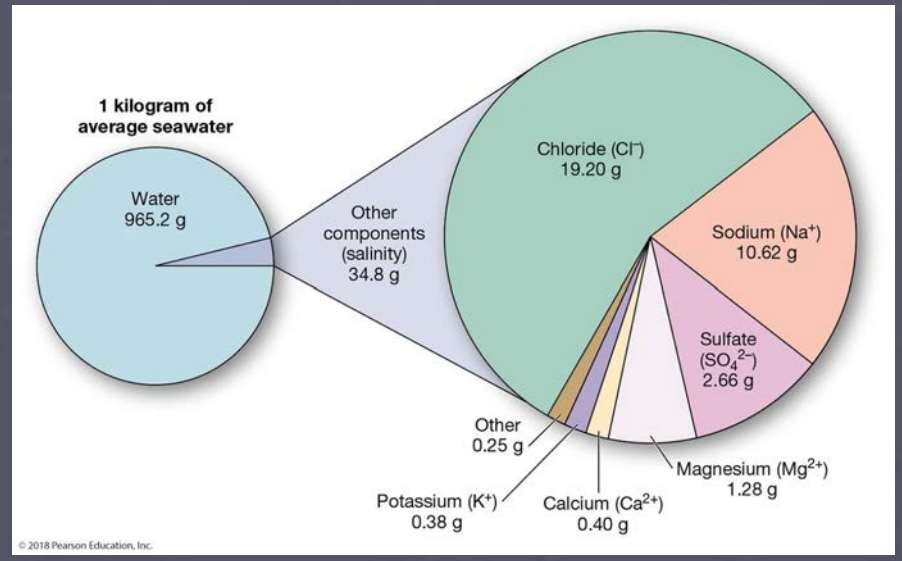
Oceanography

Chapter 5: Atmospheric and Oceanic Circulations

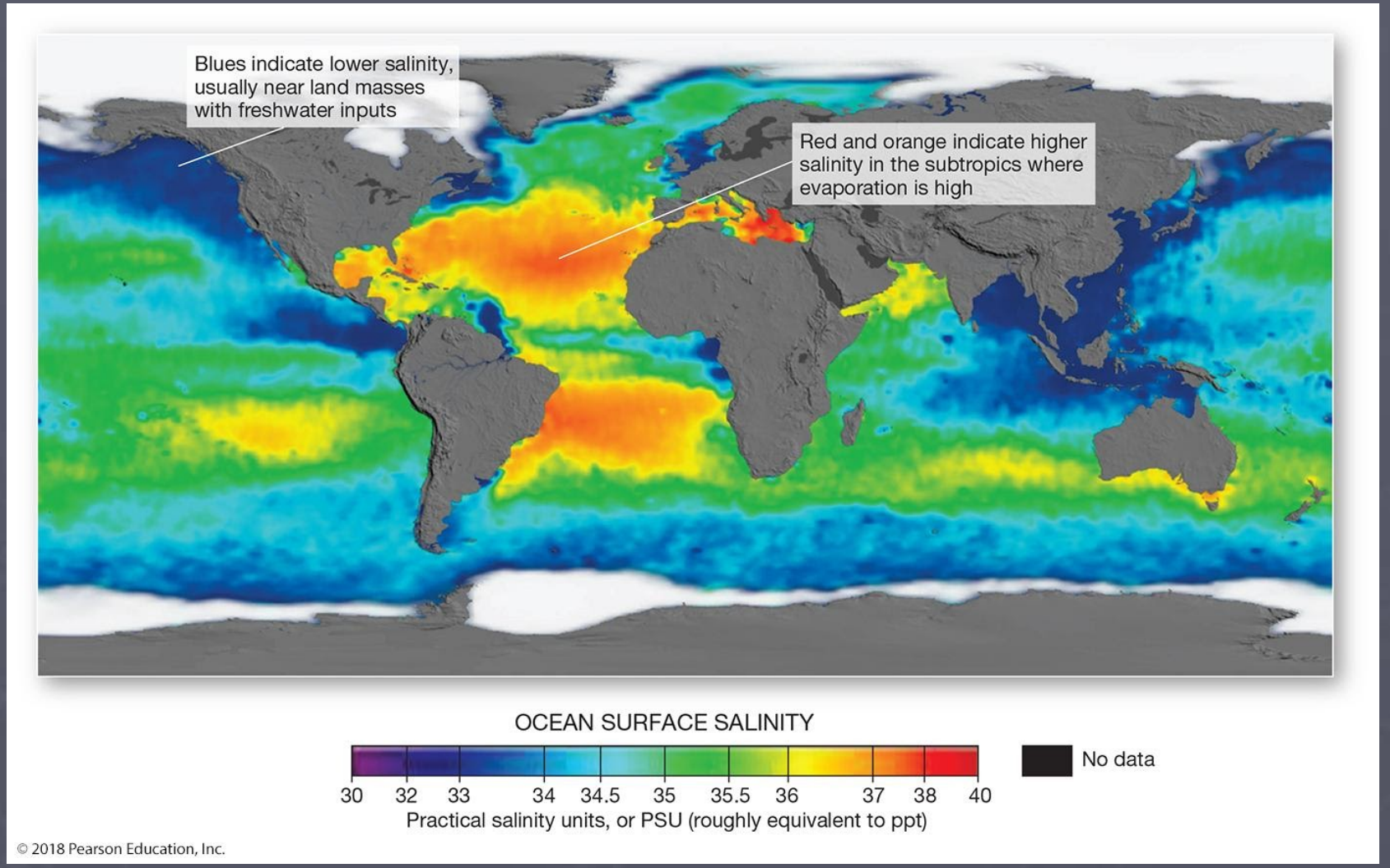
Chapter 16: Oceans and Coastal Systems

Classifying Seawater and Freshwater

- If salinity is greater than 3.5%, the seawater is **brine**. (>35ppt)
  - Mostly occurs in enclosed seas
- If salinity is less than 3.5%, the seawater is **brackish**. (<35ppt)
  - Mostly near land, especially near estuaries
- Freshwater is 0.5 parts per thousand or less

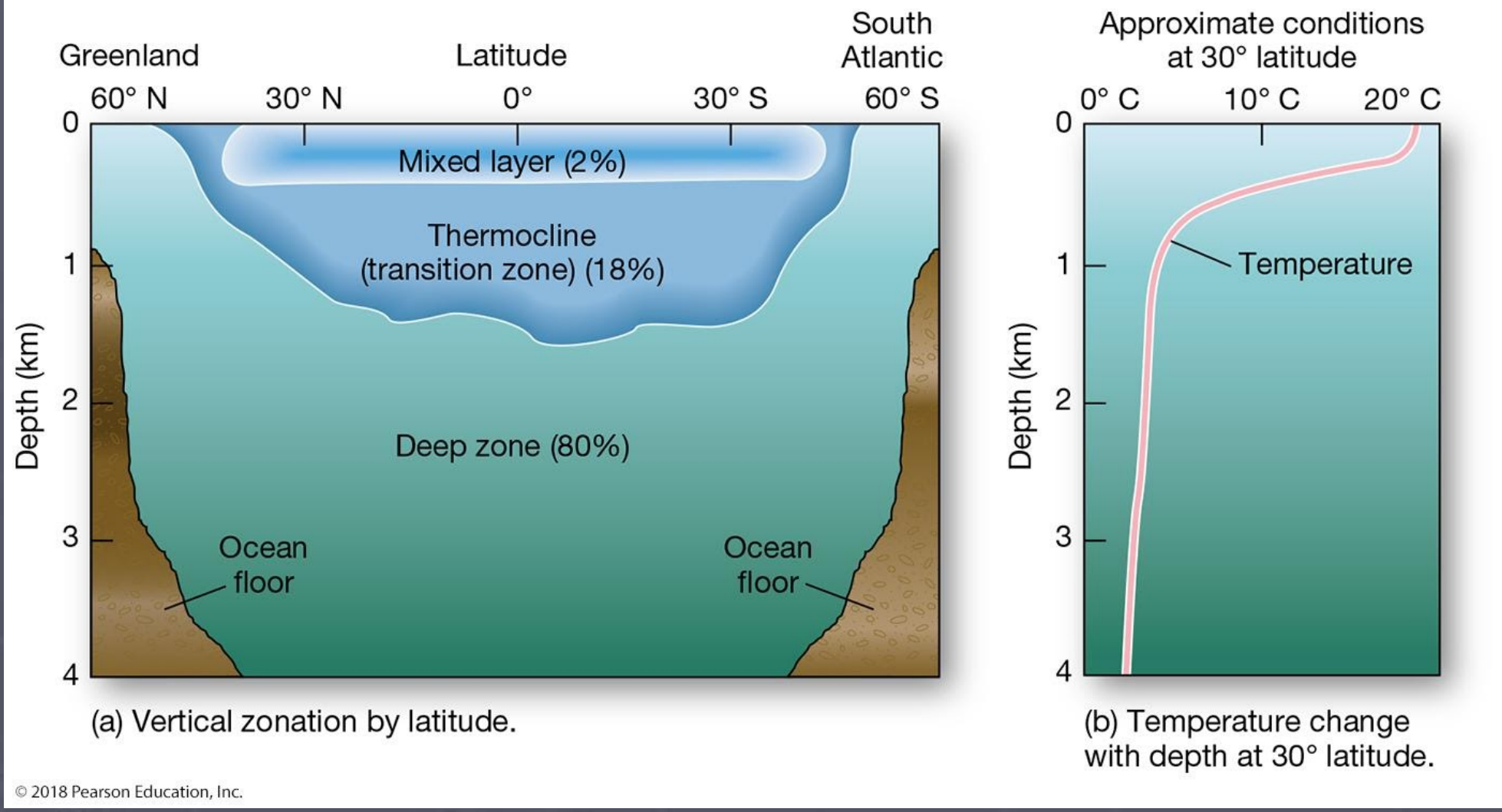


Ocean Salinity



Dead Sea (Salinity 300ppt)

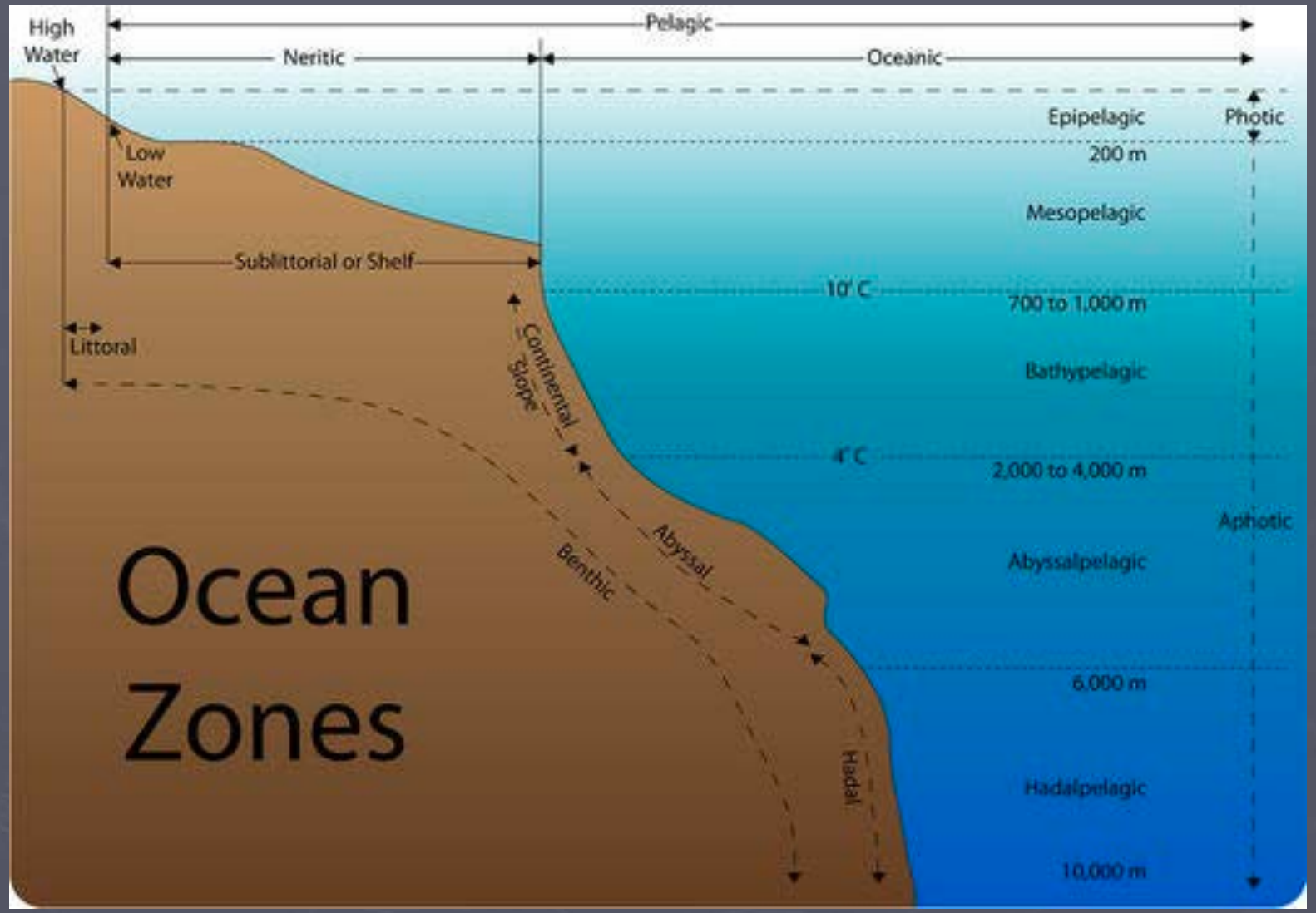
Ocean's Physical Structure



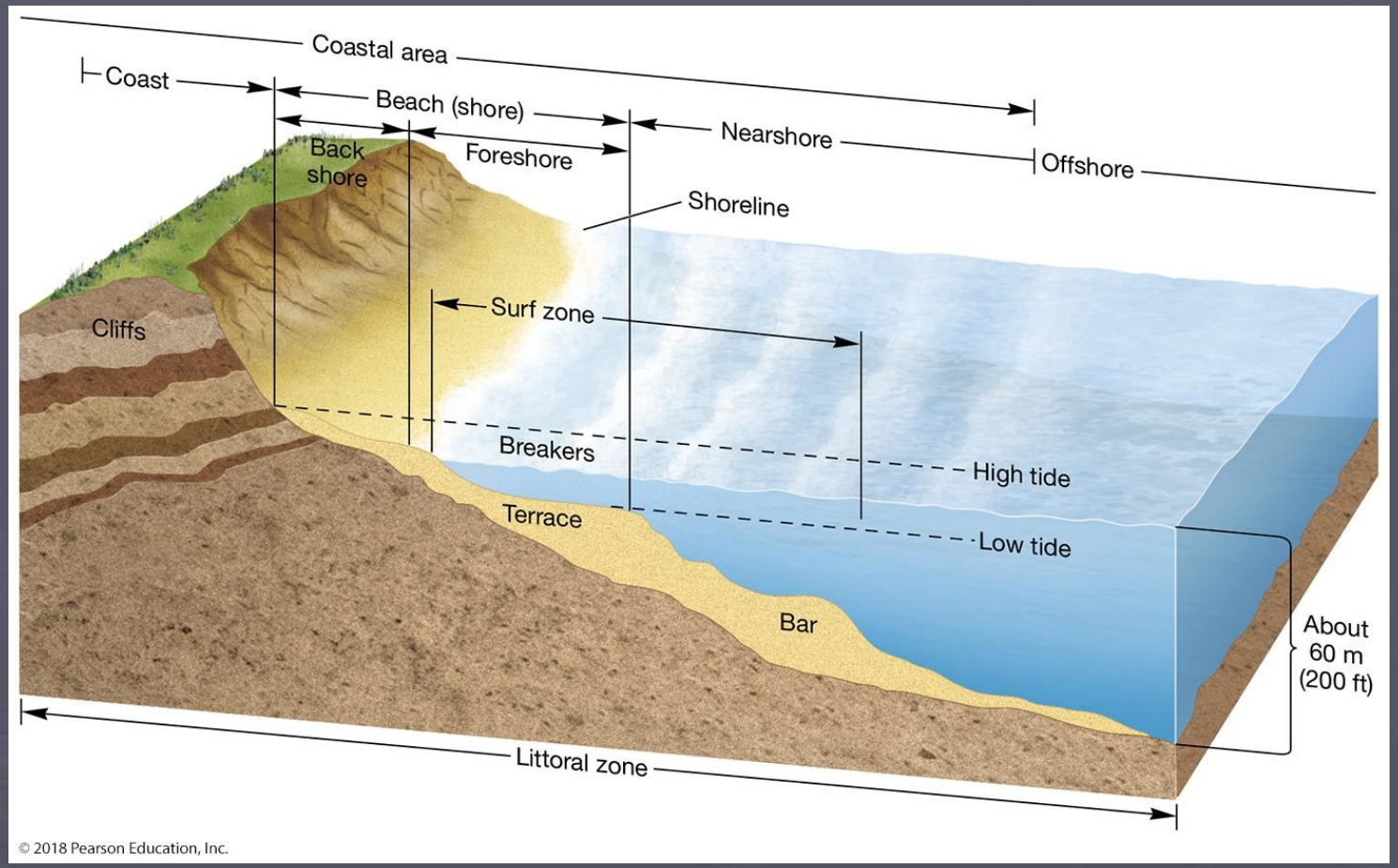
(a) Vertical zonation by latitude.

(b) Temperature change with depth at 30° latitude.

Oceanic Zones



The Littoral Zone

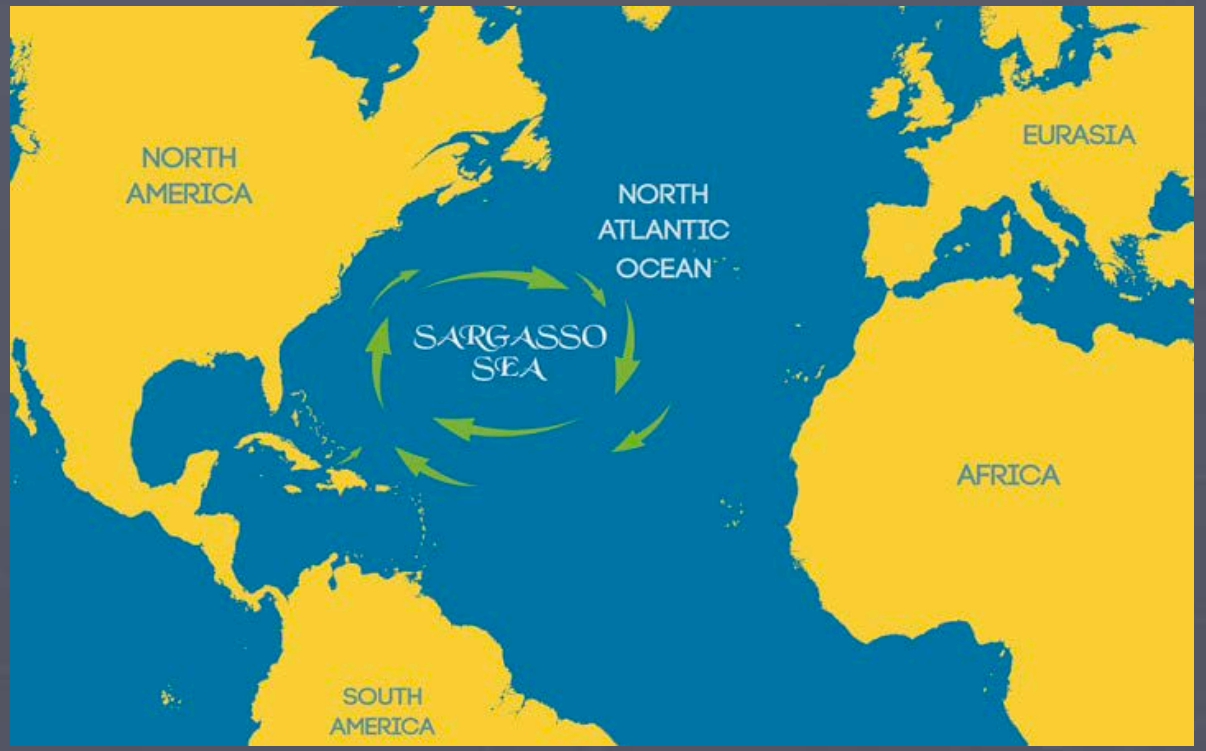


Seas vs. Oceans

- Seas are smaller than oceans and usually partially surrounded by land
  - Almost all seas buffer land from oceans

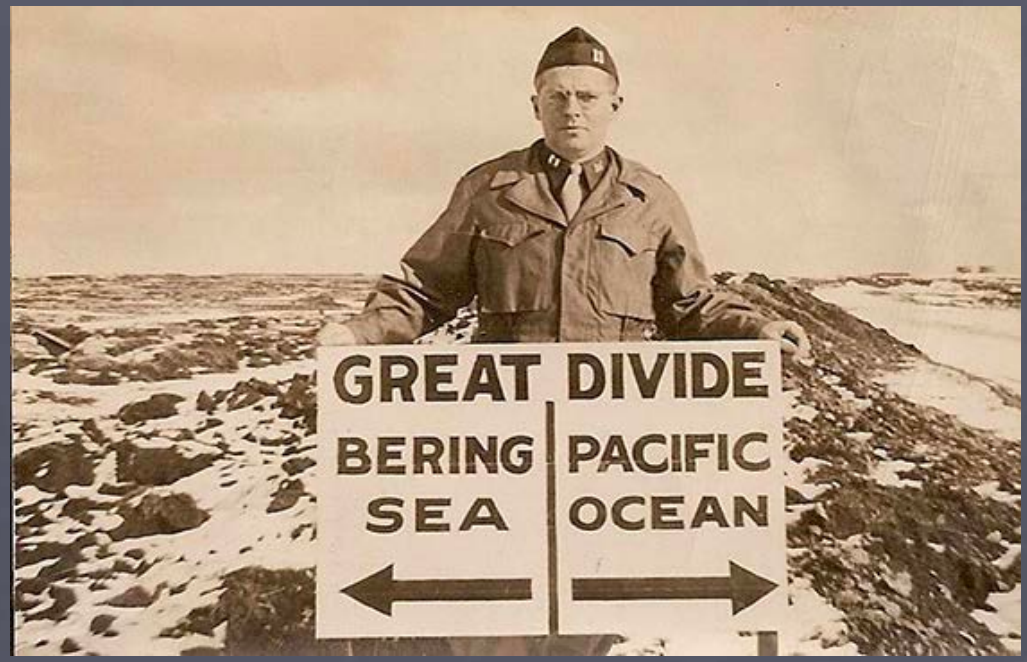
Curious Case of Sargasso Sea

- Surrounded on 4 sides by different currents
  - Only sea in Atlantic not touching any sort of land



The Seven Seas?

- More than 50 seas recognized in the world
  - Includes some Gulfs and Bays (but not Aral Sea, Caspian Sea, or Dead Sea)

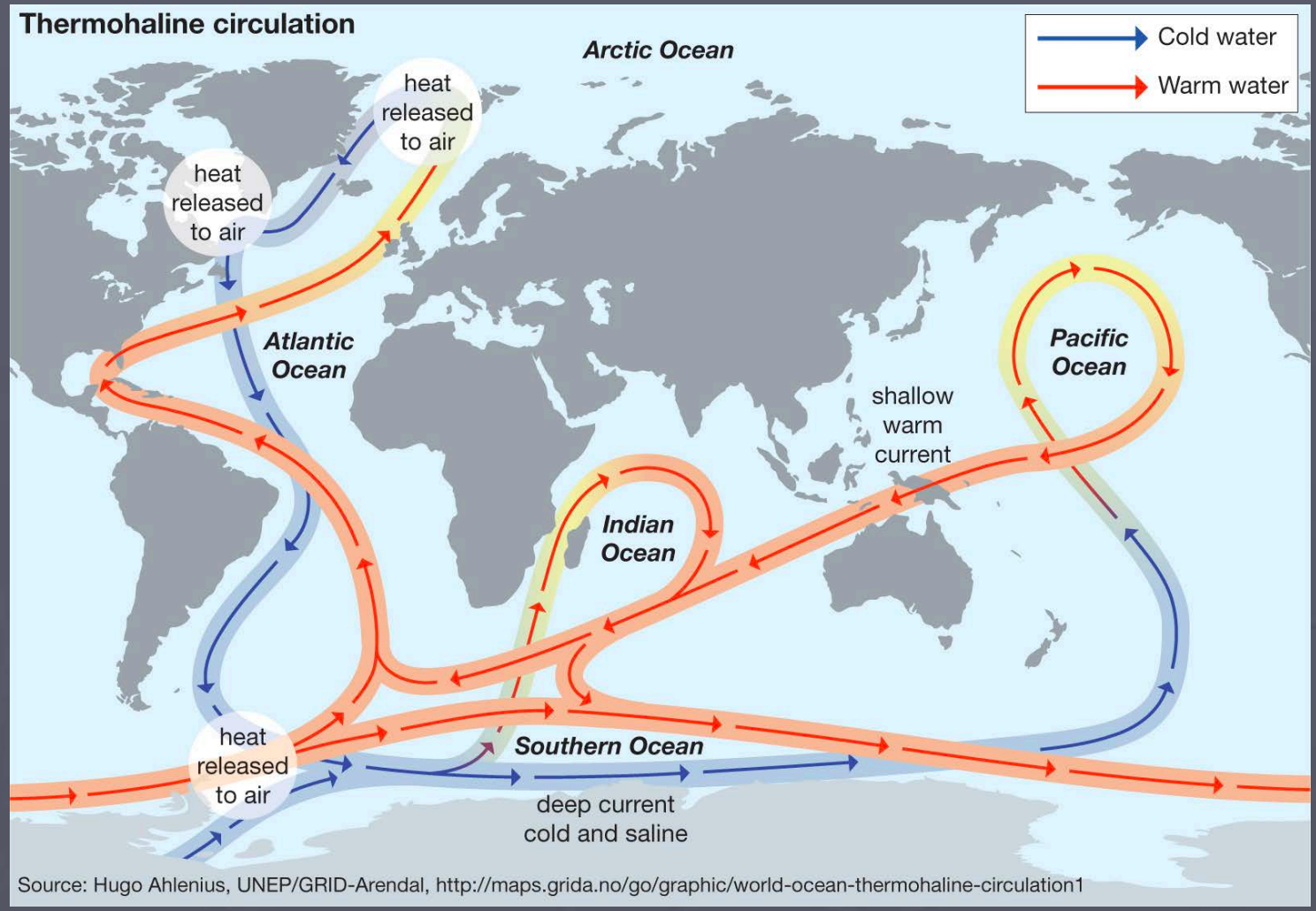


Oceanic Currents

- Surface Currents
  - Caused mainly by winds
- Thermohaline Circulation
  - Caused at depth by differences in temperature and salinity
    - Affects density of water

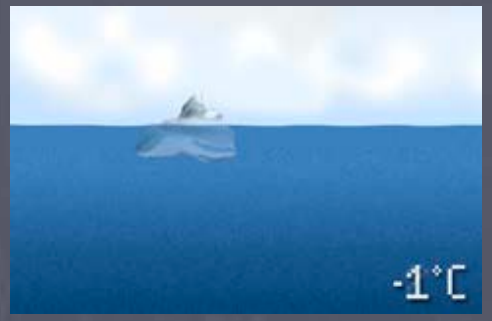
Deep-Ocean Thermohaline Circulation

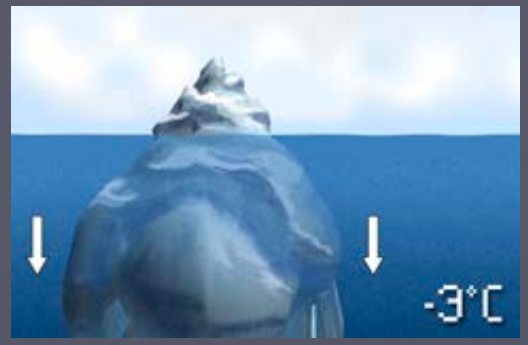
- Differences in temperature and salinity cause water to transfer from areas of high pressure to low density
  - Thermo (heat) Haline (Salinity)

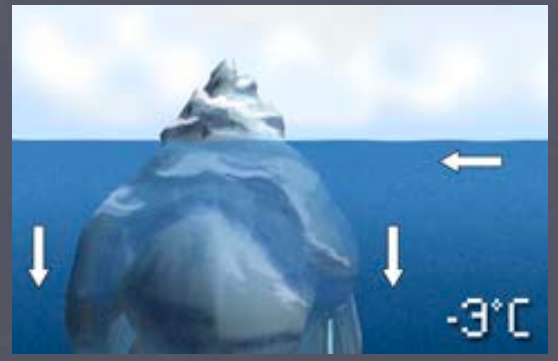


Thermohaline Circulation and Polar Salinity

- As polar waters freeze surrounding water becomes saltier, resulting in changes in density

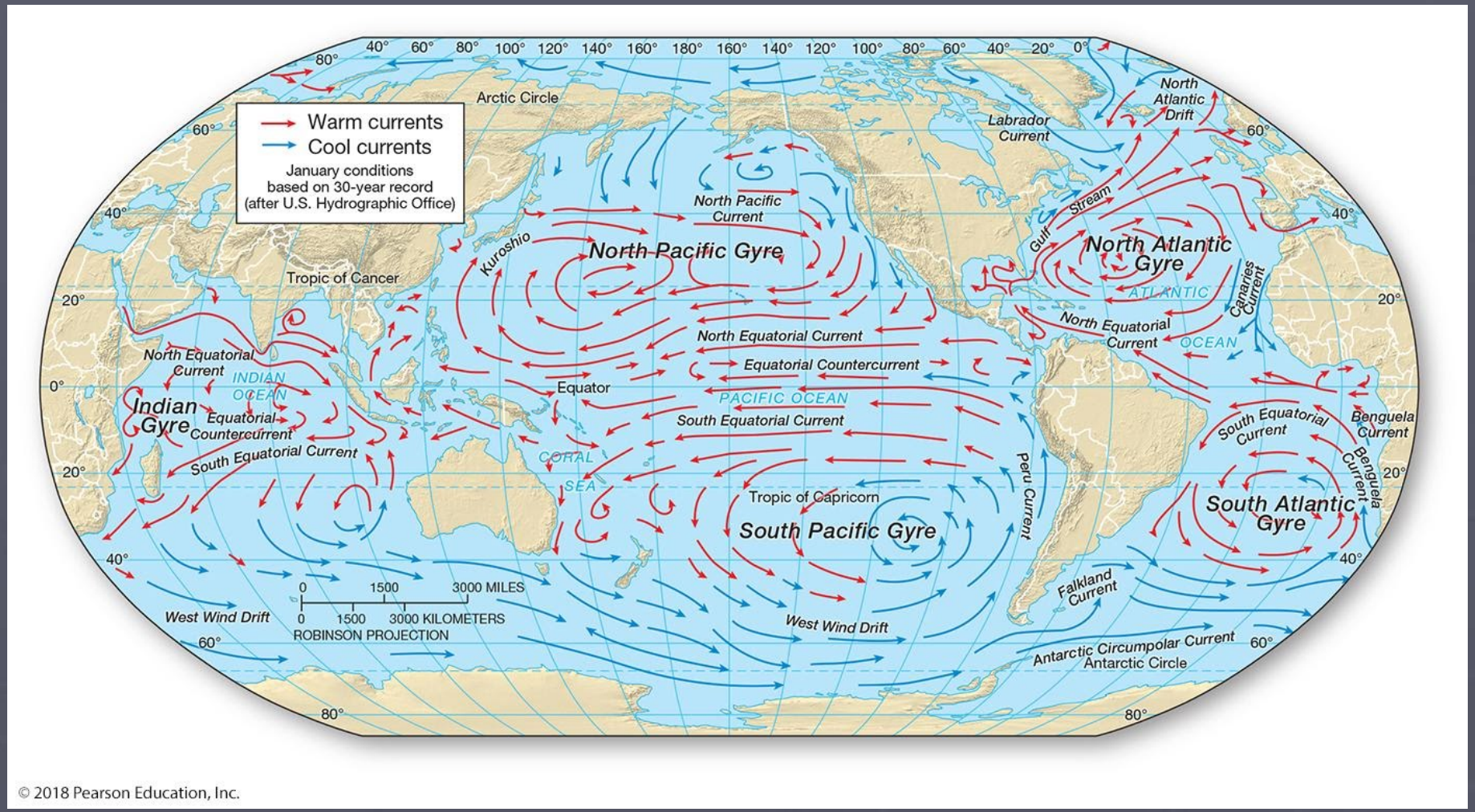






Surface Currents

- Important for redistributing warm water away from the equator and bringing in cold water from the poles



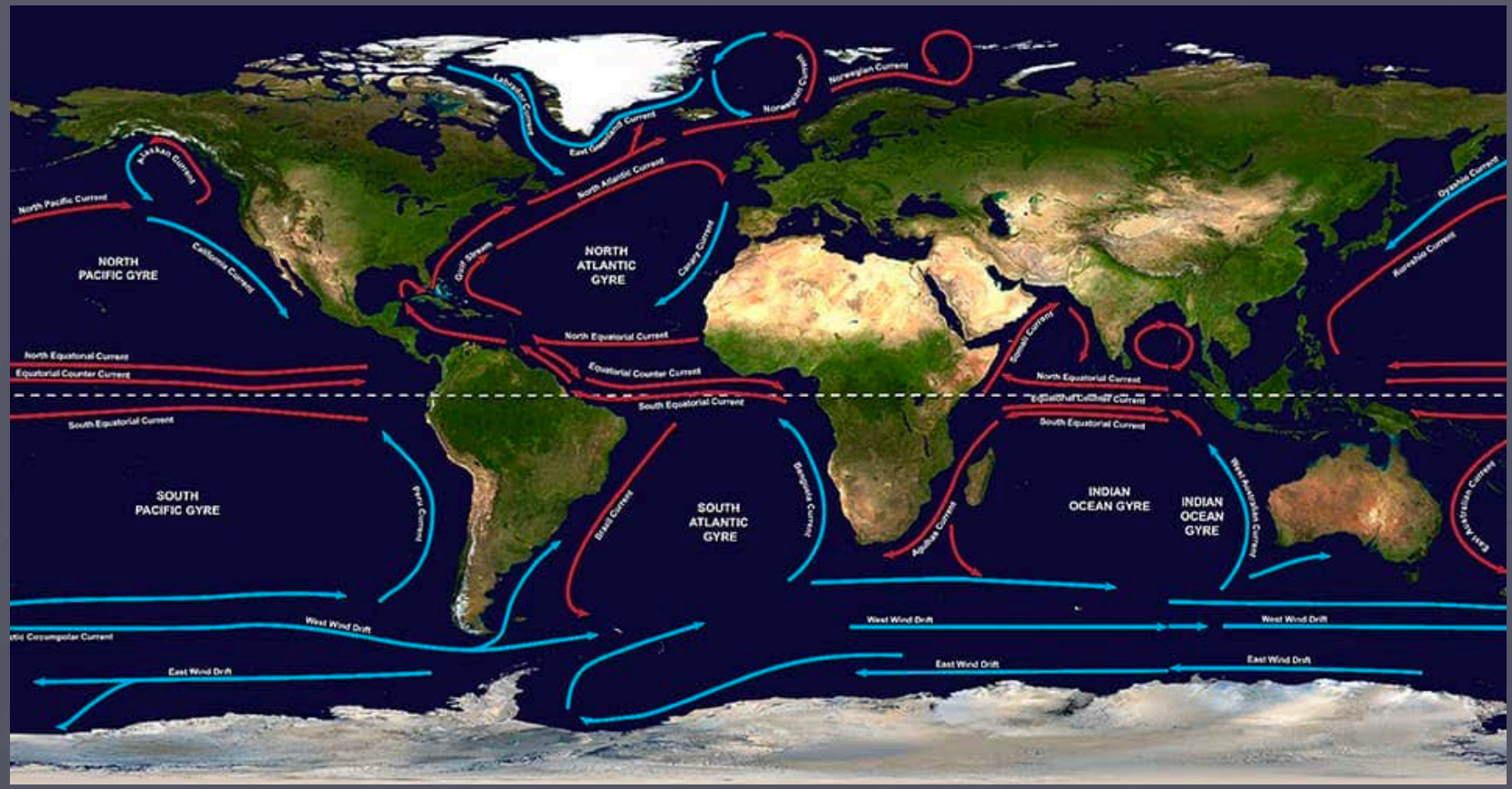
Beaufort Wind Scale

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects	
			On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft, whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-20 ft, white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (13-20 ft) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Whole trees in motion, resistance felt walking against wind
9	41-47	Strong Gale	High waves (20 ft), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (20-30 ft) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (30-45 ft) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft, sea completely white with driving spray, visibility greatly reduced	

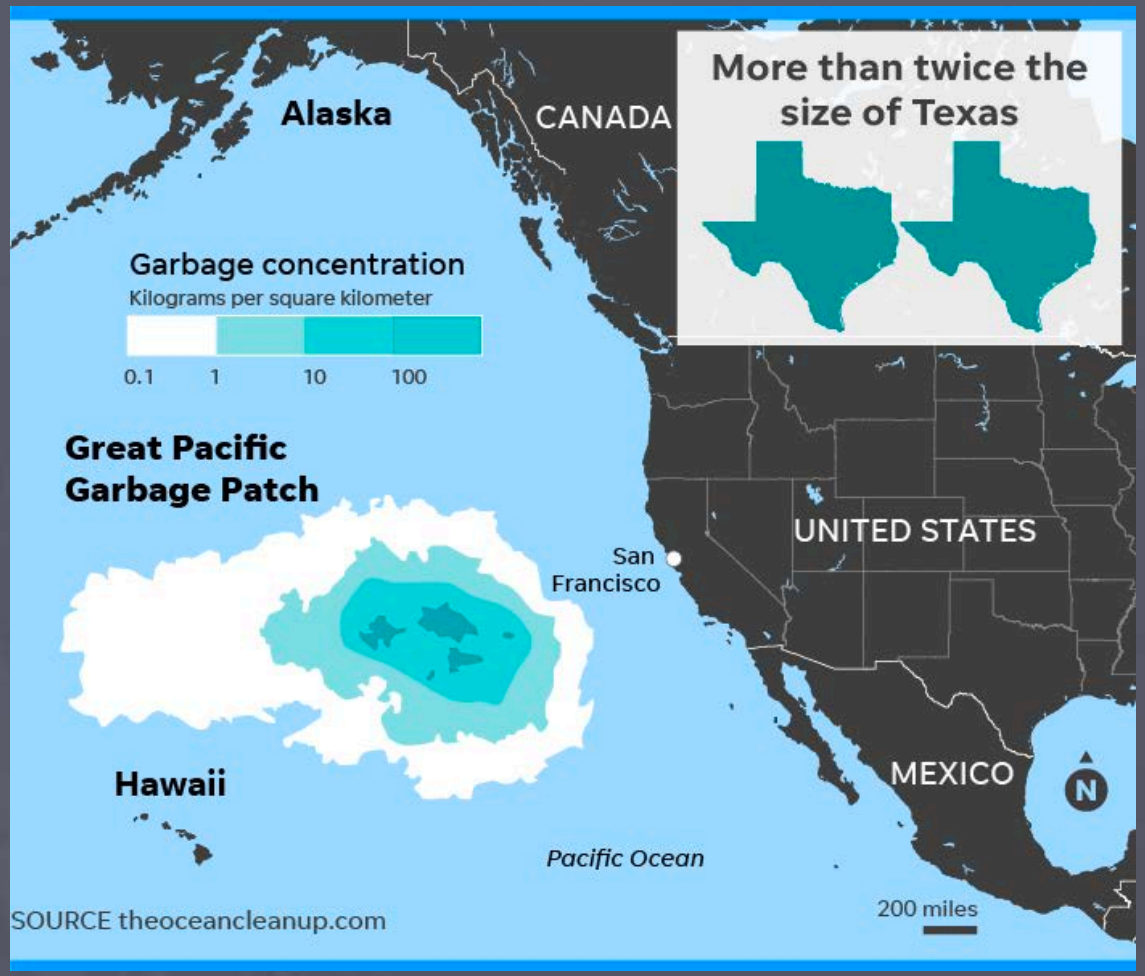
Migration of the Pacific Rubber Ducky

Oceanic Gyres

- Large rotating oceanic currents created by warm and cold waters circulating

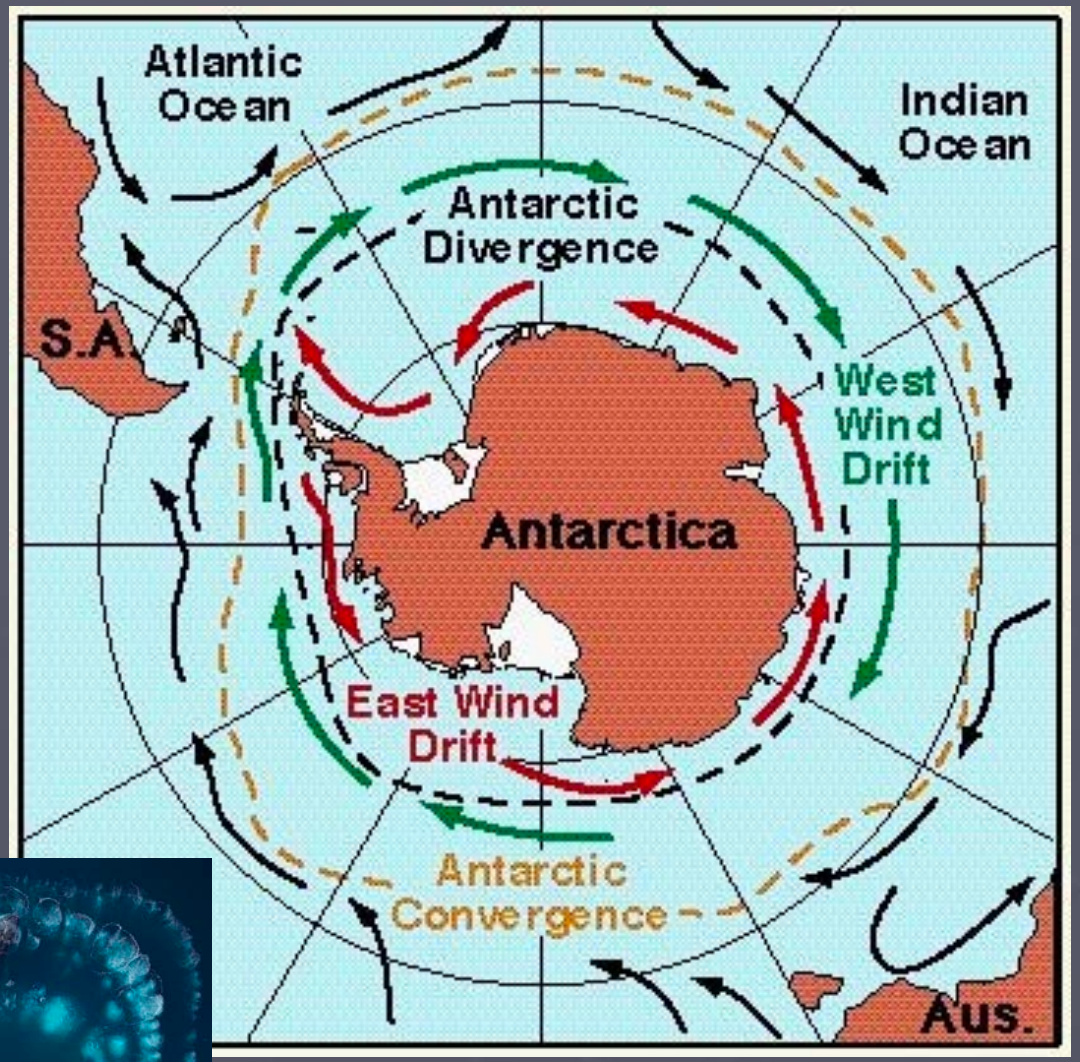


Great Pacific Garbage Patch

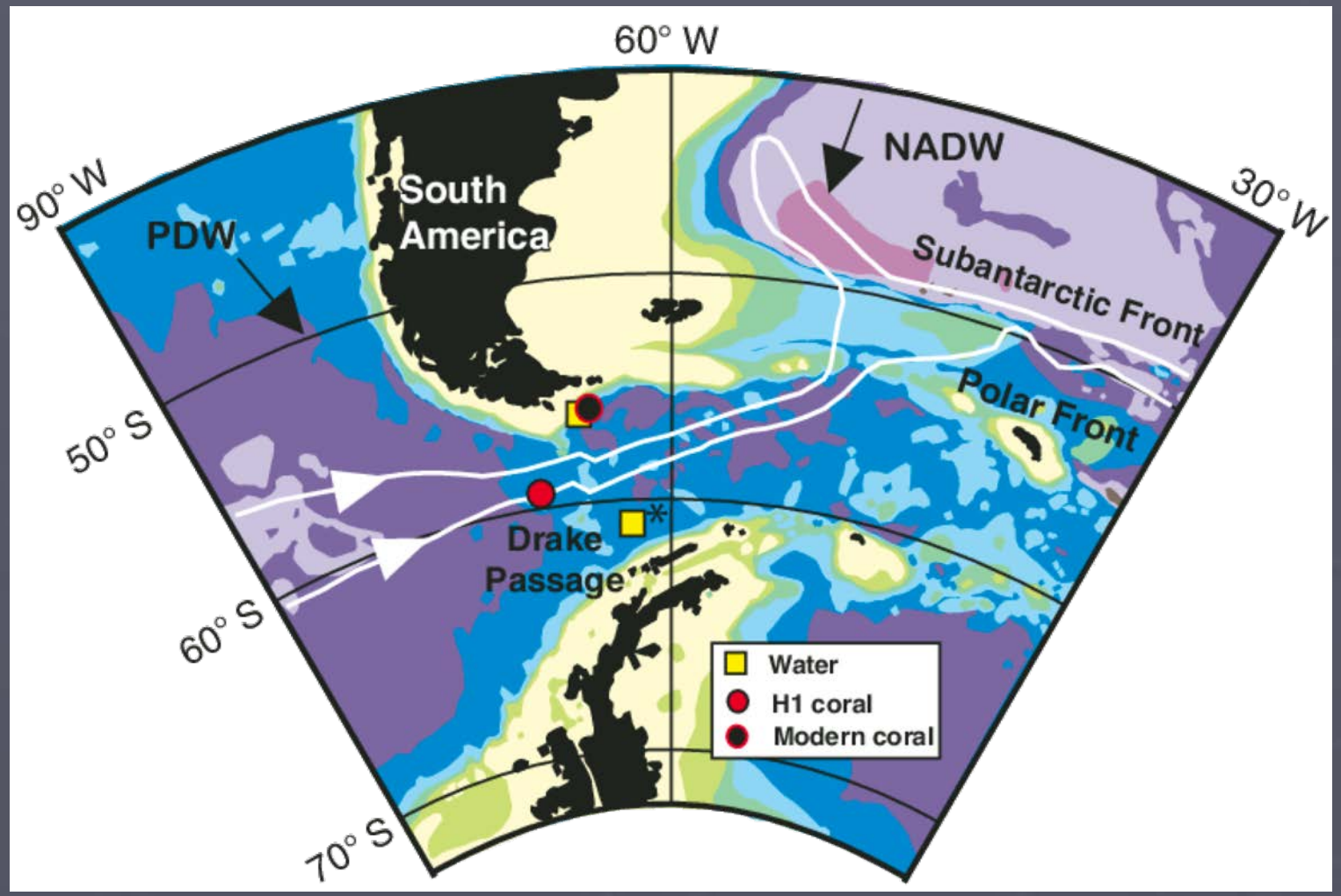


Antarctica Convergence

- Antarctic Circumpolar Current
  - Formed by polar westerlies winds
  - Ring of cold water the continually flows around Antarctica
    - Forms Southern Ocean
  - Warm water from subarctic pushed up nutrient rich cold waters from deep

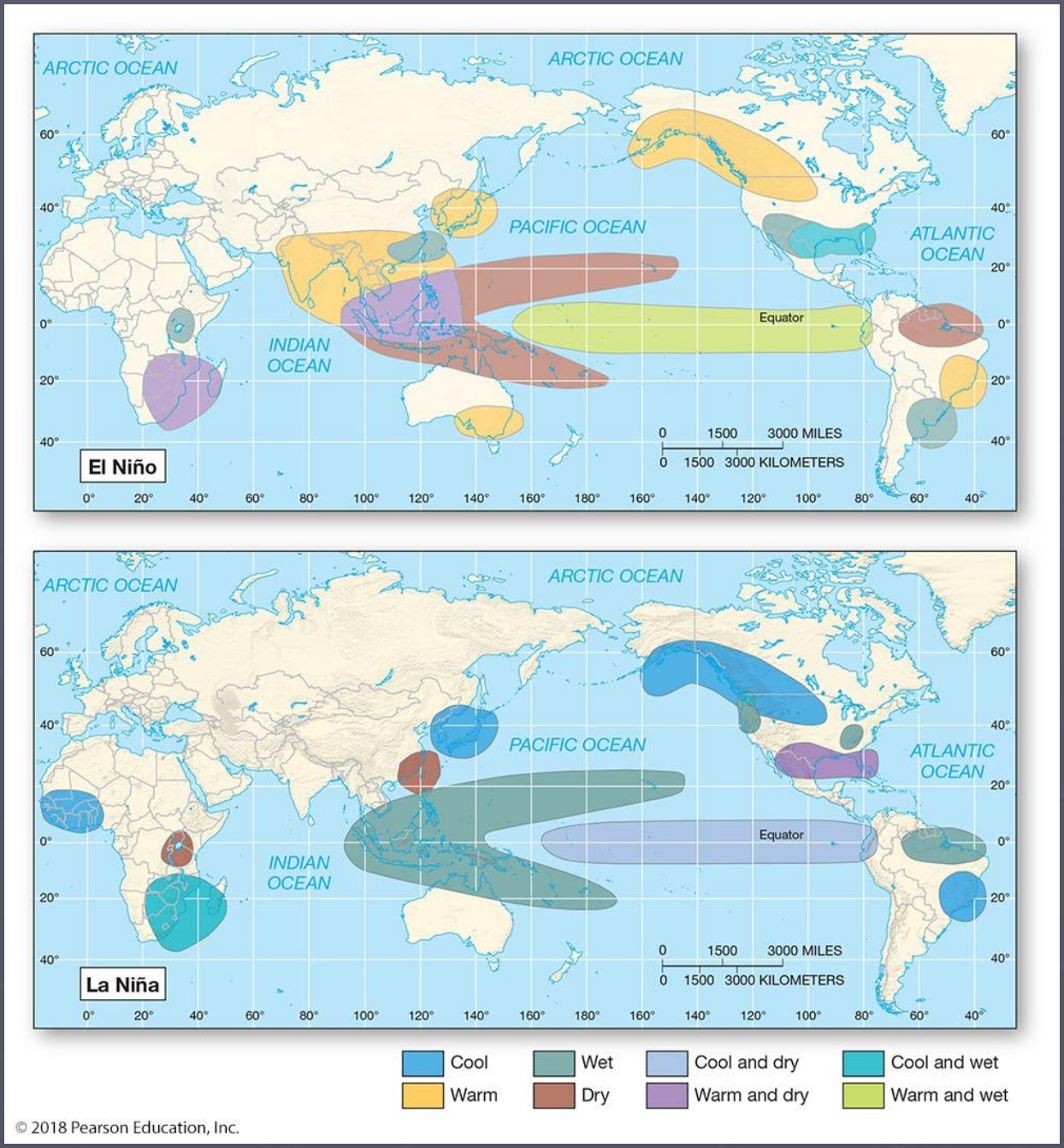


The Drake Passage



El Niño and La Nina

- In normal pattern trade winds carry warm water away from Americas to Asia
- El Nino is when winds shift resulting in warm water staying near Americas
- La Nina is stronger trade winds that pull up more cold water from depth

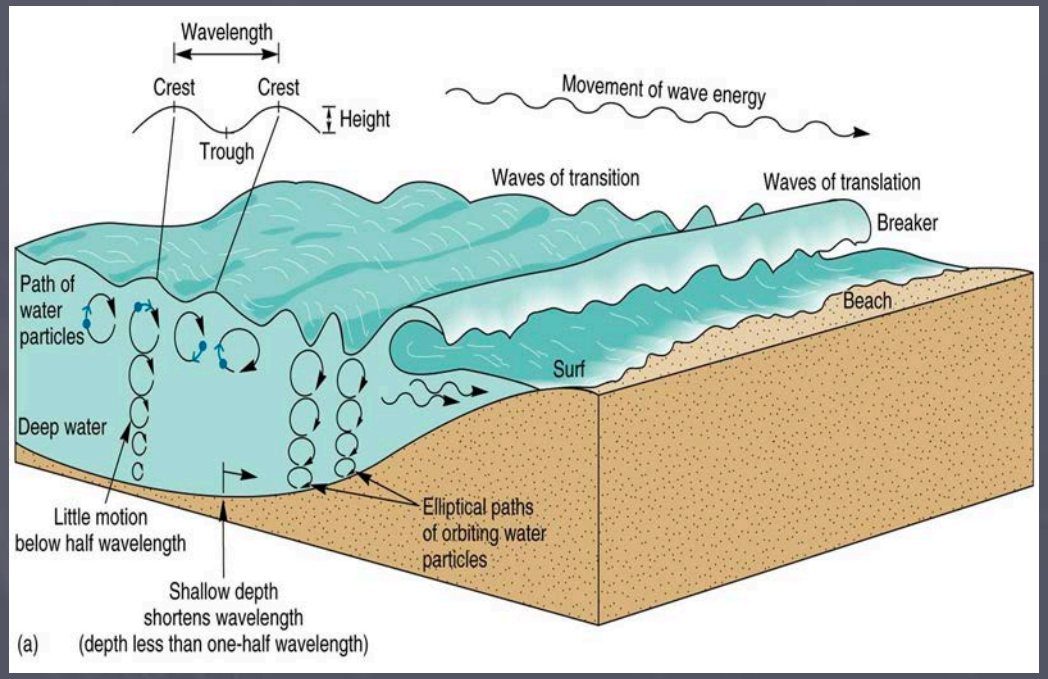


Tides

- Tides are the twice daily changes in sea-level
- Affected by the gravitational pull of the sun and moon
  - Also impacted by shoreline shape, ocean basin characteristics, and latitude

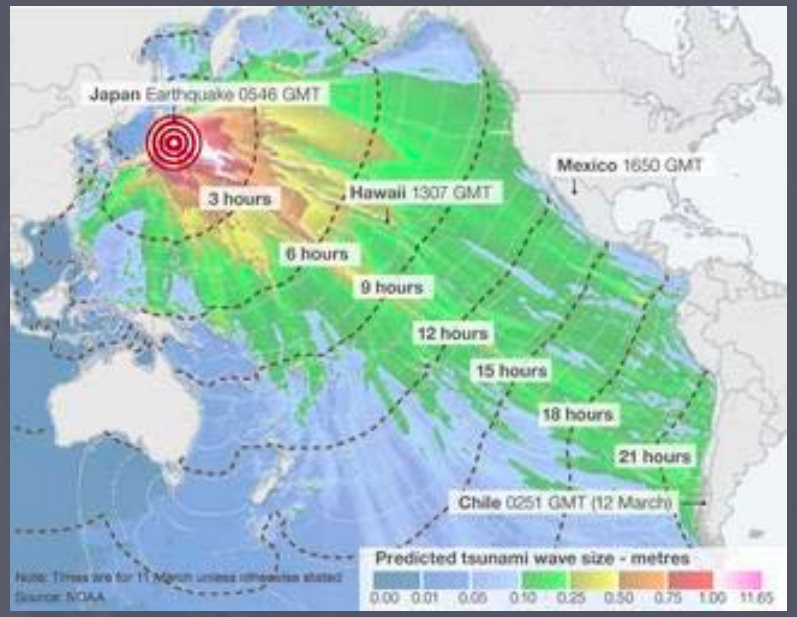
Waves

- Created by differences in friction between wind and ocean ocean floor
  - Swell is waves that have traveled beyond origin



Tsunamis

- Tsunamis are produced by sudden and sharp motions in the seafloor, caused by earthquakes, submarine landslides, or eruptions of undersea volcanoes.

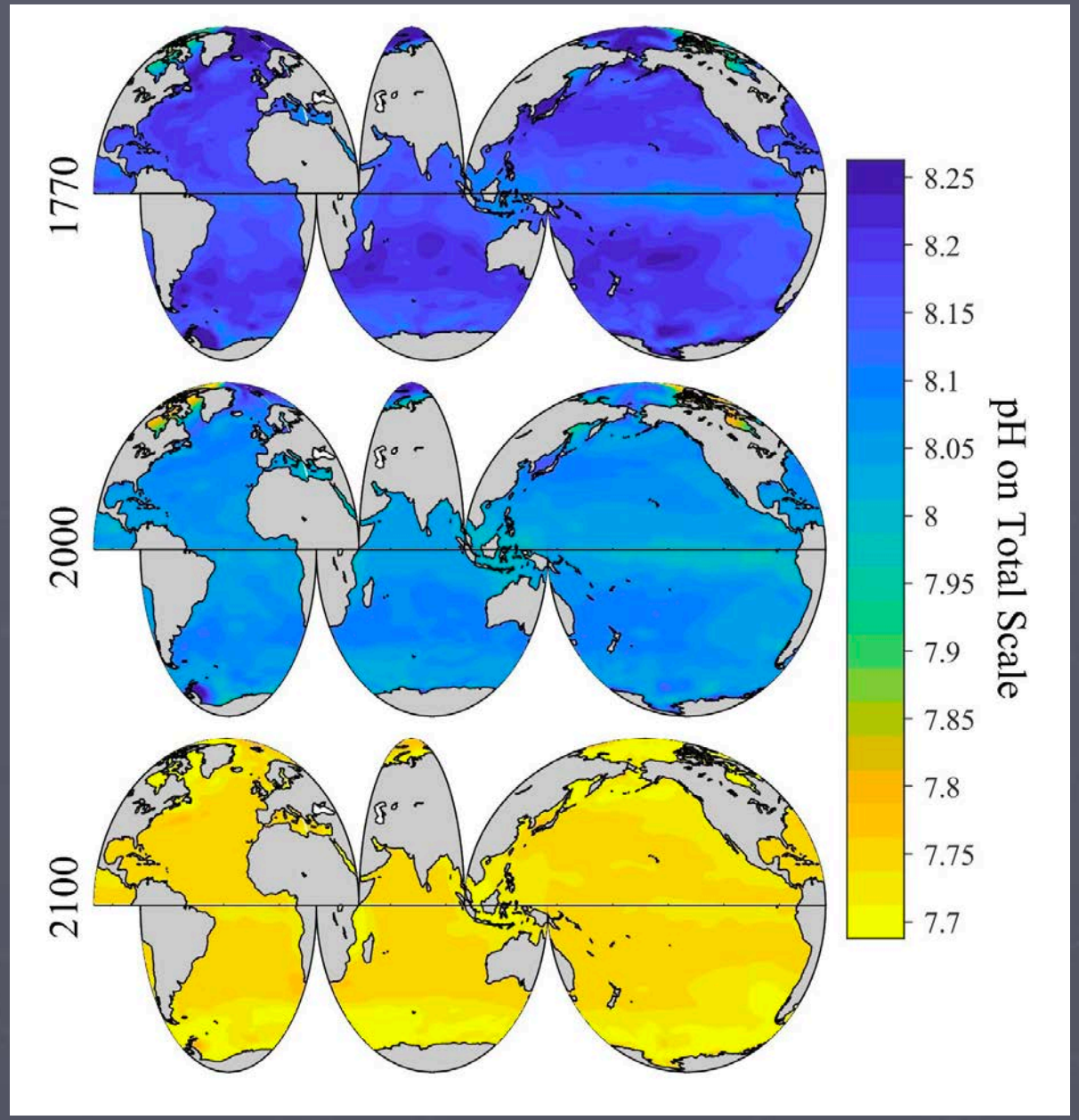


Ecological Concerns of the Oceans

- Pollution
- Overfishing
- Ocean Acidification
- Warming
- Sea Level Rise

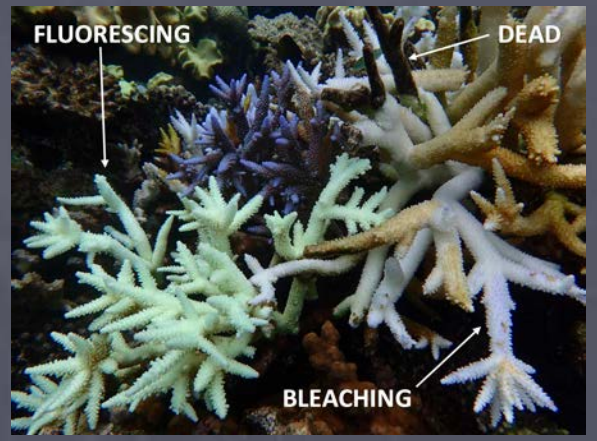
Ocean Acidification

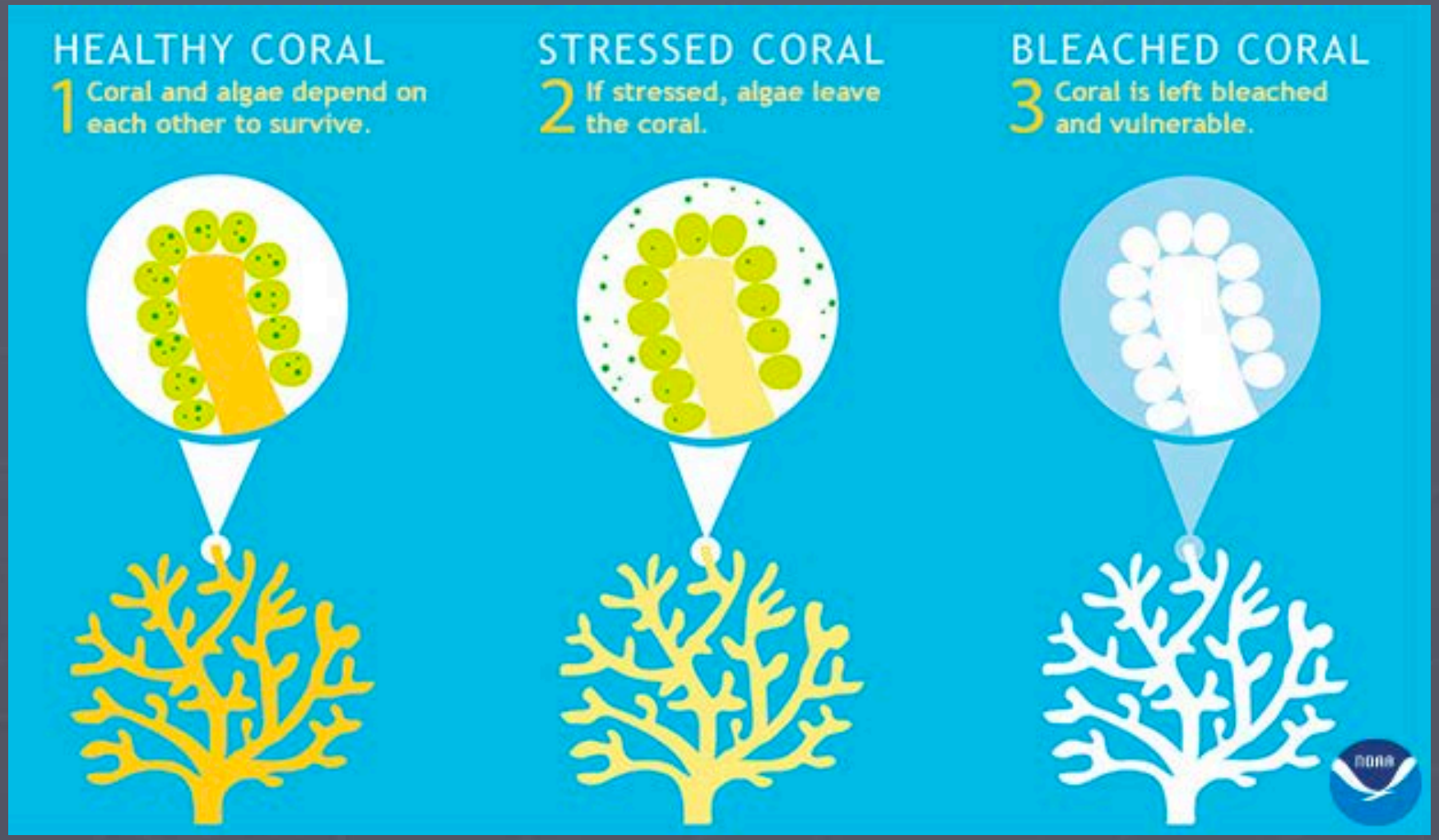
- Oceans absorb CO_2 from the atmosphere, form carbonic acid in the seawater, and reduce the ocean pH value.
  - Current ocean mean pH is 8.1.
  - pH could decrease by 0.4 to 0.5 units by the end of this century.



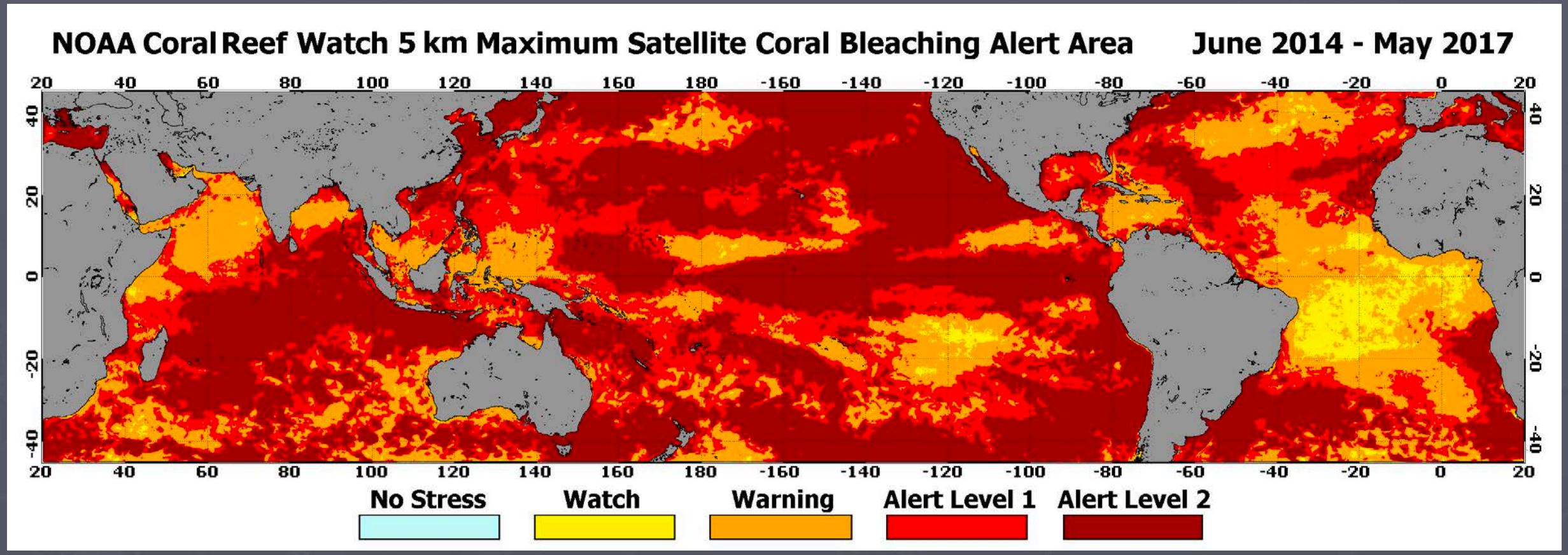
Coral Bleaching

- Oceanic acidification and increased temperatures causing widescale coral bleaching



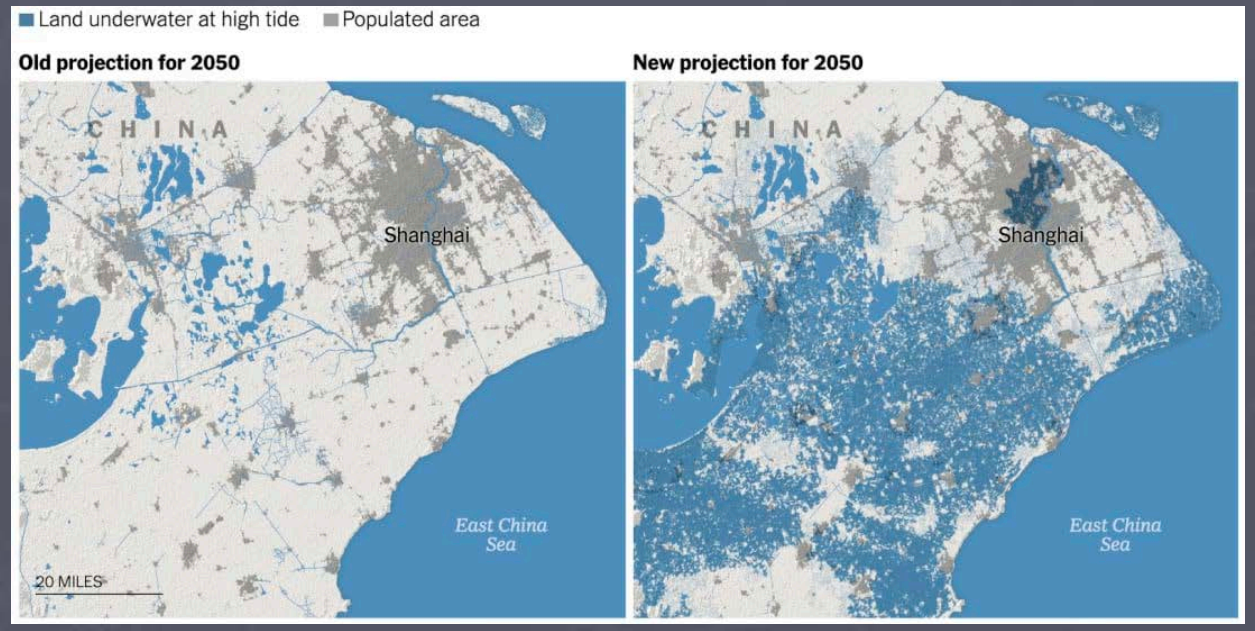


Global Coral Bleaching



Sea Level Rise

- As glacial and ice cap ice melts sea levels rise
  - If Antarctica and Greenland became ice-free, sea level would rise at least 65 m worldwide.
- As water heats it expands



Overfishing