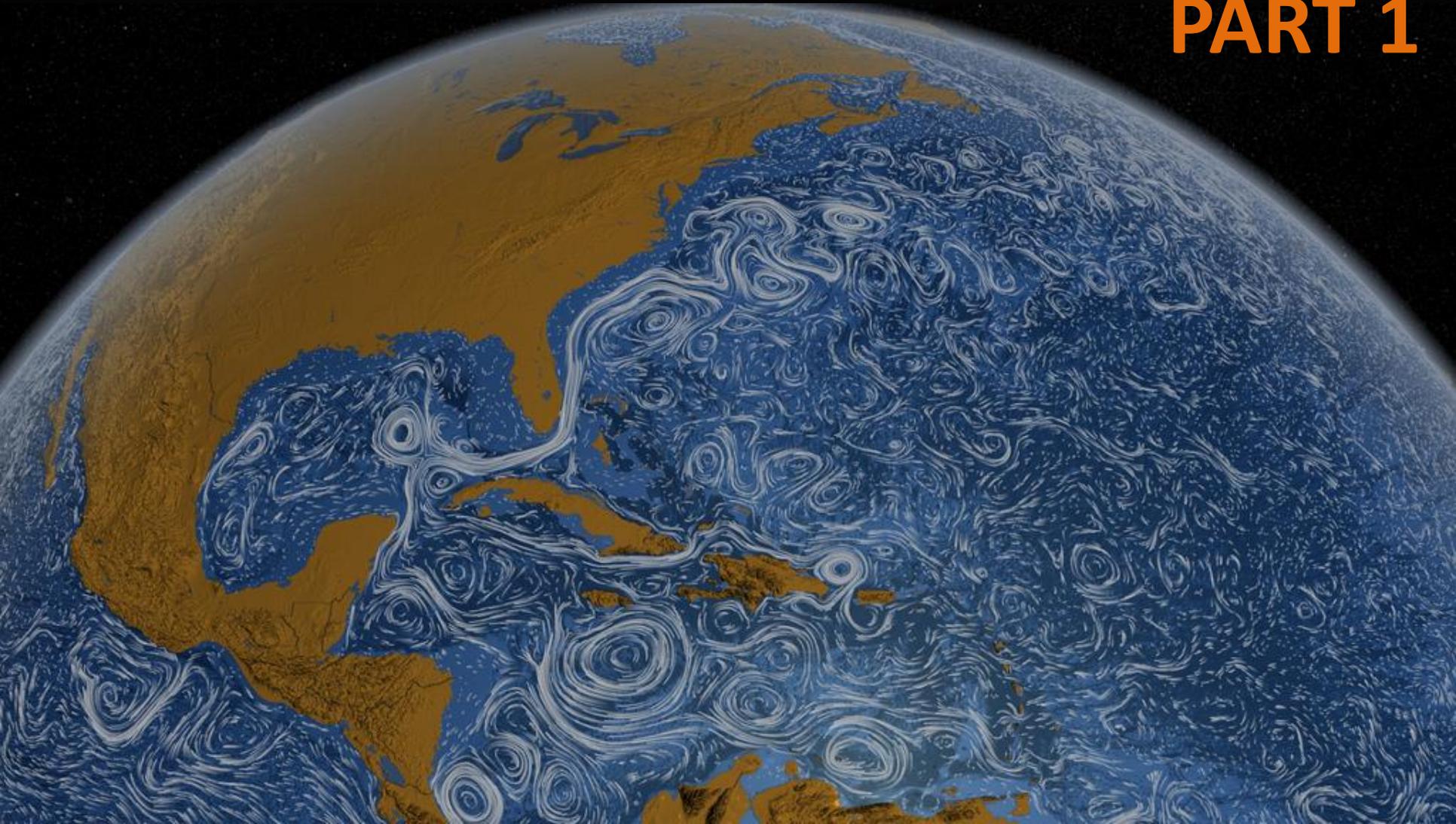
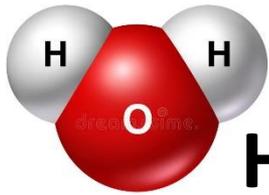


WORLD OCEAN

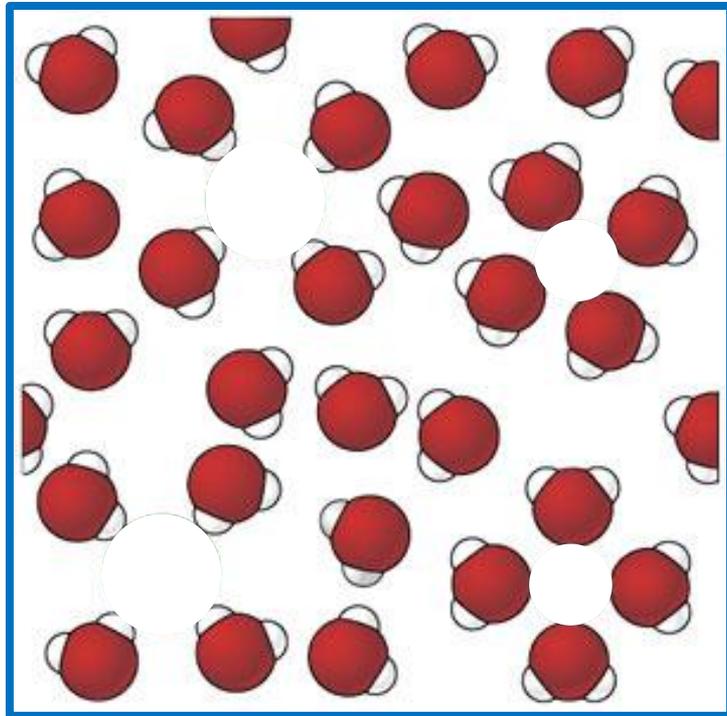
PART 1



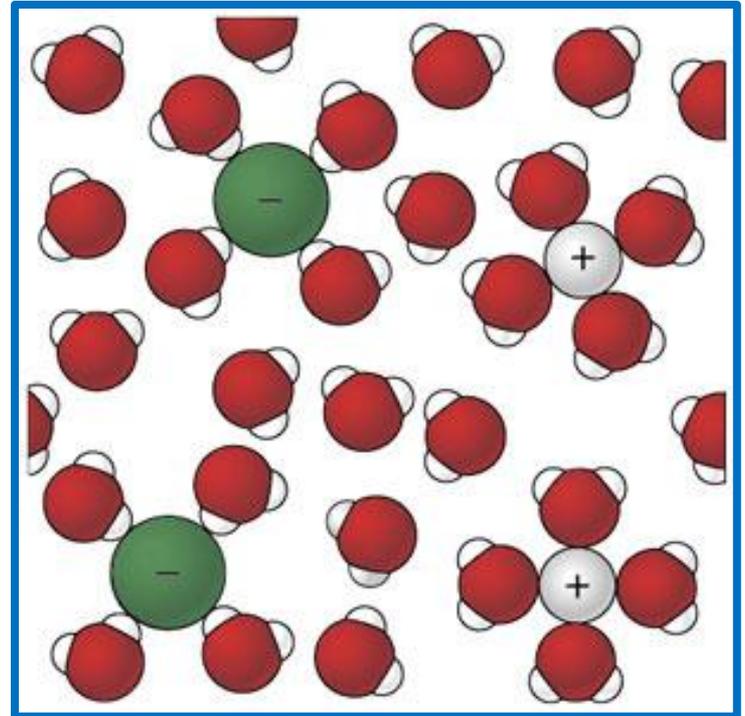
What Kind of Water?



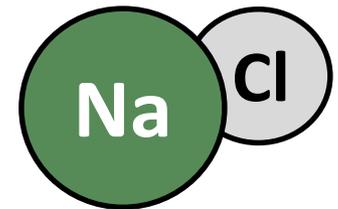
H₂O (water)



VS

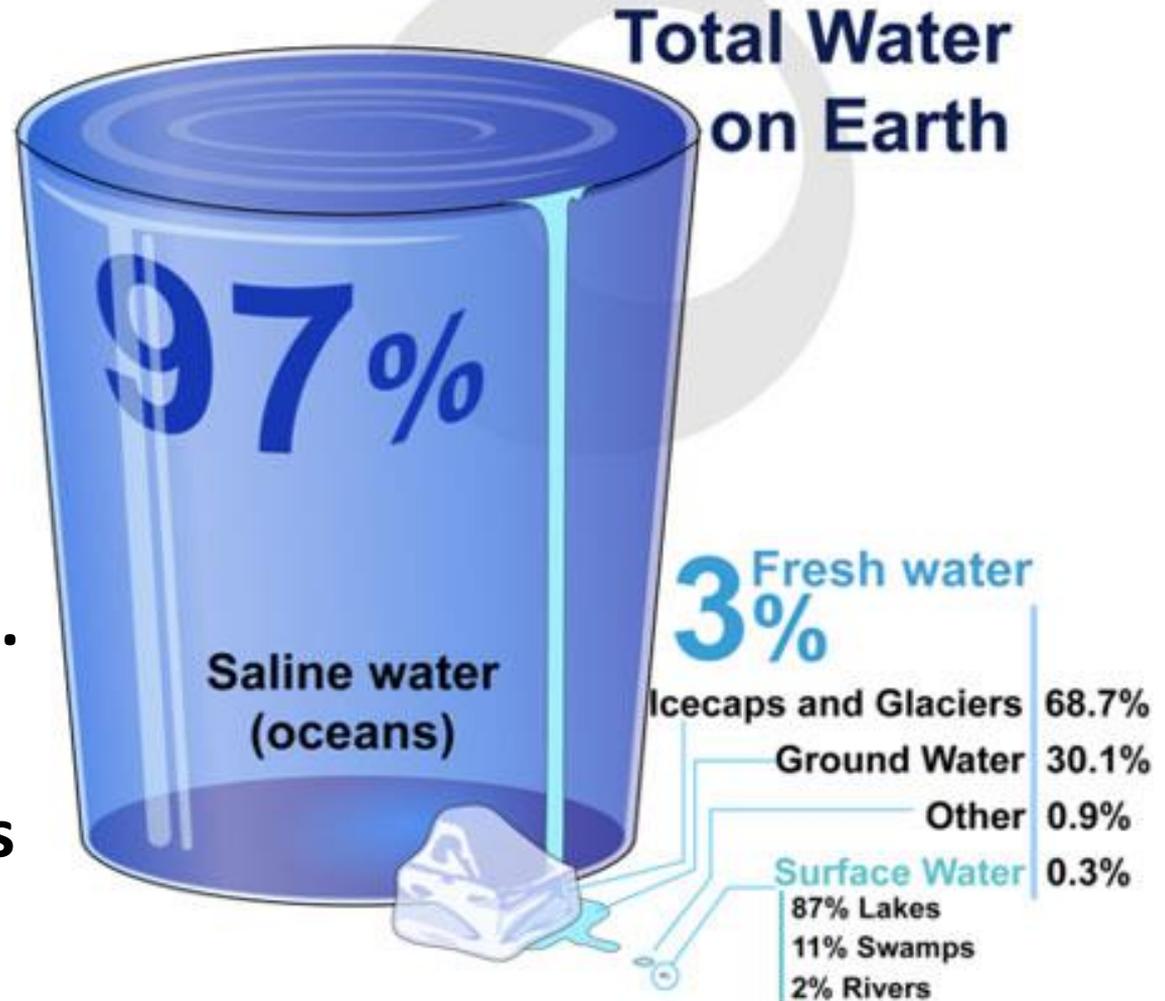


NaCl
(table salt)

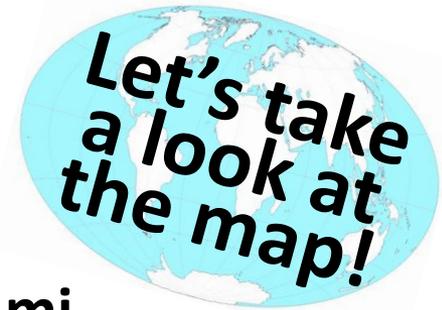


Saltwater (Saline Water)

- 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.

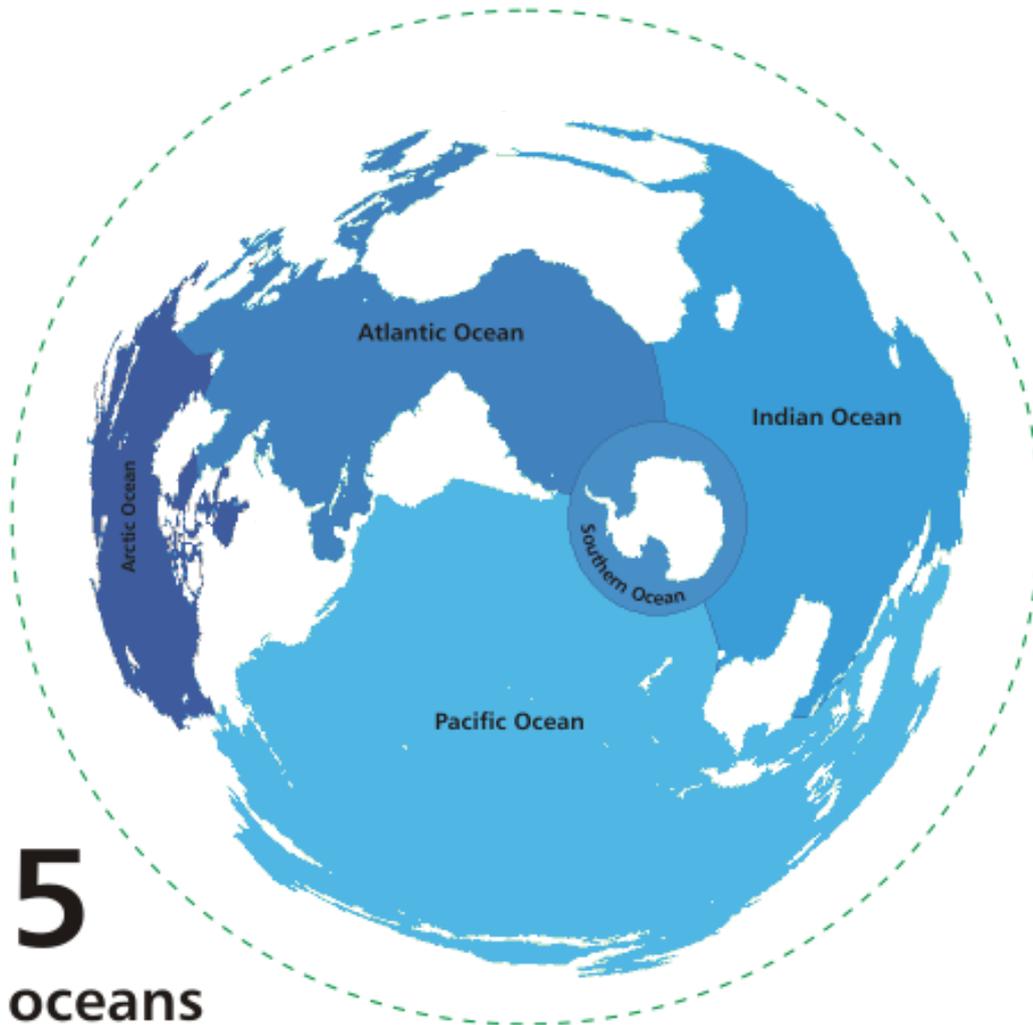


Quick Sea Facts



1. There are 111 seas in the world!
2. Largest sea: **Philippine Sea**, ~2 million sq mi.
3. Smallest sea: **Marmara Sea (Turkey)**, at 4,380 sq mi.
4. Saltiest true (open) sea: **Red Sea**, ~4.0%, due to high evaporation, little precipitation, and few (and mostly seasonal) inflowing rivers.
5. Saltiest land-locked sea: **Dead Sea**, ~30%!
6. Lowest salt content: **Baltic Sea**, only 1.0-1.5%, due to low evaporation and many inflowing rivers.
7. Warmest sea: the **Persian Gulf** contains the warmest sea water in the world reaching at 35°C (95°F); Red Sea is the second warmest.
8. Coldest seas are found near the poles.
9. The only sea without a land boundary: **Sargasso Sea**, home to free-floating seaweed called Sargassum and an amazing variety of marine species.

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.

5
oceans

Tides

Tides are the slow, periodic vertical rise and fall of the ocean surface.

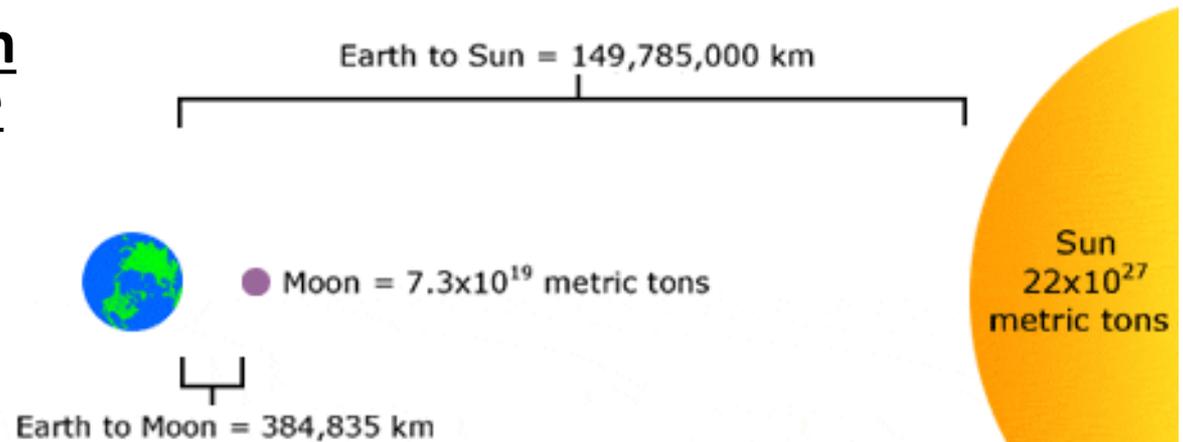


- Tide is a **giant wave** caused by **gravitational pull** of the Moon and Sun on the rotating Earth.
- The gravitational pull on liquids is much more noticeable than on solids (because liquids move more easily than solids).
- One low-tide/high-tide cycle takes about **12 hours and 25 minutes** (the *lunar day* is equal to about 24.8 hours).
- Tidal range is the difference in water level between high-tide and low-tide.
- Tides produce oscillating currents known as tidal streams.
- 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.

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.

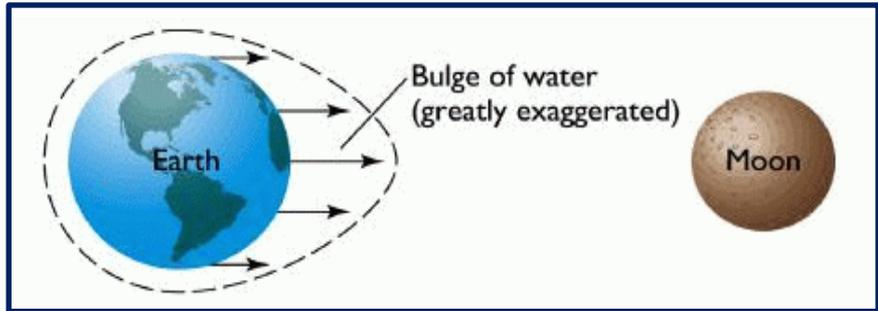
- The Sun is 27 million times more massive than the Moon.
- It is also 390 times further away from the Earth than the Moon.
- As a result, the Sun's tide-generating force is about **half** that of the Moon.



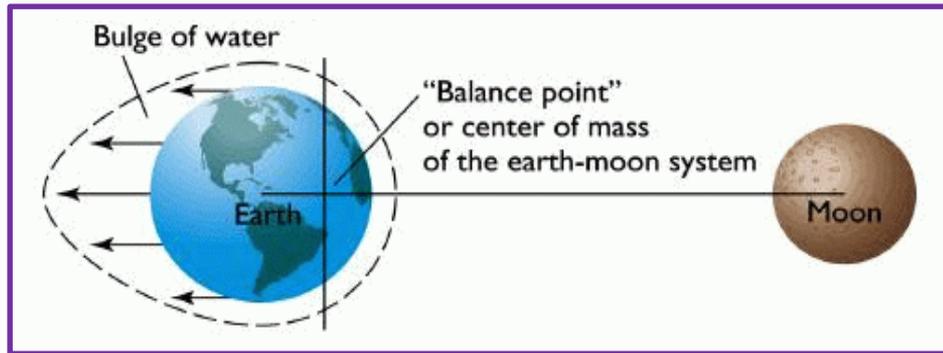
$$\text{Tide-Generating Force} \sim \frac{\text{Mass}}{(\text{Distance})^3}$$

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

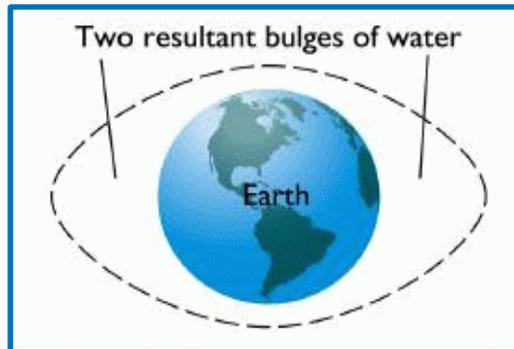
Tidal Bulges



gravitational attraction
of the Moon



centrifugal force
due to Earth rotation



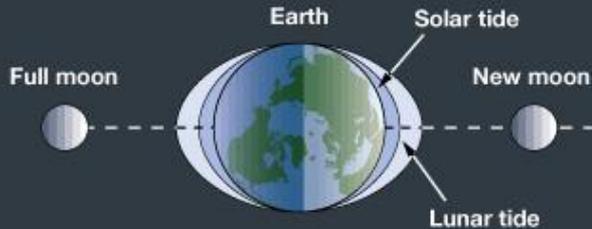
two tidal bulges
of water

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

Monthly Tidal Cycle (29½ days)

About every 7 days, Earth alternates between:

Spring Tide



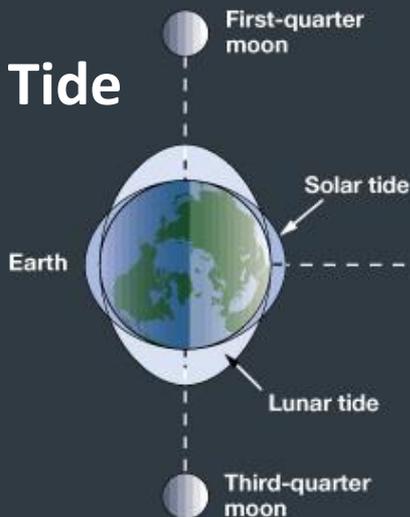
Alignment of Earth-Moon-Sun system (syzygy)

Spring Tide

large tidal range,

highest high tide and lowest low tide

Neap Tide

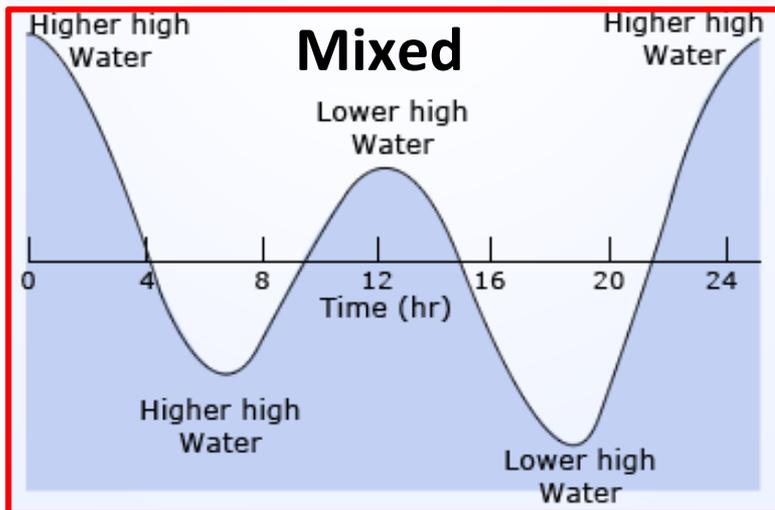
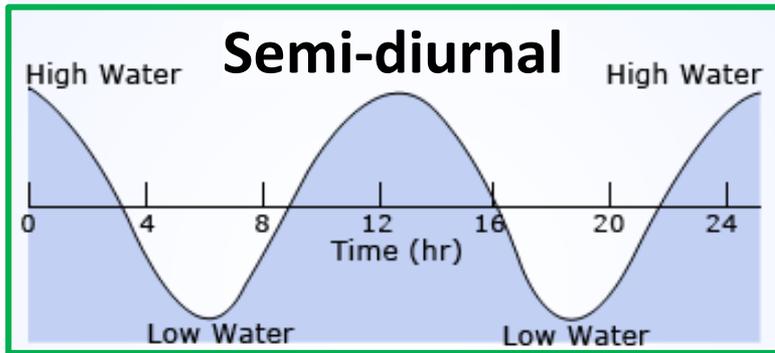
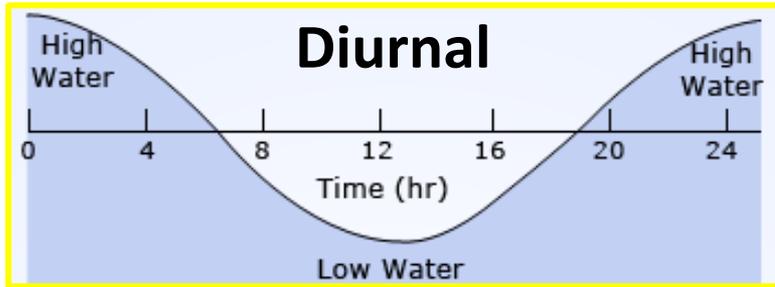


Earth-Moon-Sun system at right angles (quadrature)

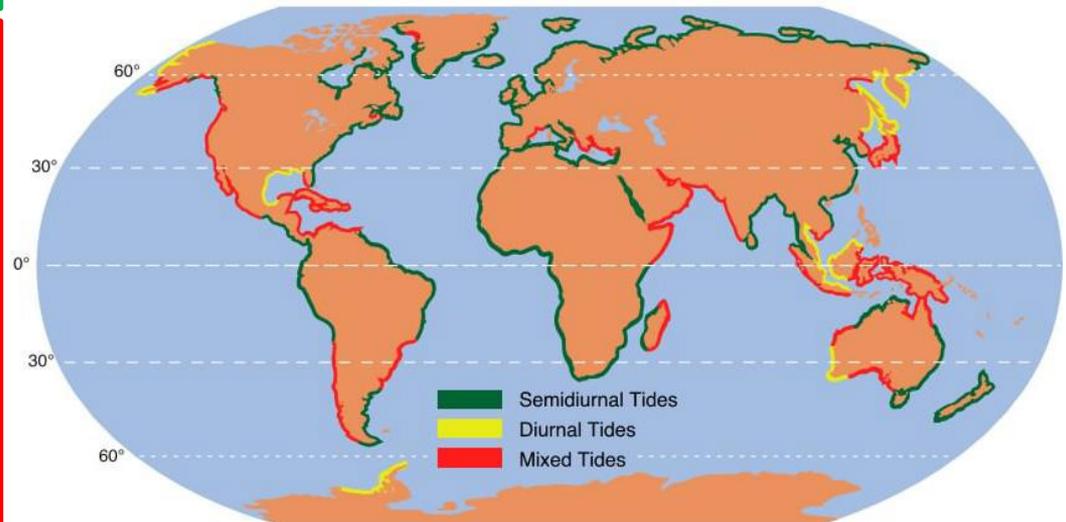
Neap Tide

moderate tidal range

Types of Tides



- **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**

