- The horizontal movement of water in a well-defined pattern, such as a river or stream is referred to as a current.

Lesson 1 - Ocean Currents

Chapter 21

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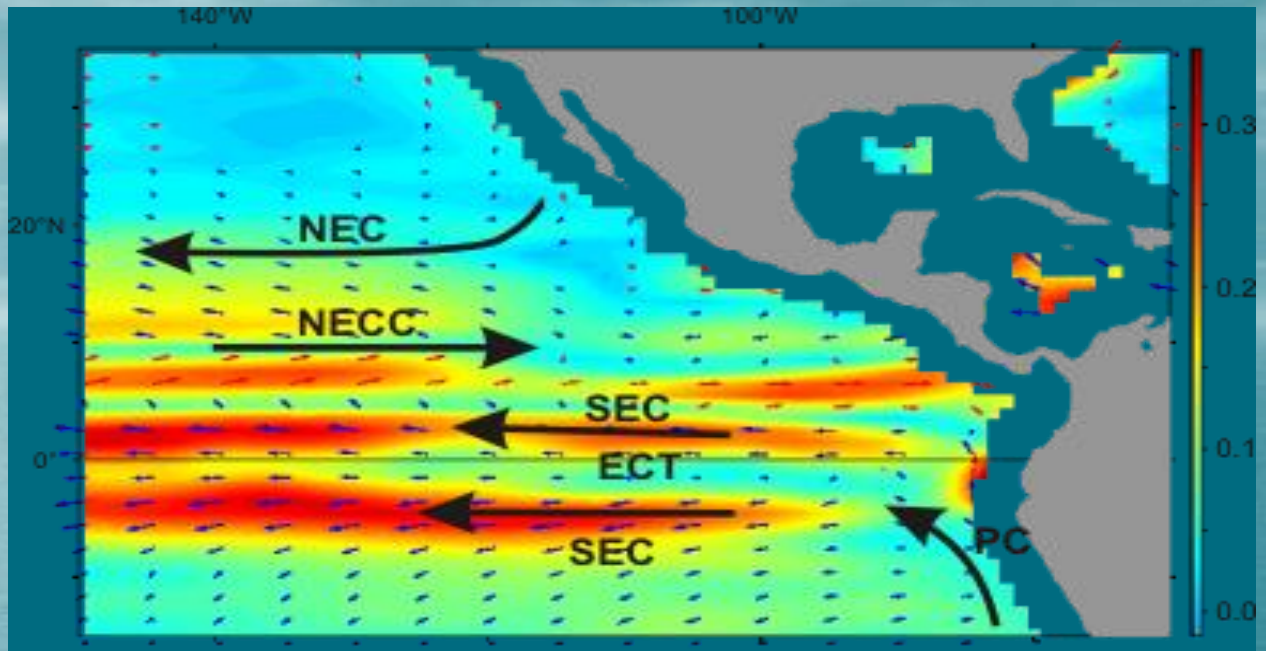
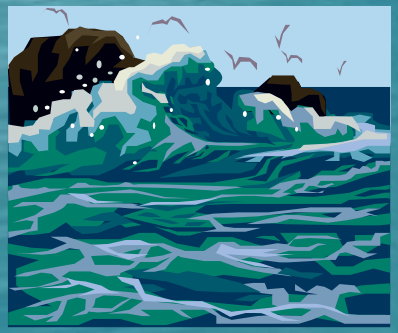


- Scientists place ocean currents into two major categories:
- (1) surface currents
- (2) deep currents

Ocean Currents

Chapter 21

- The water at the surface is moved primarily by winds that blow in certain patterns because of the Earth's spin and the Coriolis Effect.
- These waters make up about 10% of all the water in the ocean.



Surface Currents

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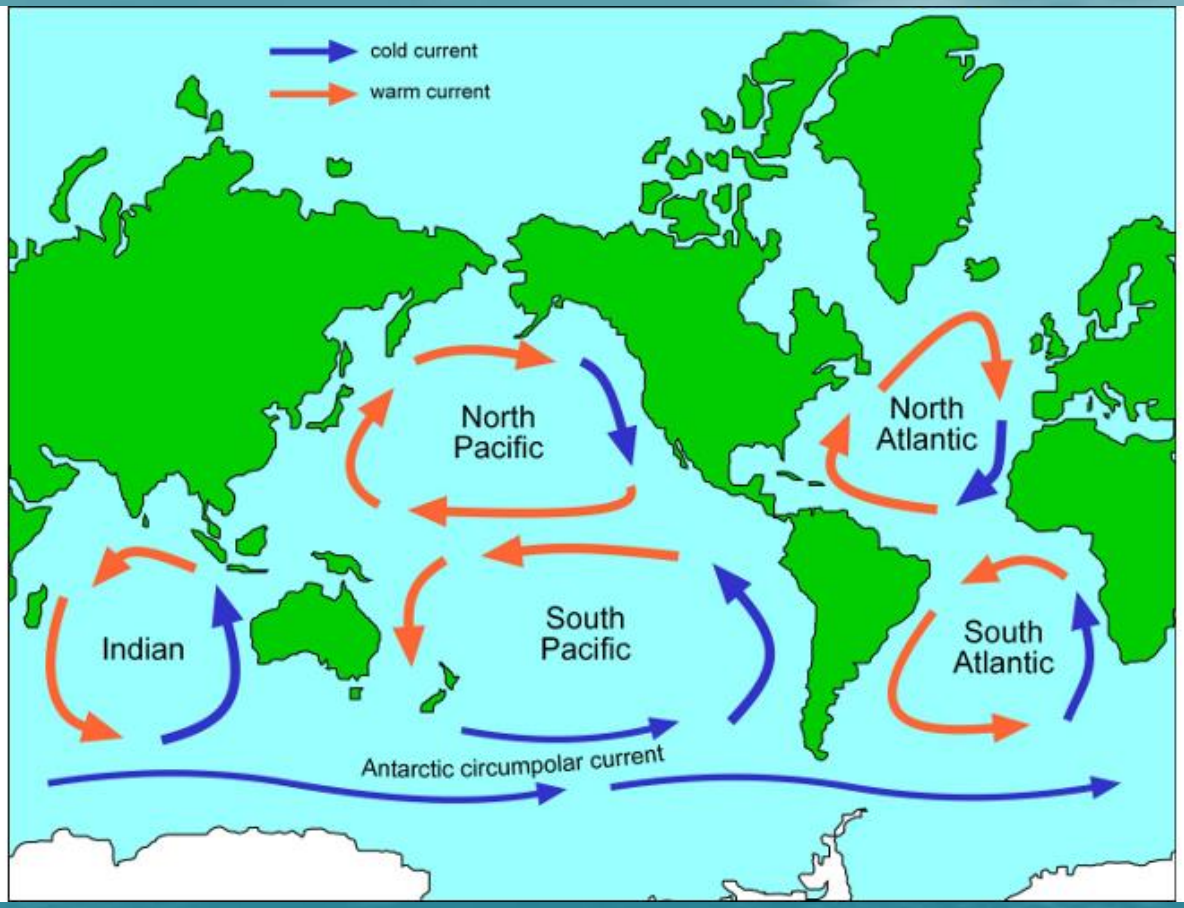
- Surface currents are controlled by three factors:
- (1) The earth's rotation (Coriolis effect)
- (2) air currents
- (3) location of the continents



Factors That Affect Surface Currents

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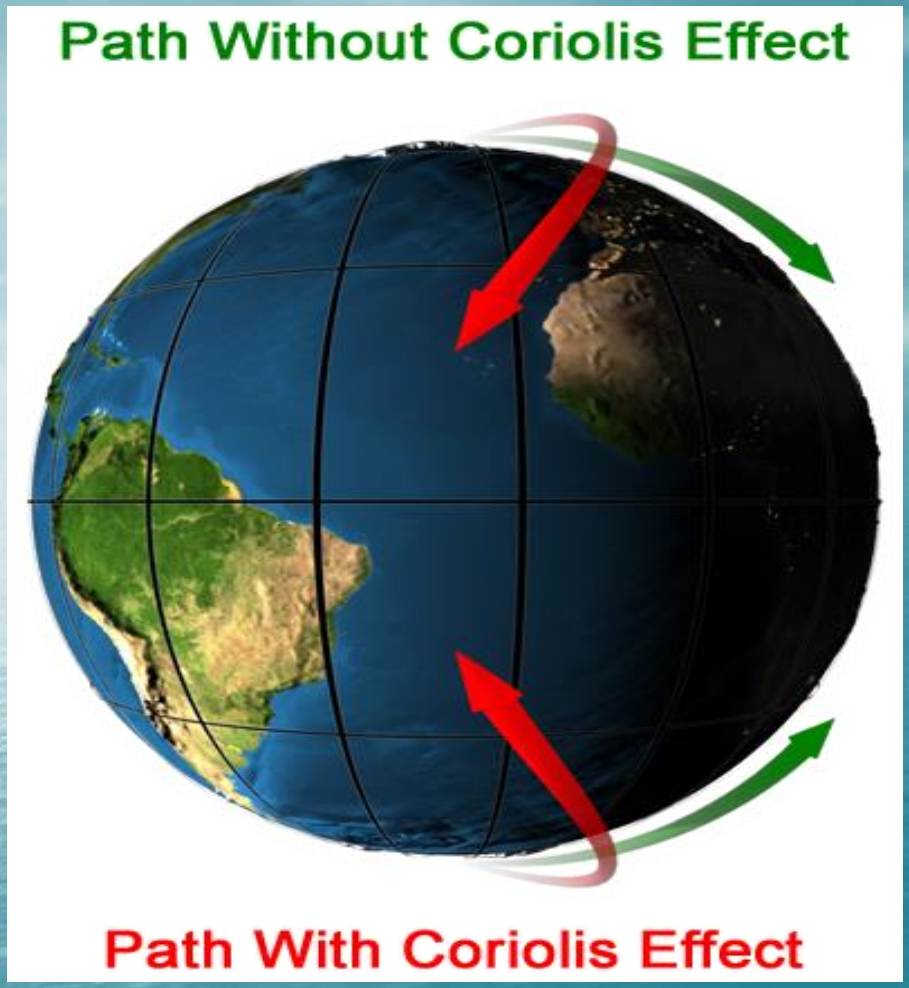
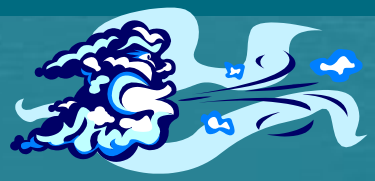


Coriolis Effect

- When looking down at the North Pole, the Earth spins counterclockwise around its axis.
- A point on the equator travels at about 1,100 mph, while a point directly at the poles does not move at all.



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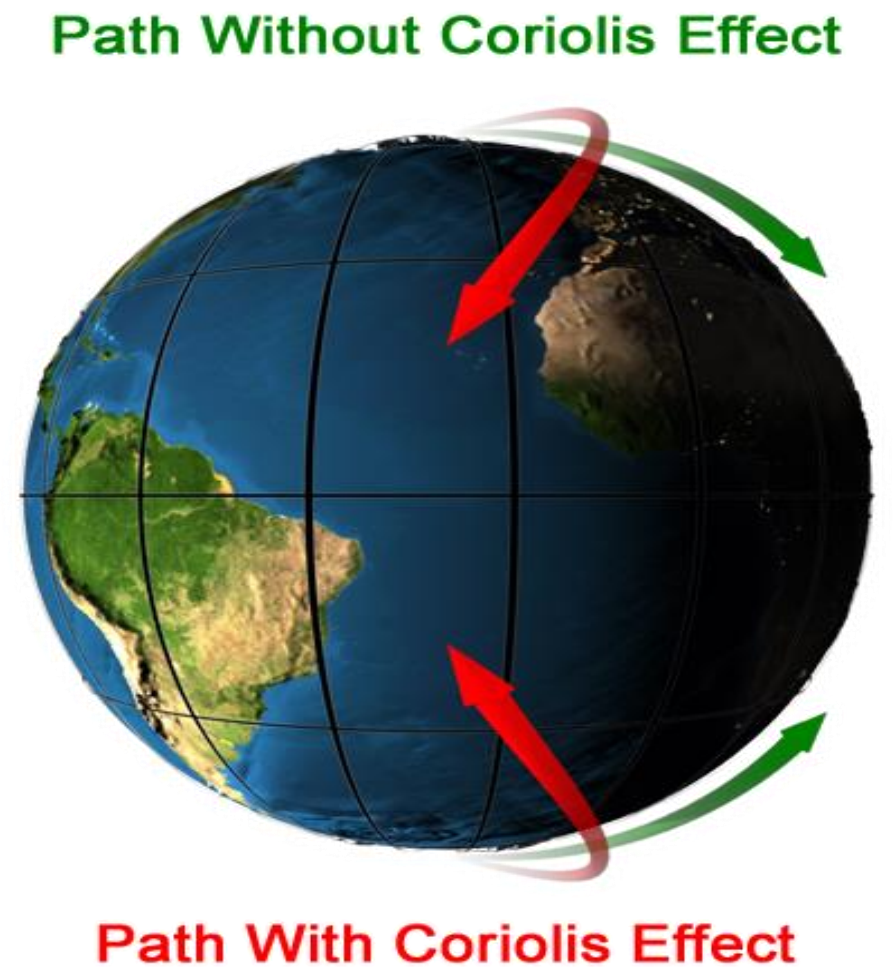
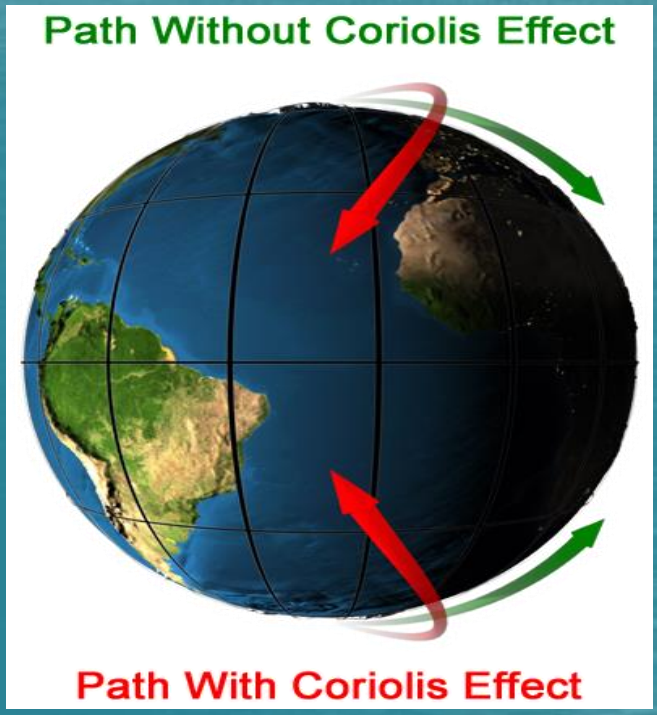


Coriolis Effect

- The Coriolis effect (force) is the apparent deflection of objects (such as airplanes, wind, and ocean currents) moving in a straight path relative to the earth's surface.

- Objects normally move in a straight line when you're on a non-spinning world.

Coriolis Effect



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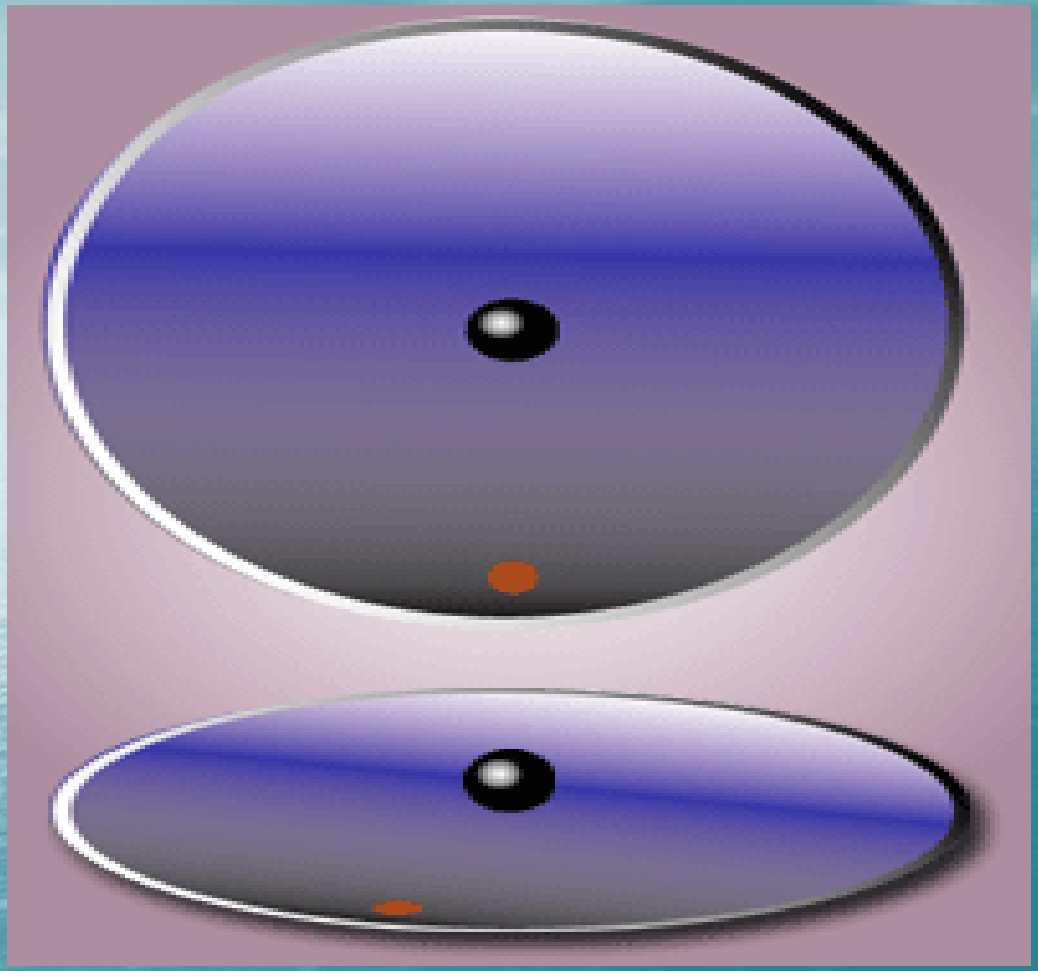
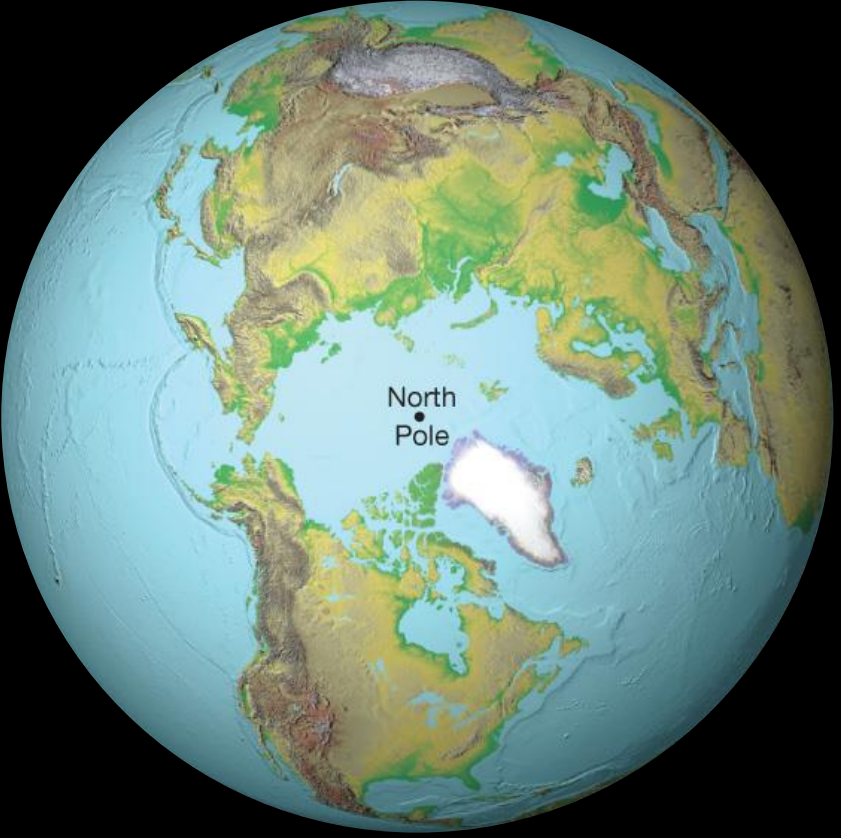


Coriolis Effect

- However, in a spinning world, if you move in a straight line, you really wind up curving and never get to the place you want to go.



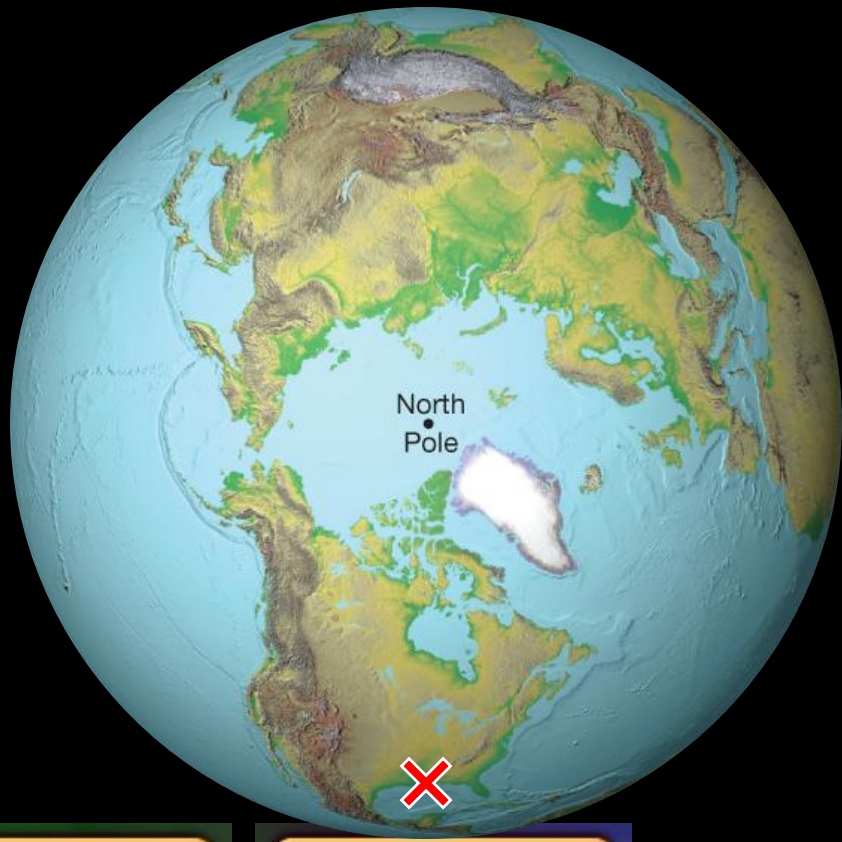


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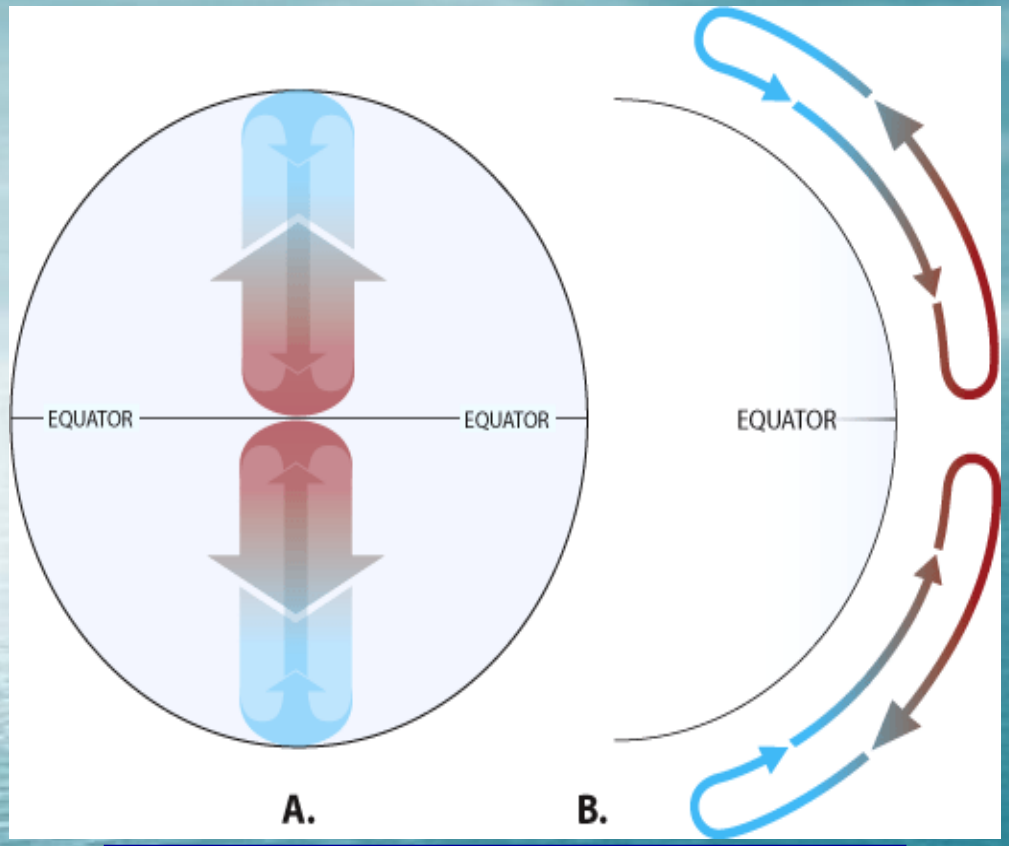
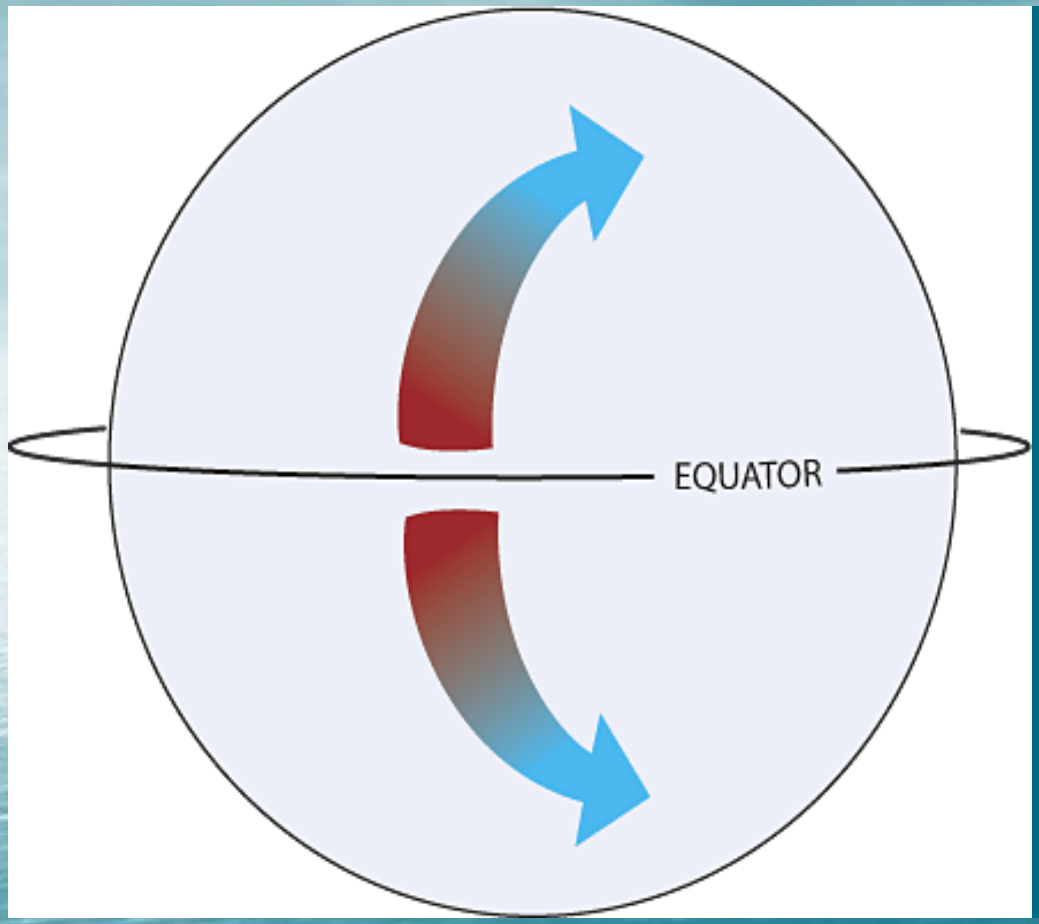
Illustration: Dennis Tasa



Why does the Coriolis Affect Ocean Currents

- If the Earth did not rotate and remained stationary, the atmosphere would circulate between the poles (high pressure areas) and the equator (a low pressure area) in a simple back-and-forth pattern.



- But because the Earth rotates, circulating air is deflected.
- Instead of circulating in a straight pattern, the air deflects and curves:
- in the Northern Hemisphere to the right
- in the Southern Hemisphere to the left

Why does the Coriolis Affect Ocean Currents

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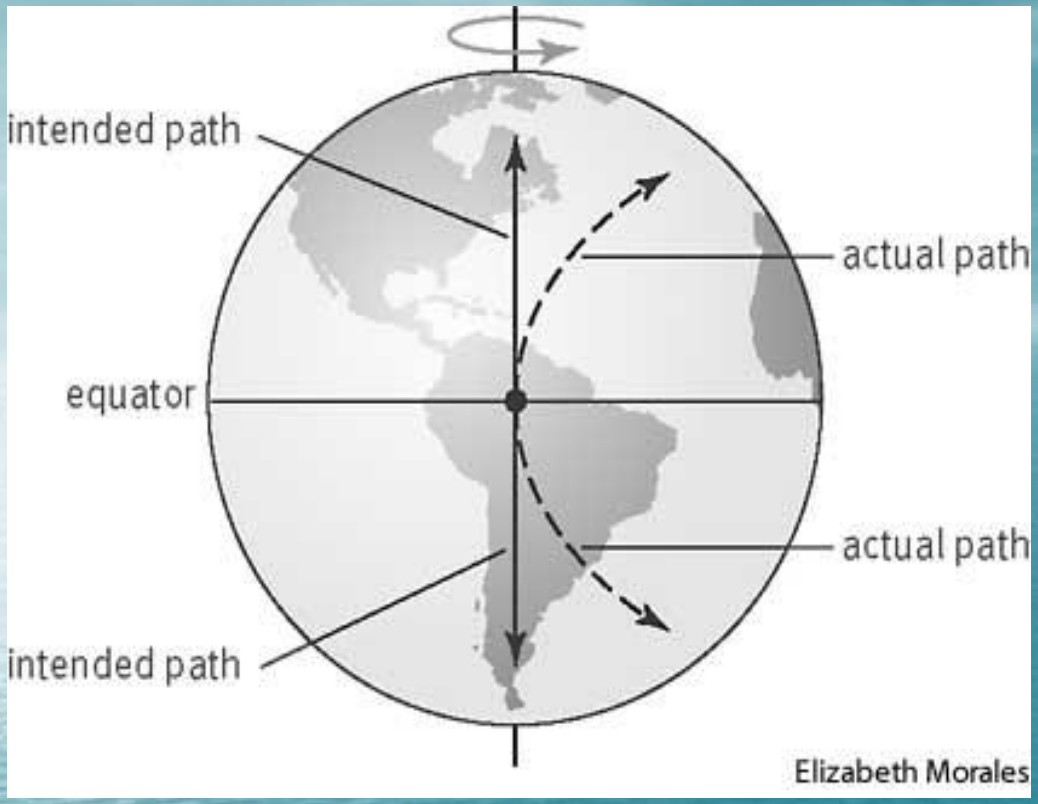
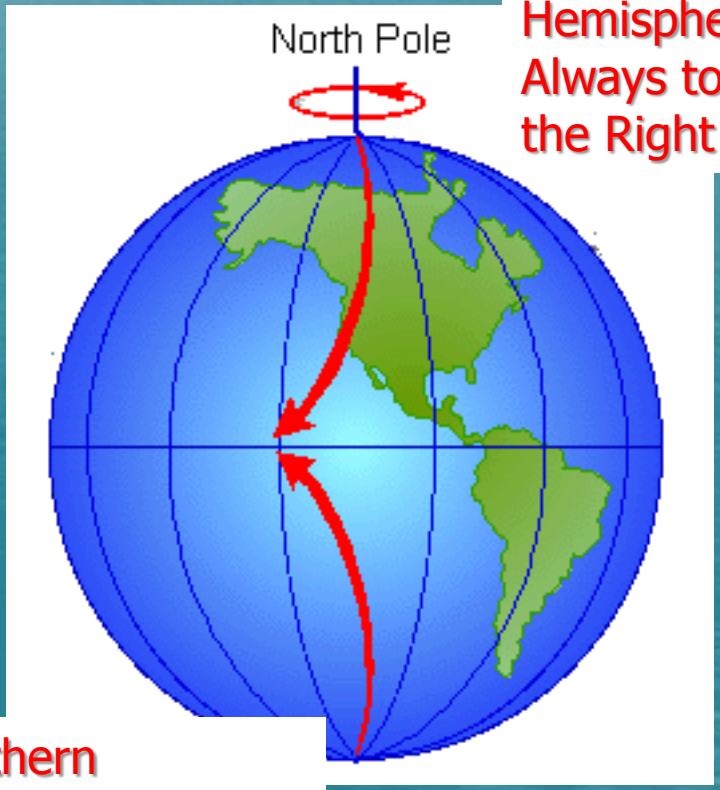


- This deflection is called the Coriolis effect.



Why does the Coriolis Affect Ocean Currents

why isn't it faster to fly west

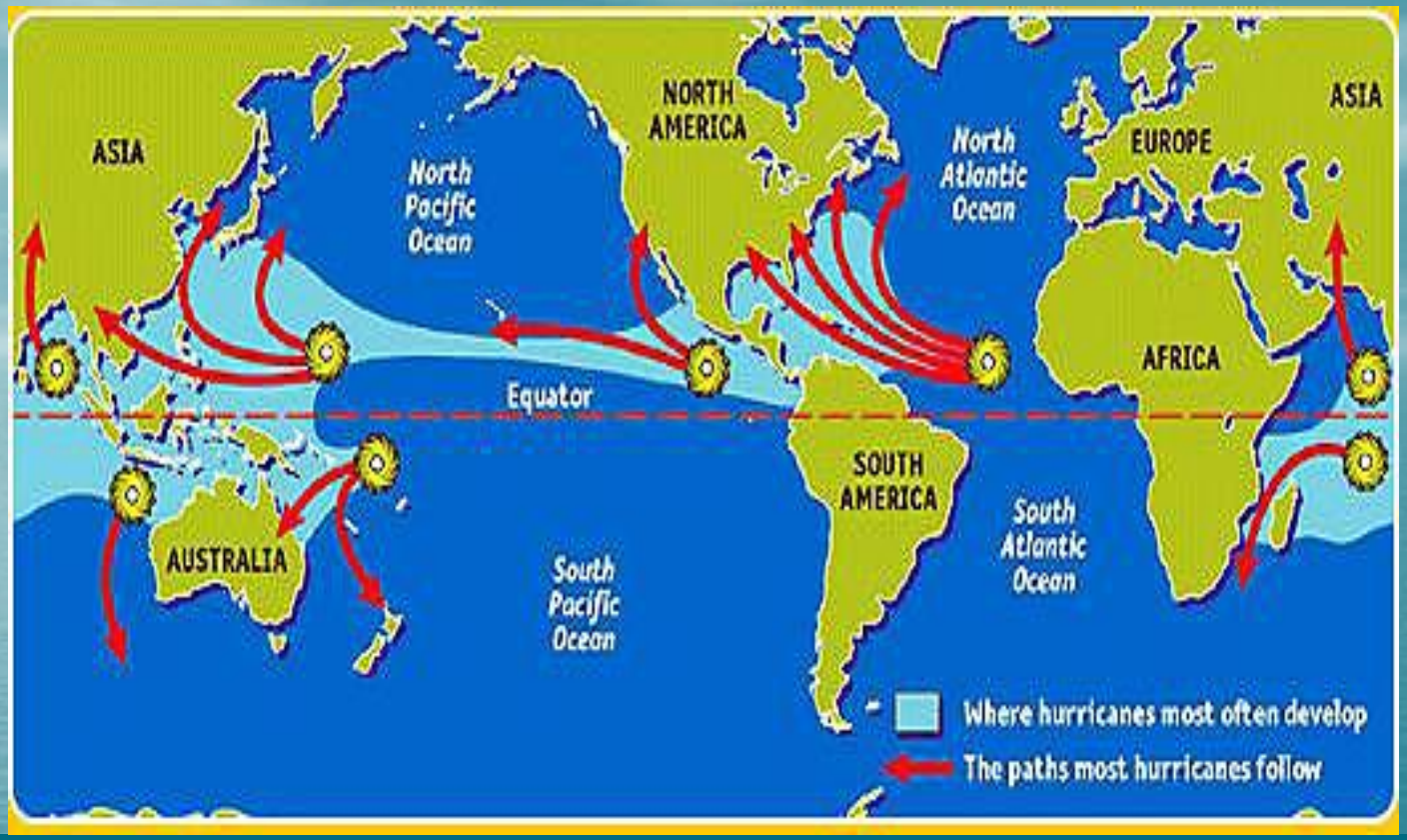
Resour

The Coriolis Force

Trade Winds

- The trade winds blow from east to west from 30º latitude to the equator in both hemisphere's.
- In the Northern Hemisphere, that means that the strong trade winds that originate in the northeast and blow westward pull the surface of the ocean along with them near the equator.

Trade Winds



- Thanks to the coastline and the Coriolis effect, the warm-water current then heads north, turning at about 30 degrees north latitude.
- The westerlies take over then, completing the circuit.

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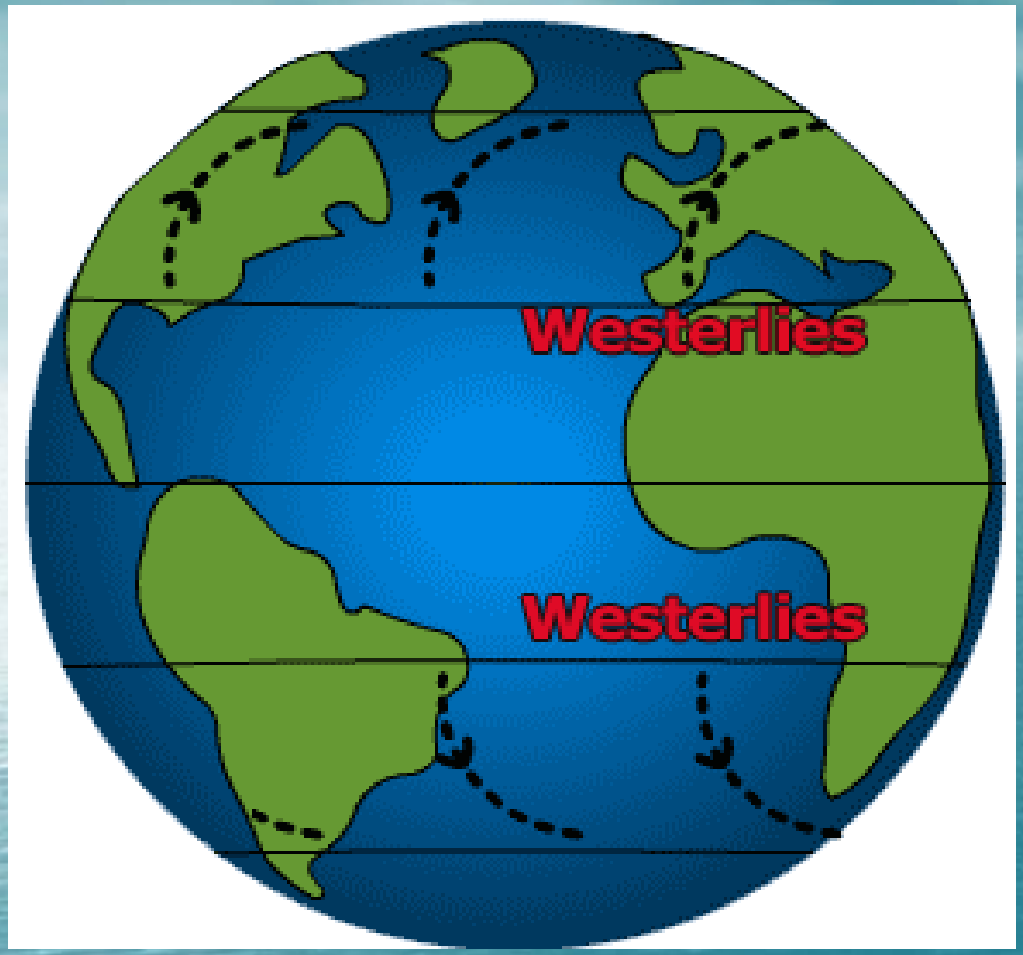
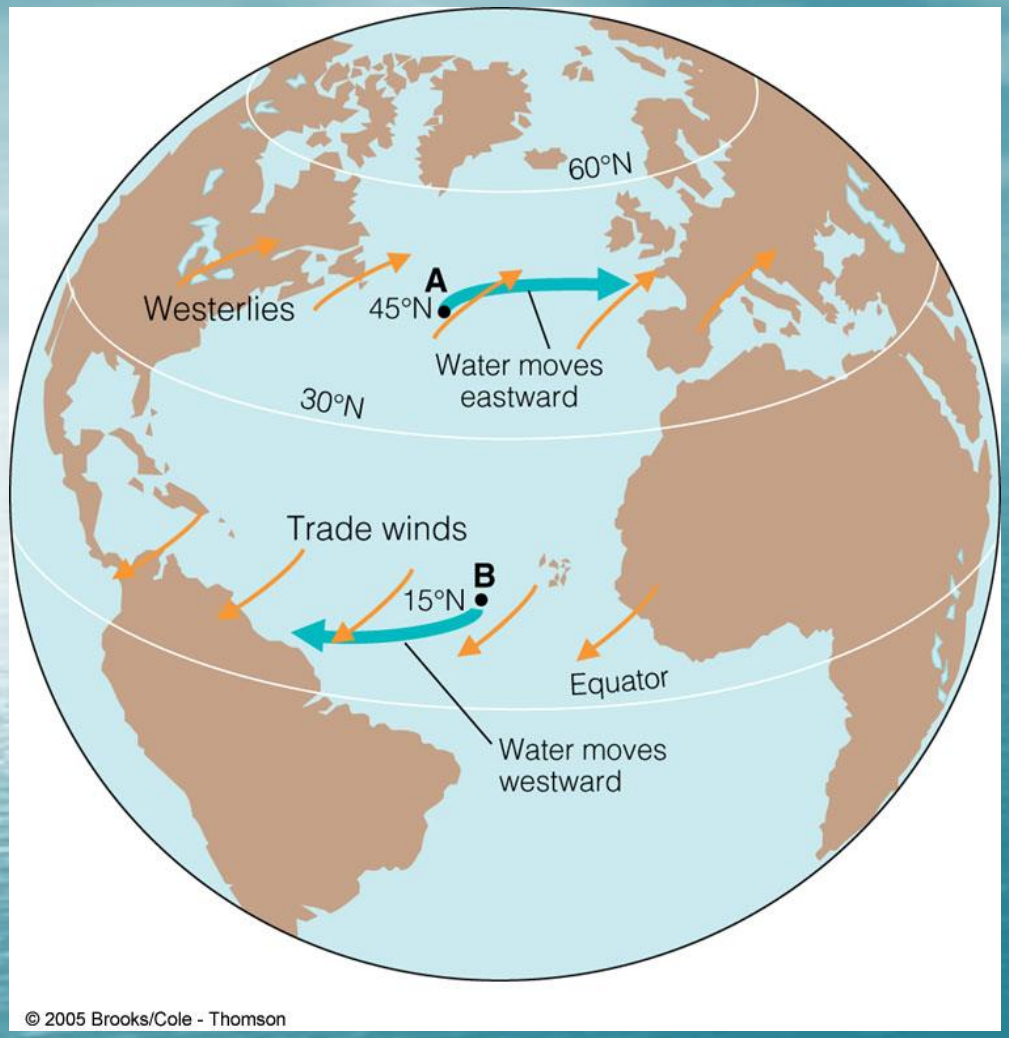
Resources



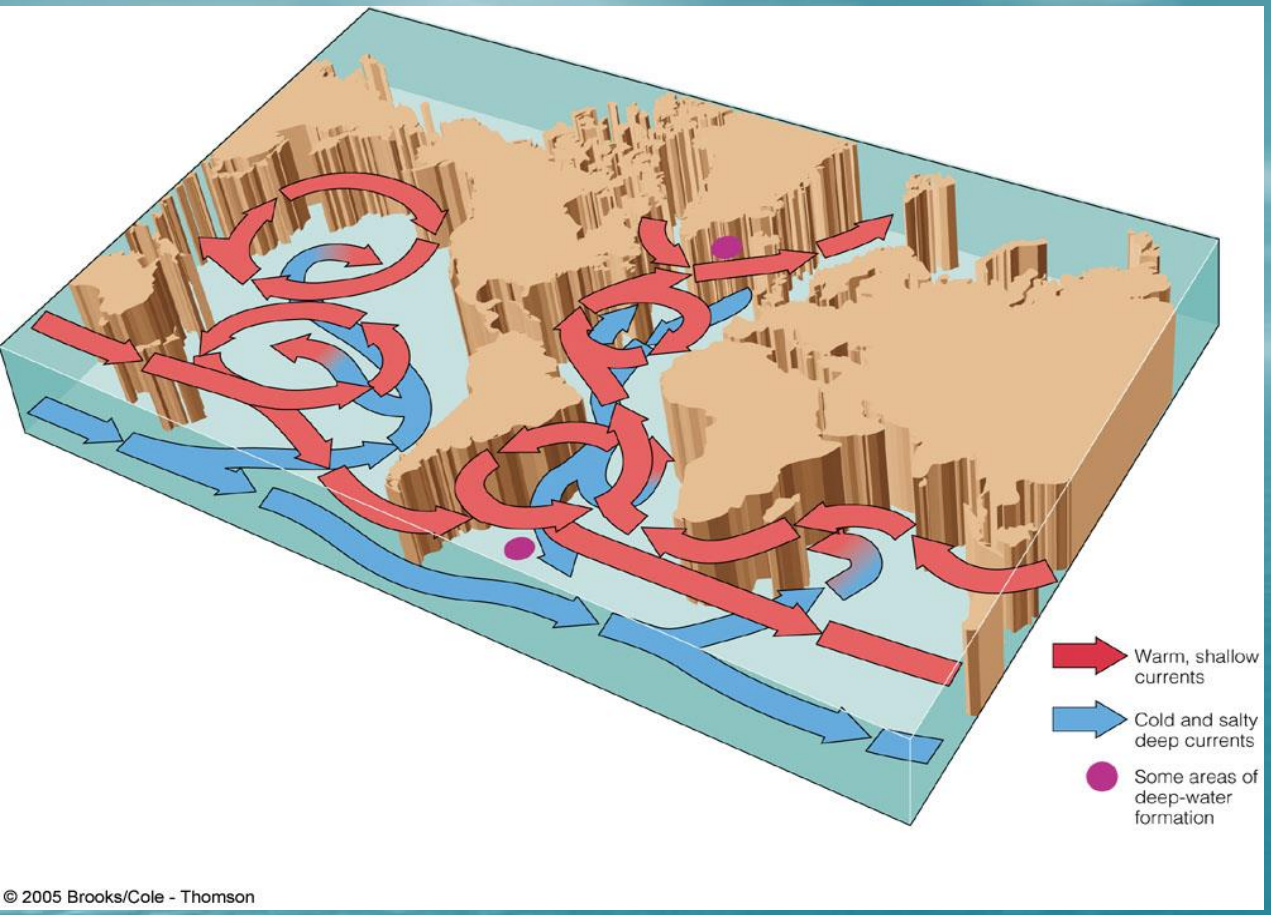
- The Westerlies blow from the west to the east between 30º and 60º latitude in both hemispheres, these winds guide the current eastward and south after they hit land.

The Westerlies



- These two wind patterns create a continual circular pattern of wind flowing clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere.

The Westerlies



- The continents are another major influence on surface currents because they act as barriers by deflecting them, much like a goalie in hockey or soccer, so that they can continue their circular path.

Continental Barriers

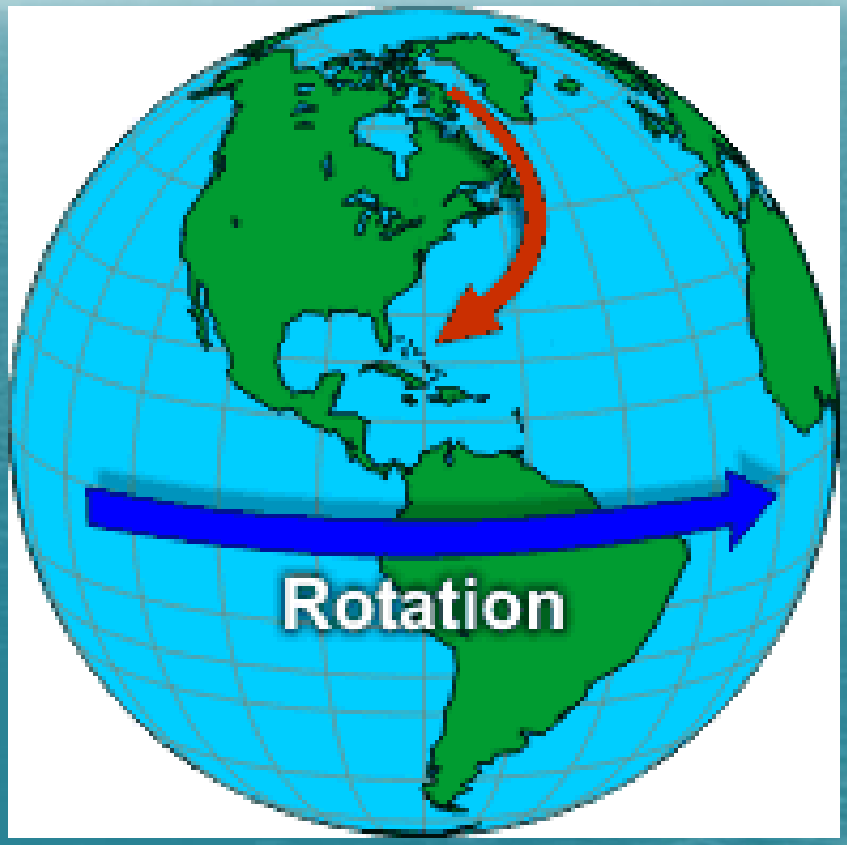
Gyre

- These circular wind patterns create spiral ocean currents called **gyres**.

Check for Understanding

- Draw a picture of the earth and using arrows describe how the Coriolis effects occurs in both the southern and northern hemisphere.

- Draw two arrows in each hemisphere.



Complete the chart.

What do you KNOW about ocean current?	What did you LEARN about ocean currents?	What QUESTIONS do you have about ocean currents?
1. 2. 3.	1. 2. 3.	1. 2. 3.

Lesson 2 Global Currents

- Every major ocean has 2 gyres except the Indian Ocean.
- In order to complete a gyre you need a major warm water current and a major cold water current.
- This means that each ocean has two warm-water equatorial currents that move in a westward direction and two cool water currents that complete the gyre.

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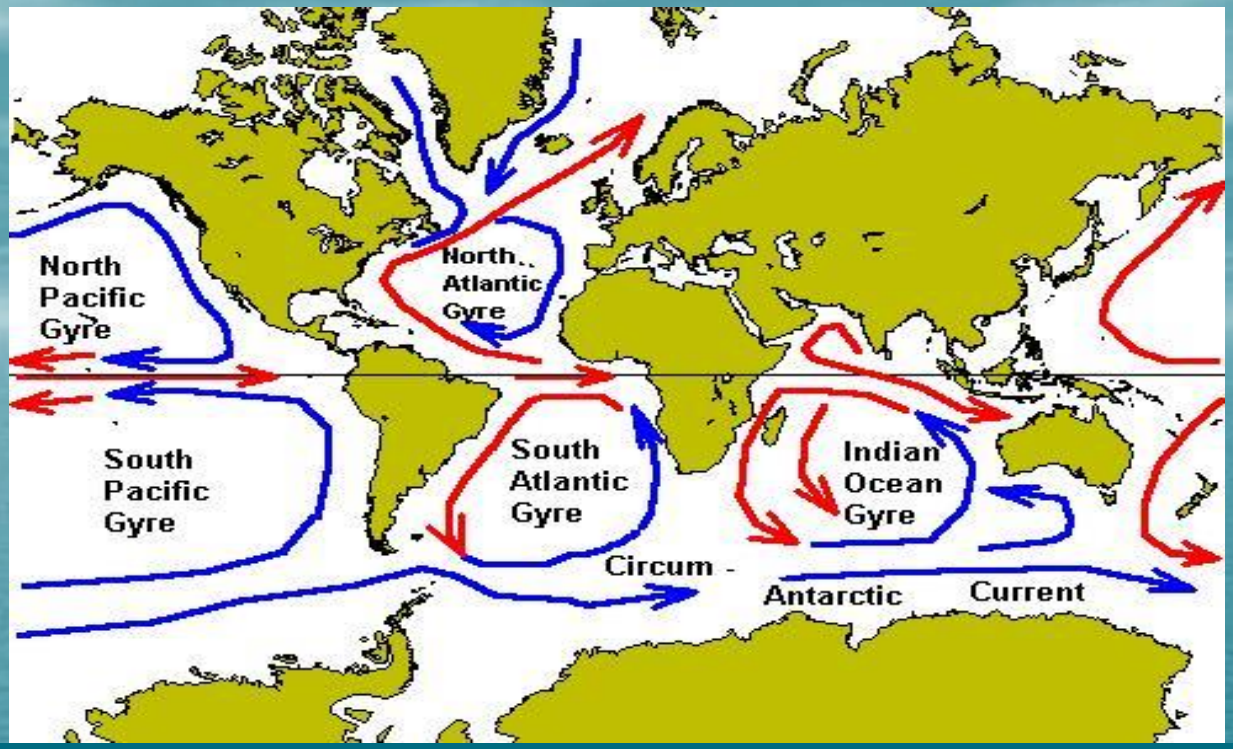
Gyre in the North Hemisphere



- Because of surface winds, continental barriers and the coriolis effect there are two major gyres north of the equator.

- Both of these gyres, the Pacific and Atlantic rotate in a clockwise fashion.

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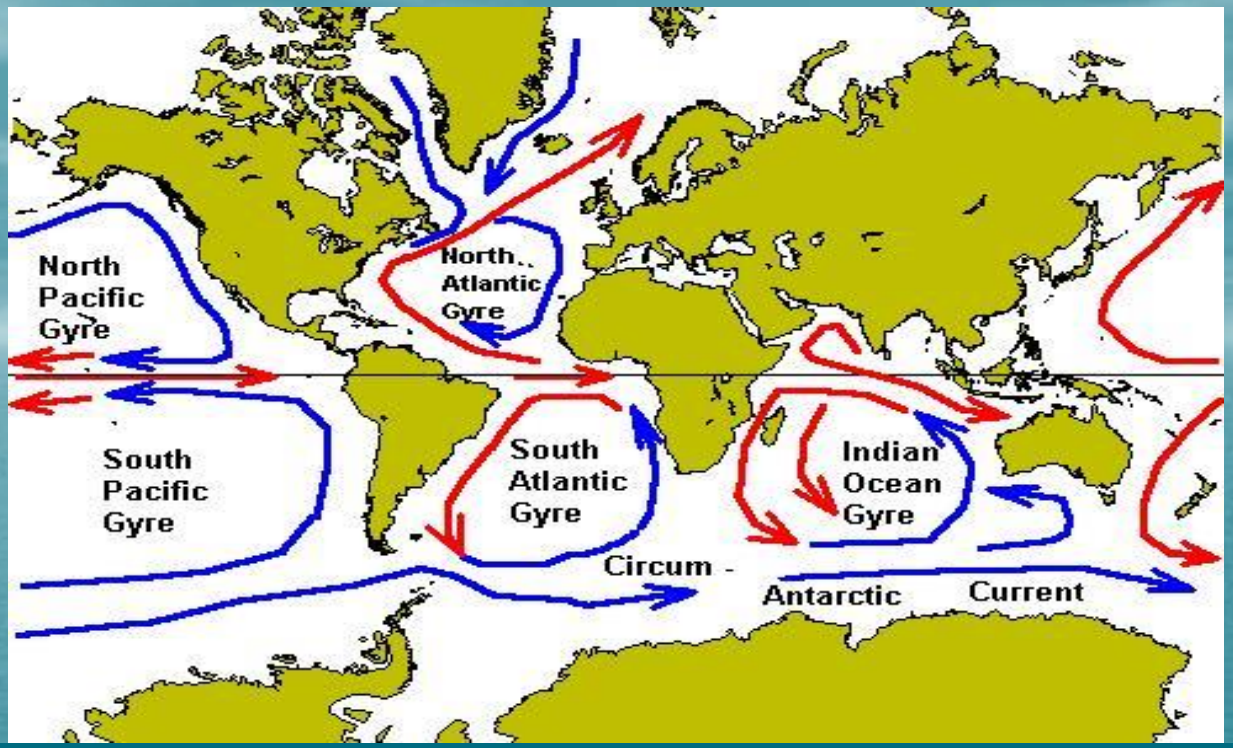
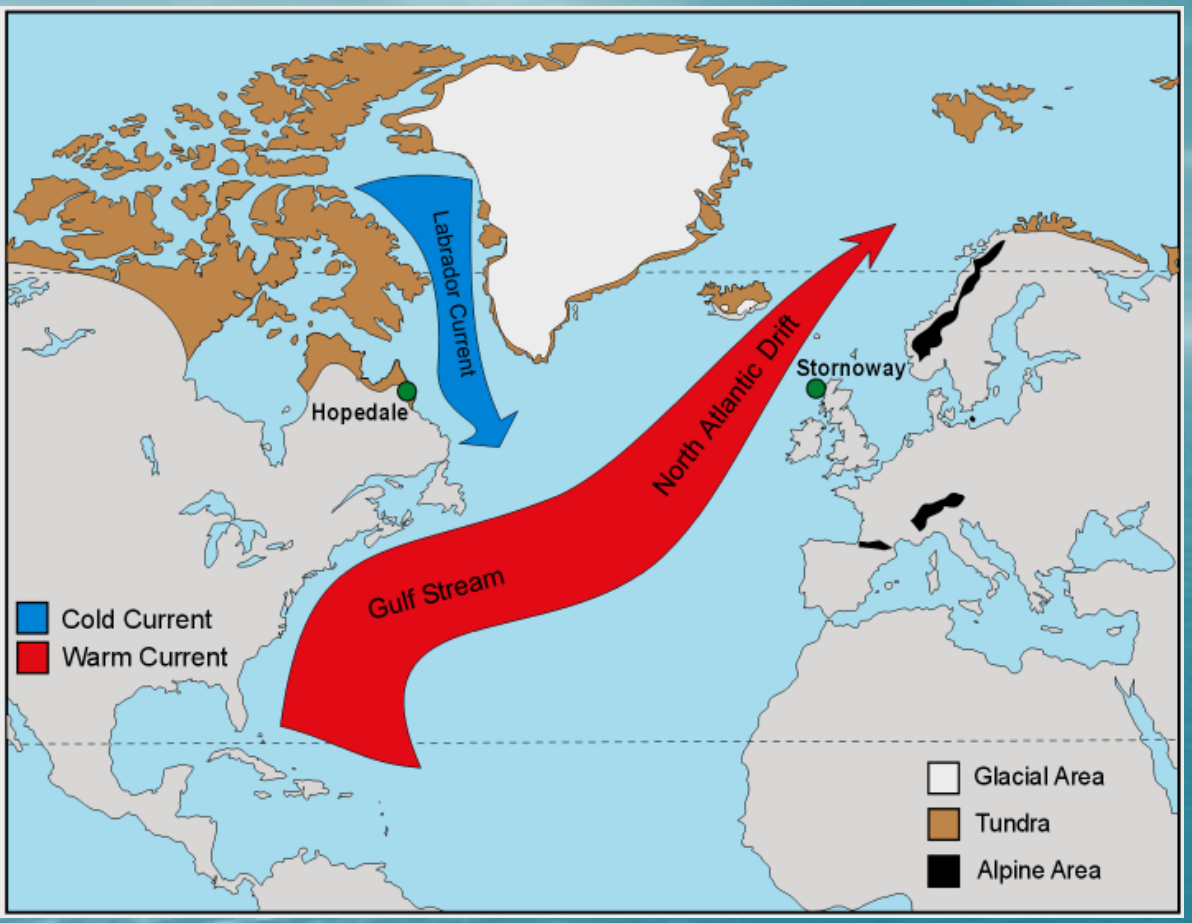
Gyre in Hemisphere's

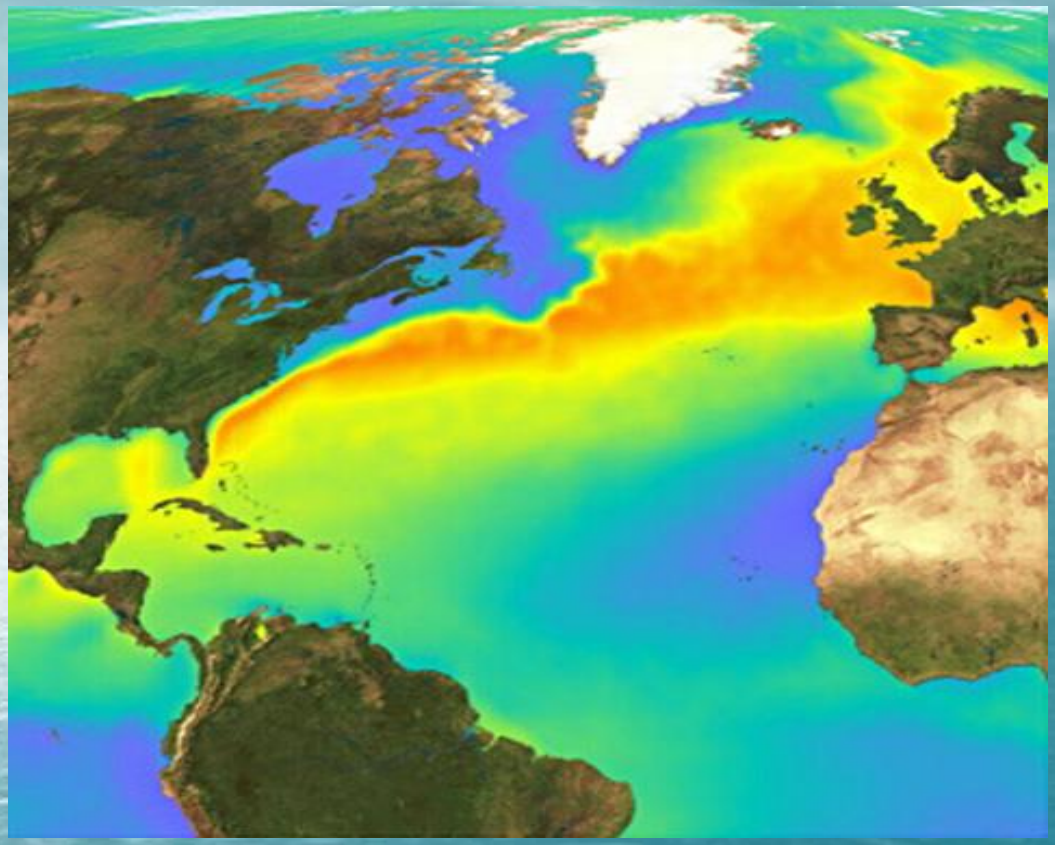


- There are 3 major gyres in the southern hemisphere because of the Indian Ocean.
- Because of the surface currents, continental barriers and coriolis effect these gyres rotate in a counter-clockwise fashion.



- The swift, deep, and warm Atlantic current that flows along the eastern coast of the United States toward the north is called the Gulf Stream.
- Speed: 5.6 MPH
- Wind – Trade Wind

North Atlantic Gyre



- The Gulf Stream is the second strongest current in the world.

North Atlantic Gyre

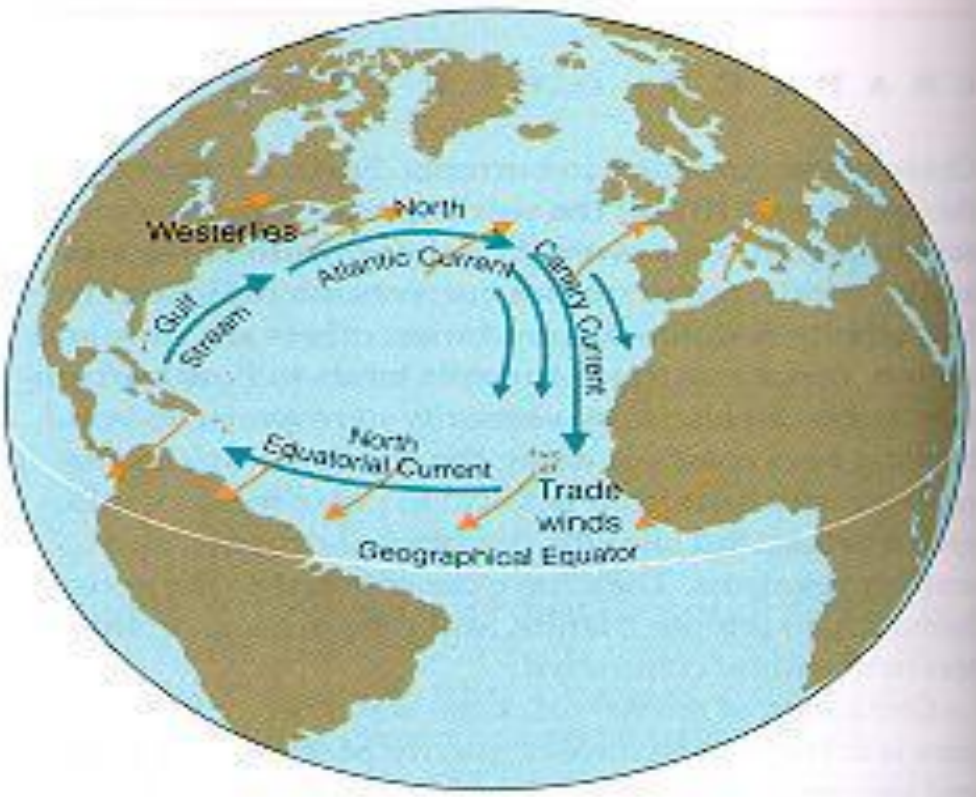


Figure 9.3 The North Atlantic gyre, a series of four interconnected currents with different flow characteristics and temperatures.

- The cold Canary Current combines with the Gulf Stream current to form the North Atlantic Gyre.
- Speed: 500 yd/h
- Wind: Westerlies

North Atlantic Gyre

End Of Slide

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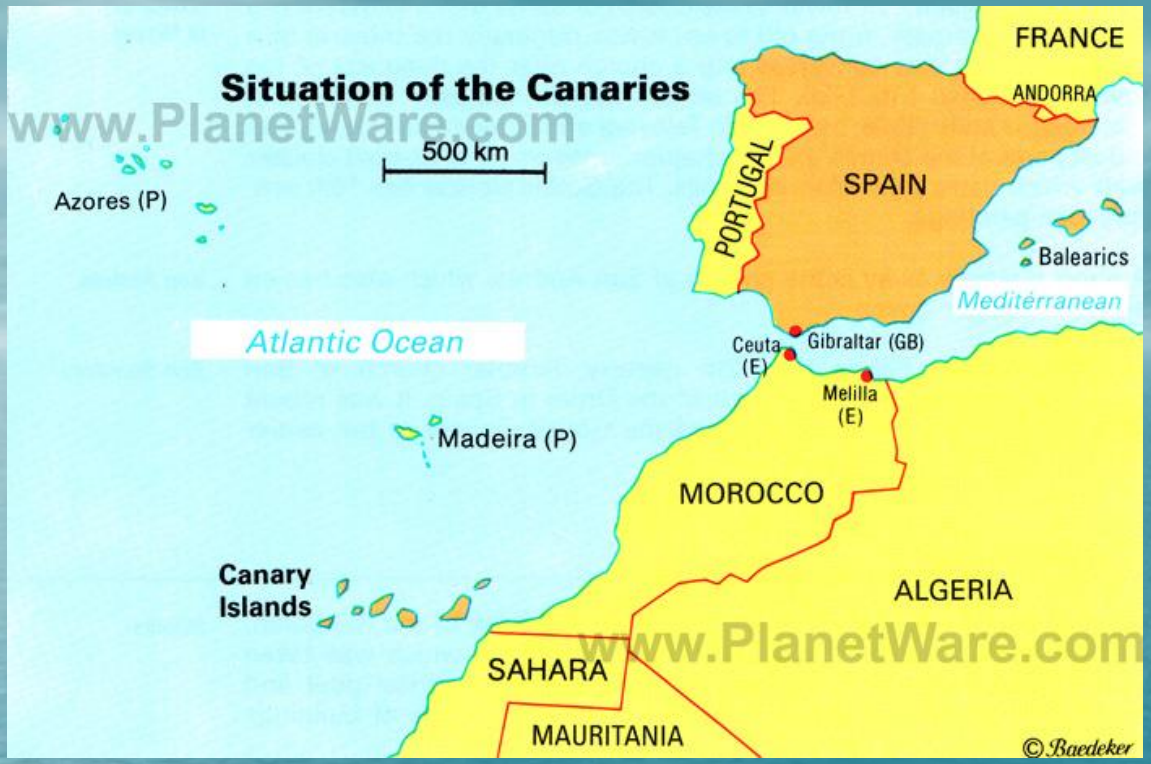

- The current is named after the Canary Islands archipelago (chain or cluster of islands).

North Atlantic Gyre

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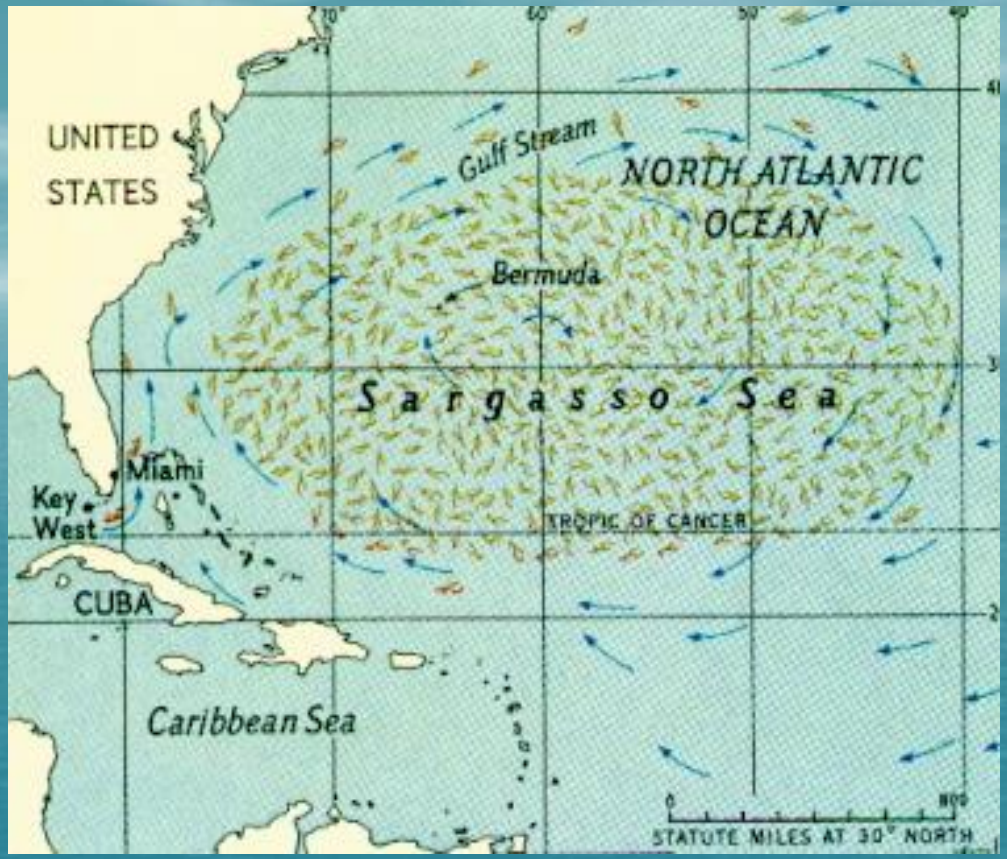
- At the center of the North Atlantic gyre lies a vast area of calm, warm water called the *Sargasso Sea* (named after seaweed).



Sargasso Sea

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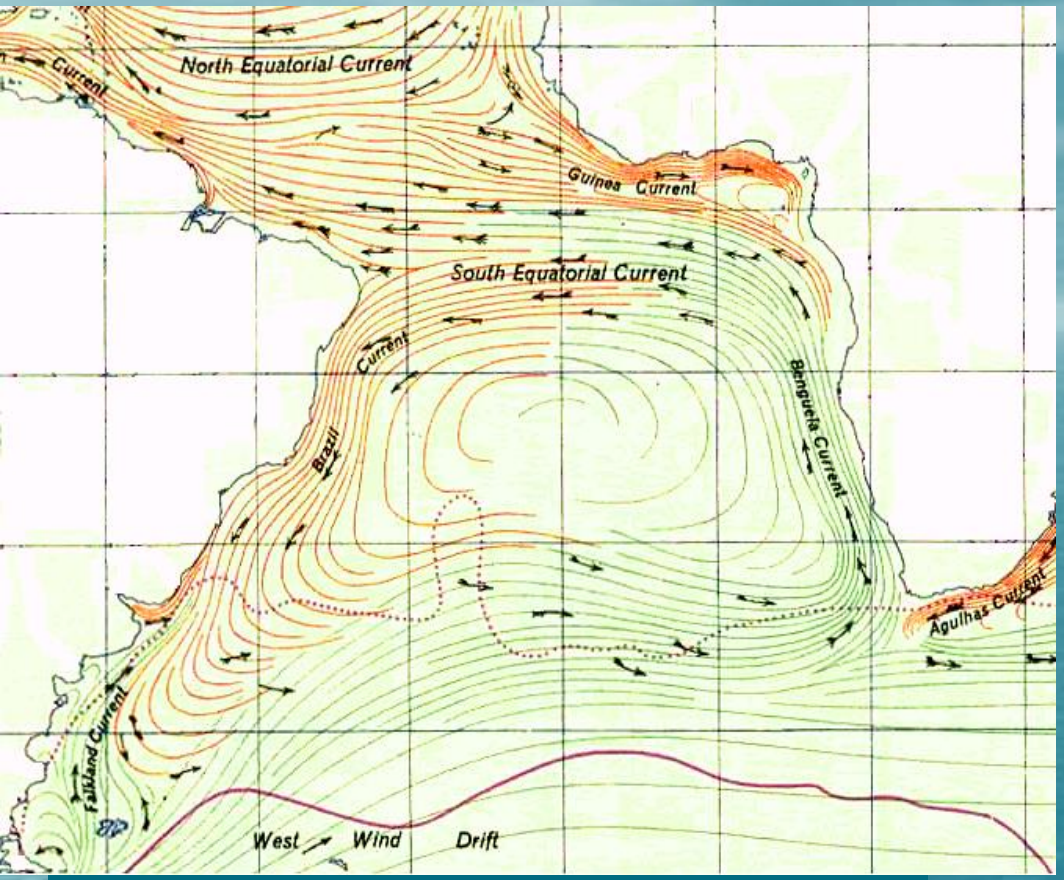

South Atlantic Gyre

- The South Atlantic Gyre has a southern flowing warm Brazil current which is weaker then the Gulf Stream due to its depth.
- The cool north flowing Benguela current that runs along Africa completes the counter-clockwise South Atlantic Gyre.

- The dense, highly saline water of the Mediterranean Sea forms a deep current as it flows through the strait of Gibraltar and into the less dense Atlantic Ocean.

Mediterranean Sea

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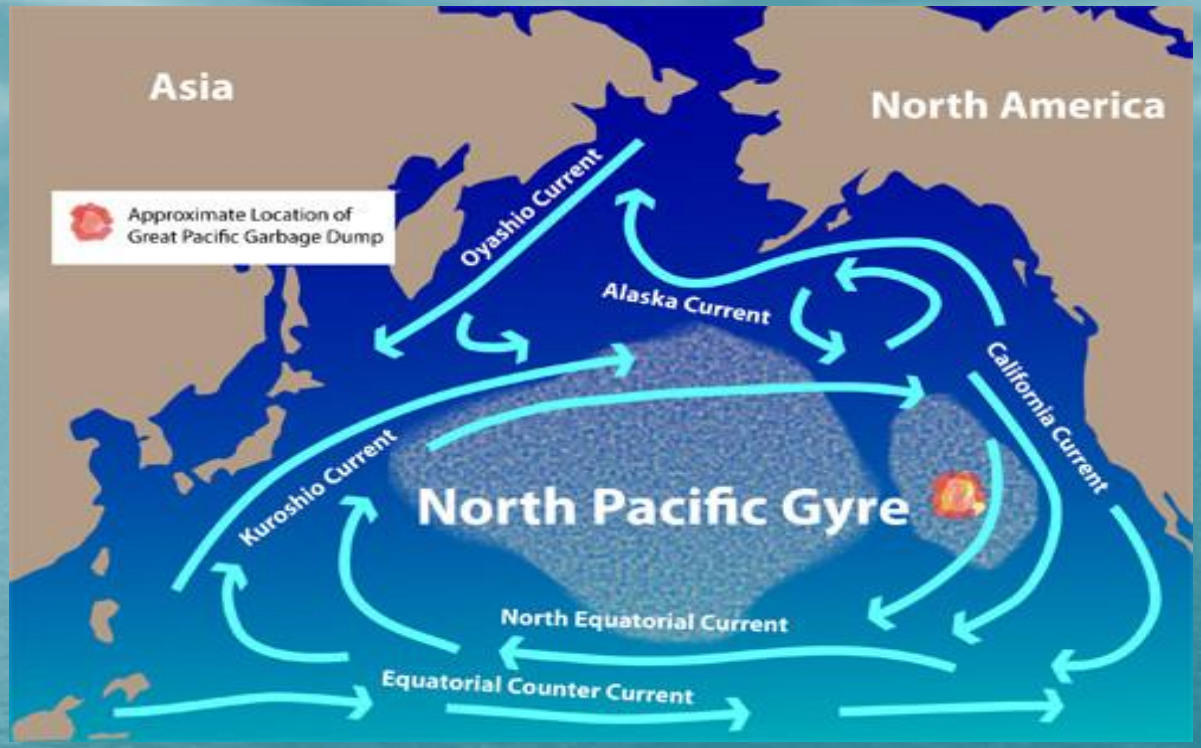
North Pacific Gyre



- The patterns of currents in the North Pacific is similar to that in the North Atlantic.
- The warm Kuroshio Current, the Pacific equivalent of the Gulf Stream, flows clockwise and northward along the east coast of Asia.

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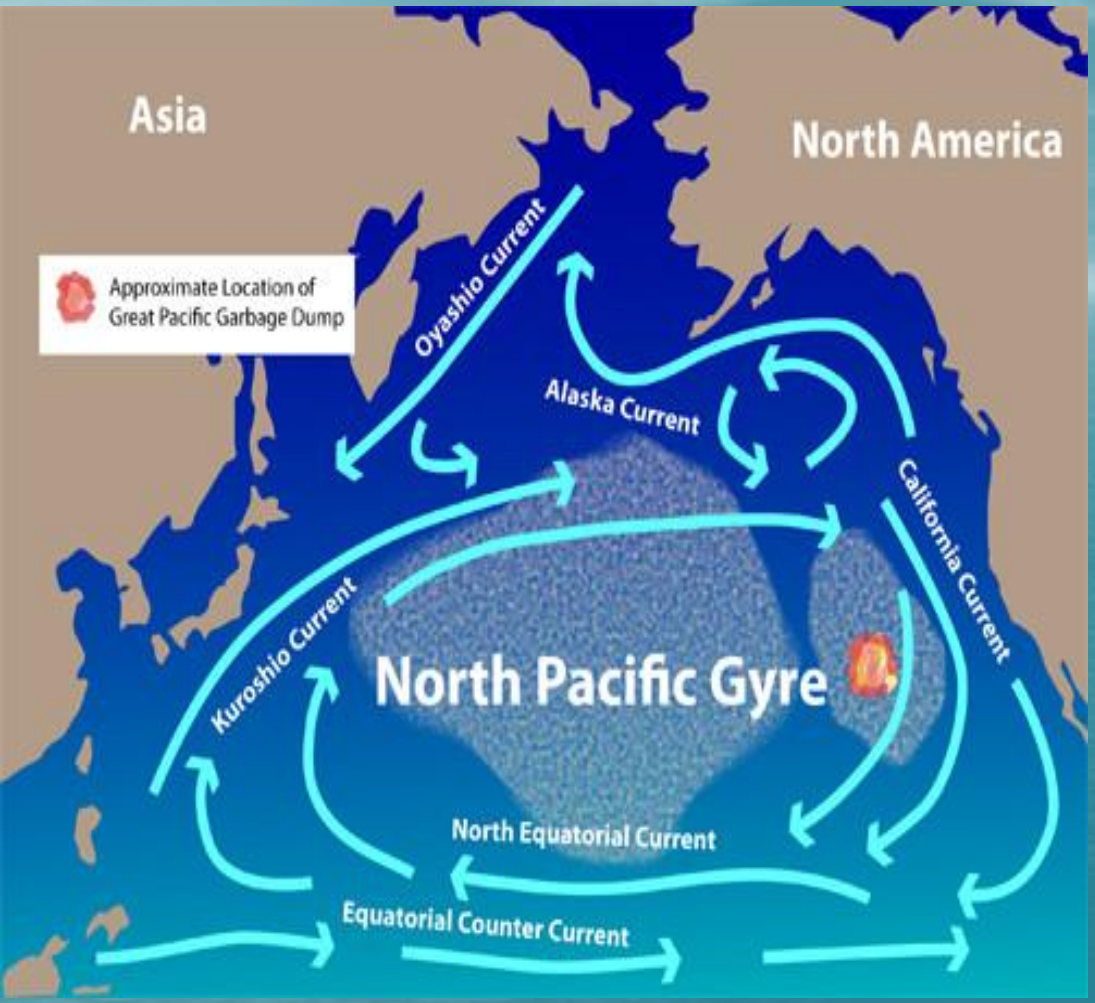
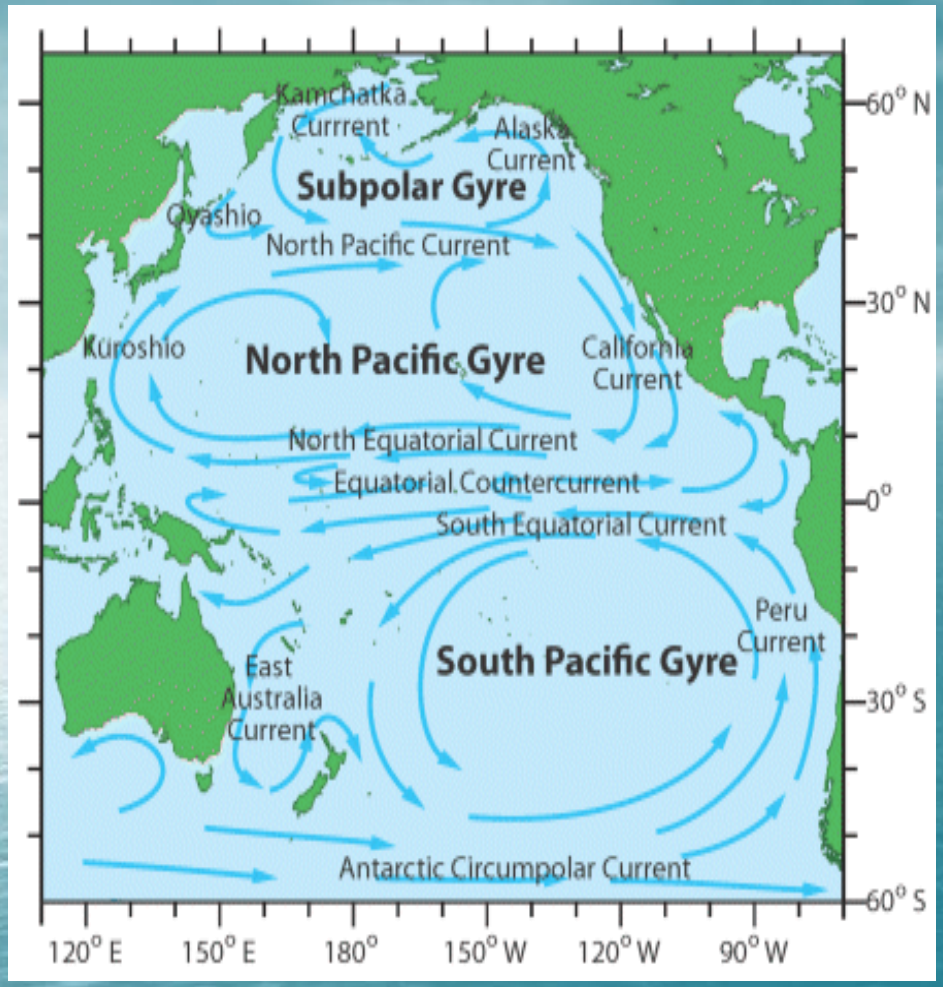


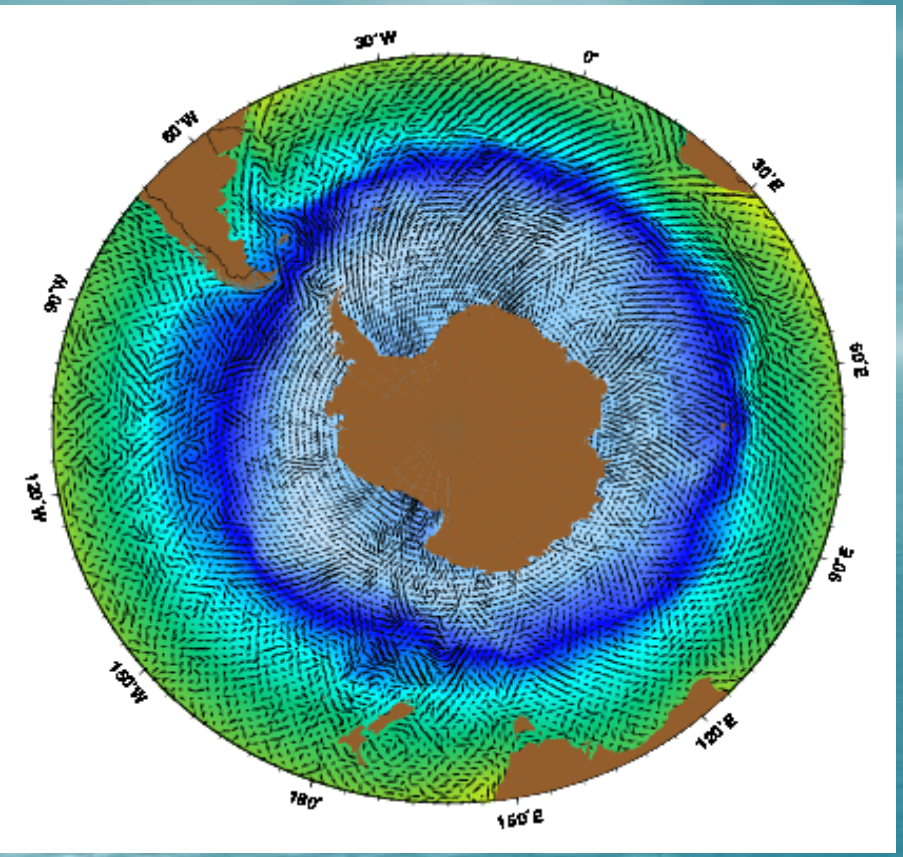
- The northern Pacific gyre is completed by the southward flowing cold California Current.

North Pacific Gyre



The South Pacific Gyre

- The East Australian Current (EAC) is an ocean current that moves warm water in a counter-clockwise fashion down the east coast of Australia.
- The South Pacific gyre is completed by the cooler Peru current.



- The Antarctic Circumpolar Current (ACC) is the strongest current on our planet and the only current that flows completely around the globe.
- The ACC transports more water than any other current and is home to Cape Horn which has the world's roughest seas.

The Antarctic Circumpolar Current - (ACC)

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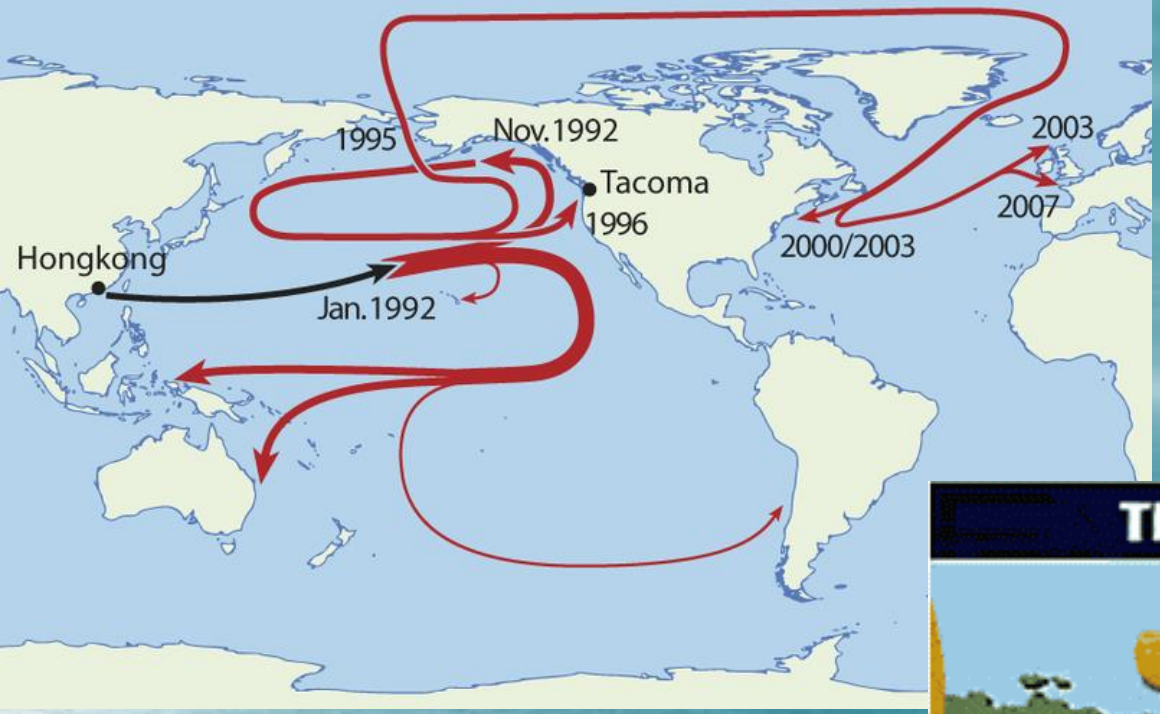

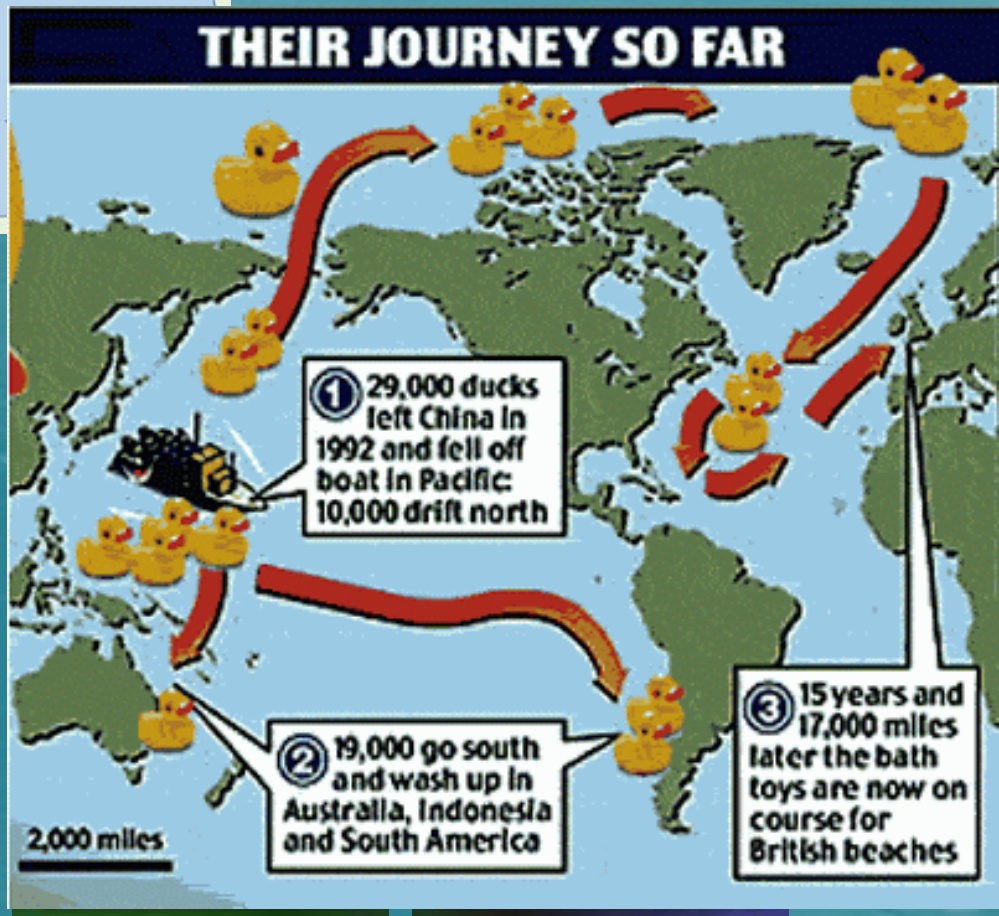

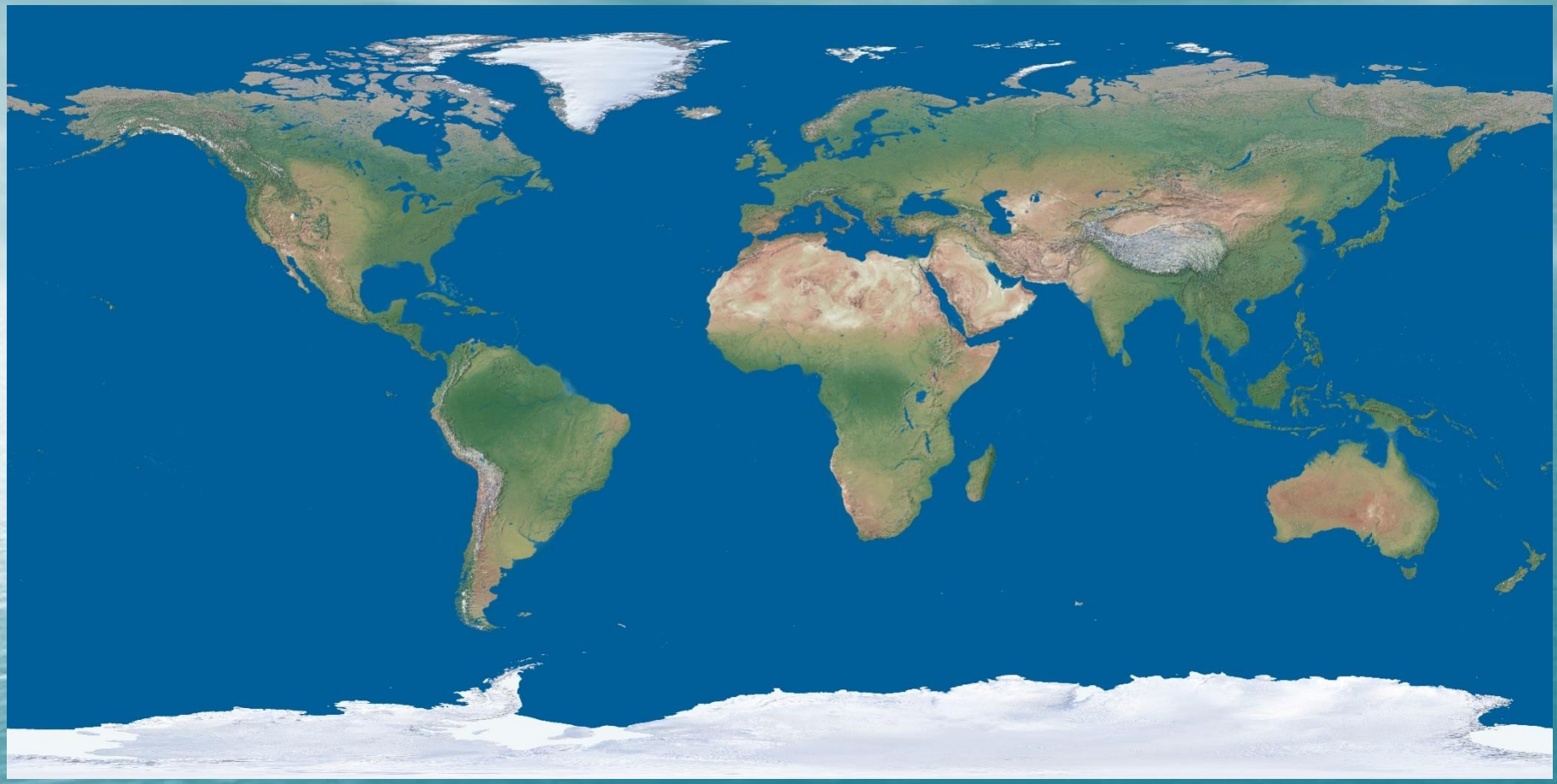

Assignment

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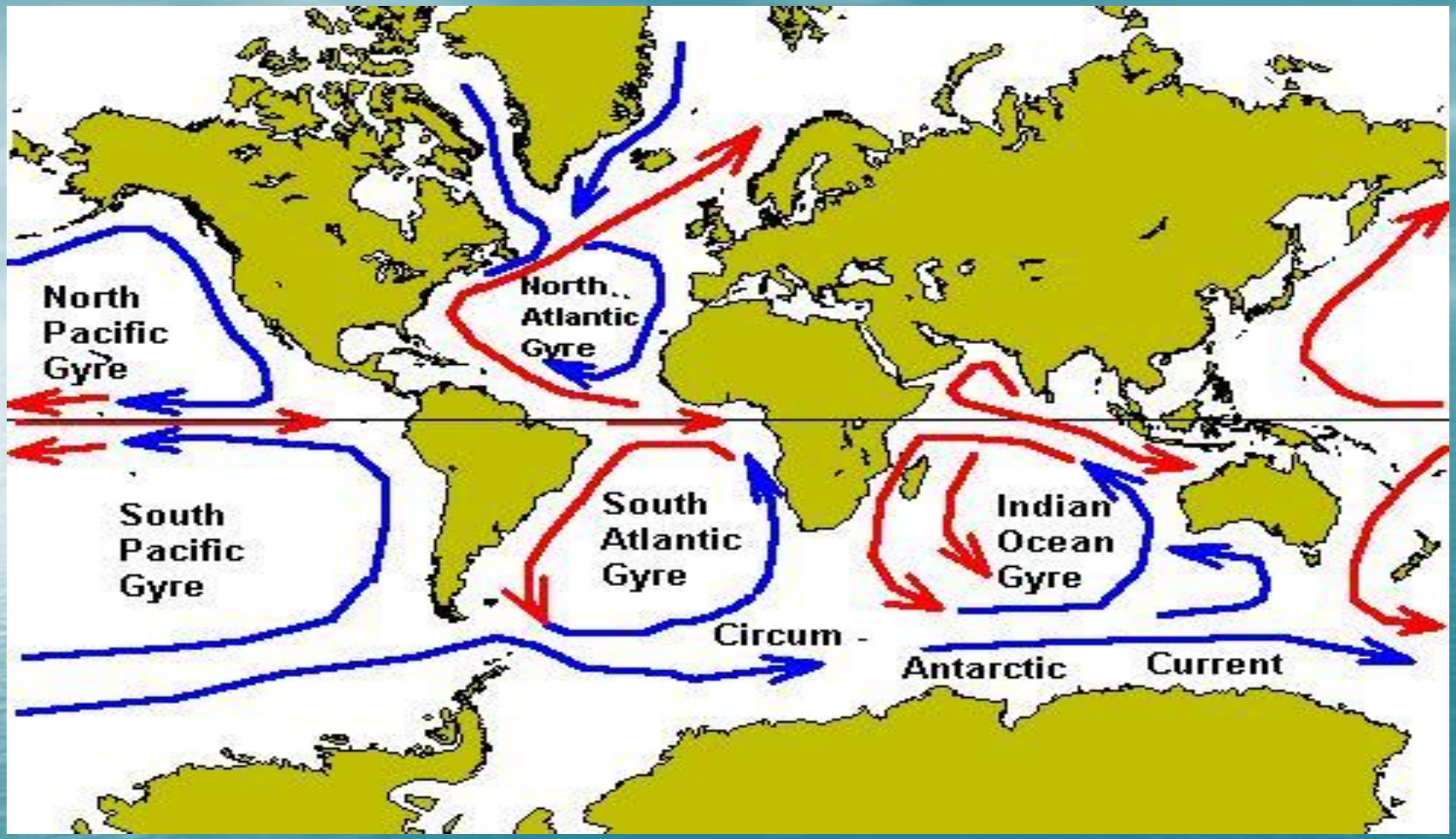

Assignment

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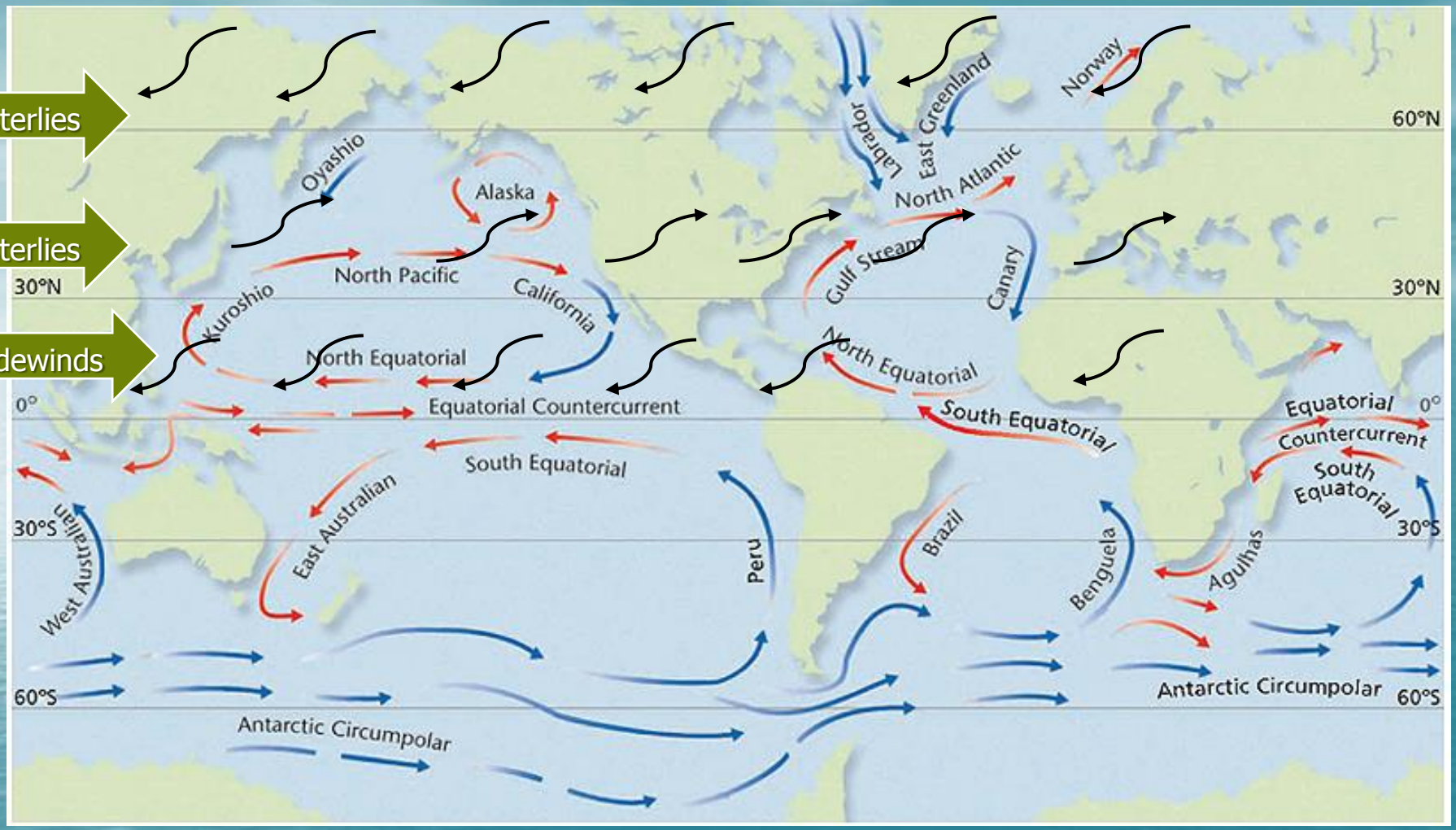

Answer Sheet

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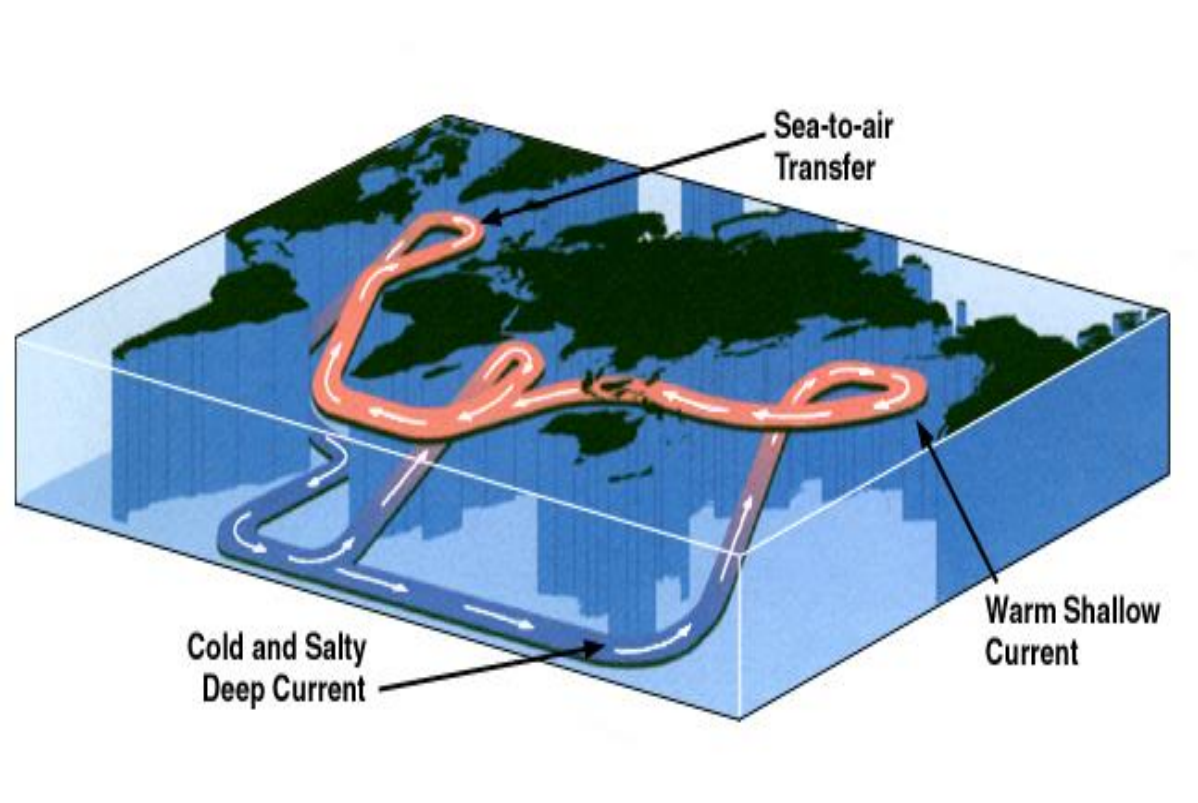
Resources

Complete the Chart

What do you KNOW about ocean current? 1. 2. 3.		

Lesson 3 - Deep Currents

NASA 1:24
Density 2:12



- **Deep current** are streamlike movement of ocean water far below the surface
- These waters make up the other 90% of the ocean.

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Global Conveyer Belt

- The deep-water current is known as the global conveyor belt or Thermohaline circulation.
- The GCB is driven by density differences in the water.

End Of Slide

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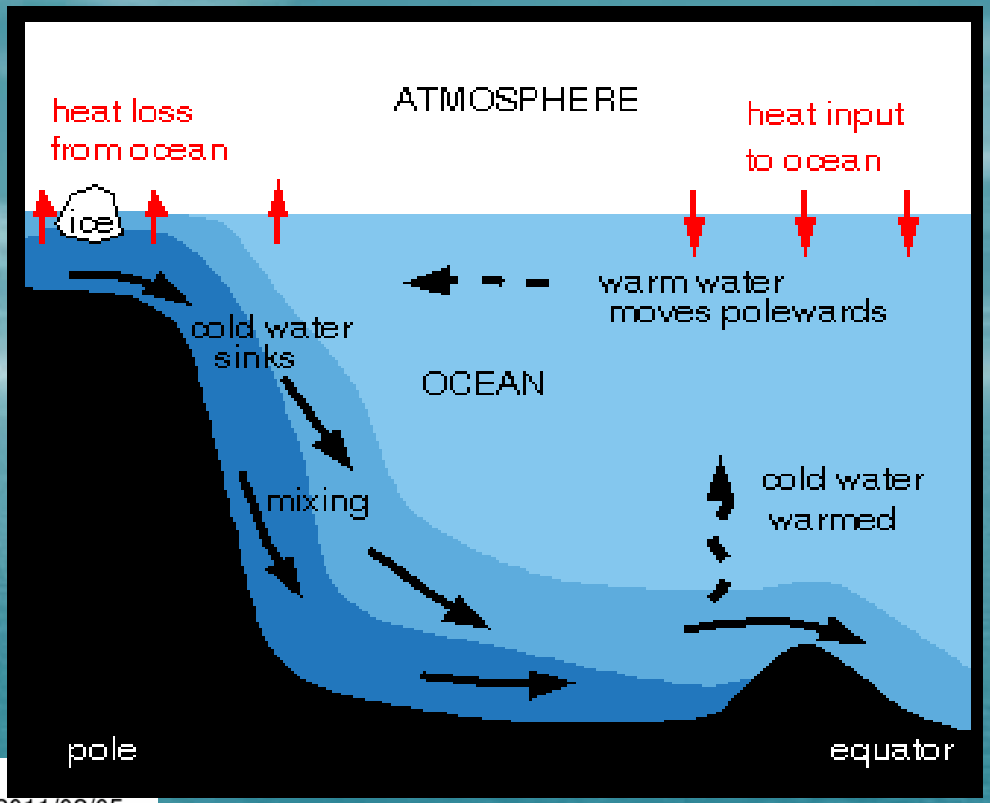
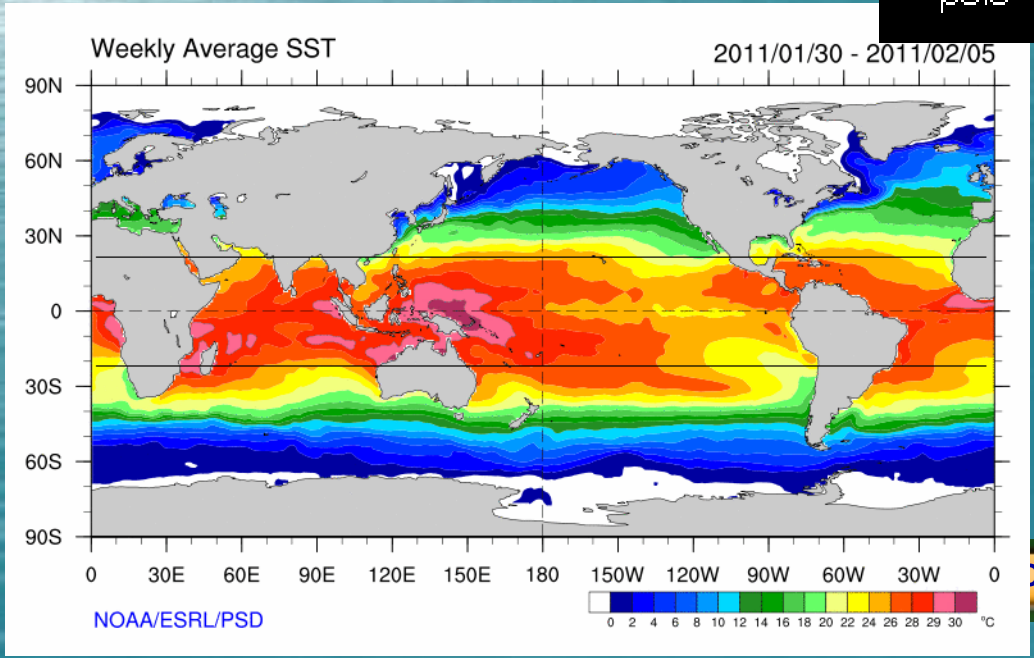
- Surface water is made denser by the removal of heat and freshwater.
- Because of this, the water then sinks.





How Density Drives the Ocean Current

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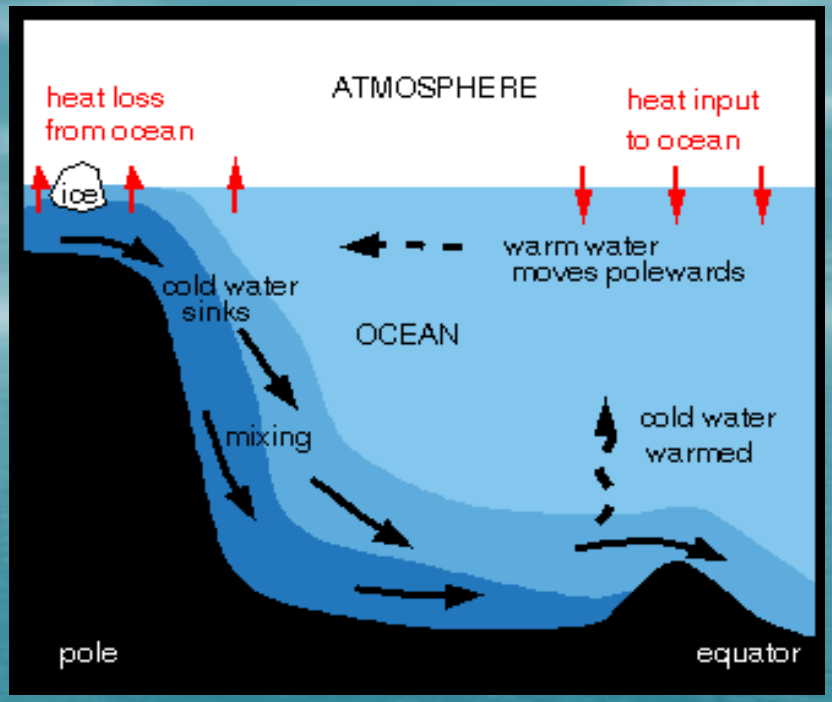
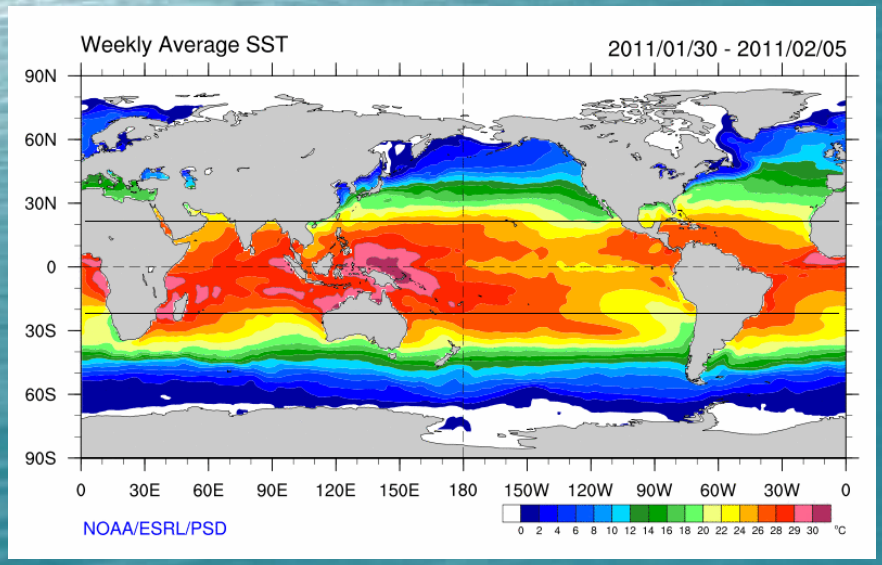
- As the water descends to the ocean floor, water moves in to replace it , creating a current.





How Density Drives the Ocean Current

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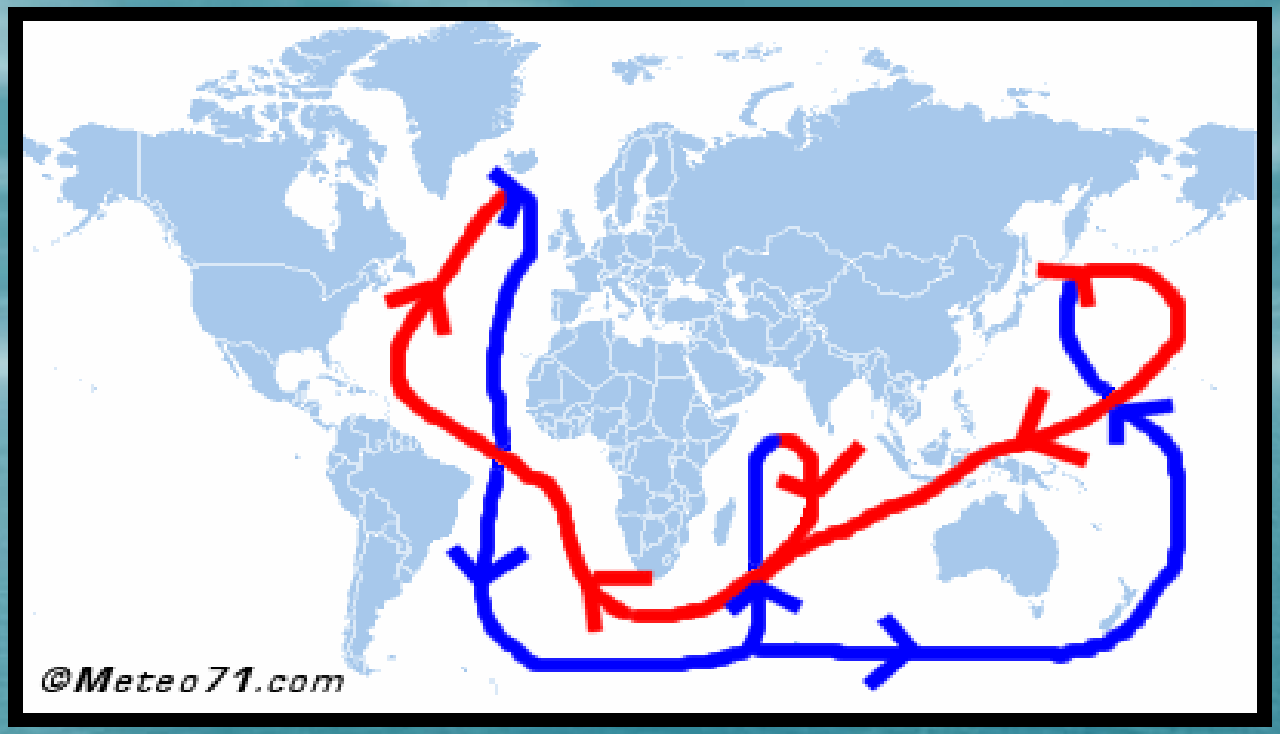
How Density Drives the Ocean Current



- The new water also gets cold and sinks, continuing the cycle.
- This process drives the Thermohaline current around the globe.

The Global Conveyer Belt

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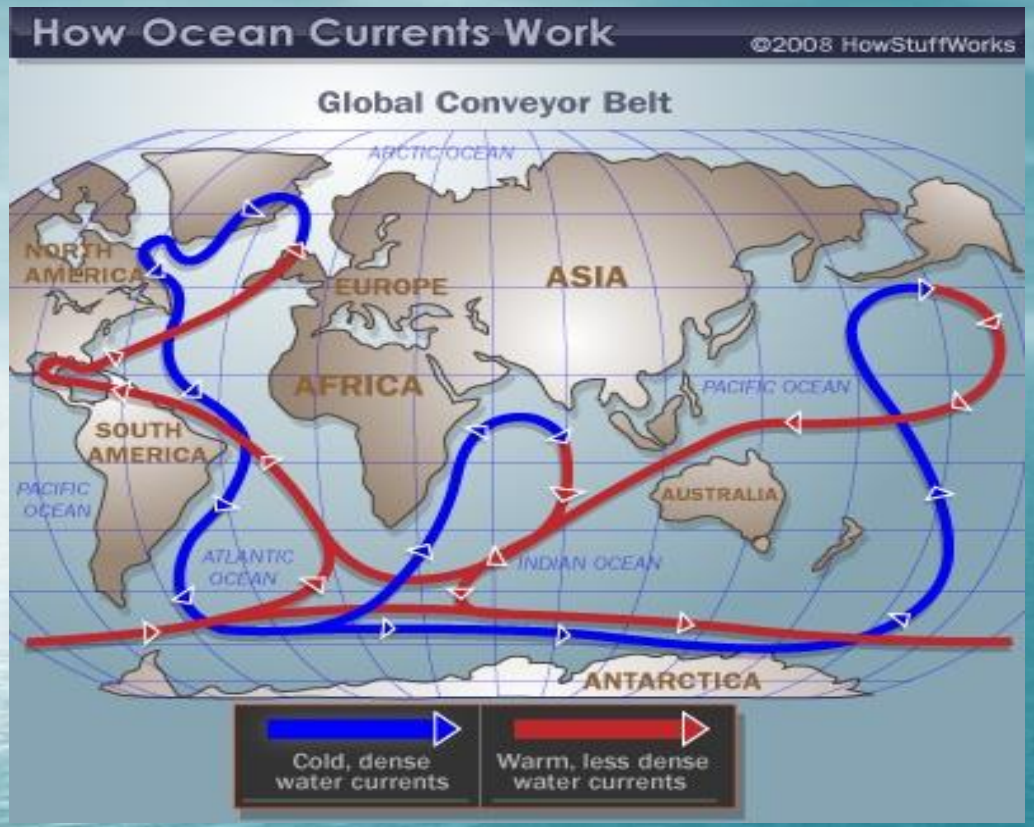
Resources

Check for Understanding

Using your knowledge of the following topics describe how the two concepts are related.

1. Density and Thermohaline circulation

Write using complete sentences and a minimum of 3 sentences.



- Deep Currents GCB moves at a few centimeters per second.
- Surface currents move at tens or hundreds of centimeters per second.

Speed of the Global Conveyer Belt

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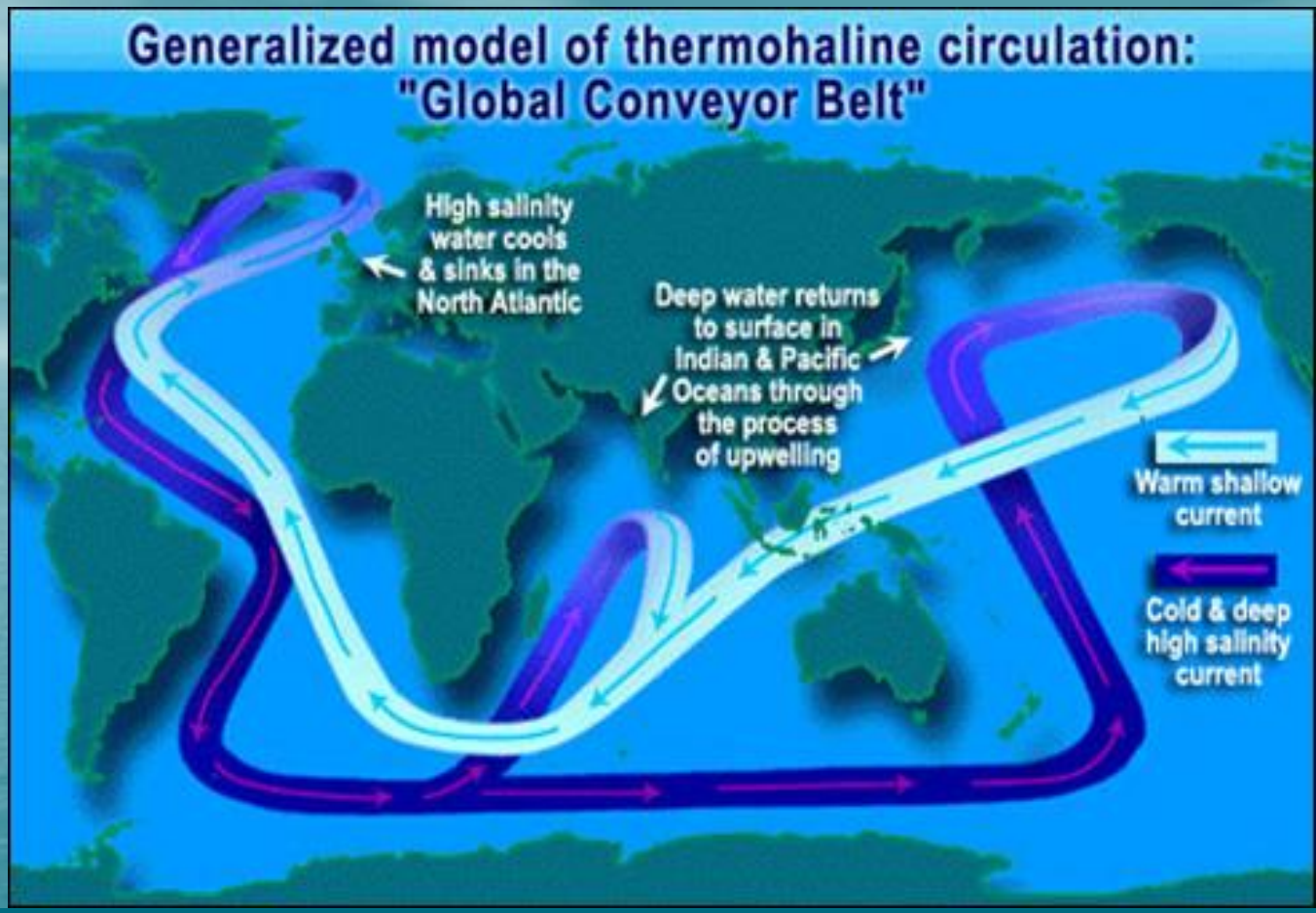
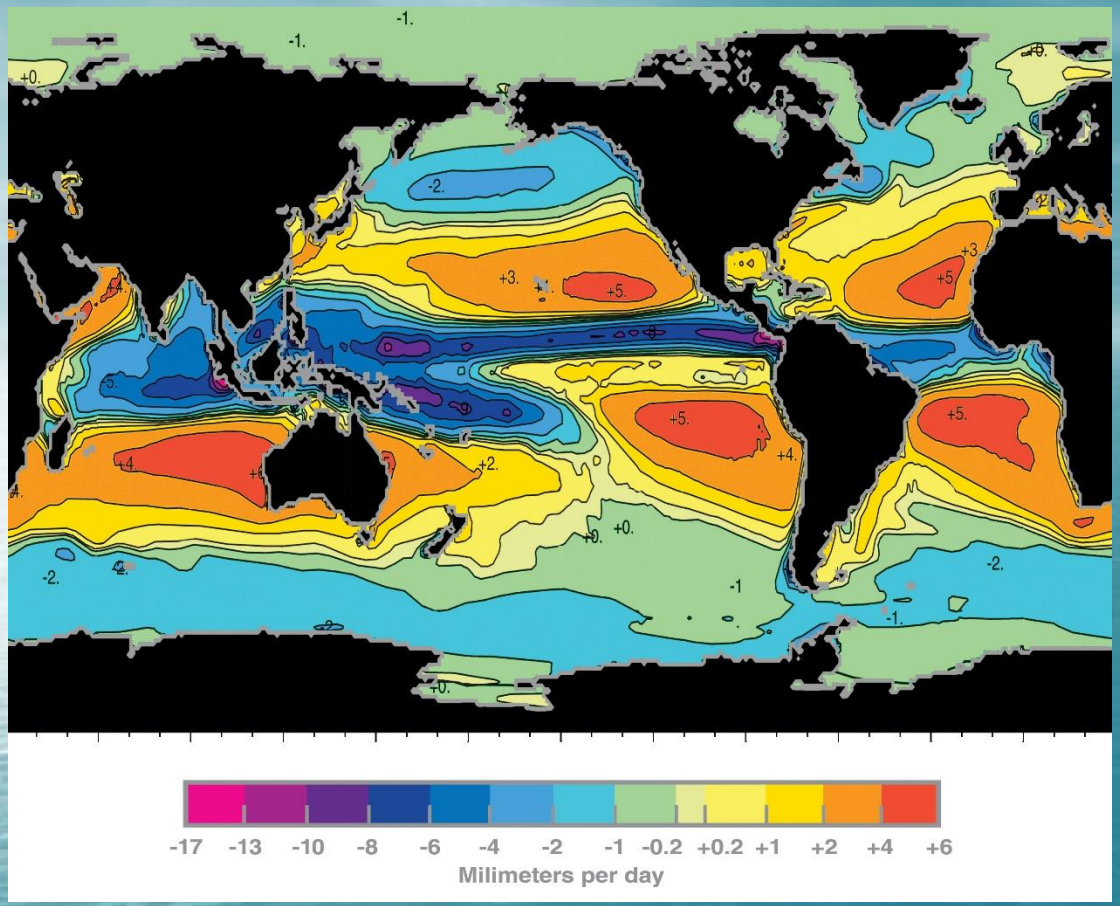
Global Conveyor Belt's Effect on Food Chain



- The global conveyor belt is crucial to the base of the world's food chain.

Global Conveyor Belt's Effect on Food Chain

- As it transports water around the globe, it enriches nutrient-depleted surface waters by carrying them through the ocean's deeper layers where those elements are abundant.



Global Warming

- Many scientists fear that global warming could affect the thermohaline circulation.
- If global warming leads to increased rain, the added fresh water could decrease the salinity levels at the poles.

Effects of Global Warming

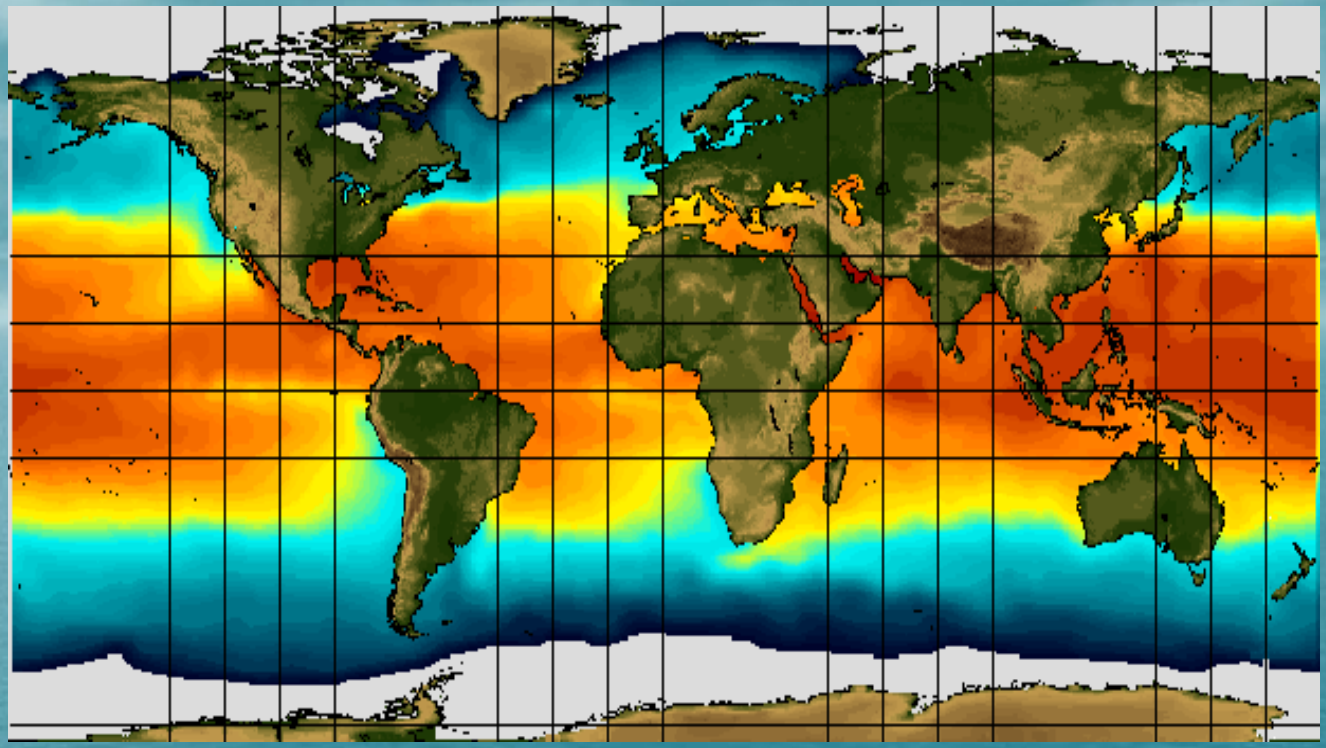
- Melting ice, another possibility of global warming, would also decrease salinity levels.
- Warmer, less dense water won't be dense enough to sink, and the global conveyor belt could stop.

Effects of Global Warming

- Not only would circulation be stopped but the carbon sink would be exposed by this melting water.
- According to newer scientific studies, the ability of oceans to soak up atmospheric carbon dioxide is being hampered by climate change.

Oceans role in Climate

Inconvenient truth



- The ocean current's have a significant role in governing climate.
- The surface layers store heat energy from the Sun and the currents help mix heat and salinity levels between the extreme oceans on our planet.

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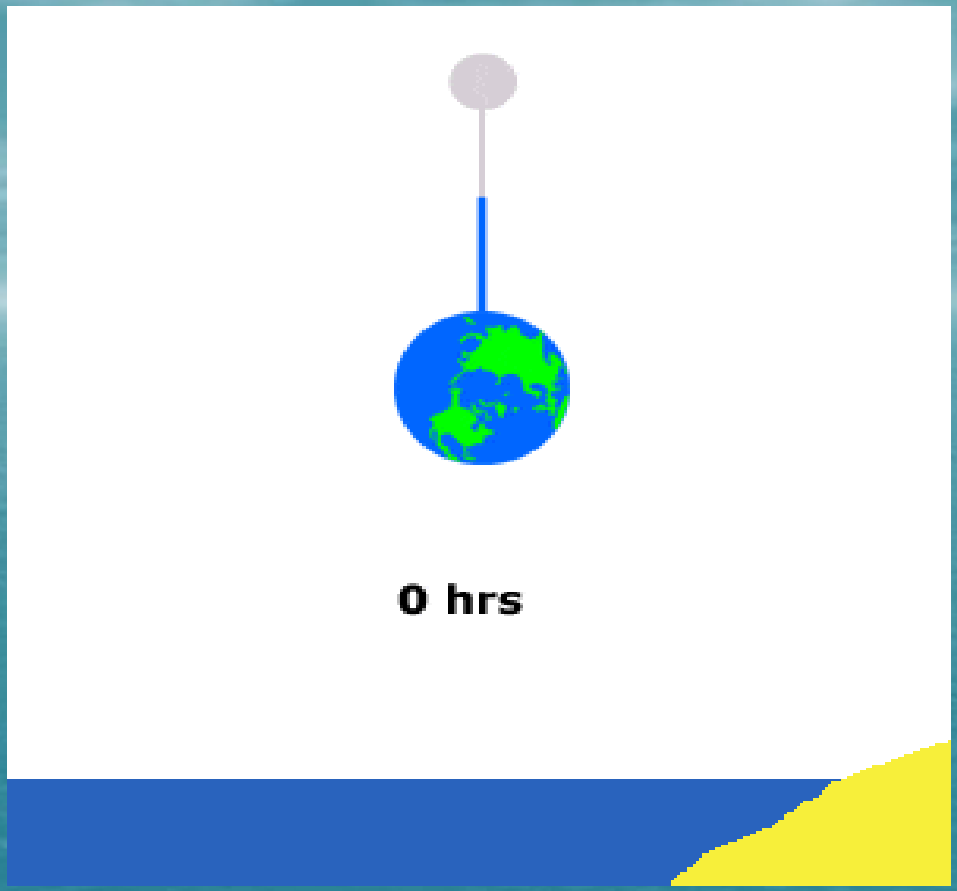
Complete the Chart

What do you KNOW about ocean tides?	What did you LEARN about ocean tides?	What QUESTIONS do you still have about ocean tides?
1.	1.	1.
2.	2.	2.
3.	3.	3.

Lesson 4 - Tides

- Ocean tides refer to the periodic rise and fall of the water level in the oceans and other large bodies of water

- High tide is when the water level is highest before it starts to fall again.
- Low tide is when the water level is lowest before it starts to rise again.



Tidal Differences

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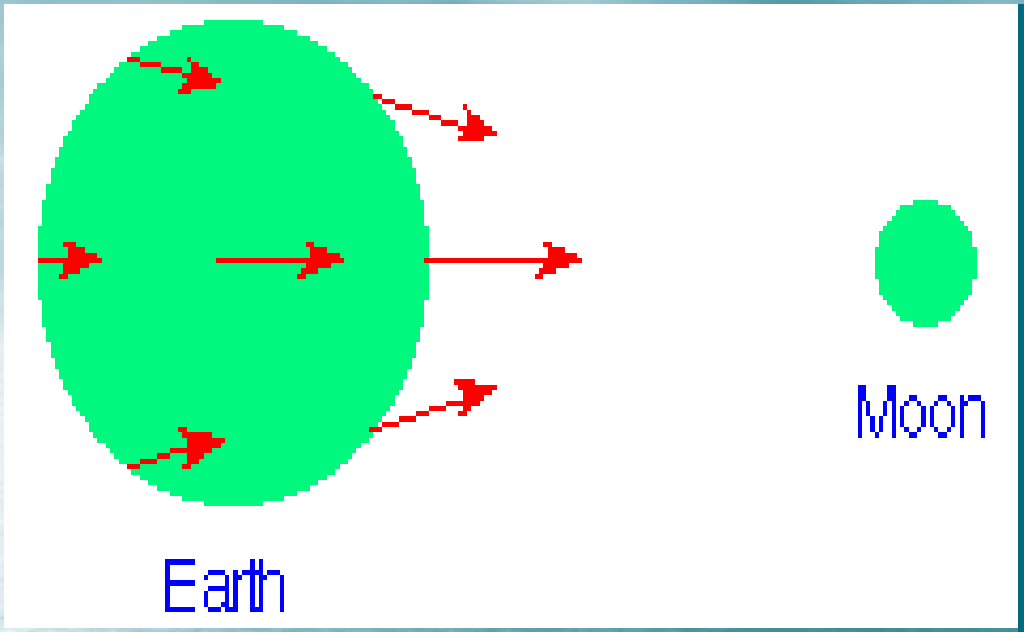
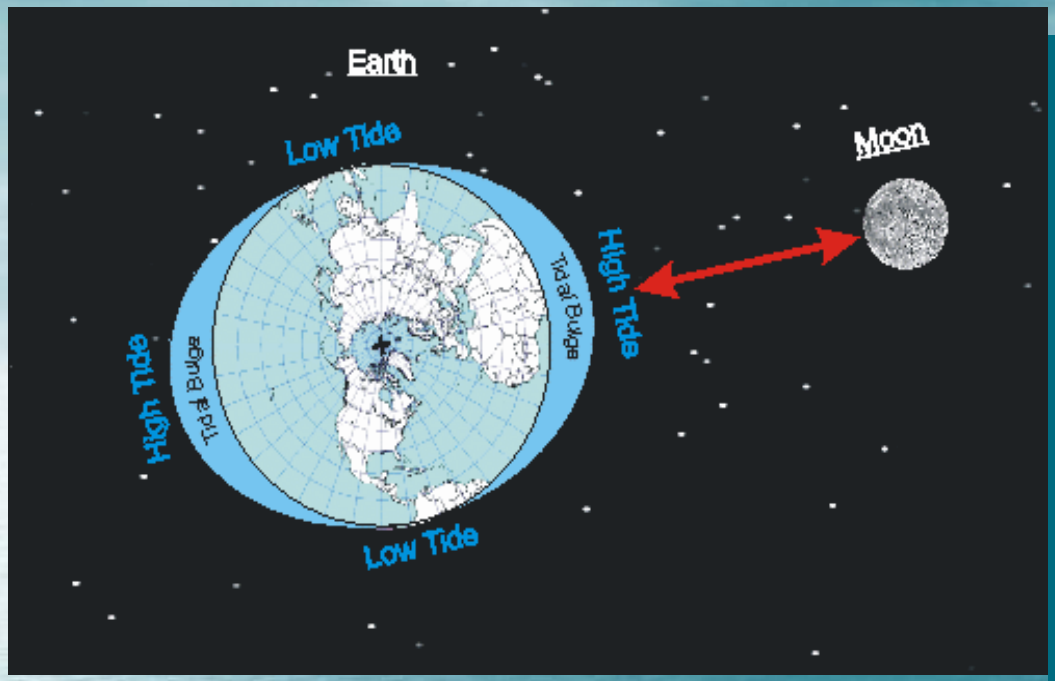
Sir Isaac Newton on the Causes of Tides



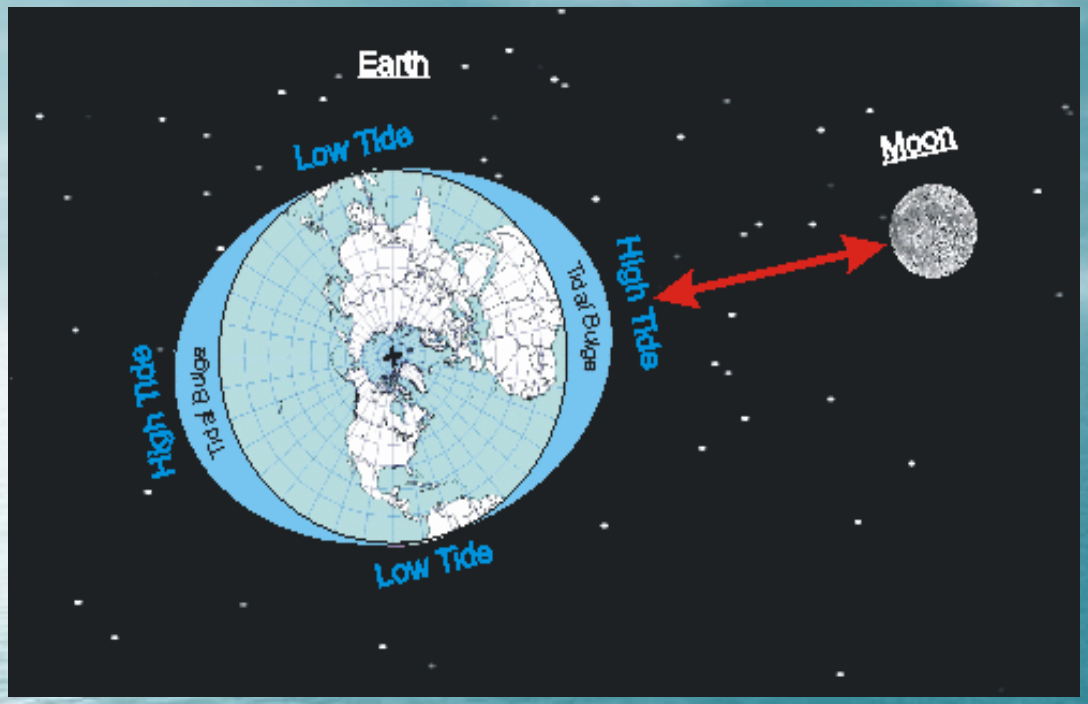
- Isaac Newton identified the gravitational effects of the moon and, to a lesser extent, the sun causes tides.
- The moon revolves around Earth about every 28 days and exerts a gravitational pull on the entire Earth.



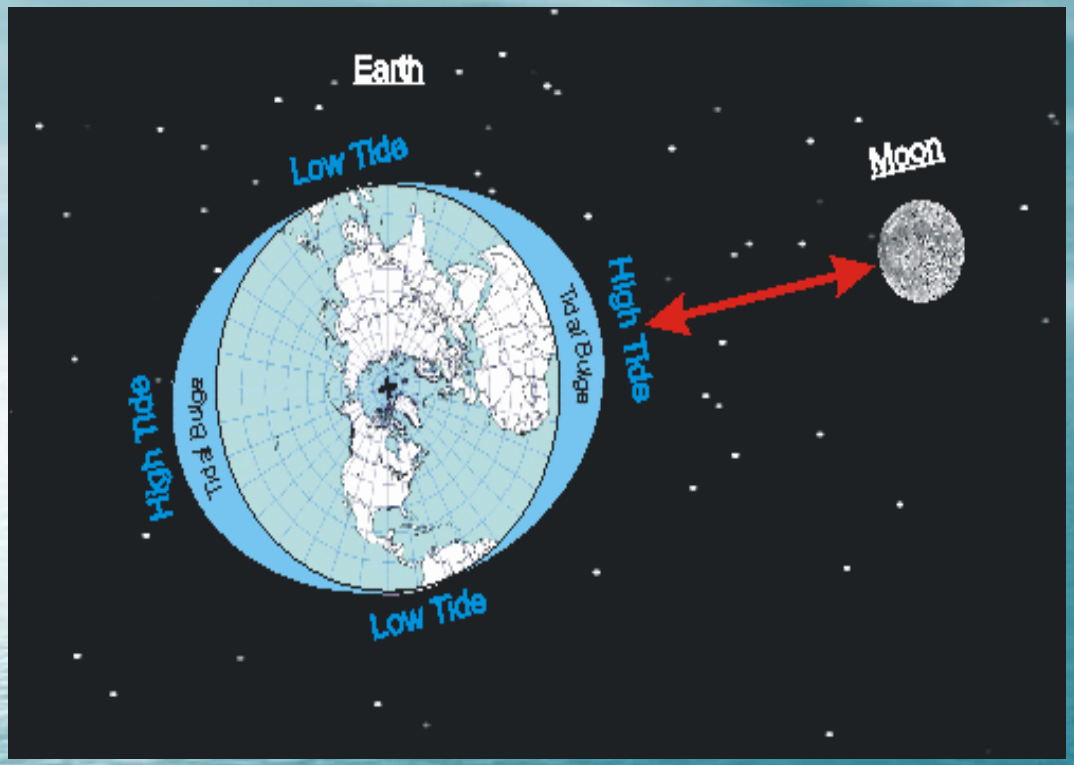
The Causes of Tides

- The force of the moon's gravity decreases with distance from the moon.
- Therefore the gravitational pull of the moon is strongest on the side of Earth that is nearest to the moon.

The Causes of High Tides



- As a result, the ocean on Earth's near side bulges slightly.
- This bulge causes a high tide within the area of the bulge on both sides of Earth.



- Away from this bulge, low tides form halfway between two high tides.
- Low tides form because as ocean water flows toward areas of high tide, the water level in other areas of the oceans drop.

The Causes of Low Tides

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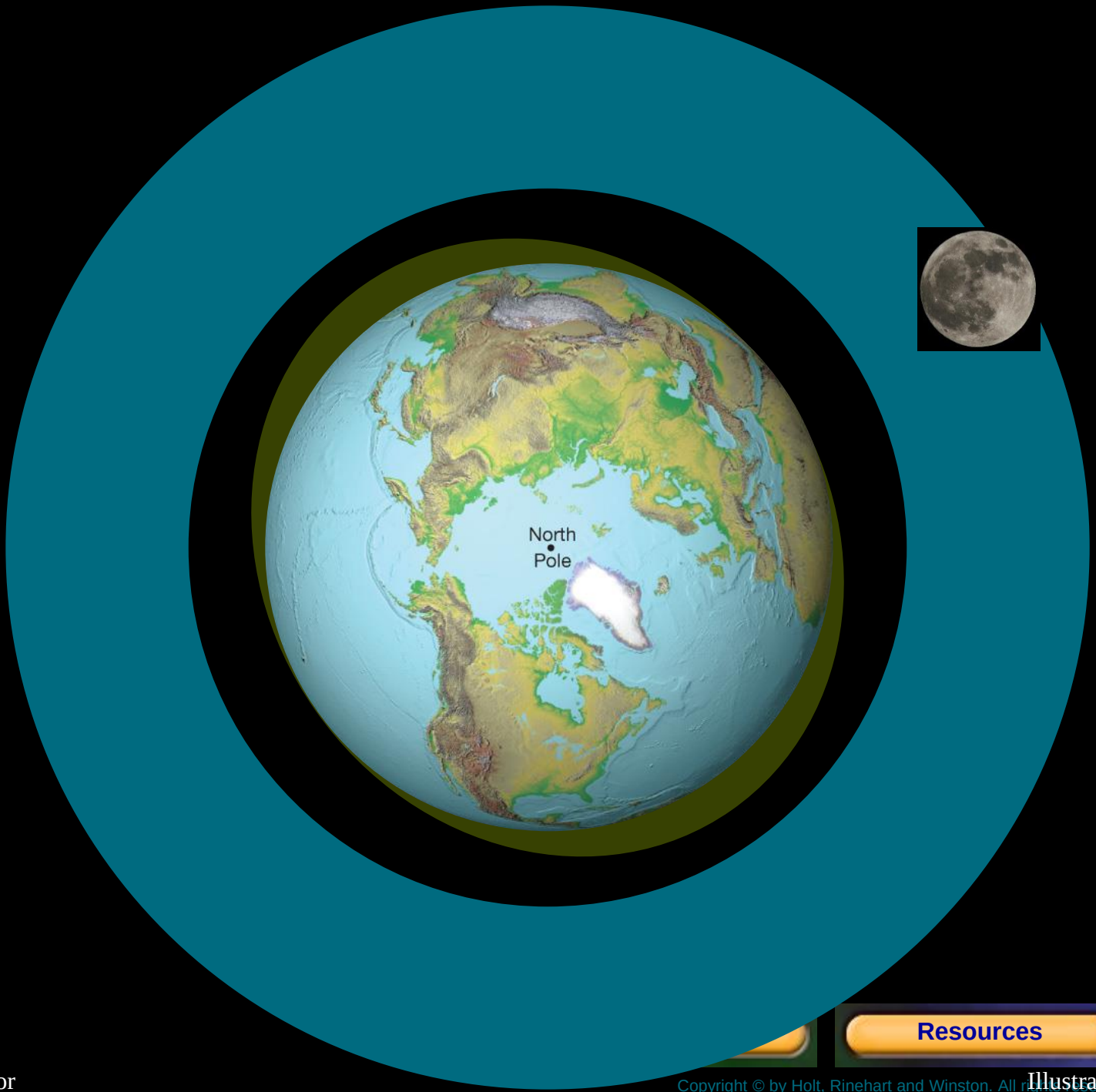
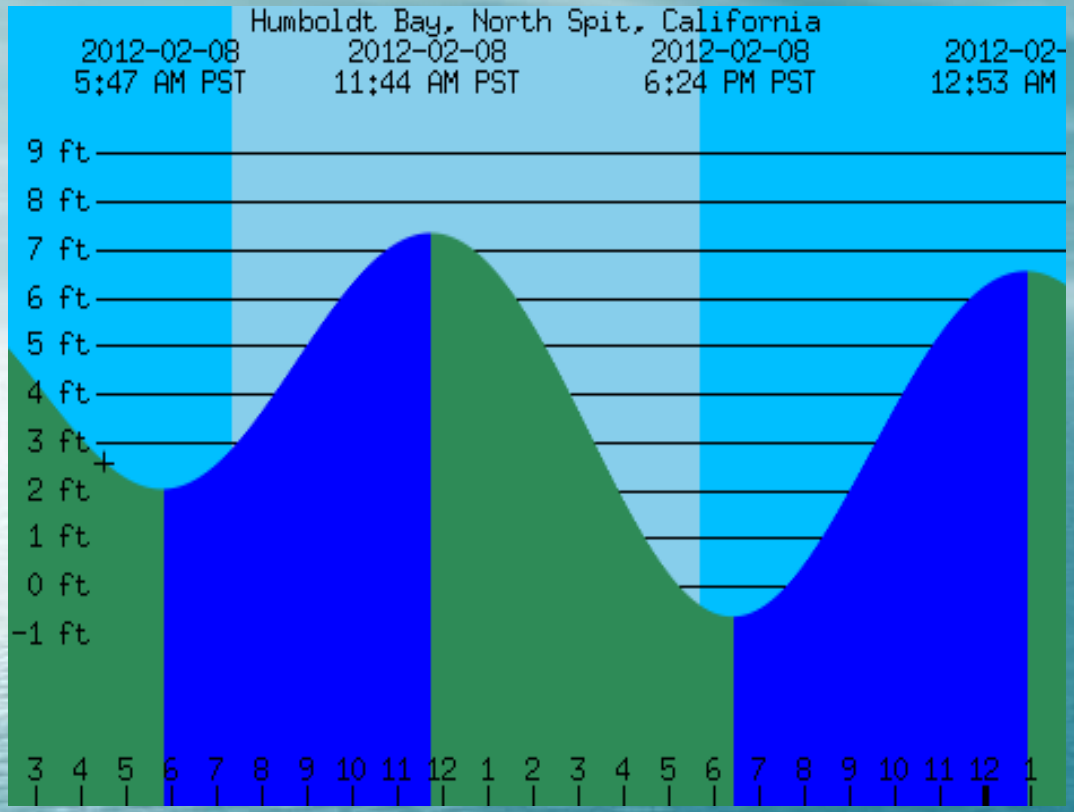


Resources

Photo: Hugo Victor

Illustration: Dennis Tasa



- Because there are two tidal bulges per day, most locations in the ocean have two high tides and two low tides daily.

The Causes of Low Tides

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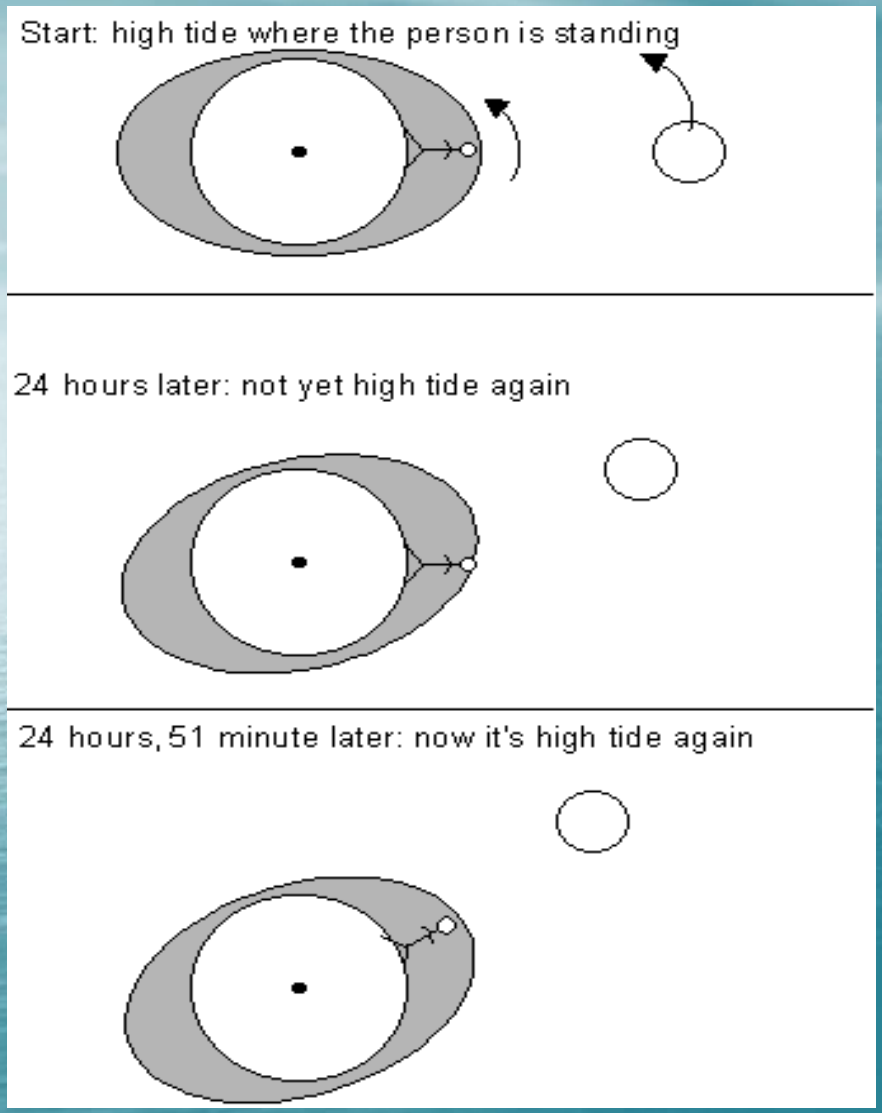
Check for Understanding

- What causes ocean tides?
- What causes high tide and what causes low tide?

Write answers using complete sentences and in your own words.



- In one day the moon has moved 1/28 of the way around Earth.
- So when Earth gets to the spot it was in 24 hours ago, the Earth still has to rotate 1/28 of a day to catch up with the moon.
- 1/28 of 24 hours = 52 minutes.

Why We Have Two High Tides a Day

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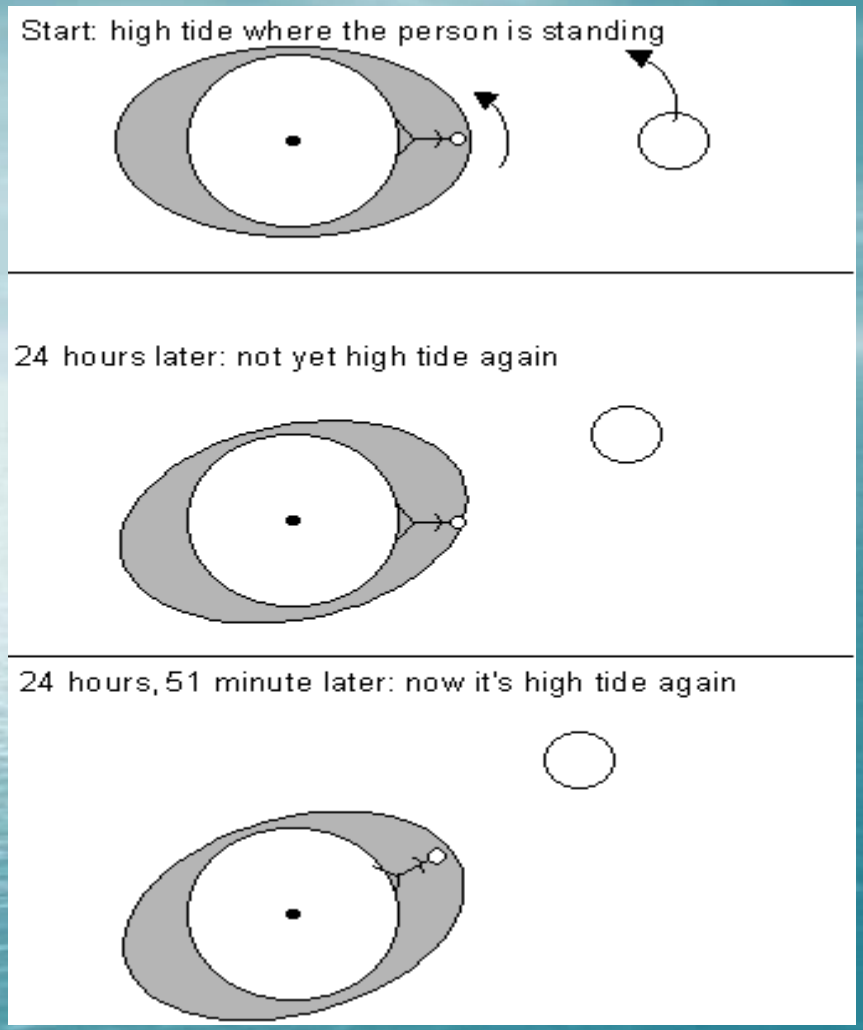

- So the tides come about 51 minutes later each day.
- Now, remember that there are (usually) two high tides each day.
- If the moon stood still they would be 12 hours apart, but since the moon revolves around the earth, the two high tides come about 12 hours and 25.5 minutes apart.

Why We Have Two High Tides a Day

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- Tidal range is the difference in levels of ocean water at high tide and low tide.

Behavior of Tides

The Power of the Bay of Fundy

Bay of Fundy near Nova Scotia, Canada is an excellent example of the tidal ranges between high and low tide.

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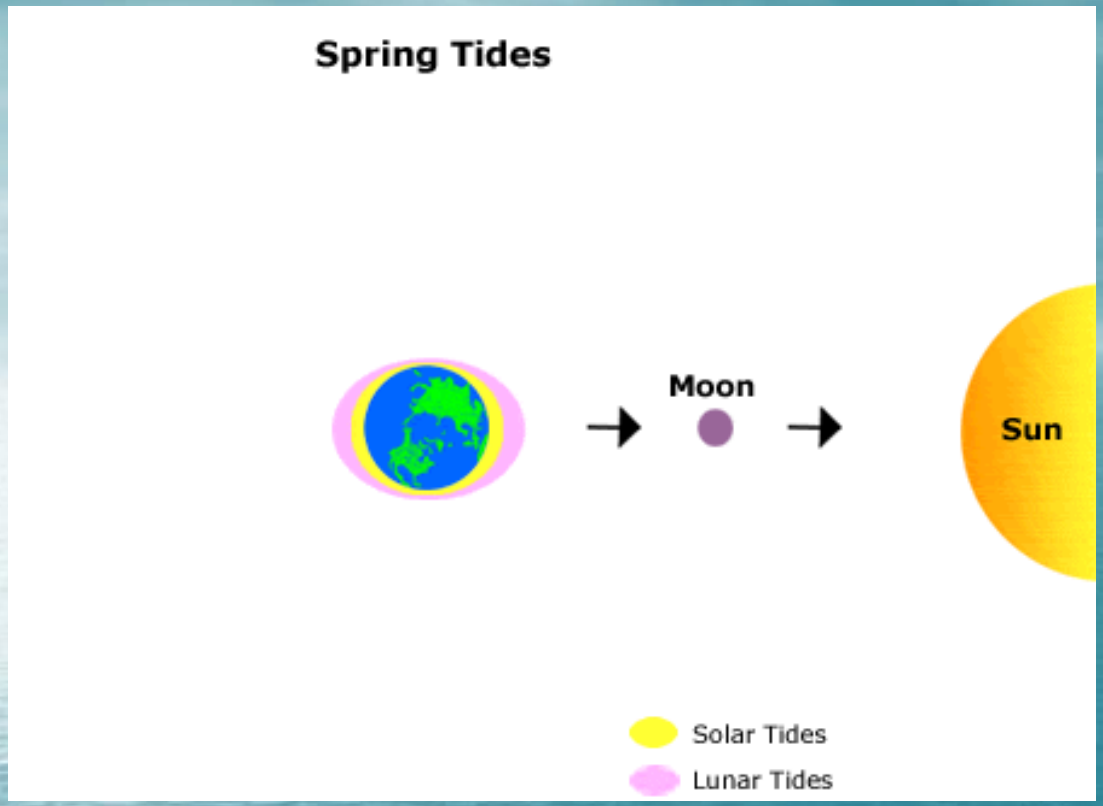

- During the new moon and the full moon, Earth, the sun, and the moon are aligned.
- The combined gravitational pull of the sun and the moon results in a greater tidal range for that day.

Monthly Tidal Range of Spring Tides

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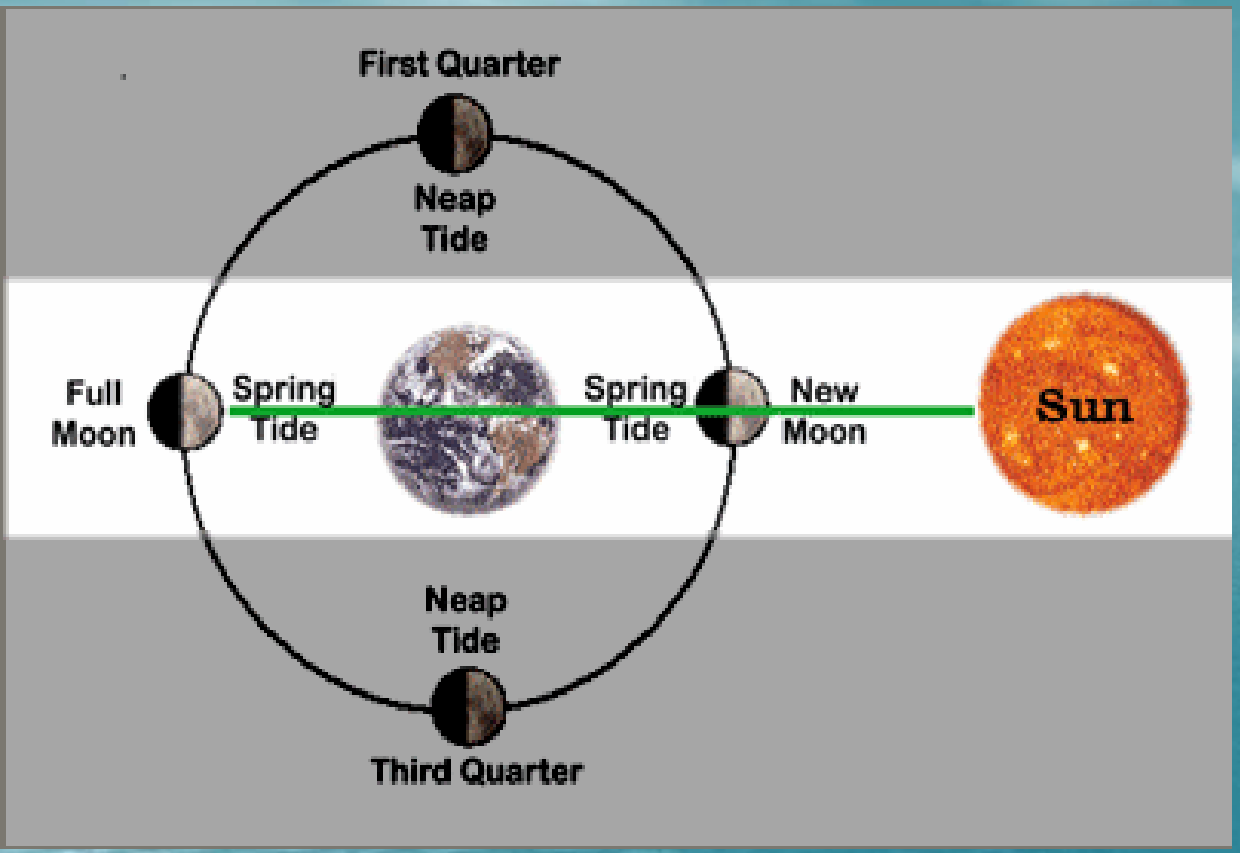
Resources



- During these two monthly periods, of great tidal range, tides are referred to as spring tides because there is a greater range between the high tide and the low tide that day.

Tidal Range of Spring Tides

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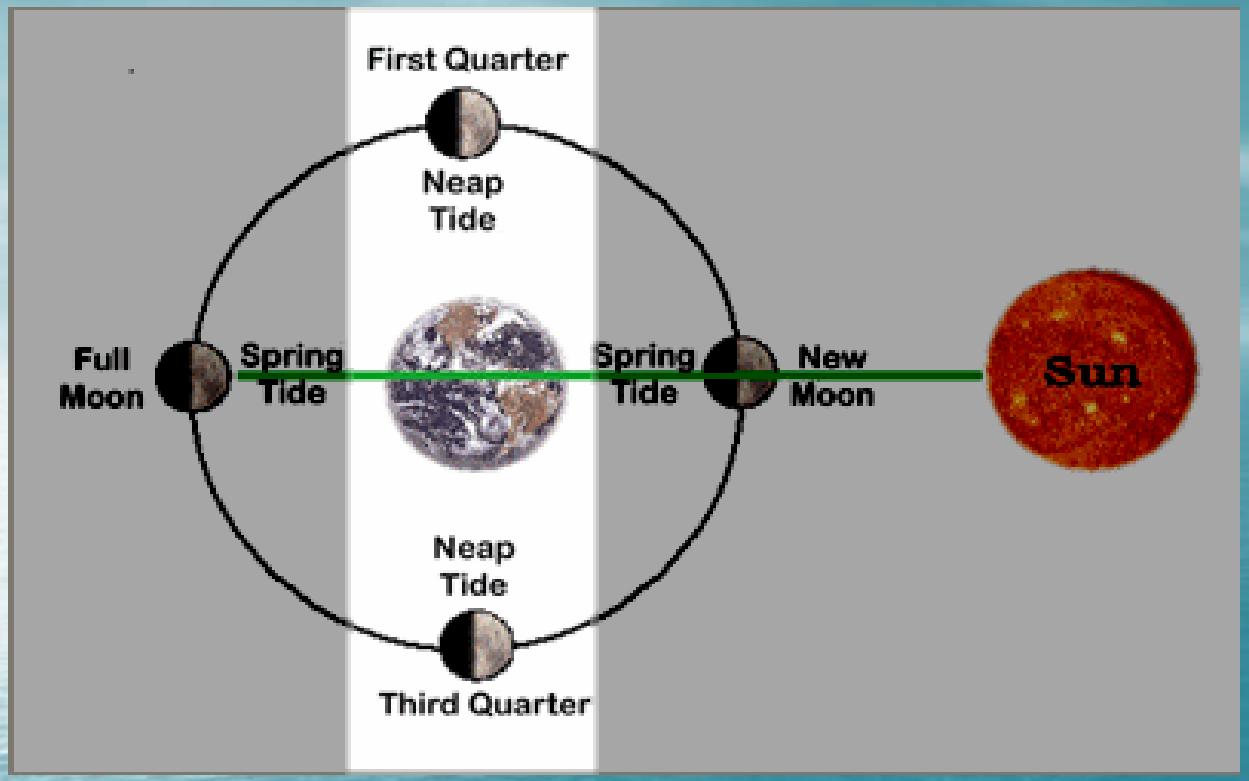

Monthly Tidal Range of Neap Tides

- During the first- and third-quarter phases of the moon, the moon and the sun are at right angles to each other in relation to Earth.
- The gravitational forces of the sun and moon work against each other.

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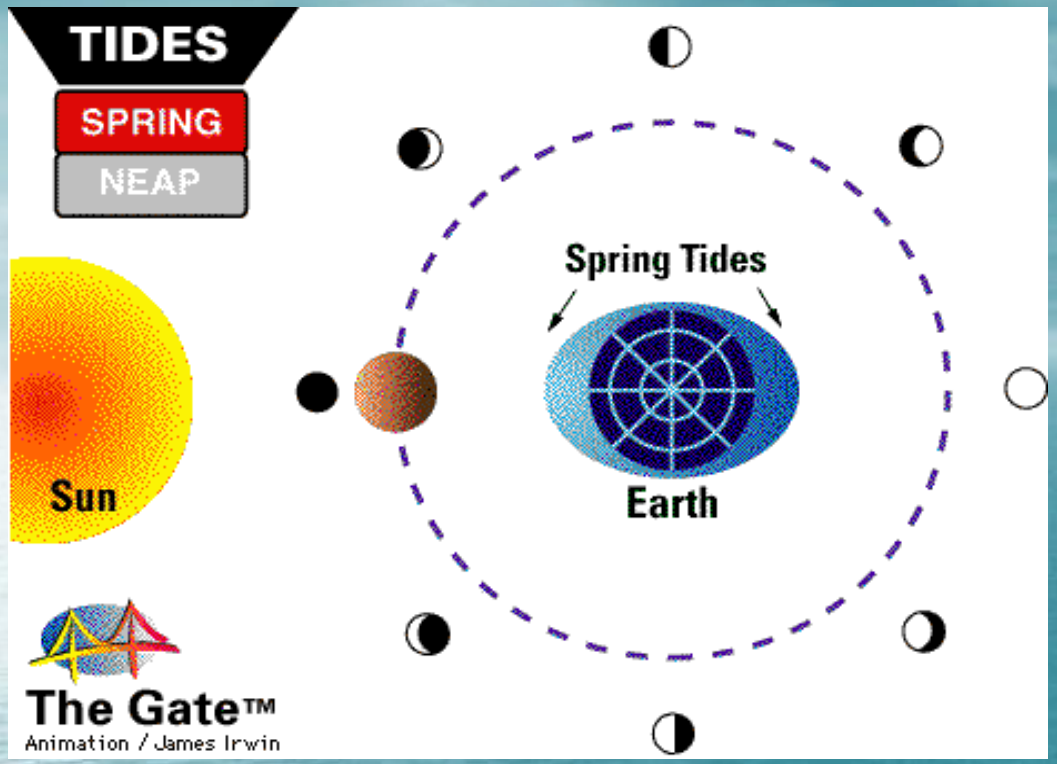

- As a result, the daily tidal range between the high tide and low tide during these two monthly periods is small.
- Tides that occur during this time are called *neap tides.*

Tidal Range of Neap Tides

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Rip Current vs. Rip Tide

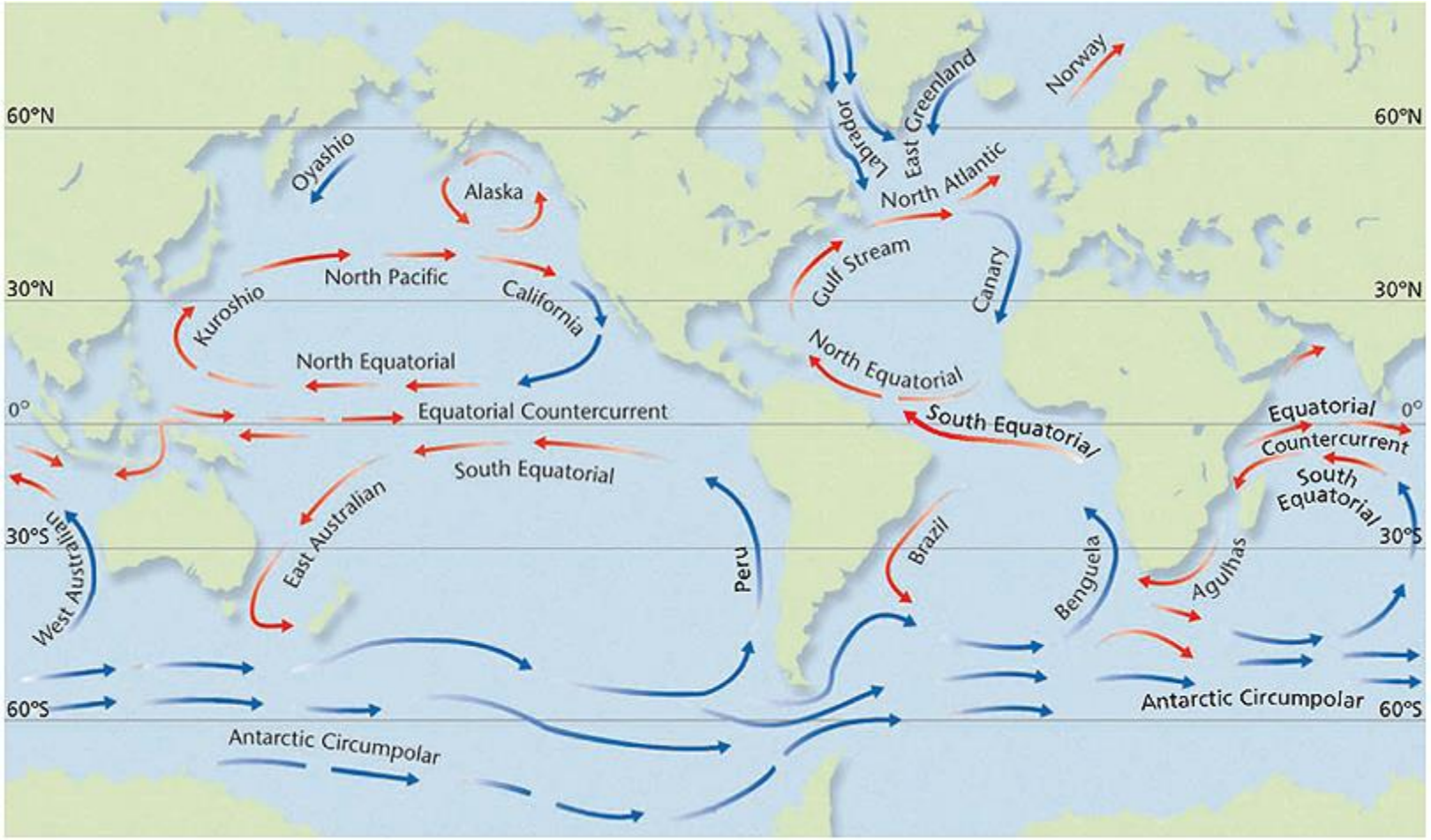
- Rip Current
  - Rip currents are powerful, narrow channels of fast-moving water that are prevalent along the East, Gulf, and West coasts of the U.S., as well as along the shores of the Great Lakes.
- Rip Tide
  - A rip tide is a specific type of current associated with the swift movement of tidal water through inlets and the mouths of estuaries, embayments, and harbors.

Check for Understanding

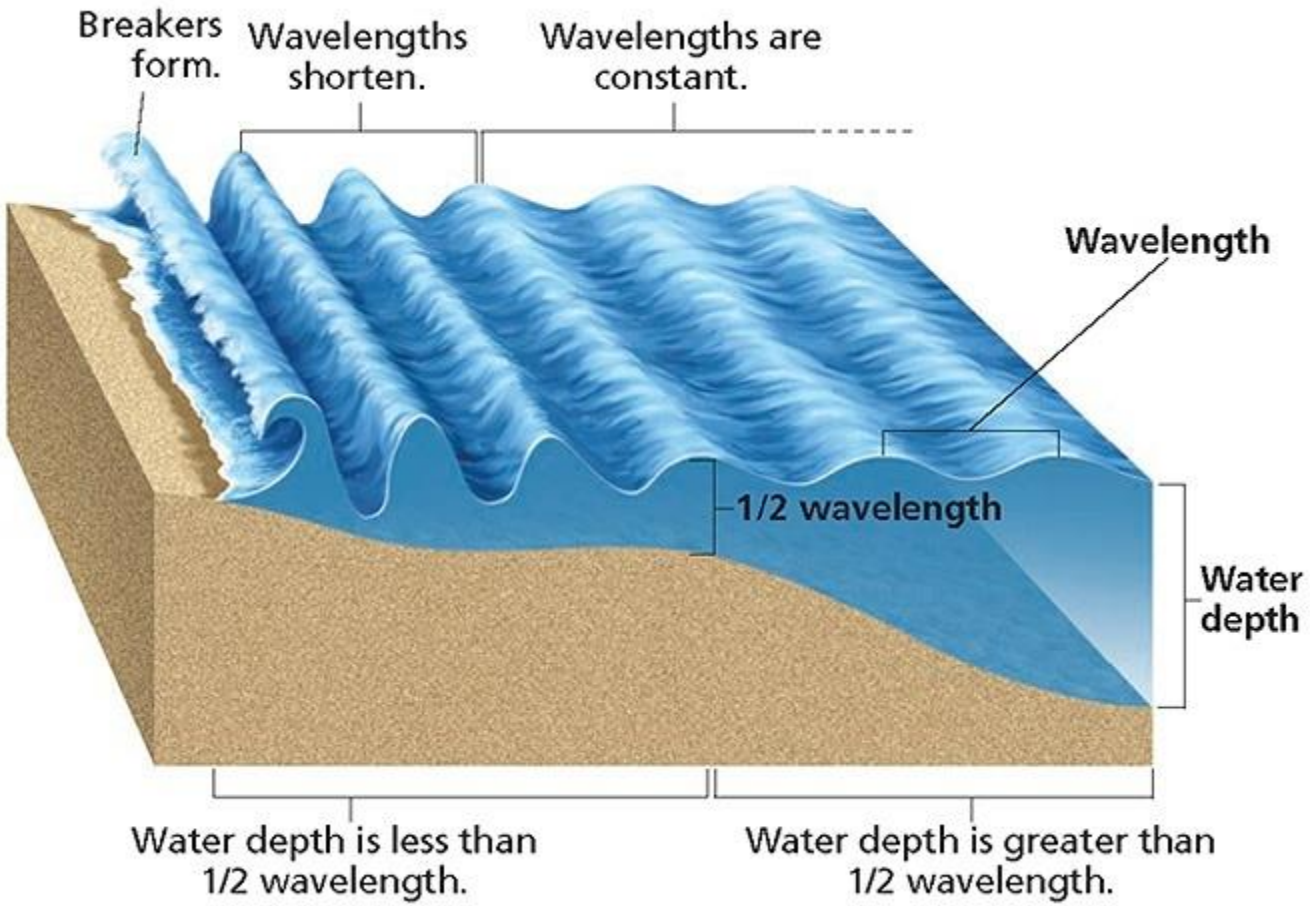
- Explain the Coriolis Effect and how it relates to the following...
  - Westerlies and Tradewinds
  - The 5 major ocean gyres
- Describe the difference between Neap tide and Spring Tide.

Write using complete sentences and in your own words.

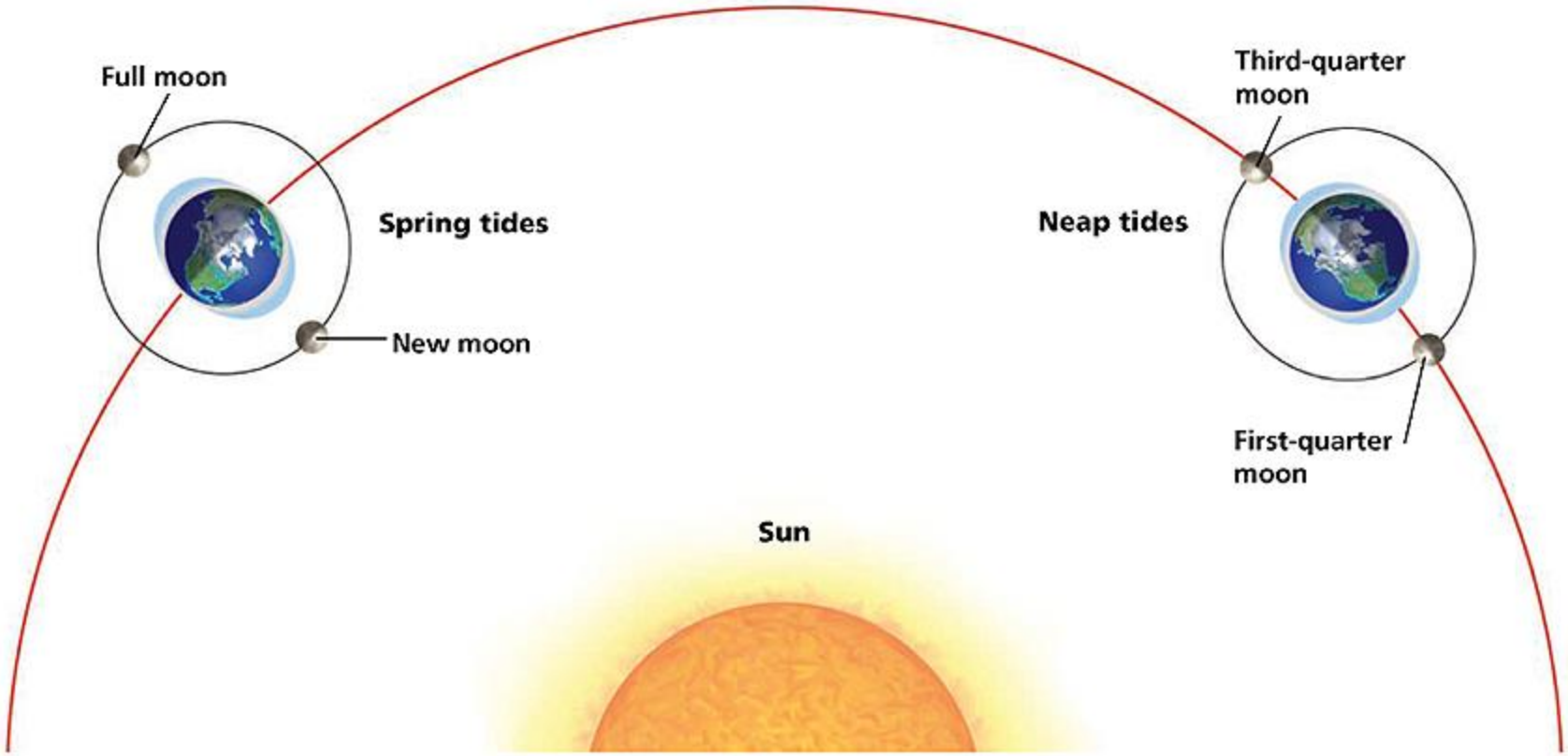
Major Surface Currents



The Formations of Breakers



Spring Tides and Neap Tides



Roaming Rubber Duckies