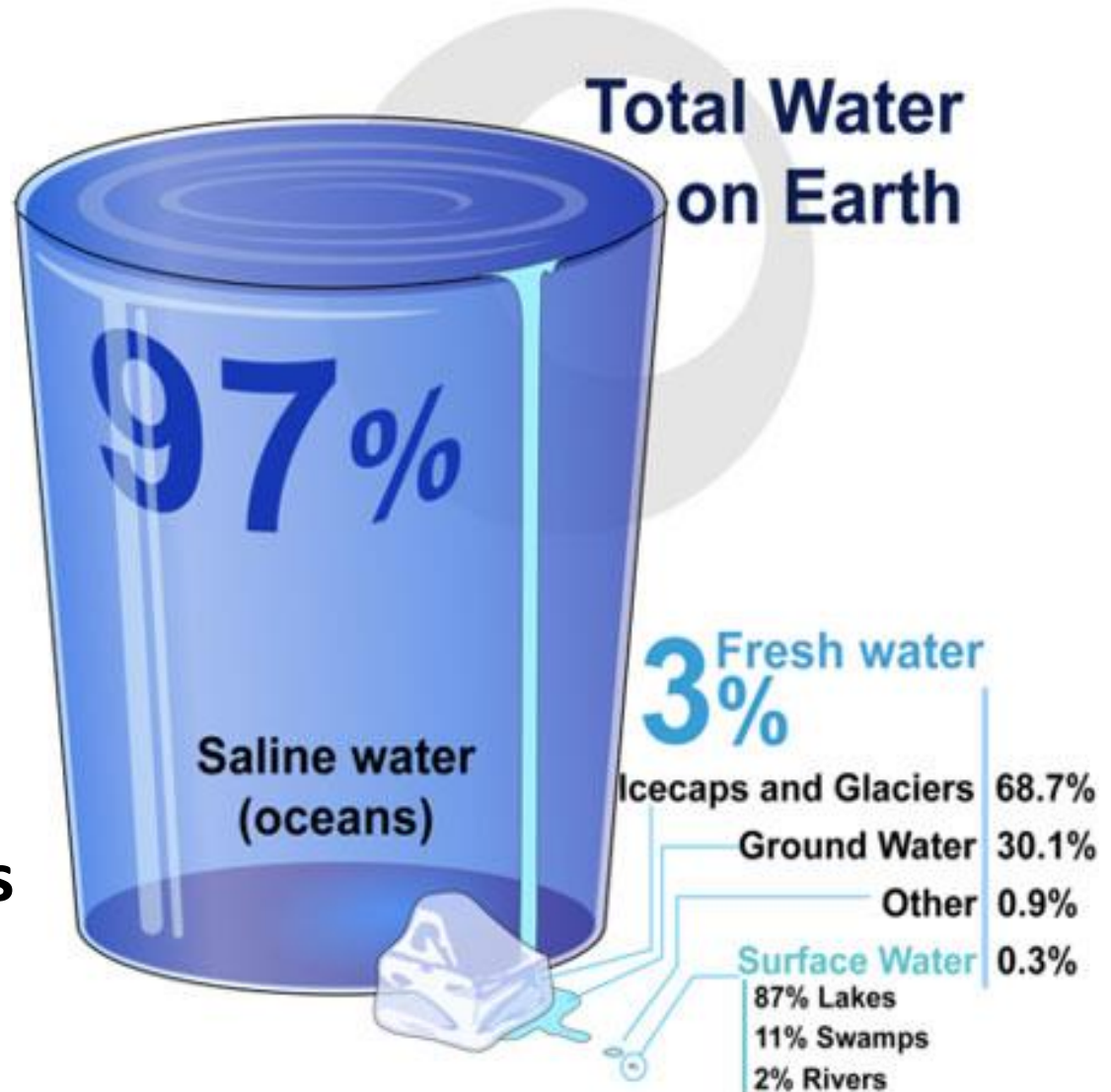
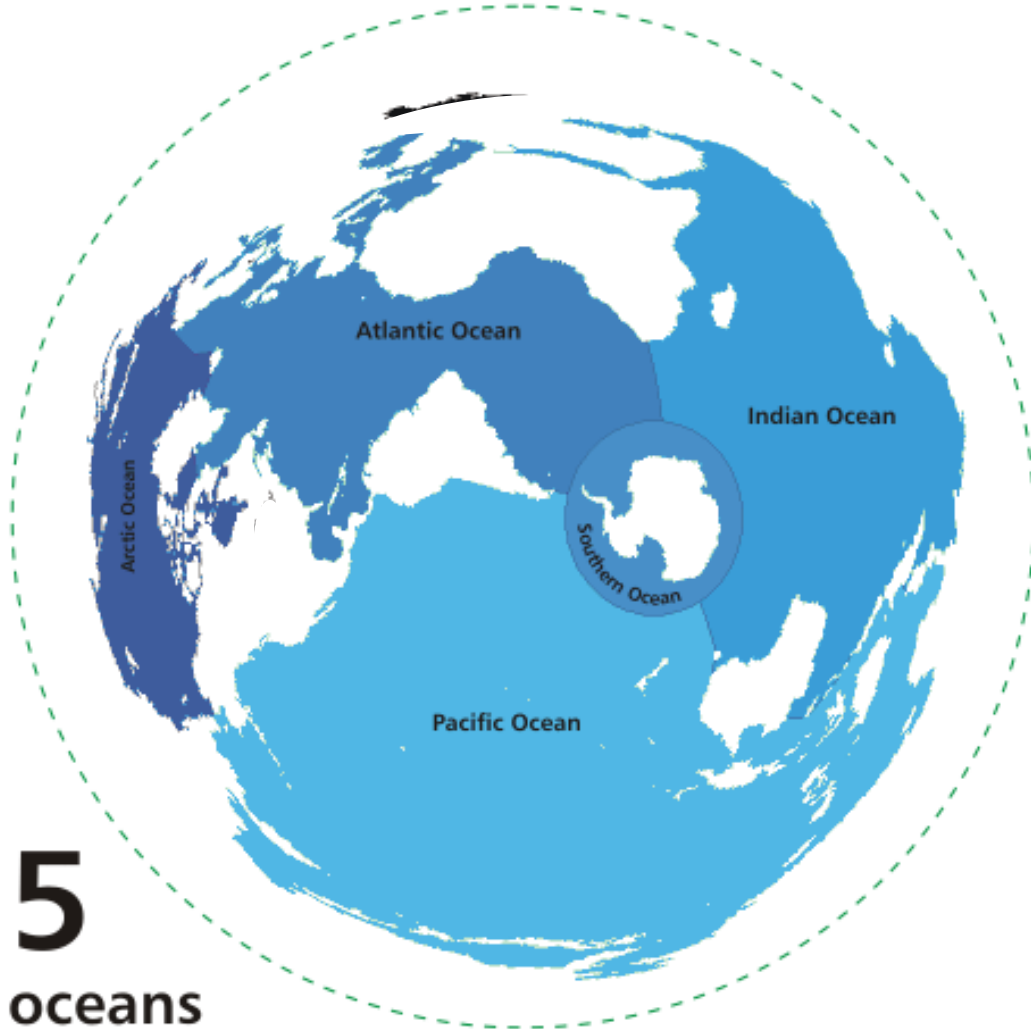


# Saltwater (Saline Water)

- Saltwater is water that contains a **certain amount of salts** with dissolved salt concentration of **more than 1%**.
- **Oceans and seas.**
- Saltwater is also found in some lakes and ponds as well as underground.



**Oceans** are the **largest bodies of water** on Earth (contain salt water only)



**5**  
oceans

- Historically, people first began exploring **shoreline shape**, **ocean depth**, and **tides**.
- **Temperature** and **salinity** are two important factors that influence **ocean circulation** and as a result, the **climate** of the Earth.

# Tides

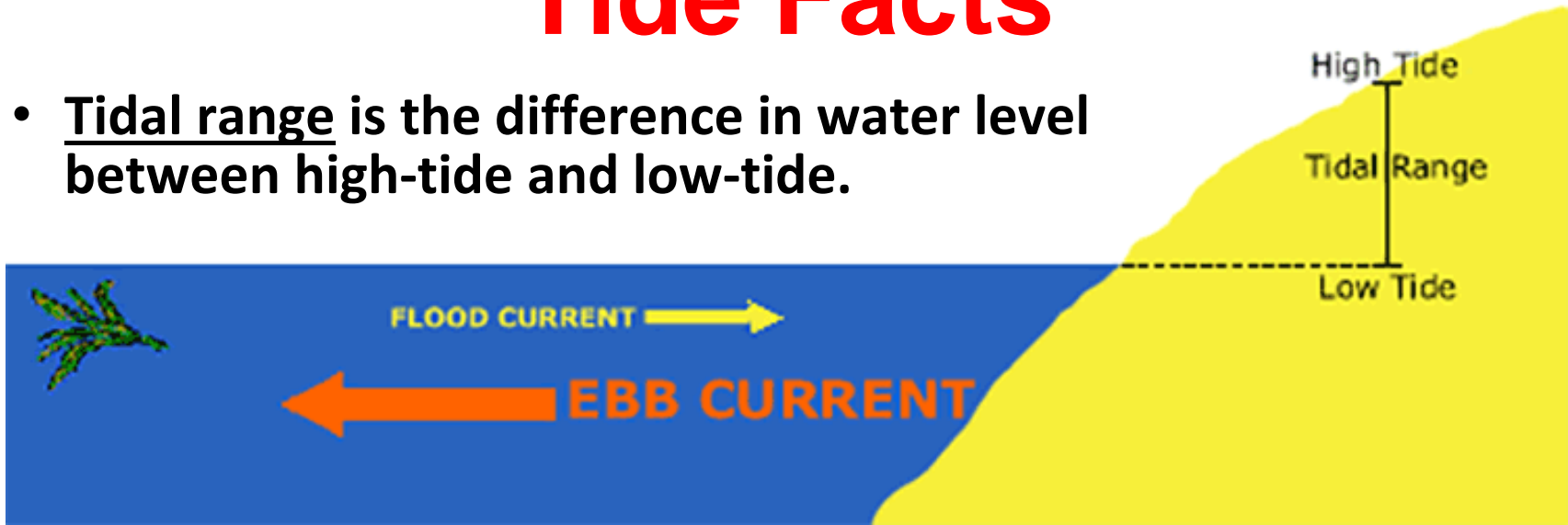
Tides are the slow, periodic **vertical rise and fall of the ocean surface** caused by **gravitational pull of the Moon and Sun** on the rotating Earth.



- Tidal forces affect the entire Earth, but the gravitational pull on LIQUIDS is much more noticeable than on SOLIDS (because liquids move more easily than solids).
- While tidal changes in sea level are easier to observe where land and water meet, they **exist everywhere** - even in the middle of the ocean.

# Tide Facts

- Tidal range is the difference in water level between high-tide and low-tide.



- Tides produce oscillating currents known as tidal streams.



## Bay of Fundy Tidal Streams



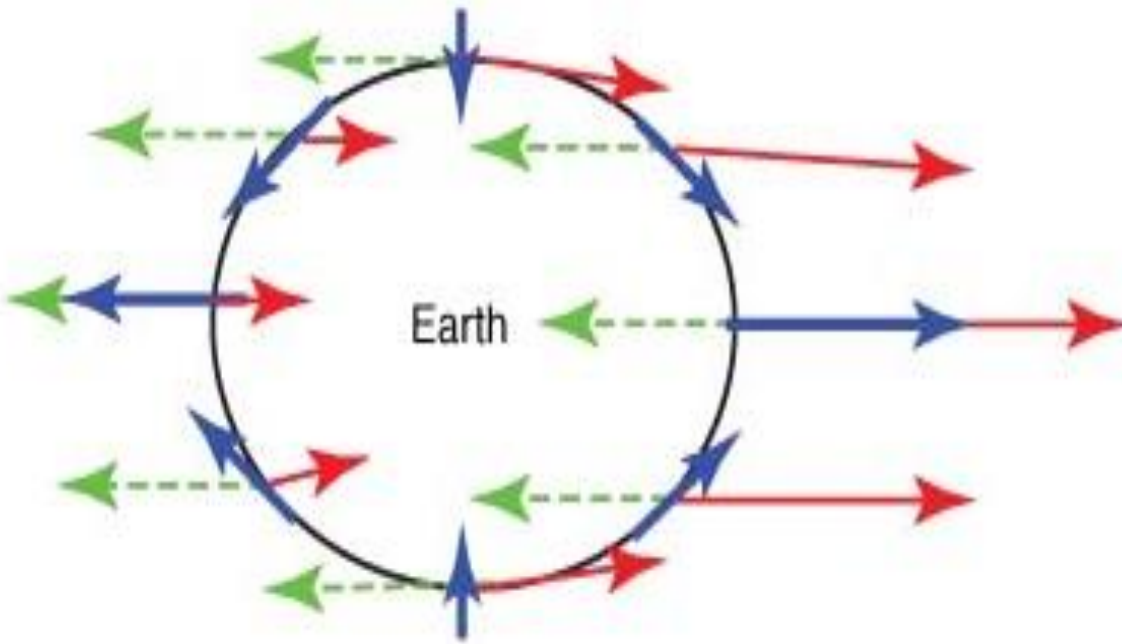
- One low-tide/high-tide cycle takes about **12 hours and 25 minutes** (the *lunar day* is equal to about 24.8 hours).



# Tide-Generating Force

For any two massive bodies rotating around the common center, let's consider the following two forces:

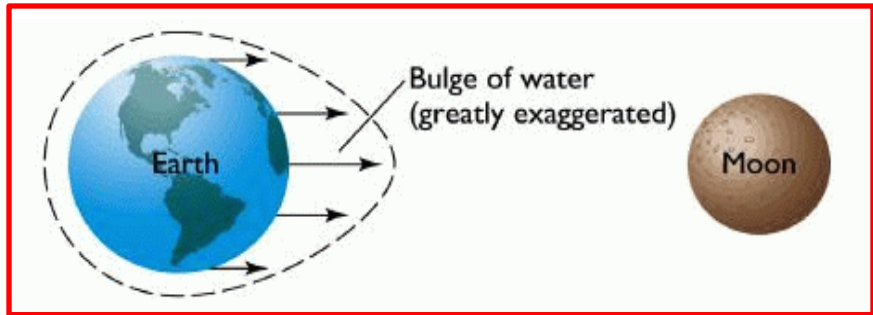
1. **Gravitational pull** (varies with distance)
2. Apparent **centrifugal force** (same everywhere)



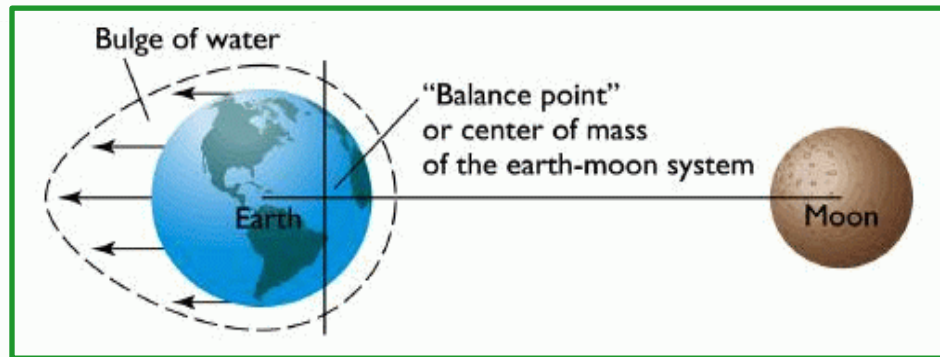
**Tide-  
generating  
force results  
from their  
difference  
(and is called a  
*differential force*)**



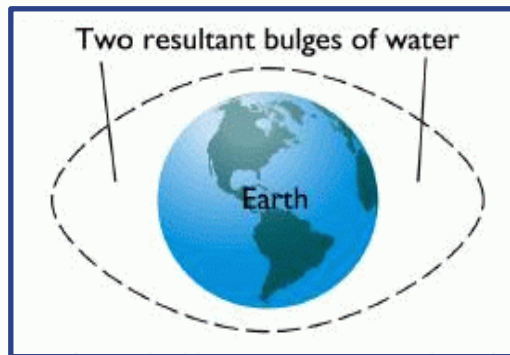
# Tidal “Bulges”



**gravitational attraction of the Moon dominates on the near side**



**centrifugal force due to Earth-Moon rotation dominates on the opposite side**



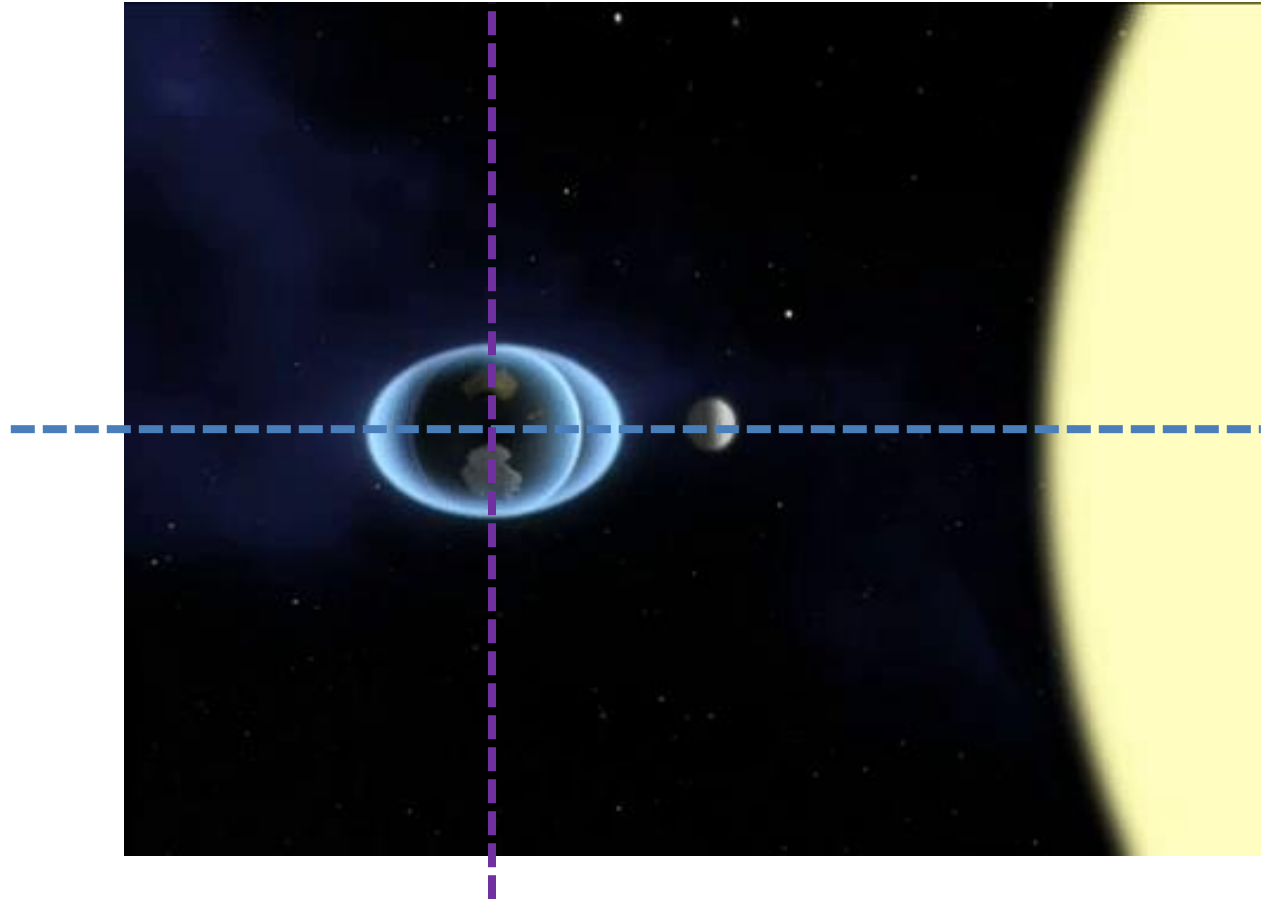
**two tidal bulges of water**

**The Sun has a similar effect, however ~2 times smaller.**

# Combined effect of the Moon and the Sun

(water bulges shown are greatly exaggerated!)

When tidal forces are aligned, tidal bulges add up.



When tidal forces act at right angle, tidal bulges are at right angle (larger one pointing towards the Moon, smaller one pointing towards the Sun)

# Monthly Tidal Cycle (29½ days)

About every 7 days, Earth alternates between:

## Spring Tide



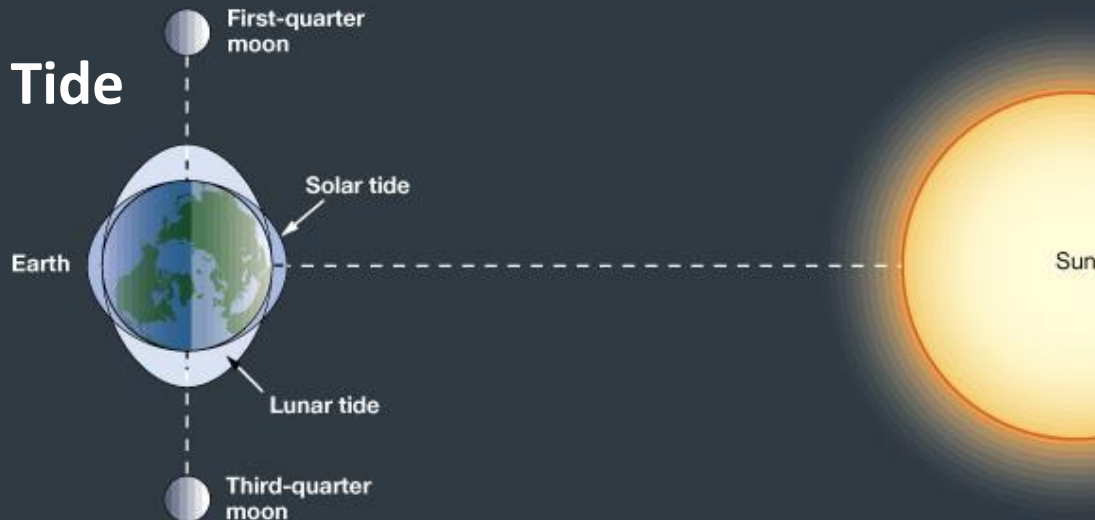
Alignment of Earth-Moon-Sun system (*syzygy*)

## Spring Tide

large tidal range,

highest high tide and lowest low tide

## Neap Tide



Earth-Moon-Sun system at right angles (*quadrature*)

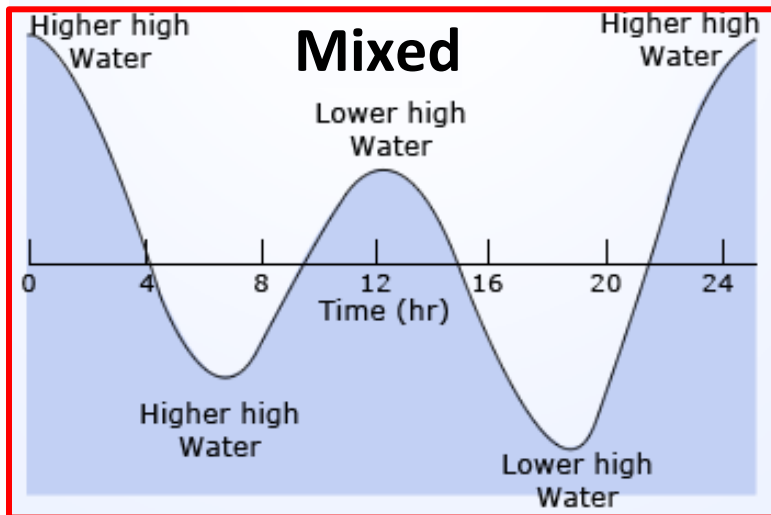
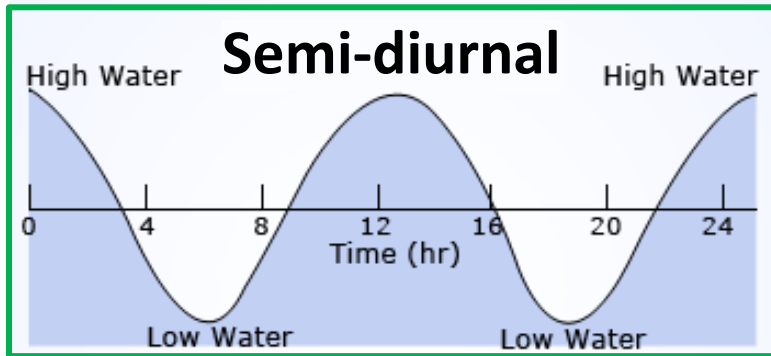
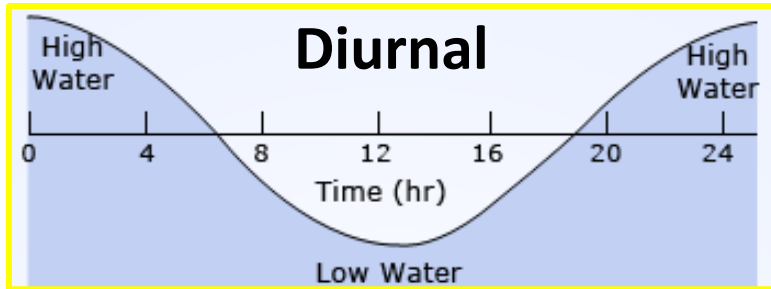
## Neap Tide

moderate tidal range

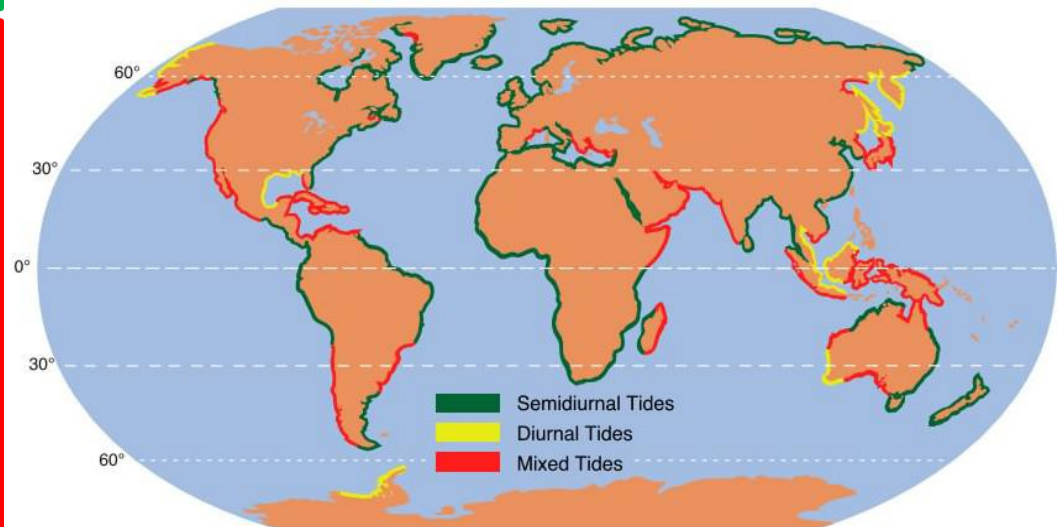


# Types of Tides

depend strongly on the location and shoreline

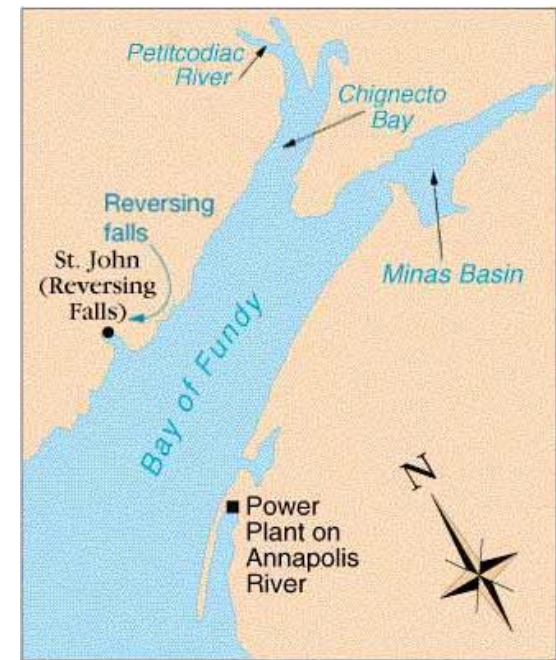


- **Diurnal**: one tidal cycle per day (Gulf of Mexico)
- **Semi-diurnal**: two high waters and two low waters each day (Boston, MA)
- **Mixed**: two high and two low waters each day, all four with different heights (Los Angeles, CA).



# The Bay of Fundy, Canada: world's largest tidal range

- Tidal energy is focused by shape and shallowness of bay.
- Maximum spring tidal range in Minas Basin = 17 meters (**56 feet!**).



Alma harbor at **High Tide** and **Low Tide**

