The course will cover basic theories of the wind driven and thermohaline circulation of the oceans. Numerical models of ocean circulation and relevant observations will also be reviewed. The course will be organized around a series of seminal papers which will form the basis of classroom lectures and discussion. Grading will be based on homework assignments to follow up the reading, a mid-term or class project, and a final exam, with the following weights:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Homework</td>
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<td>Mid-term or Project</td>
<td>30%</td>
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<tr>
<td>Final</td>
<td>40%</td>
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**Reference Books:**


*General Circulation of the Ocean*, H. Abarbanel and W. Young, Eds., 1987


**Reference Papers and visual materials:**

Reading from reference papers for each section of the course will be assigned in class. Copies of these papers, as well as visual materials shown in class, can be accessed from the MPO712 “Blackboard” on CaneLink, or from my faculty homepage [http://www.rsmas.miami.edu/users/bjohns/MPO612/MPO612_homepage.html](http://www.rsmas.miami.edu/users/bjohns/MPO612/MPO612_homepage.html)
MPO 712 - LARGE SCALE OCEAN CIRCULATION

SYLLABUS

1. Wind Stress Fields; Ekman and Sverdrup Transports
   - Review of Sverdrup Theory
   - Global Wind Stress Fields
   - Global Gyre Circulation and Major Current Systems

2. Linear Wind-driven Models of Ocean Circulation
   - Stommel’s Model (Bottom friction)
   - Munk’s Model (Lateral friction)

3. Non-linear Wind Driven Models of Ocean Circulation
   - Free Inertial Circulation on Beta-plane (Fofonoff’s Model)
   - Formation of Inertial Western Boundary Currents (Charney Model)
   - Numerical Models of mixed Frictional-Inertial Gyre Closure
   - Inertial Recirculations and Western Boundary Current Extensions

4. Western Boundary Currents
   - Observations of Western Boundary Currents and Non-linear Features
   - Comparison with Models

5. Adjustment to Variable Wind Forcing
   - Rossby Waves – Dynamical Modes in a Continuously Stratified Fluid
   - Excitement of Vertical Rossby Wave Modes by Wind Stress
   - The Gyre “Spin-up” Problem; Analytical and Numerical Models
   - Topographic Modifications of Sverdrup Theory
   - Seasonal Variability at mid-Latitudes; Comparison with Observations

6. Equatorial Circulation
   - The Observed Equatorial Circulation
   - Forcing of the Mean Equatorial Circulation
   - Review of Equatorial Waves
   - The Equatorial “Spin-up” Problem
   - Comparison of Adjustment Time Scales at the Equator and mid-Latitudes
   - Seasonal Variability of the Global Equatorial Circulation

7. Thermocline Theories
   - Diffusive Theories; Vertical Advective-Diffusive Balance (Munk)
   - Advective Theories (the “Ventilated” Thermocline; LPS)
   - Estimates of Global Diffusivity; Observational Methods
8. Abyssal Circulation and the Global Thermohaline Cell; Ocean Heat Transport
   - Thermohaline Circulation and Deep Water Production
   - Theory of Abyssal Circulation (Stommel-Arons Theory)
   - Observations of the Deep Circulation
   - Deep Western Boundary Currents
   - Role of the Southern Ocean
   - The Upper-Ocean Return Flow ("Warm" and "Cold" Routes)
   - Interaction of the Thermohaline and Wind-Driven Circulation
   - Ocean Heat Transport (Observations and Models)

9. Mesoscale Eddies and Their Role in the Large-scale Circulation
   - Sources of Mesoscale Energy
   - Eddy-Mean Flow Interaction
   - Eddy-Driven Recirculations
   - Role of Eddy-Induced Transport in the Thermohaline Circulation
I. Wind Stress Field/Ekman & Sverdrup Transports


II. Linear Wind-Driven Models of Ocean Circulation


III. Nonlinear Wind-Driven Models


IV. Western Boundary Currents


V. Adjustment to Forcing


VI. Equatorial Dynamics


VII. Thermocline Theory


VIII. Global Thermohaline Circulation/Ocean Heat Transport


IX. Mesoscale Eddies and Their Role in the Large-scale Circulation.


X. Supplemental Reading


