dynamics (GFD). The course is not meant to prepare students to become professionals in GFD, but to a provide a survey for graduate students and advanced undergraduates who expect to be professionally involved in other areas of earth science, who are not sure whether GFD should be major component of their future career or are just curious about fluid mechanics in an environmental setting. For those who want to pursue the subject further, this course is a suitable preparation for graduate level GFD courses offered by Oceanography, Atmospheric Sciences and Earth and Space Sciences.

GFD is a very broad subject and to limit the scope, I will concentrate mainly on incompressible, laminar flow. Examples will be drawn primarily from the ocean. However, the fluid mechanics of the atmosphere is very similar to the ocean in many respects. Other examples from engineering, hydrology and the Earth's interior will be considered as appropriate. A goal of the course, which I consider at least as important as the specific applications, is to teach you how to recognize what physics is important in a given situation and how to predict the behavior of the solution of a complicated, perhaps non-linear, partial differential equation before you solve it.

These notes are normally used in conjunction with **Physical Fluid Dynamics** (2nd Edition) by D.J. Tritton. This book presents the introductory material in more detail than the notes and has a wider variety of GFD examples. It has considerably more information about turbulence than you will find in these notes. It also has some glaring omissions. While it covers a wide variety of wave phenomena, it ignores what I consider the type example of dispersive waves: Surface Gravity Waves. It also has little descriptive background on the ocean. Therefore, in addition to presenting my view of the material covered in Tritton, these notes serve to fill in holes in the material in the book.

The initial goal of the course is to develop the tools necessary to understand the large scale circulation of the oceans. We will then proceed to smaller scale phenomena such as waves which depend on stable density stratification. Finally, we will consider what happens when the stratification is unstable. Emphasis throughout this course will be on physical understanding rather than mathematical rigor. The course assumes that the student is familiar with the tools of vector calculus such as dot and vector products and the operator $\nabla = \hat{\mathbf{x}}\frac{\partial}{\partial x} + \hat{\mathbf{y}}\frac{\partial}{\partial y} + \hat{\mathbf{z}}\frac{\partial}{\partial z}$ and basic techniques for solving ordinary and partial differential equations such as separation of variables.