

# Physical Oceanography

waves, currents, circulation, evaporation

old sow vortex

toroidal vortices

---

---

---

---

---

---

---

---

---

---

Water Cycle  
Carbon Cycle  
Types of Waves  
How Waves form  
Anatomy of a wave  
Currents  
Coriolis  
El Nino  
Tides

---

---

---

---

---

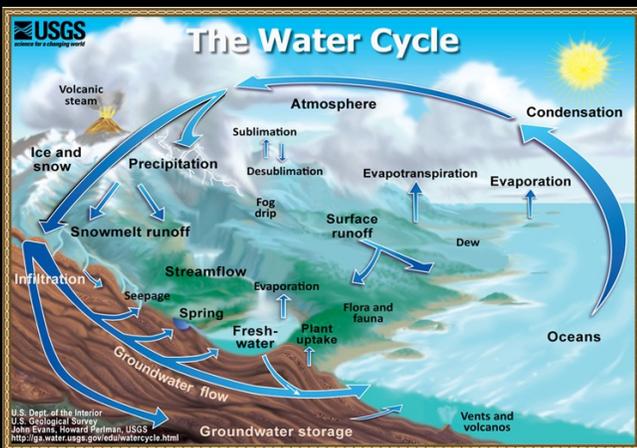
---

---

---

---

---



---

---

---

---

---

---

---

---

---

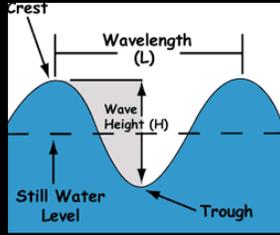
---



## Parts of a wave:

### > Parts of a Wave

- **Crest** = high point
- **Trough** = low point
- **Height** = vertical distance from crest to trough
- **Wavelength** = Horizontal distance between crest to crest or trough to trough



Wave period : time for 2 crests to pass fixed point (T) sec

Wave speed (C) :  $C = \text{wavelength} / T$  (m/s)

Wave steepness :  $H / \text{wavelength}$

When  $H / \text{wavelength} = 1/7$  or angle at crest  $120$  or less =  
**Breaker**

---

---

---

---

---

---

---

---

---

---

## Size of Wind Generated Waves

### > Depends on 3 things:

- Wind Speed
- Wind Duration (length of time wind blows)
- "Fetch" Extent of open water across which the wind can blow



---

---

---

---

---

---

---

---

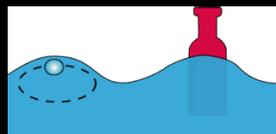
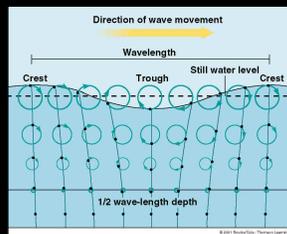
---

---

## Wave movement

> Water travels in vertical circular orbits

> Wave moves, particles don't!



---

---

---

---

---

---

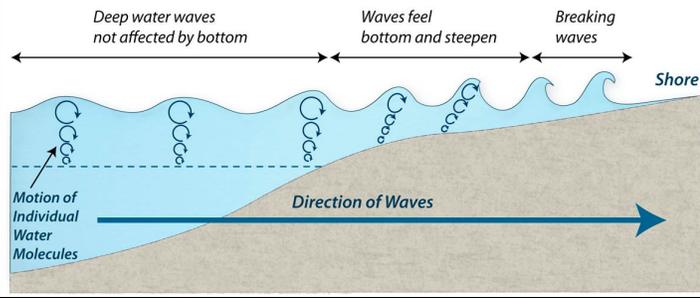
---

---

---

---

## Breaking Waves



## Importance of Waves

### > Shaping Coastlines

- Erode cliffs
- Grind rock into sand



### > Ecology

- Returns O<sub>2</sub> to water
- Stir up food for filter feeders



## Types of Waves

**CHOP** – Short period (back bays)

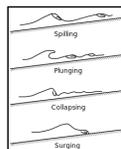
**SWELL** – Long period (boat rolls; seasickness)

**SWASH** – water up beach      **BACKWASH** – back down

Spilling: break when wind pushes them (wave breaks apart)

Plunging: curl over and break (perfect wave)

Surging: never really curls just washes ashore





## Tides

Tides occur four times a day (most of the time).  
Two High tides and two low tides that are 50 minutes longer each time. (because it takes the moon 24 hours and 50 minutes to circle the Earth).

The moon is the main gravitational pull but the Sun also plays a role.

The heights and time of tides vary depending on where you are on Earth and what the geography of your location is like.

---

---

---

---

---

---

---

---

---

---

Low Tide



High Tide



---

---

---

---

---

---

---

---

---

---

## Tides

> The rhythmic rise and fall of the ocean's water

High tide = rising, incoming tide, flow  
Low tide = receding, outgoing tide, ebb

- > Slack tide = vertical movement stops
- > Produced by motions of Earth, sun, & moon
- > Bulge on opposite side because centr. force > pull of moon



---

---

---

---

---

---

---

---

---

---



## Importance of Tides

- Expose & submerge organisms
- Circulate water in bays & estuaries
- Circulates food, wastes, etc
- Trigger spawning (grunion, horseshoe crab)



---

---

---

---

---

---

---

---

---

---

## Tidal Bores

a super cool event when the tide comes in all at one time.  
Happens in Anchorage, AK and The Bay of Fundy, Canada



---

---

---

---

---

---

---

---

---

---

Japanese waves  
ak tidal bore

bore tide 1  
bore tide 2

talbot bay australia



---

---

---

---

---

---

---

---

---

---

## Rogue waves

rogue wave

big waves

ships in storms

rogue waves music

rogue waves storm

Rogue, freak, or killer waves have been part of marine folklore for centuries, but have only been accepted as a real phenomenon by scientists over the past few decades.

Rogues, called 'extreme storm waves' by scientists, are those waves which are greater than twice the size of surrounding waves, are very unpredictable, and often come unexpectedly from directions other than prevailing wind and waves.

Most reports of extreme storm waves say they look like "walls of water." They are often steep-sided with unusually deep troughs.

Since these waves are uncommon, measurements and analysis of this phenomenon is extremely rare. Exactly how and when rogue waves form is still under investigation, but there are several known causes