

UNIVERSITY of TORONTO at SCARBOROUGH  
Department of Physical & Environmental Sciences

September 2010

*Environmental Science EES C19*

The world's oceans constitute more than 70 % of the earth's surface environments. This course will introduce students to the *dynamics of ocean environments*, ranging from deep ocean basins, to marginal seas, to the coastal ocean. The *physical nature* of ocean systems, their *origins*, and their importance in the *global hydro-climatic system* will be examined first; we will then focus on the primary physical mechanisms that control ocean dynamics. We will then examine the *major oceanic circulations*. The interactions that occur between the various fluid motions and the solid boundary, particularly around the edge of the continents will be a focus and a primary goal will be to examine the effects that the continent boundaries have on these fluid motions. Man's most direct interaction with the ocean environment occurs at the coast and in estuaries and will be a focal point.

**Instructor:** Prof. Mathew Wells  
**Office:** S410D  
**Office hours** Wednesdays 10-12 am

The course will be organized around: (a) a 2-hour lecture each week; (b) a 1-2-hour tutorial/practical class most week,s where the assignments will be discussed

I will be posting lectures on the intranet usually the day before classes.

**Lectures:**

Tuesday 1300-1500 h      **Room:** SW221

**Tutorials/Practicals/Seminars:**

Tuesday 1600-1800 h      **Room:** AA 208 or in computer labs

**Course Grade:**

**Mid-Term Test**      **15 %**  
**Assignments (4)**      **40 %**  
**Final Examination**      **45 %**

**TENTATIVE COURSE OUTLINE**

**September 14**      Orientation

**ENVIRONMENTAL CHALLENGES IN OCEANOGRAPHY**

Climate Change

Overfishing and the Exclusive Economic zone (EEZ)

Marine pollution and shipping

**INTRODUCTION TO MARINE SYSTEMS (Physical)**

The World Ocean

Ocean Morphology

Sea Water: Physical & Chemical Properties

Halocline, Pycnocline, Thermocline

**September 21**

**FORCES ON THE GLOBAL OCEAN 1: WIND**

**Surface Boundary Layer Currents**

Frictional Coupling

Surface Currents & Ekman Circulation

Inertial Currents and Geostrophic Currents

**Mixing**

Oceanic Fronts

Turbulence, Convection, Dispersion

Gyres, Rings, Eddies

*ASSIGNMENT 1 issued: Waves and Ocean Currents*

*Computer lab tutorial on Java Ocean Atlas*

**September 28**

**FORCES ON THE GLOBAL OCEAN 2: WAVES**

**Wind Waves in Ocean Current Systems**

Wave Generation & Propagation: Wind Waves & Swell

Wave Breaking & Decay, Wave Boundary Layers

Wave Guides & Kelvin Waves

Rossby Waves

Tsunamis

**October 5**

**FORCES ON THE GLOBAL OCEAN 3: Thermo-Haline Circulation**

Hydrostatic Pressure & Horizontal Pressure Gradients

Barotropic & Baroclinic States

Coriolis Effect

Geostrophic Currents & Gyres

**October 12**

**OCEANIC TIDES**

Equilibrium Theory of Tides

Tidal Constituents & Dynamical Theory of Tides

Amphidromic Systems, Tidal Currents

Forcing of Real Tides & Tidal Asymmetries

*ASSIGNMENT 2 issued: TIDES*

**October 19**

**OCEAN CURRENT SYSTEMS I:**

**Atlantic Ocean**

North Atlantic Gyre  
The North Atlantic Oscillation

**Arctic and Southern Oceans**

Sea ice dynamics

**October 26**

**OCEAN CURRENT SYSTEMS II:**

**Pacific Ocean**

The Equatorial Current Systems  
The Subtropical Gyres  
The Equatorial Undercurrent  
El Nino Southern Oscillation (ENSO)

**Indian Ocean**

Tropical Monsoon

**In class midterm scheduled during tutorial.**

**November 2**

**OCEAN WATER MASSES**

Heat Budget & Conservation of Salt  
Upper & Intermediate Water Masses  
Deep and Bottom Water Masses  
Ocean Mixing

**CGCS LECTURE on ARCTIC OCEAN**

**5-6 pm AA112**

**Title - "Arctic Climate variability: the role of the ocean"**

**Prof. Mary-Louise Timmermans, Yale University.**

*ASSIGNMENT 3 issued: OCEAN CURRENTS*

**November 9**

**MARINE-FRESHWATER INTERFACE: ESTUARIES**

Morphology & Estuary Types  
Estuarine Processes  
Environmental Problems

*ASSIGNMENT 4 issued: Student Reports on Ocean Currents*

**November 16**

**DISTRIBUTION OF BIOLOGY**

Phytoplankton and Zooplankton, Red Tides  
Oxygen and Nutrient distributions  
Upwellings zones, CO<sub>2</sub> uptake in ocean

**November 23**            15 minute Student Presentations on Ocean Currents

**November 30**            15 minute Student Presentations on Ocean Currents

**Course Review during tutorial**

## **TEXTBOOK**

Two texts from the UK Open University that will be used in this course as the textbook. You can buy them from Amazon but these two books are available online through the U of T library website

**Ocean circulation –**

<http://simplelink.library.utoronto.ca/url.cfm/51807>

**Waves, tides, and shallow-water processes -**

<http://simplelink.library.utoronto.ca/url.cfm/51808>

Other useful texts are "Regional Oceanography: an Introduction" by Matthias Tomczak and Stuart Godfrey. A PDF version of this book is available at

<http://gyre.umeoce.maine.edu/physicalocean/Tomczak/regoc/pdfversion.html>

A more technical book is "Introduction to Physical Oceanography" by Robert Stewart.

A PDF version of this book is available at

[http://oceanworld.tamu.edu/resources/ocng\\_textbook/PDF\\_files/book\\_pdf\\_files.html](http://oceanworld.tamu.edu/resources/ocng_textbook/PDF_files/book_pdf_files.html)

and the online version is available at

[http://oceanworld.tamu.edu/resources/ocng\\_textbook/contents.html](http://oceanworld.tamu.edu/resources/ocng_textbook/contents.html)

We are also able to access the online "Encyclopedia of Ocean Sciences". The encyclopedia was published in 2001 and is the most up-to-date resource on oceanography available. Here is a link to the encyclopedia

<http://simplelink.library.utoronto.ca/url.cfm/2312>