# Ocean Water

## **Ocean Water Composition**

- Minerals left behind by gases, rivers, & streams break down into elements and gases that mix with the water.
- Elements found in ocean water include: ->

| Element        | Percent of<br>Ocean water<br>by mass |
|----------------|--------------------------------------|
| Chlorine (Cl)  | 1.94                                 |
| Sodium (Na)    | 1.08                                 |
| Magnesium (Mg) | 0.13                                 |
| Sulfur (S)     | 0.09                                 |
| Calcium (Ca)   | 0.04                                 |
| Potassium (K)  | 0.04                                 |
| Bromine (Br)   | 0.006                                |
| Carbon (C)     | 0.003                                |
| Strontium (Sr) | 0.001                                |
| Boron (B)      | 0.0005                               |

#### **Ocean Water Composition**

- Dissolved gases in ocean water are:
  - Nitrogen gas (N<sub>2</sub>)
  - Oxygen gas (O<sub>2</sub>)
  - Carbon dioxide (CO<sub>2</sub>)
- Temperature plays vital role to amount of dissolved gases in water
  - Cold regions have a larger amount of gases than warm regions

# Salinity

- Amount of **dissolved salts** present in a sample of ocean water
- Described in parts per thousand
  - %o this is the notation for parts per thousand
- Salinity in various regions all differ
  - Range from 33‰ to 40‰
  - Average Salinity is 35‰

#### **Ocean Temperature**

- Surface Temperature due to ocean mixing water can be heated to a depth of **300 m**
  - Equator = 30°C (86°F)
  - Poles = -2°C (28.4°F)
- Below that depth the water is very cold, since ocean temperature decreases rapidly with depth

#### Surface Temperature and Salinity by Latitude



### **Ocean Temperature Zones**

#### Mixed Layer

- Ocean's surface region where waves and wind mix heat evenly
- Absorbs almost all of the sun's light
- Most marine life found in this layer



#### **Ocean Temperature Zones**

- Middle Zone
  - Also called the thermocline
  - **Temperature** drops very rapidly here



#### **Ocean Temperature Zones**

#### Deep Water

- This cold, dense water moves away from the polar regions along the ocean floor and spreads itself over the globe beneath other ocean water
- Here, temperatures are about 2°C



### **Ocean Water Density**

- Seawater density is influenced by two main factors: salinity and temperature
- The pycnocline is the layer of ocean water between about 300 meters and 1000 meters where there is a rapid change of density with depth
- Ocean water is most dense at 4°C

# Ocean Currents

#### Factors Affecting Ocean Surface Currents

- Wind belts
- Earth's rotational effects
- Continental location

#### **Ocean Currents**

- Ocean currents involve large water masses and are any continuous flow of water along a broad path in the ocean.
- There are two types of currents
  - Surface
  - Deep

## Surface Currents

- A surface current is an ocean current that generally flows in the upper **1000 meters** of the ocean.
- Earth's rotation and presence of continents influence the paths of currents, but surface currents are mainly caused by wind.
- Surface currents in the Northern Hemisphere turn clockwise, and in the Southern Hemisphere turn counterclockwise.

## **Types of Surface Currents**

- Warm currents flow away from the equator (ex. The Gulf Stream in the North Atlantic)
- Cold currents flow toward the equator (ex. The California Current in the North Pacific)
- Gulf Stream Rings eddies or whirlpools that break away from the edge of a current
- Countercurrents flow in the opposite direction of the wind-related currents (occur along the equator)

### **Continental Location**

 Continents are barriers to surface currents, they cause surface flows to be deflected and divided.



#### **Global Ocean Currents**



#### **Global Wind Belts**



### The Coriolis Effect

- The Coriolis effect causes a deflection of earth's winds and ocean currents caused by the earth's rotation.
- This creates huge circles of moving water called gyres. In the N. Hemisphere, the flow is clockwise and in the S. Hemisphere, the flow is counterclockwise.

#### Trade Winds



- Trade winds and westerly winds form most ocean currents.
- The trade winds blow from the NE in the Northern Hemisphere and the SE in the Southern Hemisphere

### Westerlies

 The westerlies blow from SW in the Northern Hemisphere and the NW in the Southern Hemisphere





### Map of Global Surface Currents



#### **Deep Currents**

- Cold, deep currents move much more slowly than the surface currents
- Produced as cold, dense water of the Polar Regions sinks and flows beneath warmer ocean water toward the equator.
- The movement of water is a result of **density** differences
  - Water cools and contracts
  - water molecules closer together = water denser = water sinks

## **Deep Currents**

- These currents are driven by gravity and differences in density.
- A density current is heavier and denser than surrounding water.
- These currents sink toward the bottom of the ocean where they circulate for 500-2000 years before resurfacing.
- These are found in all oceans.

## Global Conveyer Belt

- Warm water in the ocean's upper layers flow toward the poles
- As the temperature changes, this water becomes denser and returns back towards the equator as cold deep water rises/upwells completing the "belt"
- This influences global climate by converting warm water to cold, releasing heat to the atmosphere.
- <u>http://bcs.whfreeman.com/thelifewire/content</u> /chp58/5802003.html



## Density Currents from Polar Water

- The most dense water comes from the poles.
- There are three main water masses: Antarctic Bottom Water, North Atlantic Deep Water, and Antarctic Intermediate Water
- Antarctic Bottom Water is the coldest, densest water (-0.4°C)

# Density Currents Caused by Evaporation

- When seawater evaporates, salt in water is left behind, increasing both salinity and density of the remaining water.
- An example of this is in the Mediterranean
  Sea. Water here is very dense.

## Upwelling and Downwelling



- **Upwelling** is the movement of the deeper, cooler waters away from the shore that rise to the surface.
- Downwelling is the movement of surface waters toward the shore that accumulate and sink to the bottom.

B. Downwelling

## Upwelling

- Water that upwells is very nutrient rich
- These become very productive areas for plants to grow
- The plants make a great place for the animals to migrate to

#### Currents in the N. Atlantic



- Gulf Stream moves 100 million m<sup>3</sup> of water per second.
- It moves warm water from the Gulf, along the east coast and into the Arctic.