Large Scale Ocean Circulation

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Introduction

Our theoretical picture of large scale ocean circulation has grown mostly out of the development of simple models which isolate the particular phenomenon to be analyzed. In this sense dynamical oceanography differs substantially from dynamical meteorology which has progressed hand-in-hand with the amount and types of observational data that have been accumulated. The difficulties and costs of gathering oceanographic data preclude the same type of development of oceanographic theories.

The present paper contains a discussion of some of these simple theoretical models together with an attempt to extend a few of them to take into account additional features which are not normally included in the models. The presentation is necessarily selective and another author would no doubt have emphasized other models or other approaches. At the outset the plan was to discuss steady state models as well as those which include transient behavior. However, as the work progressed it became necessary to restrict attention to steady models only.

The opening section includes a simple model for deriving the ellipticity of the earth. It is followed by the derivation of the equations of fluid motion in elliptical coordinates and the approximation involved in the use of a spherical coordinate system to analyze oceanographic motions. The latter is included because the errors associated with the use of spherical coordinates are normally referred to in a casual fashion and no real attempt is made to quantify them. The approximations encountered in theoretical studies of large scale flows are then discussed and the stage is set for introducing theoretical modeling.

Simple geostrophic flows and their significance are presented next because they form the basis for the remainder of the paper. The study of Ekman layers and the role that they play in large scale circulation are followed by a brief discussion of turbulent transport.