

GEOG 101 Part II  
People and their  
Physical Environment

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The Hydrosphere:  
Oceans

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PART II: People and their  
Physical Environment

- ✓ I. Introduction to the Physical Environment
- ✓ II. Earth-Sun Relationship
- III. Earth Systems
  - A. The Hydrosphere: Oceans
  - B. The Atmosphere: Weather and Climate
  - C. The Lithosphere: Geologic Influences
- IV. Earth Habitat
  - A. Biosphere
  - B. Natural Controls and Cycles
  - C. Human Impact
  - D. Natural Hazards
  - E. Earth Resources

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HYDROSPHERE: Overview

- **Earth is the Water Planet:** 71% of surface is water and 97% of all water is in the oceans.
- **Ocean Movements:** The oceans are a dynamic system with much activity and interactions.
- **Water Temperature and Climate:** Surface ocean temperatures affect air temperature and therefore climate.
- **Oceans and People:** Oceans play an important role in earth environment, influencing many things people do.

<https://www.youtube.com/watch?v=P4QTVQUTUg>  
2 min oceans video

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HYDROLOGIC CYCLE

The "Hydrologic Cycle" explains how the earth maintains and cleans its water supply, constantly producing new fresh water. The oceans, containing over 97% of the water found on Planet Earth, are the chief source of atmospheric moisture.

More on this in the lectures on the atmosphere and biosphere.

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OCEAN BASIN TOPOGRAPHY

The ocean floor is not flat!

More on the ocean basin when we do the geology section.

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THE DYNAMIC OCEAN

The movements found in the ocean are a result of numerous aspects of fluid dynamics working together, transferring energy and creating motion.

- ❖ **Ocean current:** a ribbon (or river) of moving sea water with unique characteristics.
- ❖ **Gyre:** a giant circulation system found both on the surface of the oceans and in the atmosphere; caused by the earth's rotation and the Coriolis Effect.
- ❖ **Ocean gyre:** a system of circular ocean currents.
- ❖ **Wave:** a friction-generated phenomena created as wind passes over and touches the surface of water, dragging it forward, creating a crest.
- ❖ **Tsunami:** a seismic sea wave created by a shock (falsely called a tidal wave).
- ❖ **Tide:** a moving bulge of water created the moon's gravitational pull and by earth's rotation.

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## MOVEMENTS in the OCEAN

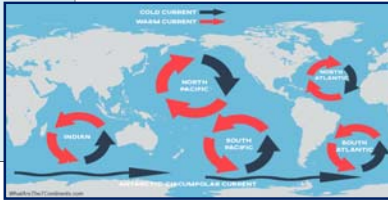
❖ **Ocean current:** A ribbon (or river) of moving sea water, with unique characteristics, generated by the earth's rotation and by the differences in water salinity and water temperature.

✓ Ocean current movements are both horizontal (surface) and vertical (deep sea).

❖ **Gyre:** giant circulation system linked to rotation and Coriolis.

➤ **Ocean gyre** is a large system of circular ocean currents formed by global wind patterns, Earth's rotation and the Coriolis Effect.

✓ The world's five ocean gyres help to drive the oceanic conveyor belt that circulates ocean water around the planet.



## MOVEMENTS in the OCEAN

❖ **Waves** (wind waves) are generated mainly by the transfer of energy from wind to water by friction.

Waves help to mix water of different temperature and salinity.

✓ Waves alter the coastline by erosion and deposition.

❖ **Tsunamis** are seismic sea waves (not tidal waves).

✓ They are generated by earthquakes, underwater landslides and any other shock inducer that transfers energy.

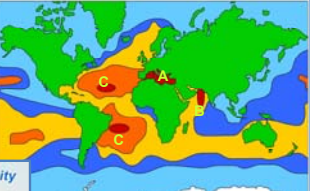
❖ **Tides** (moving water bulges) are caused by the gravitational pull of the moon and sun and by the earth's rotation.

- **Tidal bore** (the true tidal wave) is the leading edge of the incoming or high tide, esp. evident when approaching shallow water.
- **Tidal range** is the difference in height between high and low tide.

## Simplified Ocean Salinity Map

Note the areas of very high salinity and low salinity on the map.

The diagram below shows how salinity varies with environmental conditions.



**Salinity (ppt)**  
more than 37  
36  
35  
34  
less than 34

**Increase salinity**

Evaporation  
Freezing of ocean

**Decrease salinity**

Precipitation of rain and snow  
Melting of ice  
Dilution after flow to ocean

**WATER CYCLE EFFECTS ON OCEAN SALINITY**


- A. The Mediterranean Sea is getting more salty because of freshwater diversion by people.
- B. The Arabian Sea has high salinity because it has hot, desert conditions.
- C. The two Atlantic Ocean zones have high rates of water evaporation.

[https://www.youtube.com/watch?v=5xQP\\_B18vMw](https://www.youtube.com/watch?v=5xQP_B18vMw)  
3 min video on ocean water salinity

## SURFACE OCEAN CIRCULATION

**KEY**

- Warm (red)
- Cold (blue)

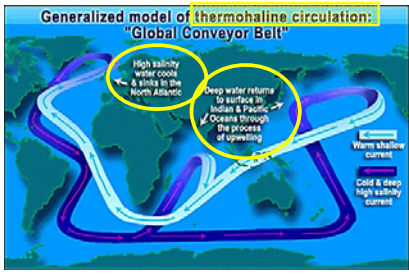


**GYRES**  
Circulation systems

Currents are designated warm and cold by their source region, not their temperature. Surface currents influence climate on land through the transfer of temperature and moisture characteristics.

## DEEP-SEA OCEAN CURRENTS

**Generalized model of thermohaline circulation: "Global Conveyor Belt"**




High salinity water cools & sinks in the North Atlantic

Deep water returns to surface in Indian & Pacific

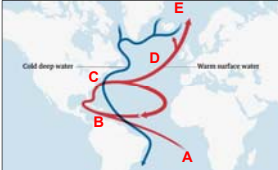
✓ Comes through the process of upwelling

Thermo = heat  
Haline = salinity  
Differences in temperature and salt content create density gradients that generate movements.



Thermohaline circulation <https://www.youtube.com/watch?v=OVvXDl0k6Y>  
3 min No sound

## Gulf Stream System



The Gulf Stream (red line) starts as the Atlantic North Equatorial (A). It carries tropical water north along the coast of South America and into the Caribbean Sea (B). It continues northward along the coasts of Florida, Georgia and North Carolina before being deflected eastward at Cape Hatteras (C).

It crosses the Atlantic Ocean as the North Atlantic Drift (D), warming the atmosphere and bringing warmth and moisture to NW Europe. As the warm ocean surface water evaporates, it makes the underlying water saltier and therefore, denser, before being cooled by the Arctic Ocean (E). The chilled saline water sinks and then begins a return-journey back south as a cold, deep-water current (blue line).

**What happens if something interferes with this system?**

- A giant meteor strikes the ocean between Great Britain and Iceland.
- Something slows the speed of flow between N. America and Europe.
- The current's surface temperature or salt content changes.

## What if the Gulf Stream Weakens?

**What happens along the east coast of the U.S.?**

**What happens to Europe?**

**What happens to the global thermohaline circulation system?**

The warming of the atmosphere is cooling the North Atlantic Ocean! **How can this be?**  
 Can you see the scenario on the map?  
**Remember, everything on earth is interrelated.**

Read the article and view the animation from the link:  
<https://www.nytimes.com/interactive/2021/03/02/climate/atlantic-ocean-climate-change.html?smid=url-share>

## WAVE FORMATION

**1.** Swells are created by wind friction

**2.** Wave energy from swells in deep sea water is contained within a circular orbital motion.

**3.** Wave energy is affected by proximity to the sea floor and in shallow water wave orbits slant shoreward; orbits become oval-shaped.

**4.** Maximum steepness of orbit occurs before the wave breaks.

**5.** The "wave swells" grow in height until they reach a point beyond which they cannot support themselves (orbit collapses) and the "swells" break apart and "crash" creating breakers.

**6.** "Broken" wave swells (breakers) create the surf zone.

**7. SURF ZONE**  
 After the waves break, turbulent water (surf) runs up the shore (swash) and then flows back to the basin (backwash).

**Most waves are wind generated.** Friction from the bottom of an air mass moving against the top of the water causes the water to move in orbits and pile on top of itself creating swells.

✓ **Breaking waves in the surf zone constantly shape the shoreline.**

## TSUNAMI: A shock-generated ocean wave

**CAUSES:**

- Earthquake
- Landslide
- Meteor strike

Sendai, Japan (2011) before and after being hit by the tsunami.

<https://www.youtube.com/watch?v=SlwZzbGh7Cw> earthquake tsunami 3D demo 1 min no sound

<https://www.youtube.com/watch?v=KstQogN8DUA> NOAA Hawaii landslide tsunami scenario, animation, 2 min

<https://www.youtube.com/watch?v=mDf6zElkDHI> Small tsunami, Indonesia, Jan. 2018, 2 min

## Tsunamis and the Ocean Floor

A tsunami's propagation velocity is reduced in shallow water, while the height of its waves rapidly increases.

Depth (meters)	Velocity (km/h)	Wave length (km)
7000	943	282
4000	713	215
2000	504	151
200	159	48
50	79	23
10	36	10.6

**In deep water the wave is barely noticeable. In shallow water the wave grows in height proportional to its length, similar to a flat piece of paper being pressed against a hard object.**

**Also, note that the wave crests are closer to each other in shallow water producing numerous "wave hits" against the shoreline within a short period of time.**

## OCEANS and PEOPLE

- ✓ Oceans help to **equalize the Earth's temperature.**
- ✓ They are the **chief source of atmospheric moisture.**
- ✓ They are an important link in the **carbon/oxygen cycle.**
- ✓ They are a **source of food.**  
<https://www.nytimes.com/2019/02/28/climate/fish-climate-change.html?login-email&auth=login-email>
- ✓ They are a **source of minerals.**
- ✓ Their rise and fall effects **coastline habitation.**

✓ They are used for:

- **transportation**
- **drinking water** through desalination process
- **recreation**
- **waste disposal**

✓ They are a major **barrier to interaction.**

✓ Historically ocean coasts have been the **gateway to cultural interaction.**

## NEXT

### THE ATMOSPHERE:

## Aspects of Weather and Climate