

# BRINGING THE OCEANS TO THE CLASSROOM

## ELEMENTARY MIDDLE HIGH SCHOOLS UNIVERSITIES

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A Website for students and teachers <http://oceanworld.tamu.edu/>

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## INTRODUCTION TO PHYSICAL OCEANOGRAPHY

(A WEB-BASED TEXTBOOK)

[http://www-ocean.tamu.edu/education/common/notes/PDF\\_files/book\\_pdf\\_files.html](http://www-ocean.tamu.edu/education/common/notes/PDF_files/book_pdf_files.html)

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### Preface

This book is written for upper-division undergraduates and new graduate students in meteorology, ocean engineering, and oceanography. Because these students have a diverse background I have emphasized ideas and concepts with a minimum of mathematical material. Acknowledgments I have taught from the book for several years, and I thank the many students who have pointed out errors and other errors. I also thank Professor Fried Schlemmer at Texas A&M Galveston who after using the book for his classes, has provided extensive comments about the material. Of course, I accept responsibility for all mistakes in the book. Please send me your comments and suggestions for improvement. Figures in the book came from many sources. I particularly wish to thank Link Ji for many global maps and colleagues at the University of Texas Center for Space Research. I especially thank nasa's Jet Propulsion Laboratory and the Topex/Poseidon Project for their support of the book through contract 960887 and 1205046.

### TEACHERS

- \*How to integrate Technology with Ocean Science.
- \*How to set up Technology Lab Stations.
- \*Key concepts for teaching Ocean topics (tied to T.E.K.S. & National Standards).
- \*On-line & Off-line Resources (where to get them.)
- \*Lesson Activities designed for problem-based Learning & Hands on Explorations. You don't have to be an Oceanographer



Bring the Ocean to your Classroom!  
Let the Ocean World Crew show you how.

Welcome to the TEACHER section of Ocean World. Here you will find three major sections to help you realize your goal of bringing the environmentally important subject of the OCEAN to your students. We can show you how to integrate various technologies into your ocean science curriculum as well. Part 1 - Technology-Lab Station Framework We have designed 7 tech-lab stations for collaborative teams of students. Check them out by clicking here-TECHNOLOGY LAB STATIONS EXPLAINED. Some stations are designed for "hands-on" exploration and observations. Others require research over the Internet or a CD-ROM. You have several choices for employing the labs.

Part 2 - Thematic Lessons & Background Information Welcome ashore! As we stated in the beginning, you don't have to be an oceanographer to teach about this environmentally important topic. We have provided you with:

- Background information in a clear and easy-to-understand format for the novice as well as the experienced ocean science teacher. Here you will find everything a science teacher ever needed to know about the ocean. Each lesson addresses one of five major themes:
  - Systems and Structures
  - Energy
  - Change
  - Interactions
  - Measurement
- Valuable Resources that are easy to obtain (quite often "free of charge") and great links to information on the Internet.
- Tied to National Standards and Texas Essential Knowledge and Skills (TEKS).

Part 3 - Ocean Science Activities for Students on Land Check out our treasure trove of activities that will involve your students in problem-solving, critical thinking, hands-on learning, and observations. These activities are designed to fit in with our technology lab stations we visited at Part 1. Check out our page on Problem-Based Learning.

Ocean World's Teacher Workroom offers you lesson plans, integrated technology lab stations, links to oceanography teaching materials, and more! Margaret Hammer, our resident education expert, has woven together quick reference background materials with easily customized activities, relating directly to a set of teaching themes.

The following links have been organized to familiarize you with the Oceanography teaching materials that Ocean World has to offer. Introduction: Developments in Oceanographic Studies

- Technology Lab Stations [http://oceanworld.tamu.edu/teachers/les\\_plans\\_introductio.htm](http://oceanworld.tamu.edu/teachers/les_plans_introductio.htm)
- Introducing and Explaining Technology Lab Stations [http://oceanworld.tamu.edu/teachers/tech\\_lab\\_stations.htm](http://oceanworld.tamu.edu/teachers/tech_lab_stations.htm)
- Table of Technology Lab Stations by Topic and Theme [http://oceanworld.tamu.edu/teachers/tech\\_lab\\_sta\\_examples.htm](http://oceanworld.tamu.edu/teachers/tech_lab_sta_examples.htm)

- Oceanography Background
  - Table of Contents [http://oceanworld.tamu.edu/teachers/les\\_plans\\_tofc.htm](http://oceanworld.tamu.edu/teachers/les_plans_tofc.htm)
  - Properties of the Ocean [http://oceanworld.tamu.edu/teachers/savage\\_sea\\_orpropofoc.htm](http://oceanworld.tamu.edu/teachers/savage_sea_orpropofoc.htm) "Savage Sea or Tranquil Ocean"
  - Ocean Currents [http://oceanworld.tamu.edu/teachers/currents\\_oceanicircul.htm](http://oceanworld.tamu.edu/teachers/currents_oceanicircul.htm) "What goes around comes around"
  - El Niño [http://oceanworld.tamu.edu/teachers/bad\\_boy\\_el\\_nino.htm](http://oceanworld.tamu.edu/teachers/bad_boy_el_nino.htm) "The Bad Boy of the Pacific"
  - The Oceanic Heat Budget [http://oceanworld.tamu.edu/teachers/norththeheat\\_heat\\_budget.htm](http://oceanworld.tamu.edu/teachers/norththeheat_heat_budget.htm) "It's not the Heat, It's the Humidity"
  - Fisheries [http://oceanworld.tamu.edu/teachers/it\\_take\\_mine\\_w\\_fisheries.htm](http://oceanworld.tamu.edu/teachers/it_take_mine_w_fisheries.htm) "It take mine with anchovies, please... the Ocean that is!"

### STUDENTS

\*Ocean Information(All you ever wanted to know but was afraid to ask.  
\*Real time data Sites(Discover what's happening now!)  
\*Interactive Quizzes(Test your recall and get the results immediately.)  
\*Internet Ocean Links(Find other great sites about the ocean.)  
\*Ask Dr.Bob.(Questions answered on line by an expert oceanographer.)

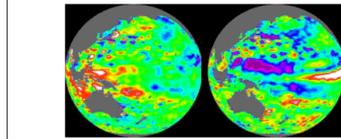
#### El Niño.



The big weather news of 1998 was certainly El Niño. Every major storm that hit the West and East Coast of North America that year was explained away with two words -- El Niño.

**A PERIODIC, SEASONAL VISITOR TO PLANET EARTH** Periodically, every three to seven years, El Niño occurs. El Niño means "the Christ Child" because it commonly appears at Christmas time. With the onset (beginning) of El Niño, water temperatures in the ocean off the coast of Peru (on the continent of South America) become warmer. Nutrients commonly found in the normally cold waters of the area disappear. The fish and other creatures who depend on these nutrients (food) also leave the area or die of starvation (hunger). (See our web page on Fisheries for more information on the effects of El Niño.) Tropical fauna (animals) and flora (plants) not native to the area's normally cold waters appear when the warm water intrudes (moves in).

The appearance of El Niño is indicated by a change in global weather patterns. (Visit our page on the Role of the Ocean in Weather.) It has been observed that this unusual flow of warm tropical water to the region offshore of Peru occurs during years when the trade winds have slowed down or, in some instances, reversed their direction. The trade winds usually blow quite vigorously. When the trade winds blow vigorously, cold nutrient-rich water occurs at the ocean surface in the eastern equatorial Pacific and offshore Peru. Under these oceanographic conditions, upwelling supports high biological productivity in Peruvian waters. In other words, the ocean teems with life. On some occasions, normal air pressure patterns break down which causes the trade winds to weaken and even reverse their direction thus dragging warm nutrient-poor water to the east as far south as Peru. This initiates El Niño

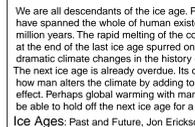


#### FISHERIES



Almost everyone enjoys seafood. But the cost of our favorite dishes is rising fast. Today, overfishing and destructive fishing practices threaten millions of jobs, global food security, and the health of the marine environment. At least 60 percent of the world's 200 most valuable fish species are overfished or fished to the limit. Eleven of the world's 15 most important fishing areas are in decline. Even the remote, windswept Southern Ocean around Antarctica is no longer safe from reckless and illegal fishing. WWF's Endangered Seas Campaign - Scientific American, The Oceans, Fall 1998, Vol. 9, Number 3.

#### ICE AGES



We are all descendants of the ice age. Periods of glaciation have spanned the whole of human existence for the past 2 million years. The rapid melting of the continental glaciers at the end of the last ice age spurred one of the most dramatic climate changes in the history of the planet. The next ice age is already overdue. Its onset depends on how man alters the climate by adding to the greenhouse effect. Perhaps global warming with man's assistance, might be able to hold off the next ice age for a little while longer. Ice Ages: Past and Future, Jon Ericksen

#### ICEBERG



On the night of April 14, 1912, at 20 minutes before midnight, the "unsinkable" ship RMS Titanic was cruising across the Grand Banks of Newfoundland at more than 20 knots on its maiden voyage. Lookouts suddenly saw an iceberg dead ahead rising six stories out of the water. Their warnings to the bridge were too late. The great liner struck the iceberg and sank. The resulting loss of more than 1,500 passengers and crew stunned the world that had become increasingly complacent with mankind's presumed superiority over nature.

What's an Iceberg?

### REAL TIME DATA

YOUR ONE STOP FOR THE LATEST IN OCEANOGRAPHY TOPICS AND INFORMATION!

The Ocean World team has gone all over the web and the world gathering information and smart scientists so we can now present you with the latest in oceanography information and topics!

Looking for some real time data information on El Niño? We've got it! (Check out our El Niño topic section). What about expanding your knowledge of ocean currents? You've come to the right place! (check out our Currents topic section).

Each topic section is organized so that you can find the information you need quickly and easily. Each section contains quick links to various topics in the topic's pages, as well as pictures - real-time or near-time data links, and further information website links.

Ready to start? Come aboard! Select one of the topic sections in the jump down menu below to begin your voyage.

#### CORAL REEFS

<http://www.fisheryview.com/> Look at Fishery View Cam! It views a patch of coral severy 90 seconds. The remote camera captures live video for photos and streaming video of corals at Coral Gables, Florida. Check out more at: <http://oceanworld.tamu.edu/realdatlinks/realdataCORALREEFS.htm>

#### CURRENTS

<http://www.gmpco.gov/datas/realtime.html> This page points to the Gulf of Mexico related near-real-time data and forecasts. Raw data, processed data, analyses and predictions are all included. Check out more at: <http://oceanworld.tamu.edu/realdatlinks/realdataCURRENTS.htm>

#### EI NINO

[http://www.jpl.nasa.gov/el\\_nino/](http://www.jpl.nasa.gov/el_nino/) Want to see present images and news releases based on observations of the El Niño/La Niña phenomenon in the Pacific Ocean? Come and visit this site which has current data from the TOPEX/Poseidon and other NASA/JPL satellites and instruments. Check out more at: <http://oceanworld.tamu.edu/realdatlinks/realdataELNINO.htm>

#### FISHERIES

<http://www.pac.dfo-mpo.gc.ca/ops/fm/fishmgmt.htm> Canada's Fisheries and Oceans site runs this site which links you to their current fisheries information. Swim through this site and find interesting pages as the one on real time data on predictions of tides. Find more at: <http://oceanworld.tamu.edu/realdatlinks/realdataFISHERIES.htm>

#### ICEBERGS

<http://uawmrc.ssec.wisc.edu/amrc/realtime.html> This site brings you real-time data from Antarctica. It has images of icebergs and ice shelves. The data comes from a variety of stations and provides temperature, dew point, air pressure reduced to sea level, current weather, wind speed (mph) and direction, precipitation (mm) during an amount of time (hh:mm:ss), and visibility (km). Find more at: <http://oceanworld.tamu.edu/realdatlinks/realdataICEBERGS.htm>

#### ROLE OF THE OCEAN IN WEATHER

<http://www.rap.ucar.edu/veather/> The Real-time Weather Data page brings to you a complete set of information on Surface, Satellite, Radar and Upper-Air Data. Find more at: <http://oceanworld.tamu.edu/realdatlinks/realdataV...>

#### SATELLITES AND OCEAN EXPLORATION

<http://www.ssec.wisc.edu/data/> In SSEC site you find a variety of links to different pages which show actual satellite images for North America, Western Hemisphere, and Eastern Pacific Ocean. Composite satellite, volcano watch, sea surface temperature data and images are also on this site. The information is updated on a regular basis (one daily, every 3 to 6 hrs. or every 30 mins). Find more at: <http://oceanworld.tamu.edu/realdatlinks/realdataSATELLITES.htm>

#### WAVES

<http://oceanworld.tamu.edu/realdatlinks/realdataWAVES.htm>



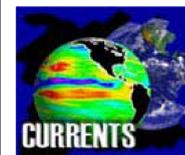
CORAL: ANIMAL, MINERAL OR VEGETABLE?

A coral reef harbors as much life as a rainforest "Cradle to Myriads of Species Millennia to Create Moments to Destroy" --Jim Morris

"There has long been a belief that the sea, at least, was inviolate beyond man's ability to change and to despoil. But this belief, unfortunately, has proved to be naive." --Rachel Carson

"Pollution, overfishing, and overuse have put many of our unique reefs at risk. Their disappearance would destroy the habitat of countless species. It would unravel the web of marine life that holds the potential for new chemicals, new medicines, unlocking new mysteries. It would have a devastating effect on the coastal communities from Cairns to Key West, Florida -- communities whose livelihood depends upon the reefs." --President Bill Clinton

What is coral? When you see pictures in National Geographic of huge rock like things in the ocean with fish swimming all around, is that coral? Well, sort of. That is a coral reef. Coral is an animal that belongs to the phylum cnidaria. A phylum is a group or classification scientists place animals in that share certain characteristics. Cnidarians are radially symmetrical; that means they are the same all the way around, 360 degrees! They are built like sacs with a hole in one end that is surrounded by stinging tentacles. Jellyfish are cnidaria. Now, you are probably thinking jellyfish don't look anything like what I thought coral was! That's because the only pictures you have ever seen of coral are of coral colonies called reefs.



CURRENTS

The weeks passed. We saw no sign either of a ship or of drifting remains to show that there were other people in the world. The whole sea was ours, and, with all the gates of the horizon open, real peace and freedom were waited down from the firmament itself. It was as though the fresh salt tang in the air, and all the blue purity that surrounded us had washed and cleansed both the body and soul. To us on the raft the great problems of civilized man appeared false and illusory--like perverted products of the human mind. Only the elements mattered. And the elements seemed to ignore the little raft. Or perhaps they accepted it as a natural object, which did not break the harmony of the sea but adapted itself to current and sea like bird and fish. Instead of being a fearsome enemy, fling itself at us, the elements had become a reliable friend which steadily and surely helped us onward. While wind and waves pushed and propelled, the ocean current lay under us and pulled, straight toward our goal.

What Heyerdahl, from Kon-Tiki  
A CURRENT IS A CURRENT BY ANY OTHER NAME, BUT WHAT IS A CURRENT? Ocean currents can be divided into two types of flow based on the forces that drive them. Most currents in the upper kilometer of the ocean are driven by the wind. Deeper currents are density-driven (which means that dense water sinks and is replaced by less dense water). Deeper water is affected by long variability of climate. Climate controls salinity and temperature of the water which has everything to do with density. (See our page: Role of the Ocean and Weather.)

#### SATELLITE OCEANOGRAPHY and TOPEX/Poseidon

On the beach at night alone, As the old mother sways her to and fro singing her husky song, As I watch the bright stars shining, I think a thought of The vast of the universes of the future. A clef similitude interlocks all, All spheres, grown, ungrown, small, large, suns, moons, And all distances of place however wide, All distances of time, all inanimate forms, All souls, all living bodies though they be ever so different, or in different worlds, All gaseous, water, vegetable, mineral processes, the fishes, the brutes, All nations, colors, barbarisms, civilizations, languages, All identities that have existed or may exist on this globe, or any globe, All lives and deaths, all of the past, present, future, This vast similitude spans them and always has spanned, And shall forever span them and complexity hold and enclose them.

What is Satellite Oceanography?

Well you're on a satellite right now. Yeah, for real! A satellite is an orbiter--something that travels around another object. Planet Earth is a satellite of us you guessed it--the sun. The gravity of the sun holds us in orbit. Without the gravitational pull of the sun, we would go zooming out into space--never-never land. The moon is a satellite of Earth. What do you suppose holds the moon in orbit around Earth? Right! Gravity! Earth and Moon are natural satellites. Humans have learned how to create artificial satellites. Don't let that word "artificial" throw you. The satellites are real. Artificial simply means "not natural" because they are made by humans.

### VOLVO OCEAN ADVENTURE



#### Project Overview

The Volvo Ocean Adventure is an Internet based education project designed to encourage young people to find out more about global environmental issues that influence everyone's day-to-day lives. Initially the project will follow the Volvo Ocean Race 2001-2002 round the world, using it as an opportunity to bring marine environmental science to a wider audience. However, the project intended to last beyond the 2001-2002 race, and will also cover wider environmental issues. There are three key elements to the website: -

1. Data from the Yachts. Sea surface temperature and ocean colour data from the yachts will be combined with satellite images from the race region and made available on the website together with background information and hints for data analysis.
2. Understanding the Ocean. A series of weekly topics following the yachts around the world looking at oceanographic phenomena and the role of the ocean in the global environment, combined with brief background information and suggestions for school activities. Selection of material for this part of the project will be done in close collaboration with Science Partners along the route of the Race.
3. Learning by Action. A programme to encourage young people to participate in practical projects locally, to help solve environmental problems.

#### Satellite and Yacht Data

- \* Ocean colour data provided by the SeaWiFS Project and Orbimage
- \* Wind and wave data provided by Satellite Observing Systems.
- \* We also hope to provide sea surface temperature data.
- \* Link to the ocean colour and sea surface temperature data collected by each yacht

Each satellite image will have the position of the yachts over the previous 24 hours superimposed. This information will be obtained from the race office by SOC and automatically relayed to science partners responsible for providing the satellite data. The hope is that the data will be available in near real-time, so the procedures for uploading images to the VOA website will need to be automated. Along with the satellite and yacht data, we hope to provide a brief daily guide pointing out interesting features of the images and yacht data, with links to relevant background information within the Subject Areas / Topic of the Week sections.

#### Volvo Ocean Adventure

- Subject Area Content List
  - Water and Heat Cycles
    - The earth's radiation budget
    - The water cycle
  - Weather and Seasons
    - Weather or climate?
    - Atmospheric convection and prevailing winds
    - Comparison of global maps of SST, wind-speed, cloud cover
  - Climate change
    - The global carbon cycle (interactive diagram)
    - Ocean Basins and the Sea Floor
    - Mapping the sea floor
    - The main ocean basins (Pacific, Atlantic, Indian Ocean)
    - Active and passive continental margins
  - Water in motion
    - Waves
    - Wind-driven currents
    - Thermohaline circulation
  - Life in the Ocean
    - Classification of the marine environment
  - Marine pollution
    - All identities that have existed or may exist on this globe, or any globe,
    - Marine debris
    - Heavy metals
    - Coastal environments and reefs

