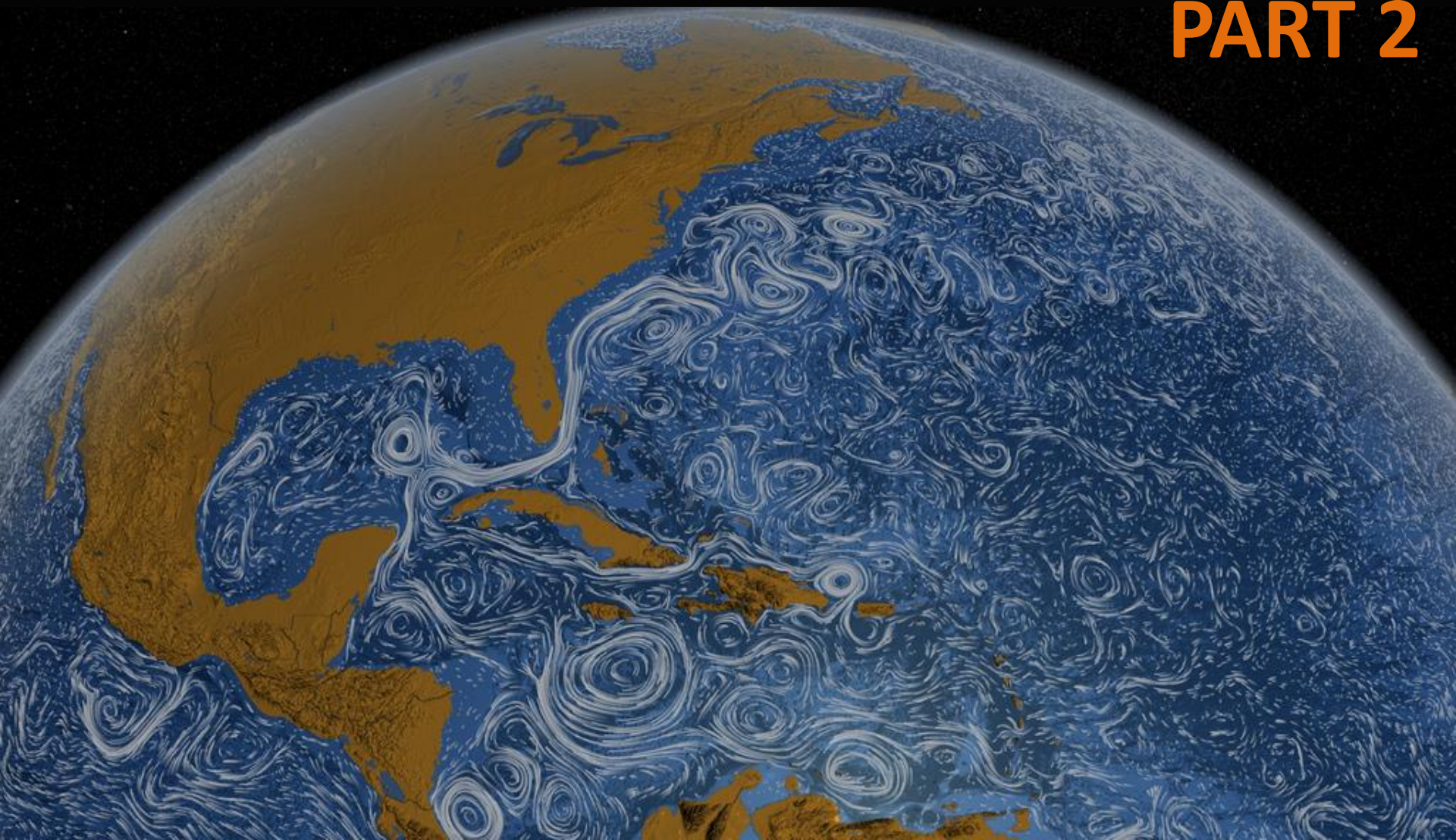
WORLD OCEAN

PART 2



Tides

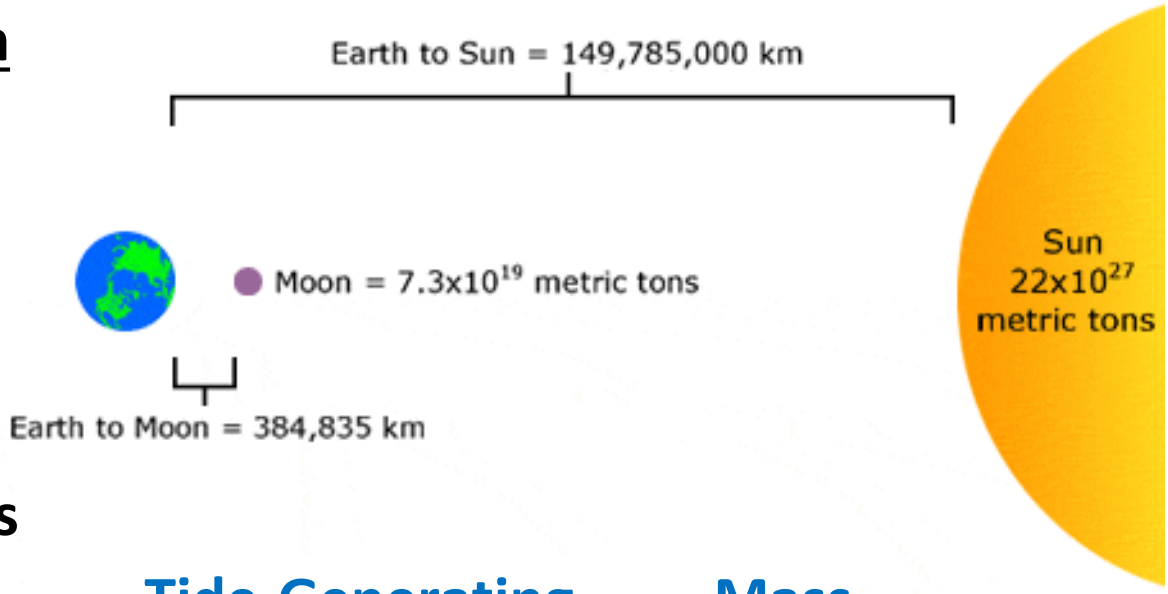
Tides are the slow, periodic vertical rise and fall of the ocean surface.

- **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.

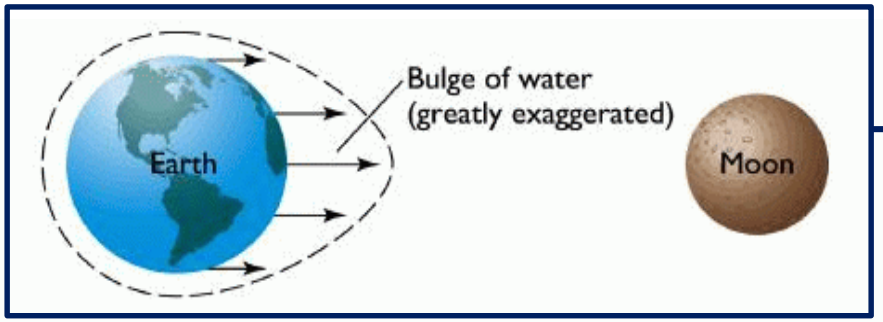
- **The Sun is 27 million times more massive than the Moon.**
- **It is also 390 times further away from the Earth than the Moon.**
- **As a result, the Sun's tide-generating force is about half that of the Moon.**



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

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

Tidal Bulges



gravitational attraction of the Moon

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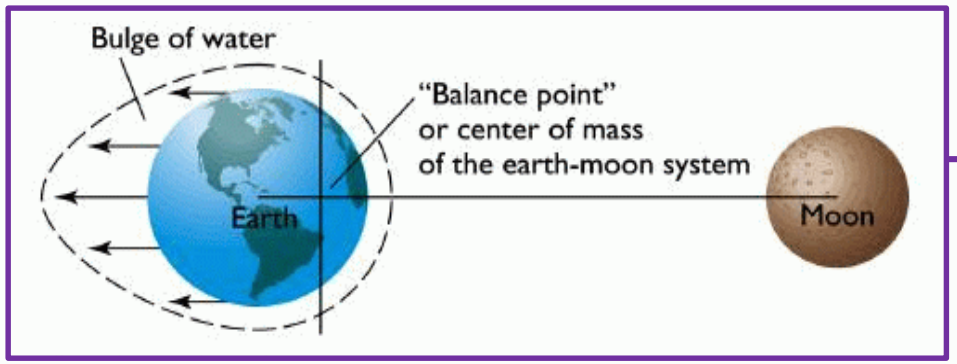
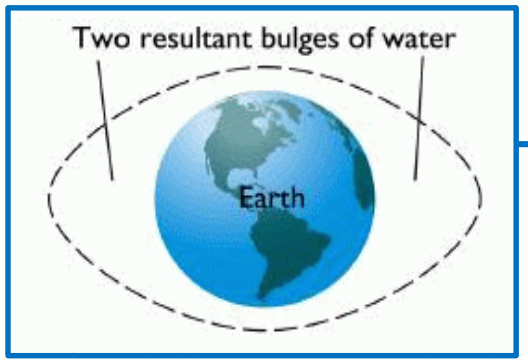


centrifugal force due to Earth rotation

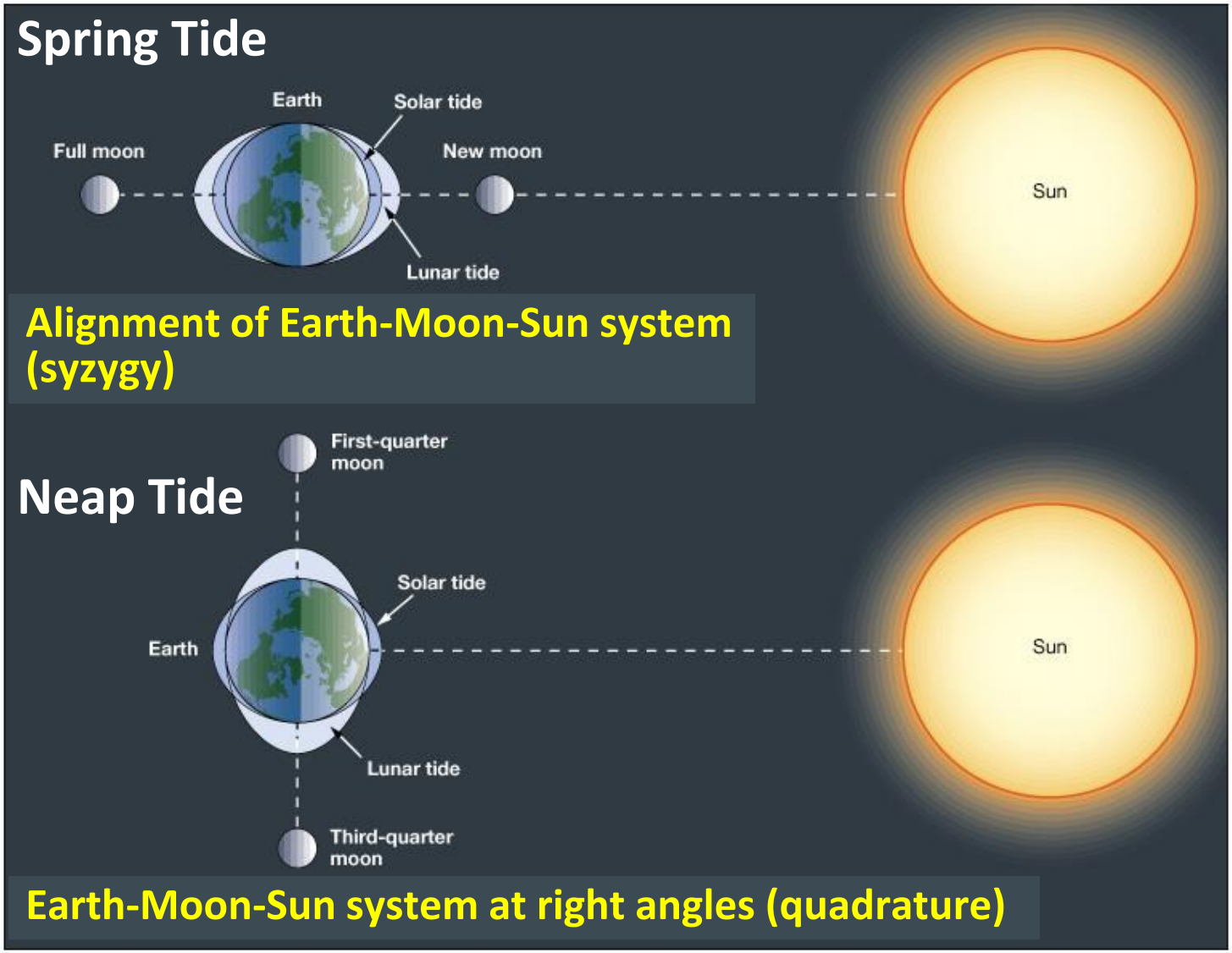


two tidal bulges of water

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

Monthly Tidal Cycle (29½ days)

About every 7 days, Earth alternates between:



Spring Tide

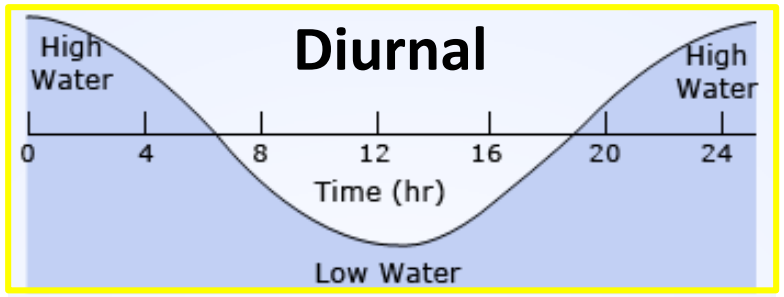
large tidal range,

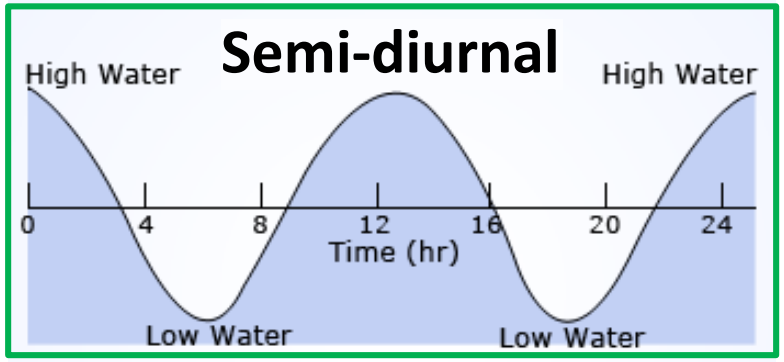
highest high tide and lowest low tide

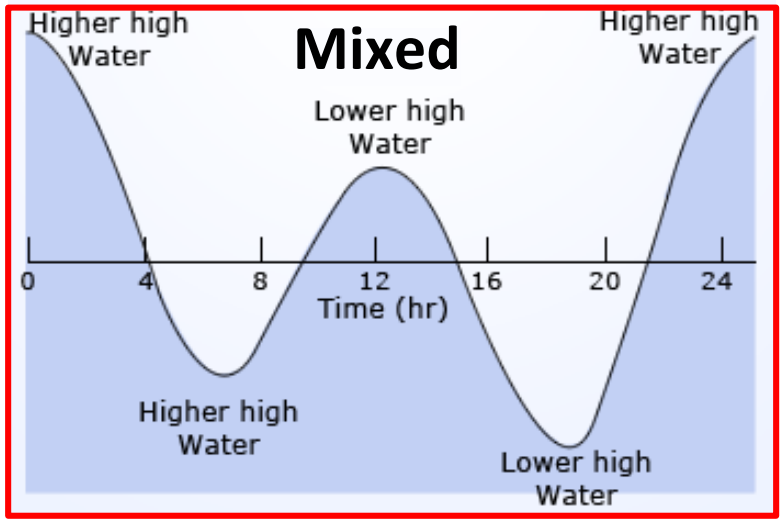
Neap Tide

moderate tidal range

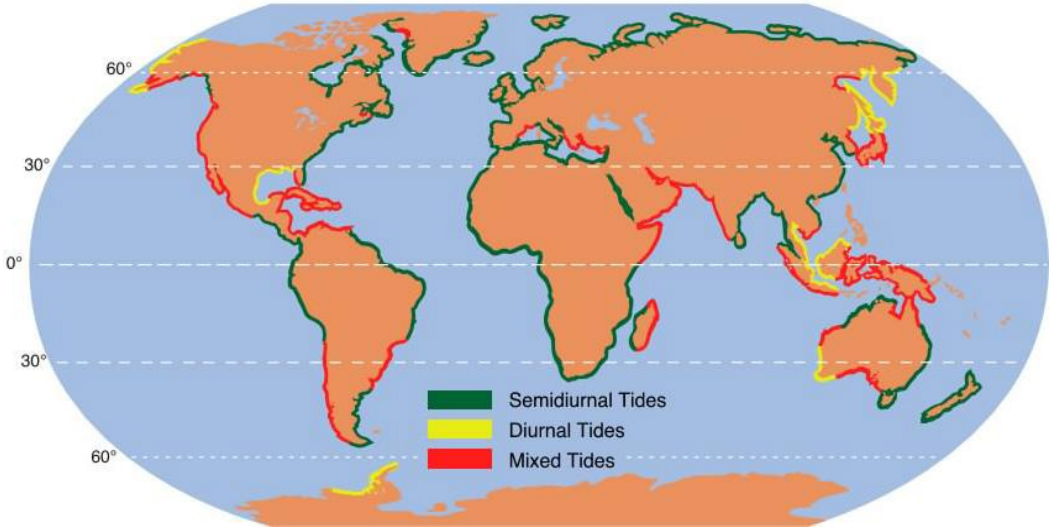
Types of Tides



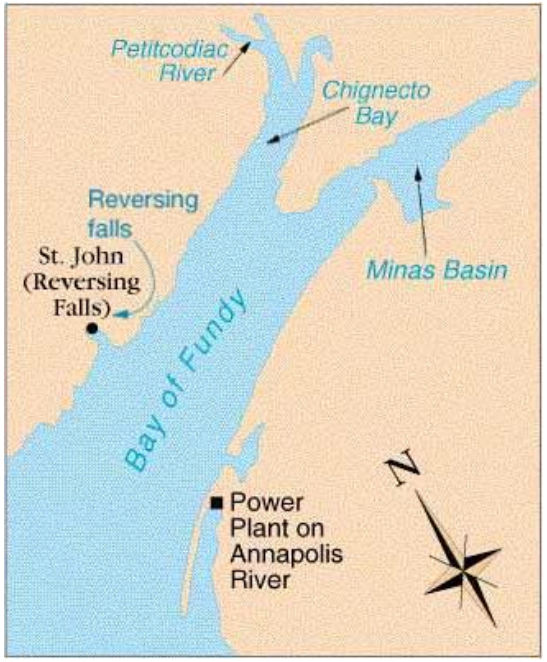




- **Diurnal: one tidal cycle per day (Gulf of Mexico)**
- **Semi-diurnal: two high waters and two low waters each day (Boston, MA)**
- **Mixed: two high and two low waters each day, all four with different heights (Los Angeles, CA).**



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



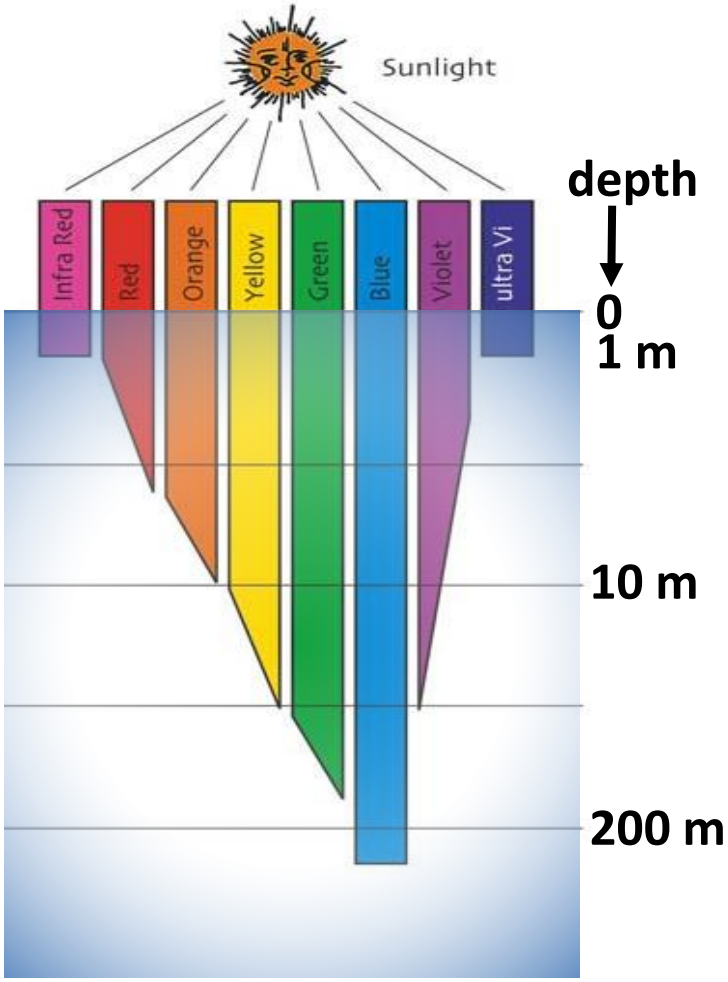
- **Tidal energy is focused by shape and shallowness of bay.**
- **Maximum spring tidal range in Minas Basin = 17 meters (56 feet).**

Alma harbor at High Tide and Low Tide

Ocean Temperature

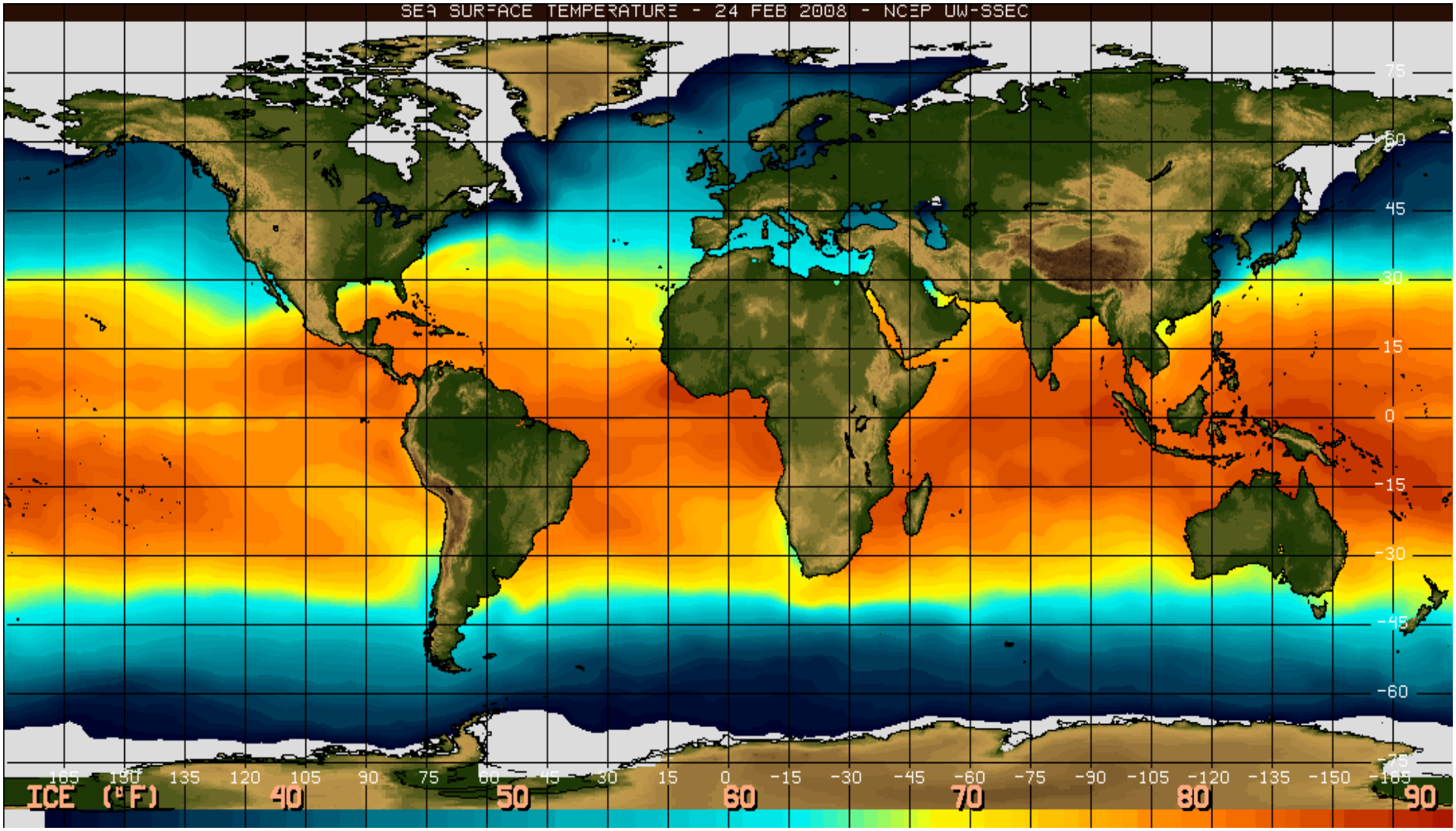
Ocean temperature varies with depth, latitude, and season.

- **Ocean is heated by the Sun from the surface downward.**
- **Ocean surface temperature can vary a lot but deep waters are very cold, 75% of the ocean is between 30 to 43°F (–1 to +6°C).**
- **Both *seasonal* and *latitude* variation of ocean surface temperature are mostly due to the relative position of the Earth and the Sun.**
- **Seasonal change is slight: water loses or gains heat much more slowly than land.**



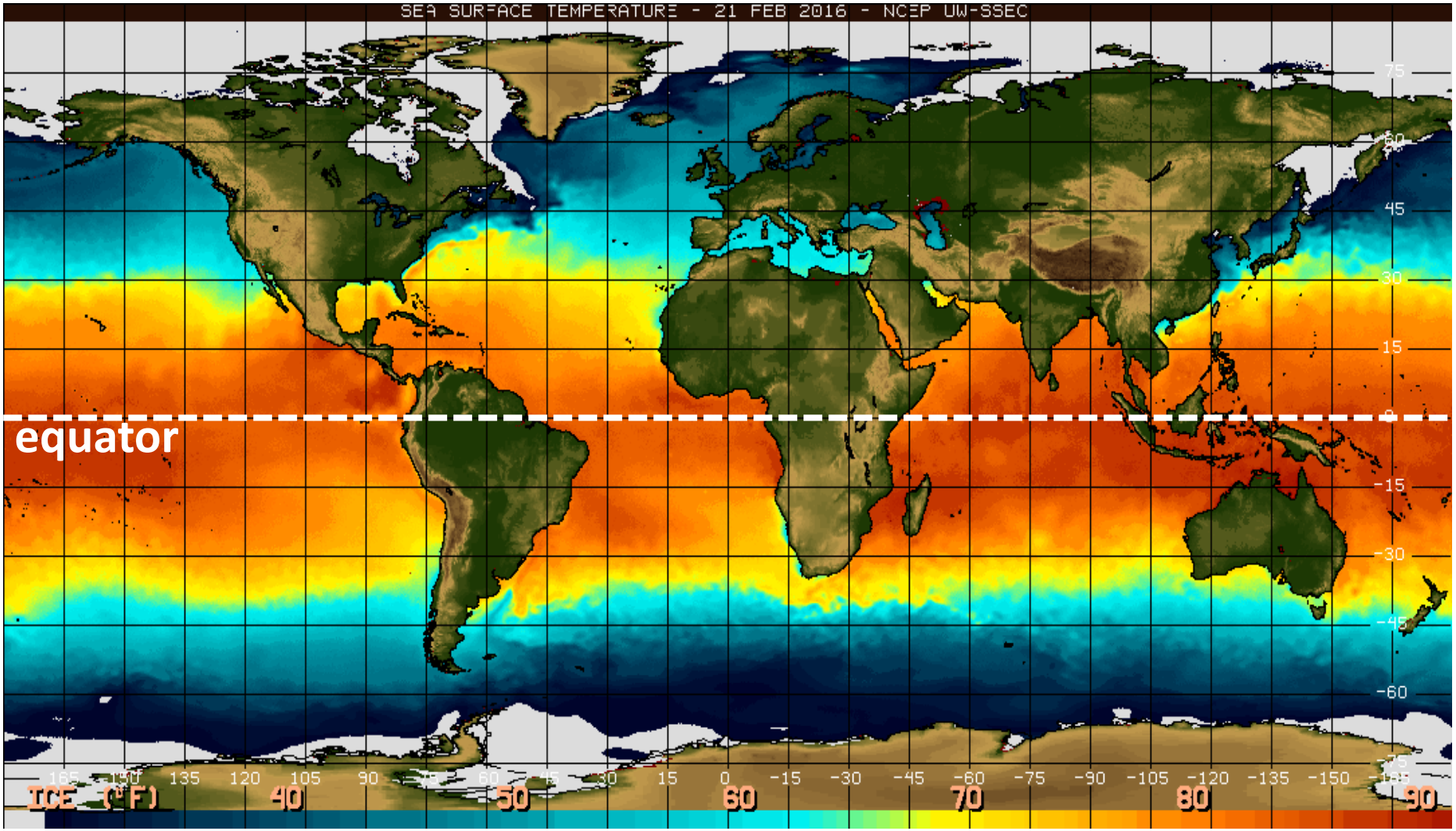
Sunlight penetration in ocean

Temperature: Latitude Variation



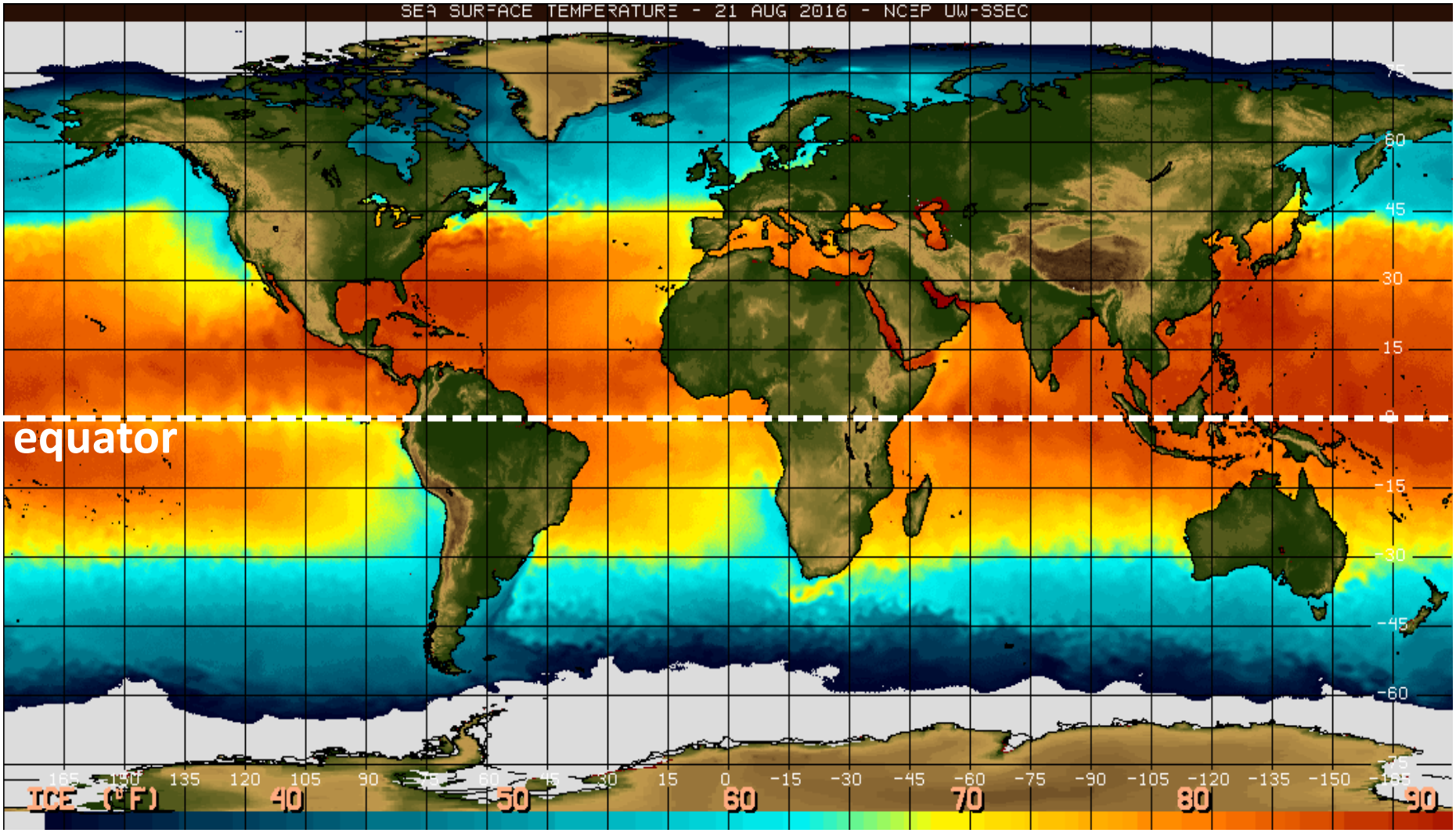
Ocean surface temperature varies greatly with latitude.

Temperature: Seasonal Variation



Ocean surface temperature on February 21, 2016.

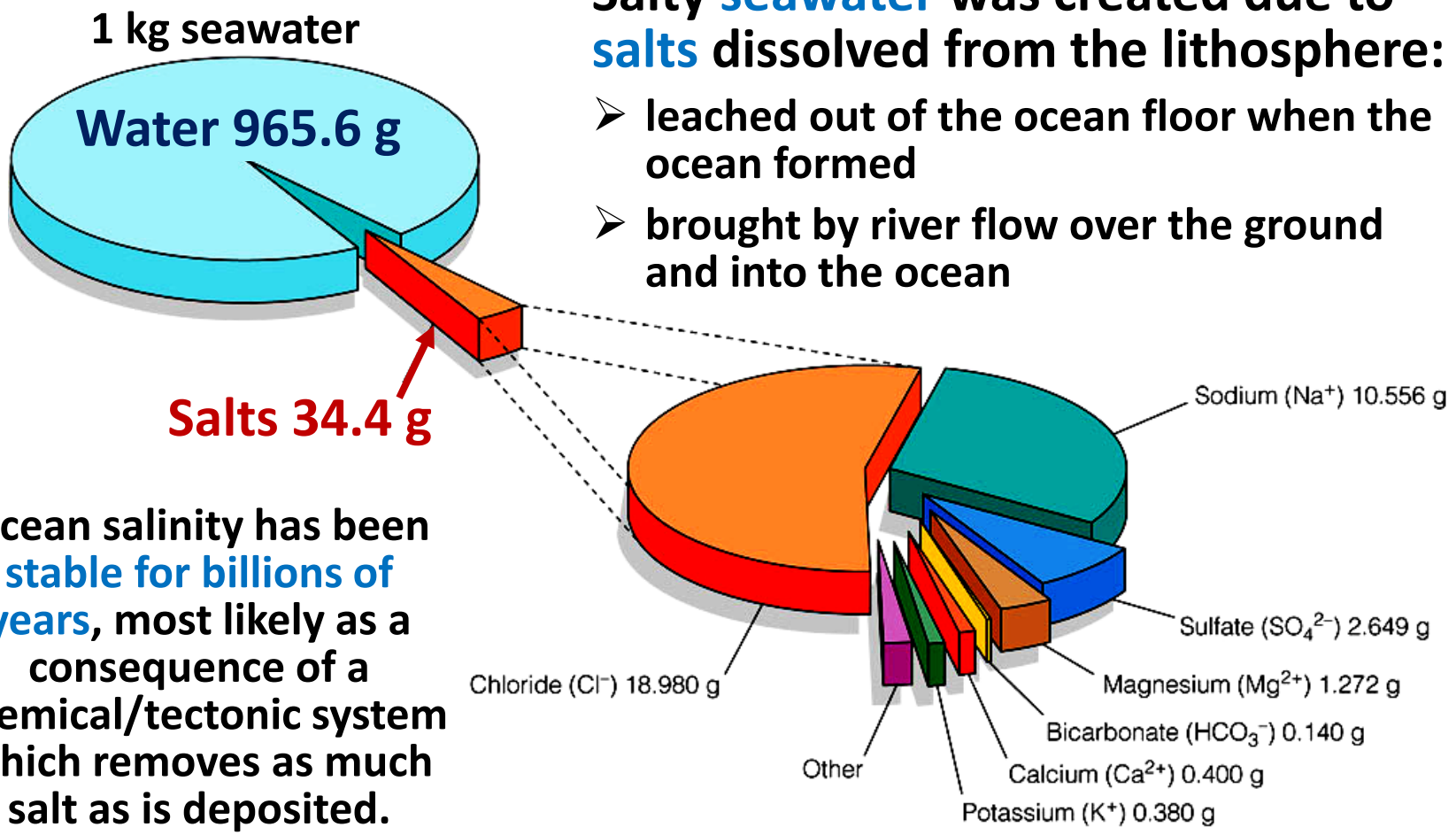
Temperature: Seasonal Variation



Ocean surface temperature on August 21, 2016.

Ocean Salinity

Salinity is a measure of the amount of salt dissolved in a liquid (measured in *percent ,%* or *parts per thousand, ppt or ‰*).

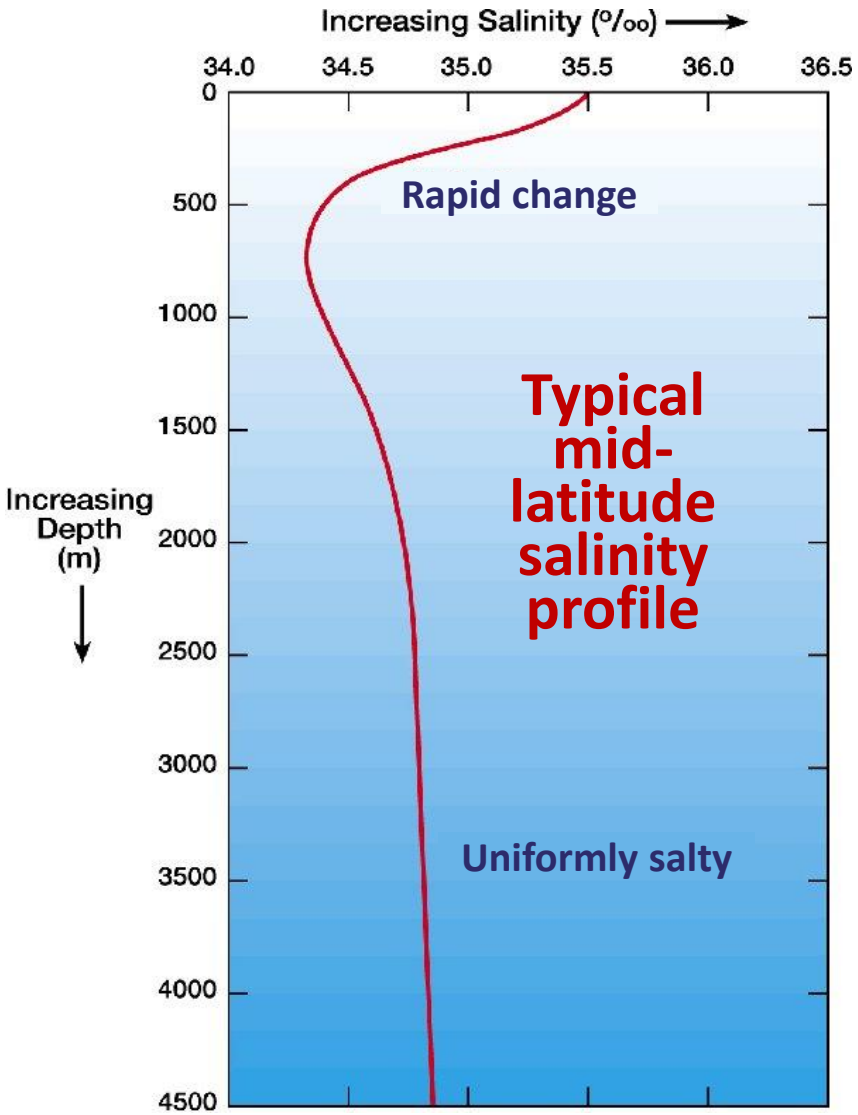


Salty seawater was created due to salts dissolved from the lithosphere:

- **leached out of the ocean floor when the ocean formed**
- **brought by river flow over the ground and into the ocean**

Ocean salinity has been stable for billions of years, most likely as a consequence of a chemical/tectonic system which removes as much salt as is deposited.

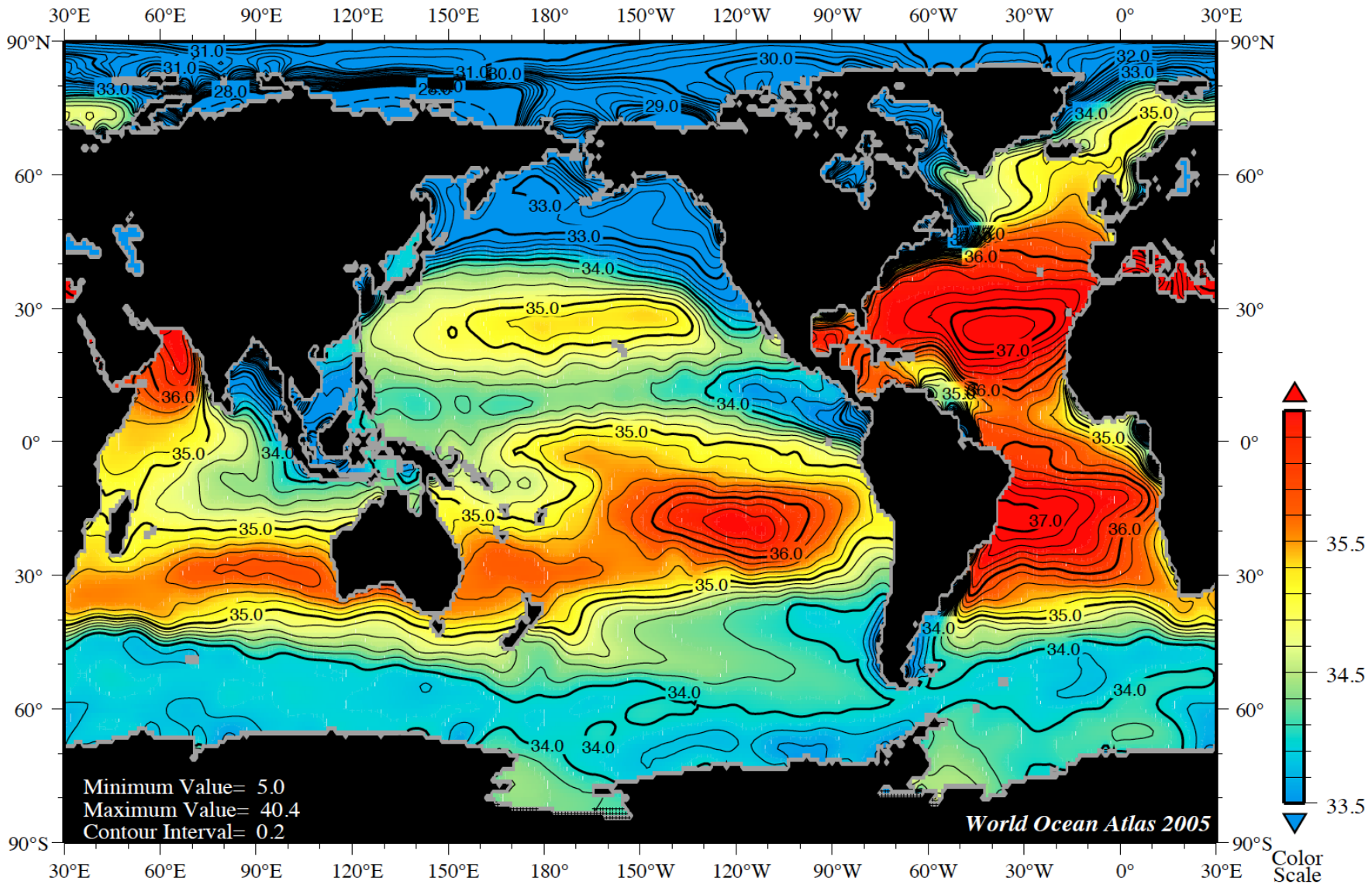
Salinity: Variation with Depth



Seawater is **not uniformly saline** throughout the world.

- Surface (mixed) layer salinity is influenced by:
  - evaporation of water (‰↑)
  - ice formation (‰↑)
  - ice melting (‰↓).
- Saltier water is denser and consequently, it sinks down.
- Beyond ~1000 m, salt content changes very little.

Ocean Surface Salinity Pattern



Difference in Salinity

Two bodies of water merging in the middle of <u>The Gulf of Alaska</u> form a strange and distinctive junction:

- One side is water from the melting glaciers (very low salinity) while the other has a higher percentage of salt.
- **Different salinity means different densities** and therefore makes it more difficult to mix.

Question: which side is which?

Salinity is an ecological factor of great importance, influencing:

- **the types of organisms that live in a body of water,**
- **the kinds of plants that grow either in a water body, or on nearby land.**