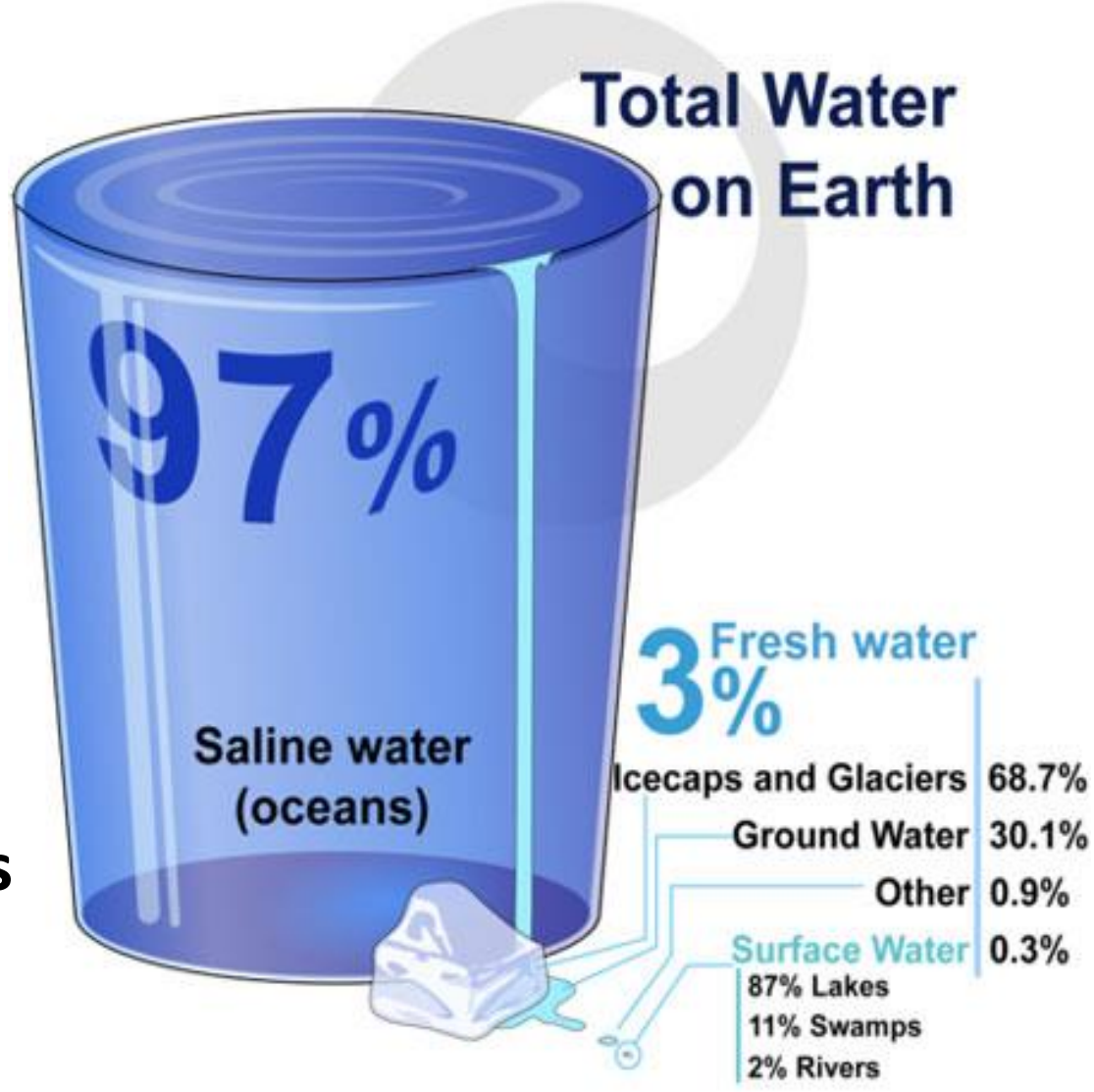
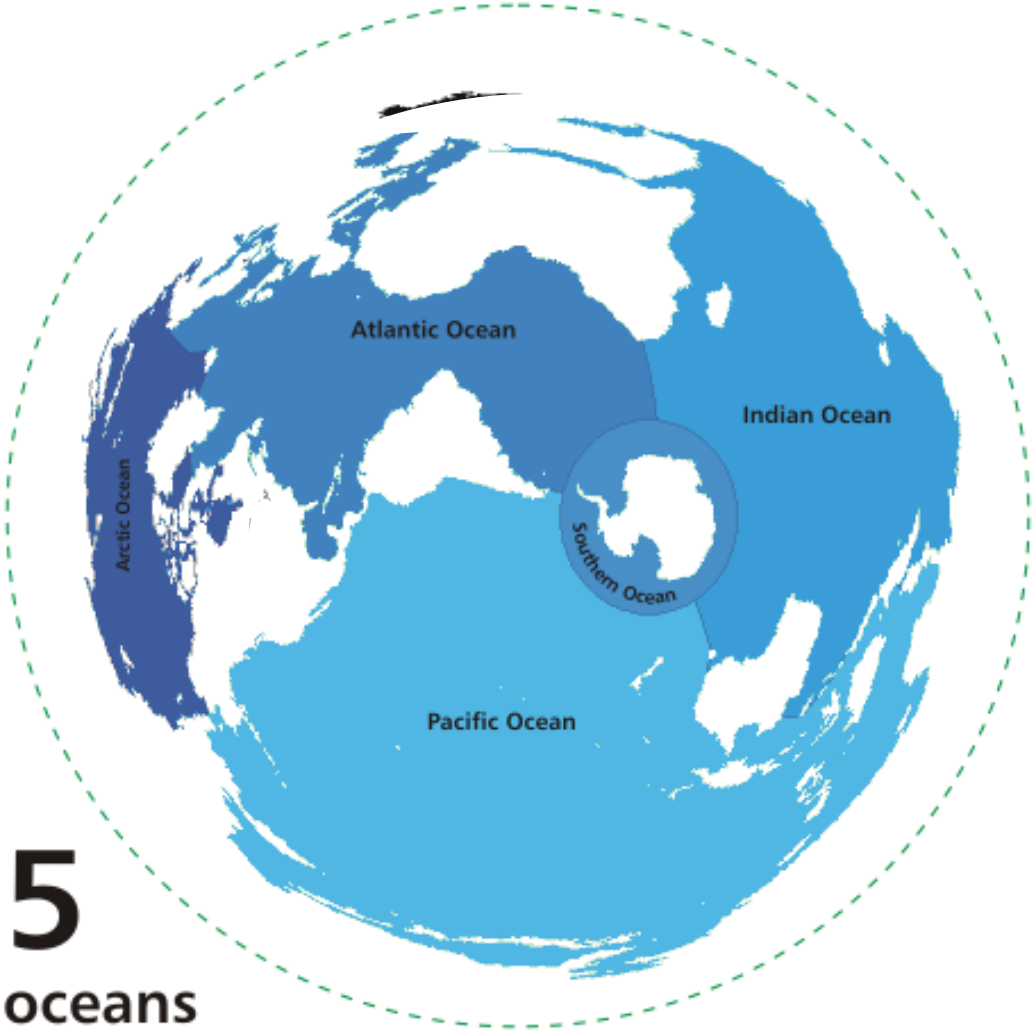
# Saltwater (Saline Water)

- **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)




- **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

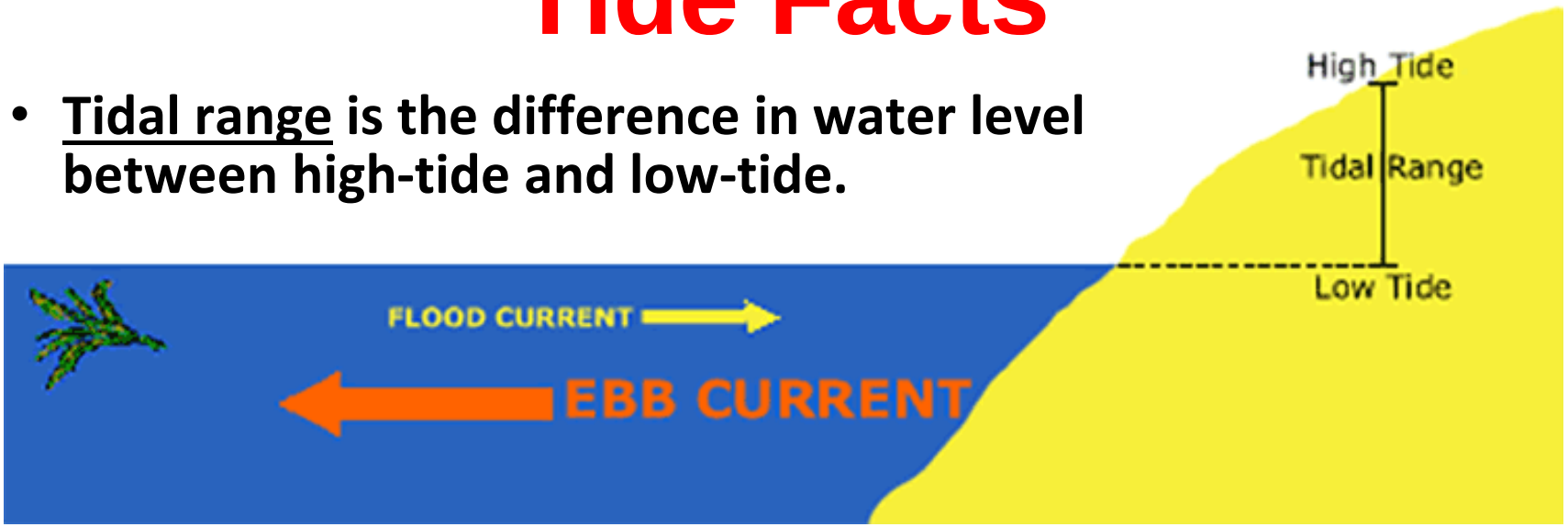
**Tides are the slow, periodic vertical rise and fall of the ocean surface caused by gravitational pull of the Moon and Sun on the rotating Earth.**

- **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

- **<u>Tidal range</u> is the difference in water level between high-tide and low-tide.**




- **Tides produce oscillating currents known as <u>tidal streams</u>.**

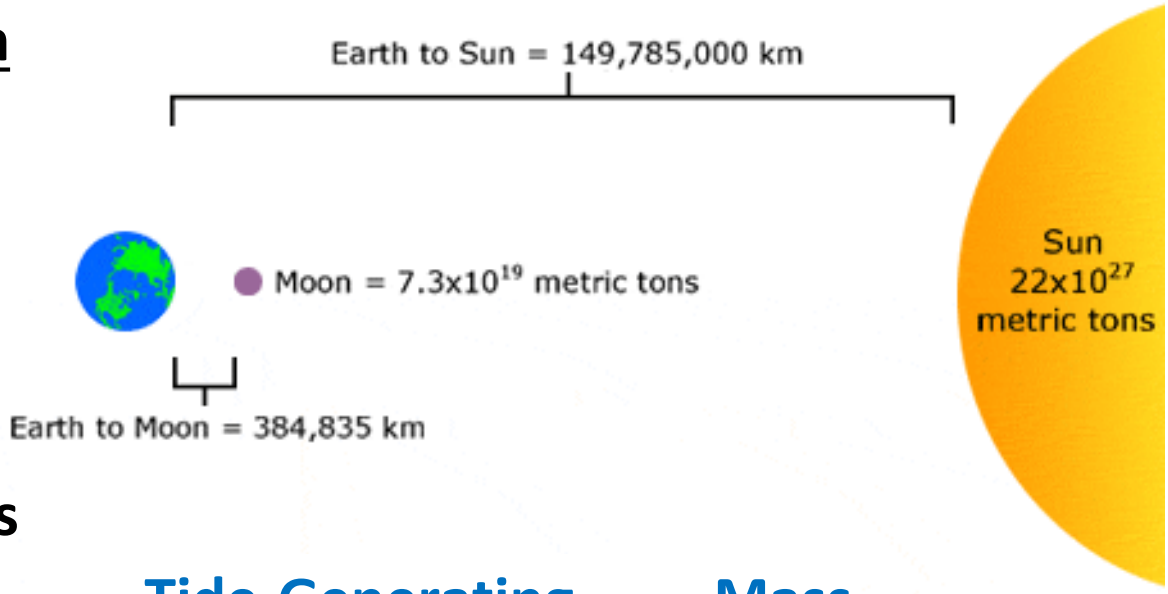

**Bay of Fundy Tidal Streams**


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

# Gravitational Pull of the Moon and Sun

**The relationship between the *masses* of the Earth, Moon and Sun and their *distances* to each other play a critical role in affecting the Earth's tides.**

- **The Sun is 27 million times more massive than the Moon.**
- **It is also 390 times further away from the Earth than the Moon.**
- **As a result, the Sun's tide-generating force is about half that of the Moon.**



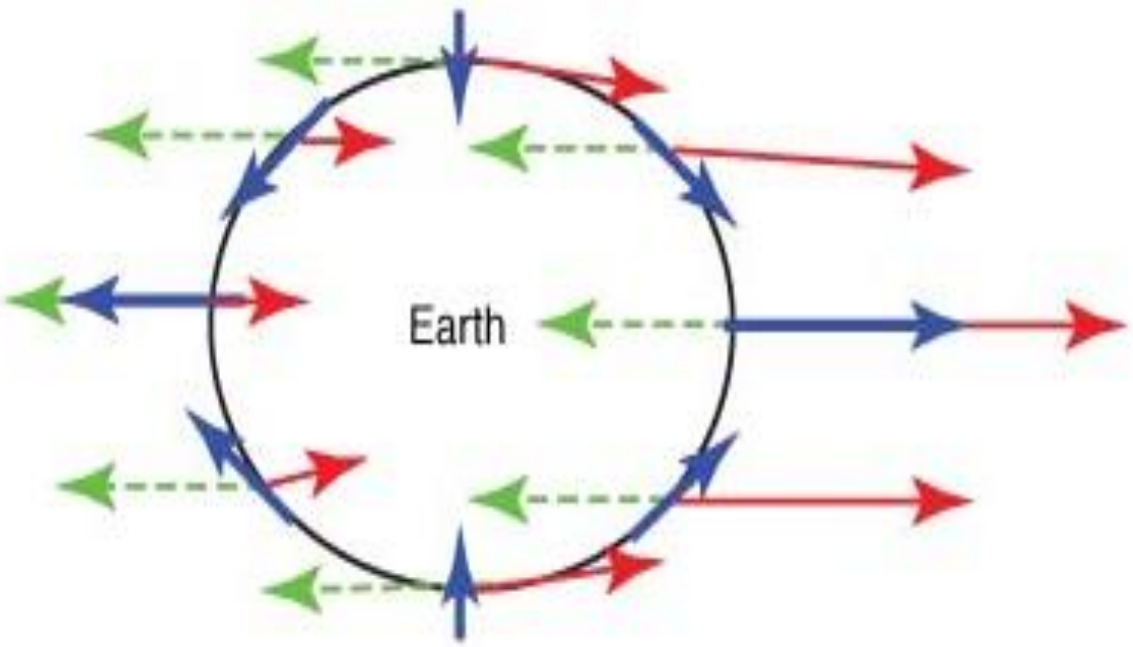

$$\text{Tide-Generating Force} \sim \frac{\text{Mass}}{(\text{Distance})^3}$$

**The Moon is the dominant force affecting the Earth's tides.**

# Tide-Generating Force

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

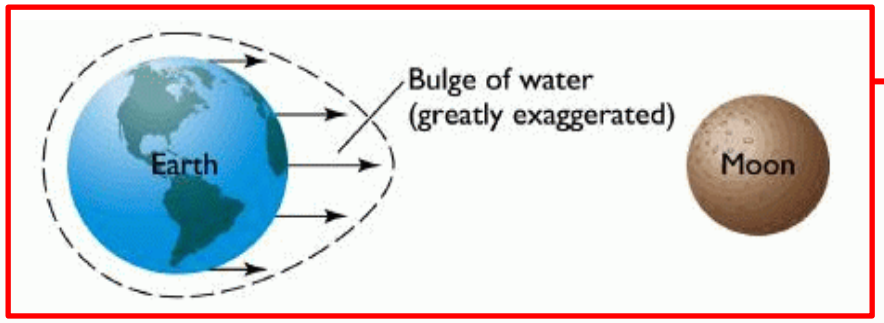
1. **Gravitational pull (varies with distance)**
2. **Apparent centrifugal force (same everywhere)**




**Tide-generating force results from their difference**

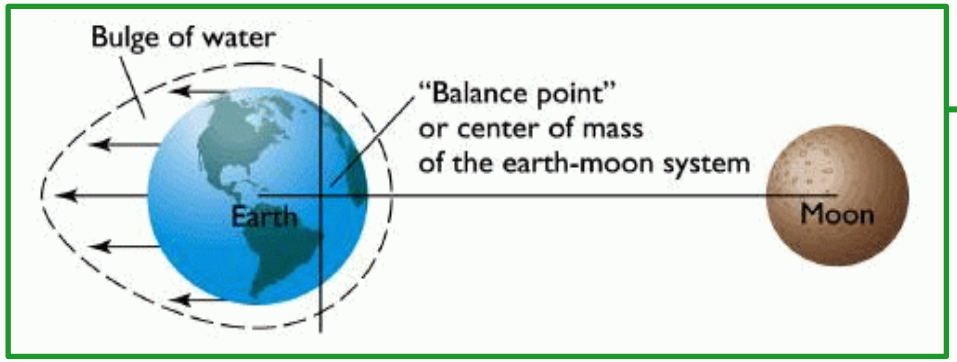
**(and is called a *differential force*)**

# Tidal Bulges

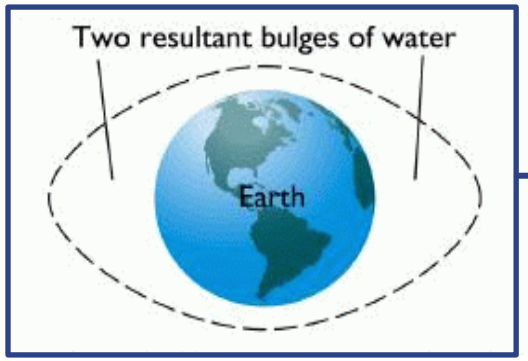



**gravitational attraction of the Moon dominates on the near side**

+




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



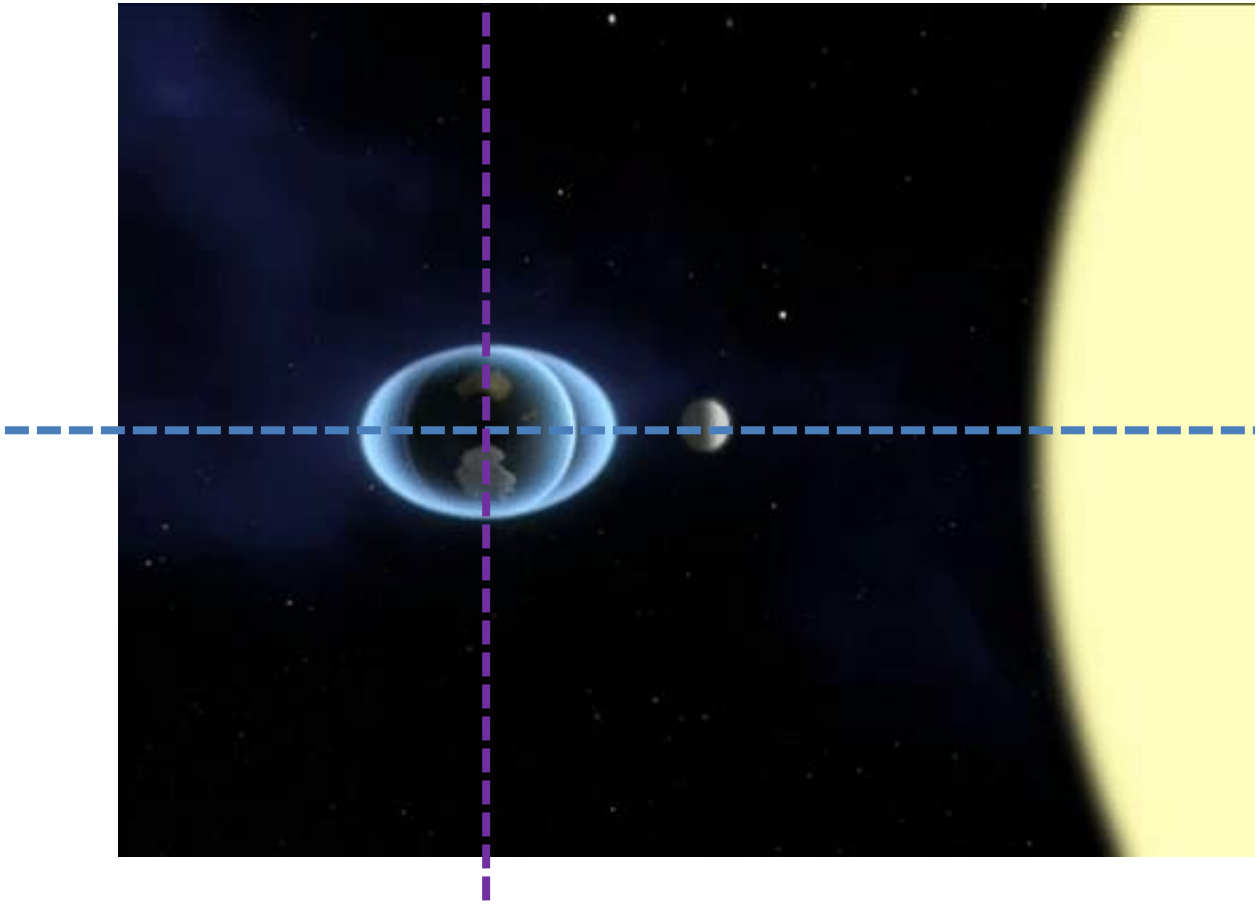

**two tidal bulges of water**

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

# Combined effect of the Moon and the Sun

**(water bulges shown are greatly exaggerated!)**

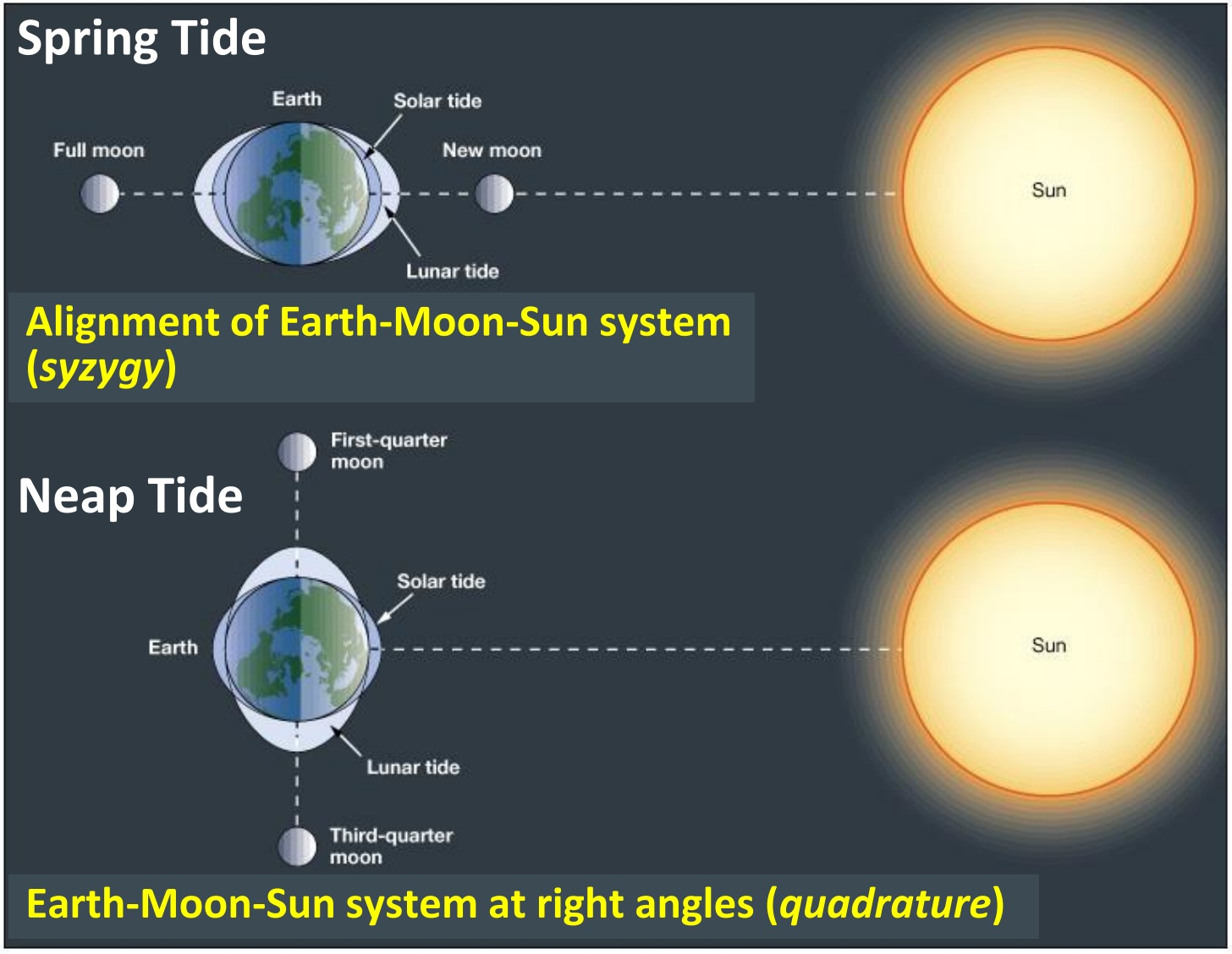
**When tidal forces are aligned, tidal bulges add up.**



**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**

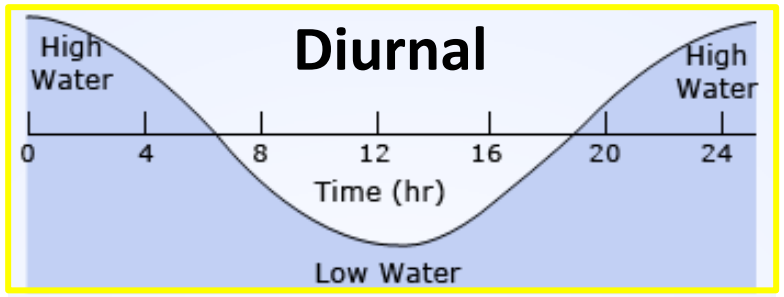
**large tidal range,**

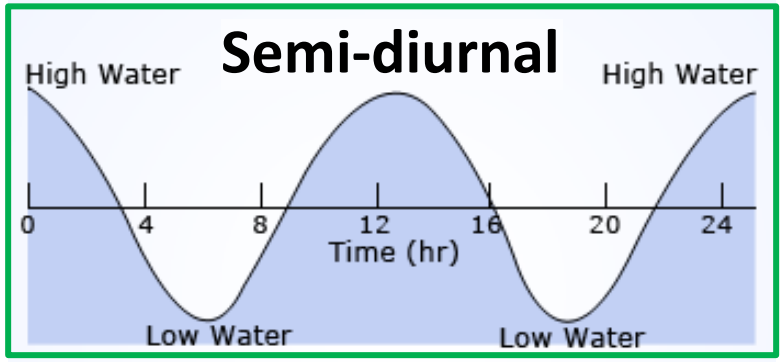
**highest high tide and lowest low tide**

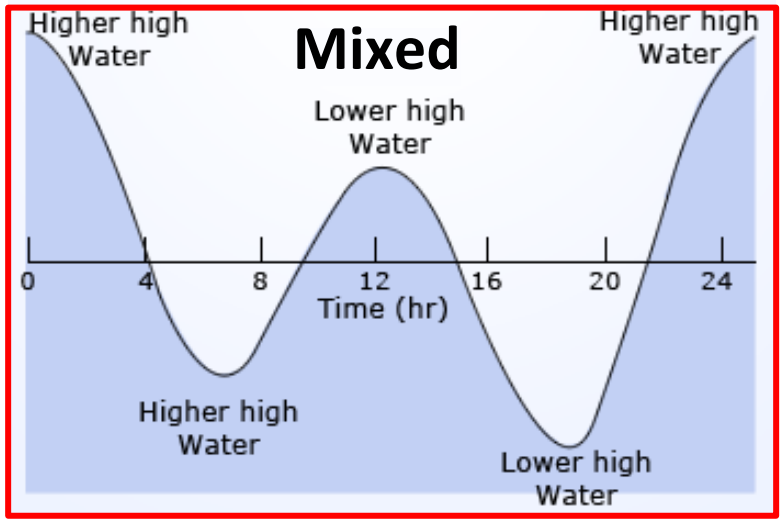
**Neap Tide**

**moderate tidal range**

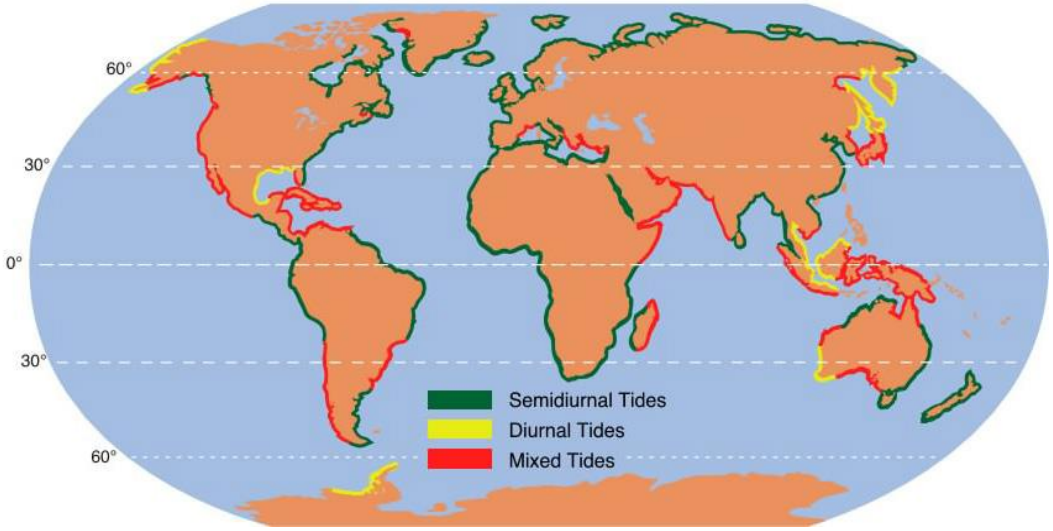
# Types of Tides depend strongly on the location and shoreline



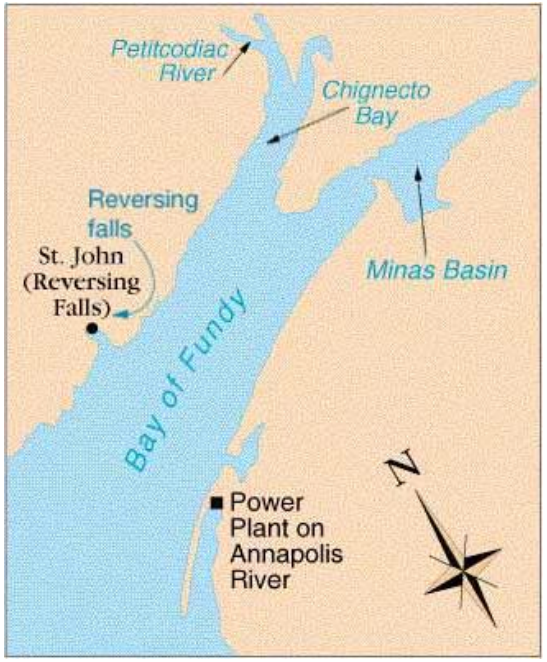




- **Diurnal: one tidal cycle per day (Gulf of Mexico)**
- **Semi-diurnal: two high waters and two low waters each day (Boston, MA)**
- **Mixed: two high and two low waters each day, all four with different heights (Los Angeles, CA).**



# 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