

GEOG 8901: Ocean Dynamics AU, 2026

Instructor Prof. Zhengyu Liu,
Class Meetings TR 11:10am-12:30pm, 08/25/2026-12/05/2026
Classroom Derby Hall, Room 1186 (in person)
Credits 3
Course website
Prerequisites ATMOSSC 5951, 5952

Instructor Information:

Prof. Zhengyu Liu
1106 Derby Hall
Phone: 614/292-7948
Email: liu.7022@osu.edu
Office Hour: after class and email appointment over zoom.

Course Objectives

The basic objective of this course is to provide students with the advanced knowledge of the fundamentals of the dynamics of general oceanic circulation. The course is designed as the advanced dynamics course beyond Dynamic Meteorology I and II for graduate students.

Course Structure

The class will meet two days per week for 80 minutes each day. Lectures present material on dynamic processes and their applications. Important equations are derived and the implications of assumptions discussed. Examples of atmospheric and oceanic problems are discussed.

Course Description

This course discusses advanced dynamic theories for large-scale oceanic circulation. The course studies the wind-driven circulation theory, thermocline circulation theory and thermohaline dynamics.

Textbook

Zhengyu Liu, *Dynamics of Ocean Circulation* (handout)

Grading:

25% homework, 25% (for 1) presentation, 50% term paper

Dynamics of Oceanic Circulation

Prof. Z. Liu

Fall, 2026

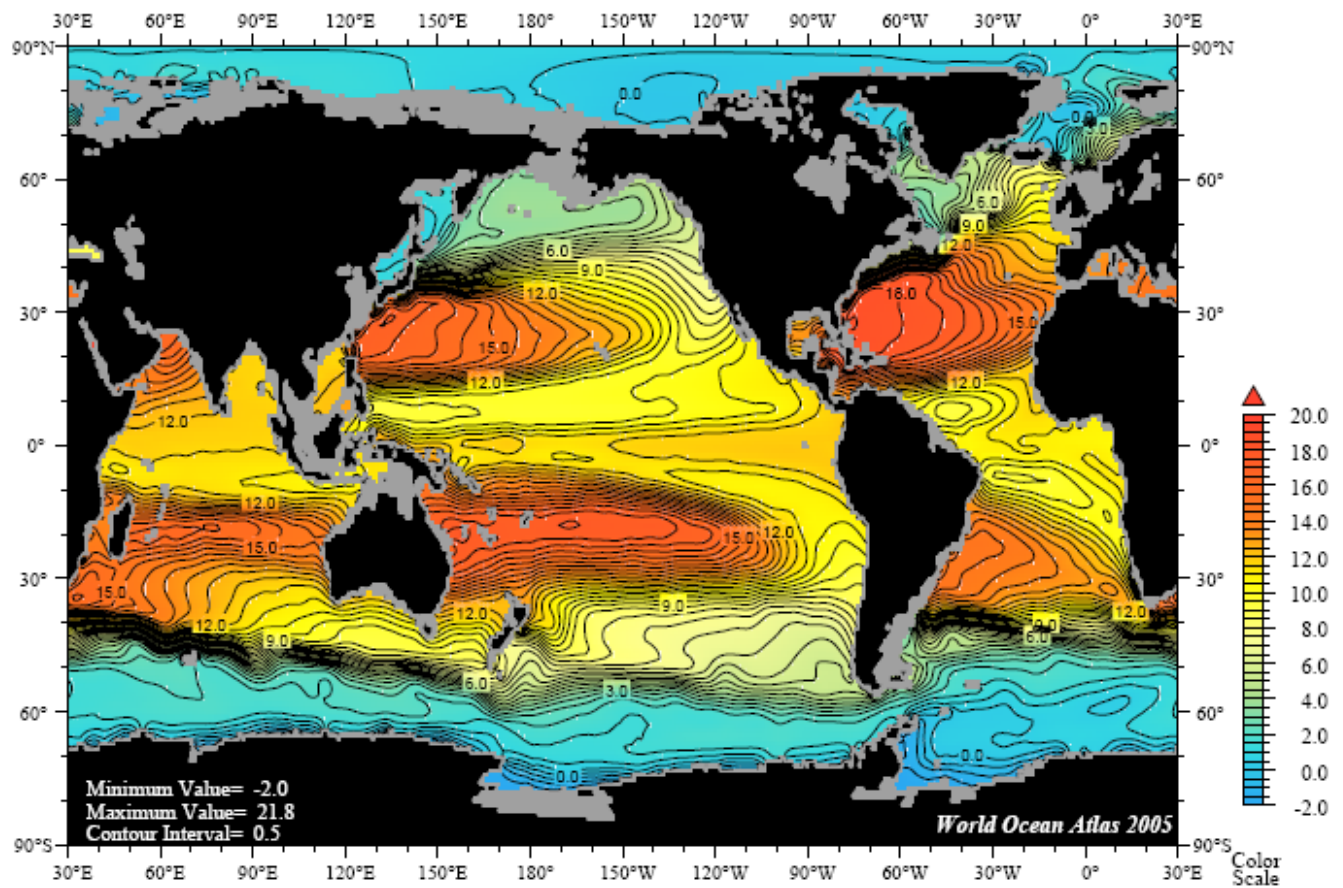


Table of Contents

Ch.1: Introduction (3 lectures)

Sec.1.1: Observations

Sec 1.2: Basic Equations

Sec 1.3: Approximated Equations

Sec 1.4: Planetary Geostrophic Equations

Sec 1.5: Potential Vorticity

Sec 1.6: Quasi-Geostrophic Equation

Sec 1.7: Rossby Waves

Sec 1.8: Energy Propagation and Group Velocity

Ch.2: Wind-Driven Circulation: I. Homogeneous Model (8 lectures)

Sec 2.1: Ekman flow

Sec 2.2: Interior Circulation: Sverdrup flow

Sec 2.3: Western Boundary Layer I: Stommel's model

Sec 2.4: Western Boundary Layer II: Munk's boundary layer

Sec 2.5: Western Boundary Layer III: inertial model

Sec 2.6: The Role of Rossby Waves

Sec 2.7: Gyre Circulation and Vorticity Balance:

Sec 2.8: Fofonoff Mode – The Free Inertial Mode:

Sec 2.9: Numerical Modeling and Nonlinear Effects

Sec 2.10: Island Circulation

Sec 2.11: Further Problems on Homogeneous Model

Ch.3: Wind-Driven Circulation: II. Thermocline Circulation (8 lectures)

Sec 3.1: Introduction

Sec 3.2: Layerd Model

Sec 3.3: Layerd QG model

Sec 3.4: Recirculation theory

Sec 3.5: Potential Vorticity Homogenization

Sec 3.6: Ventilated Thermocline: LPS Model

Sec 3.7: Interaction of Rhines-Young Pool and Ventilated Thermocline

Sec 3.8*: Thermocline Variability and Planetary Waves

Sec 3.9*: Tropical-Extratropical Interaction

Sec 3.10: Further Problems of Thermocline Theory

Ch.4: Buoyancy-Driven Circulation I: Abyssal Circulation (2 lectures)

Sec 4.1: Abyssal Circulation. I: General Idea

Sec 4.2: Abyssal Circulation. II: Stommel-Arons Model

Ch.5: Buoyancy-Driven Circulation I: Thermohaline Dynamics (6 lectures)

Sec. 5.1: Introduction

Sec. 5.2: Pole-to-Equator circulation: Stommel model

Sec. 5.3: Pole-to-Pole circulation: Rooth model

Sec. 5.4: Horizontal Convection and the Paparella-Young anti-turbulent theorem

Sec. 5.5: Thermohaline Circulation and Diffusivity

Sec. 5.6: Thermohaline Circulation and Diapycnal Mixing Parameterization

Sec. 5.7: Thermohaline variability

References

Pedlosky, J, 1996: Ocean Circulation Theory. Springer-Verlag, pp453

Pedlosky, J, 1987: Introduction to Geophysical Fluid Dynamics. Springer-Verlag. 2nd ed.

Philander, G., 1991: El Nino, La Nina and the Southern Oscillation. Academic Press.

Gill, A, 1982: Atmosphere-ocean dynamics. Academic Press. Abarbanel