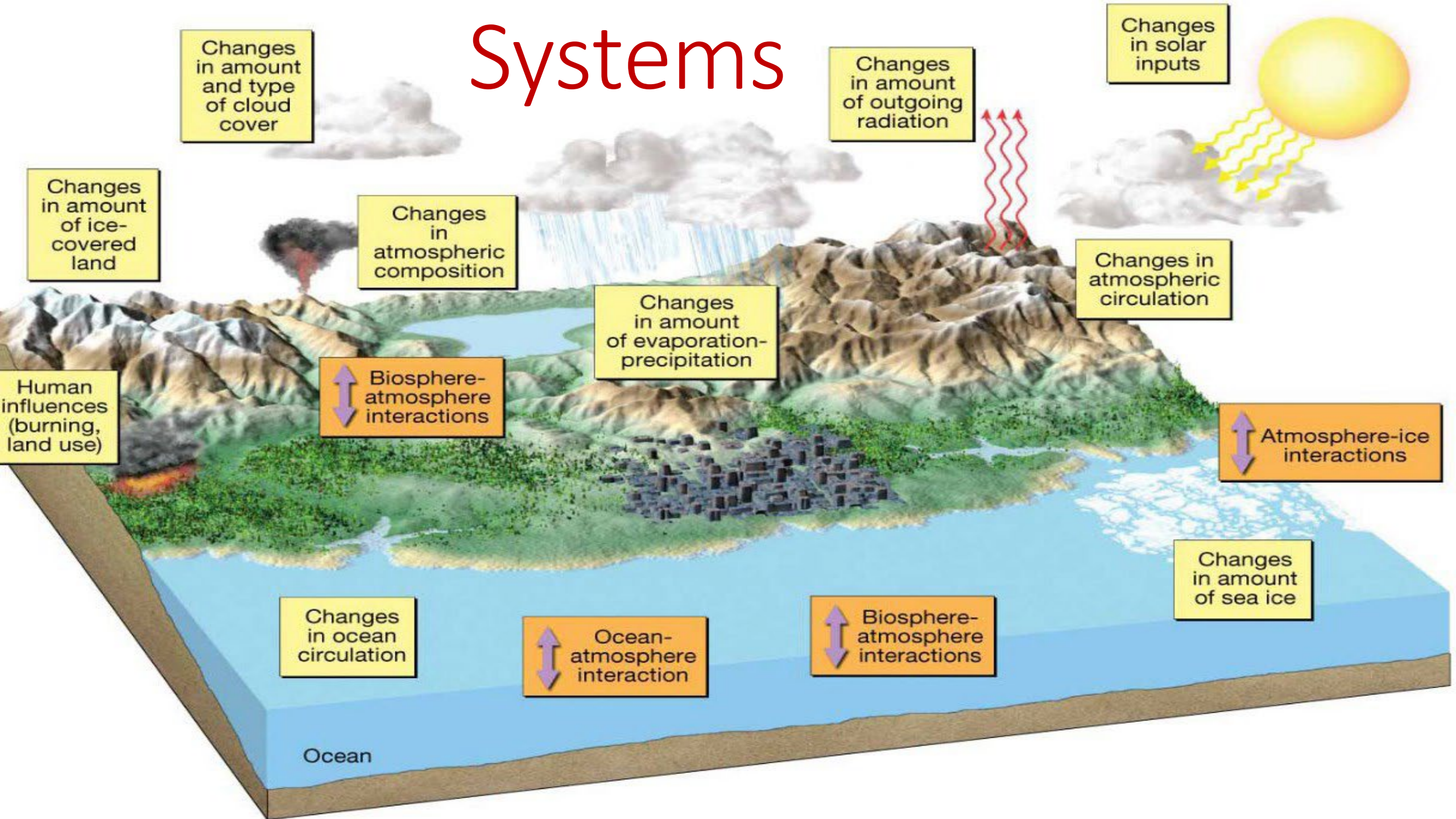
Energy, Oceans, Climate Change, Hazards & Our Home

Systems

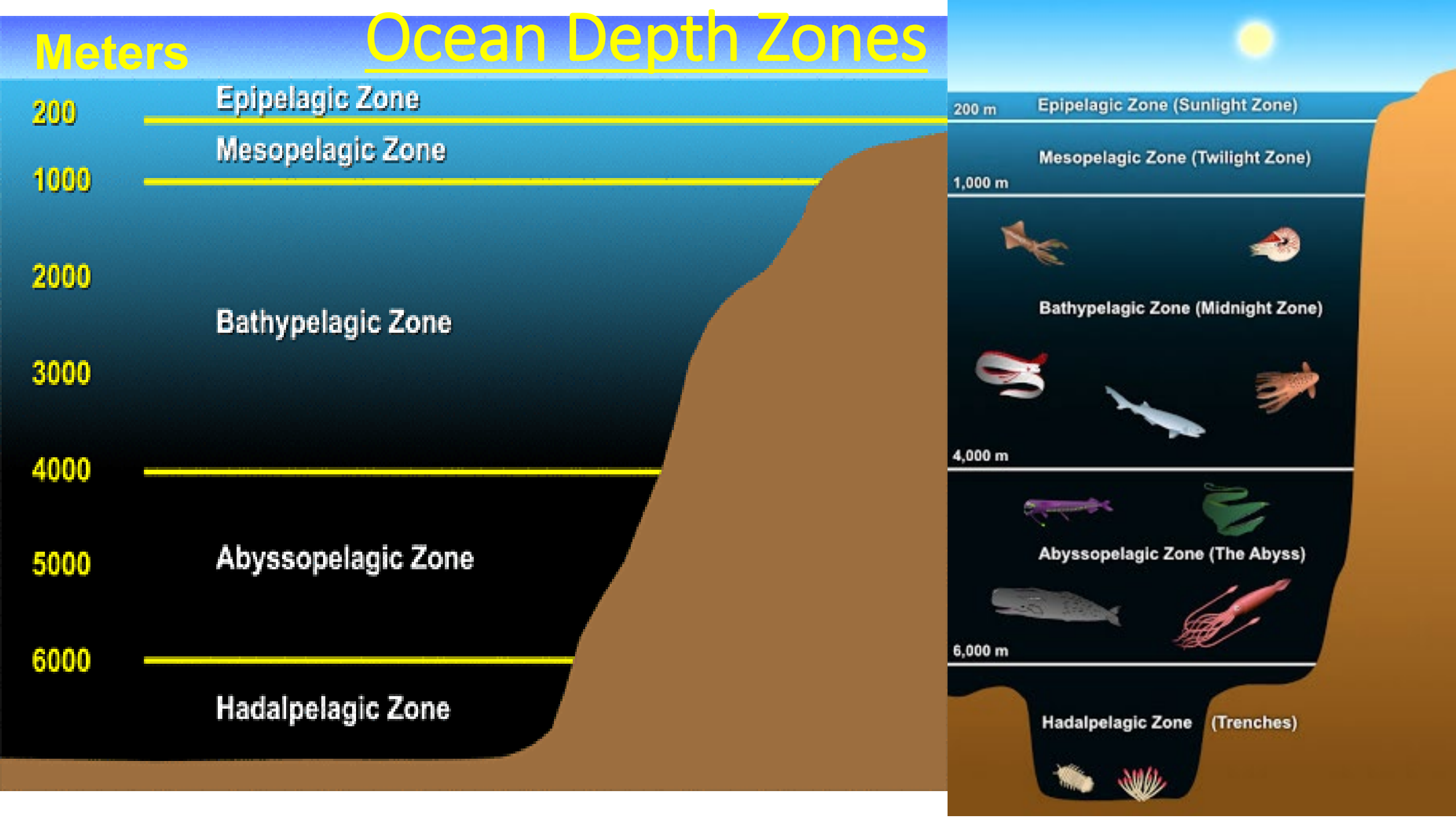

Changes in amount and type of cloud cover
Changes in amount of outgoing radiation
Changes in solar inputs
Changes in amount of ice-covered land
Changes in atmospheric composition
Changes in atmospheric circulation
Changes in amount of evaporation-precipitation
Human influences (burning, land use)
Biosphere-atmosphere interactions
Atmosphere-ice interactions
Changes in amount of sea ice
Changes in ocean circulation
Ocean-atmosphere interaction
Biosphere-atmosphere interactions
Ocean

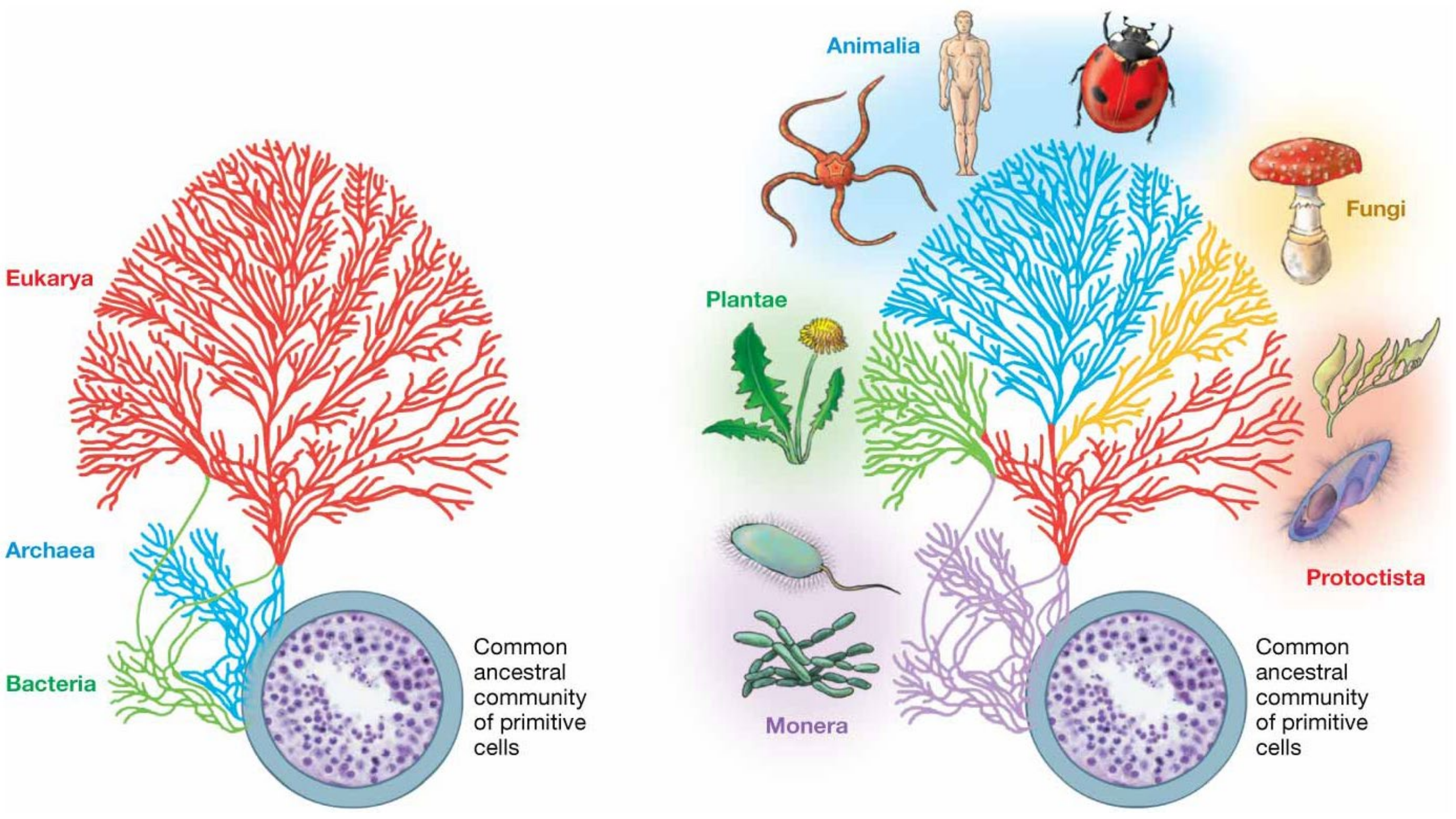
Marine Life

Objectives

1. Explain how marine organisms are adapted for the Ocean's physical conditions.
2. Compare the main divisions of marine environments
3. Describe the various types of photosynthetic marine organisms
4. Explain variations in regional primary productivity
5. Describe several issues that affect marine Fisheries.

Ocean Depth Zones

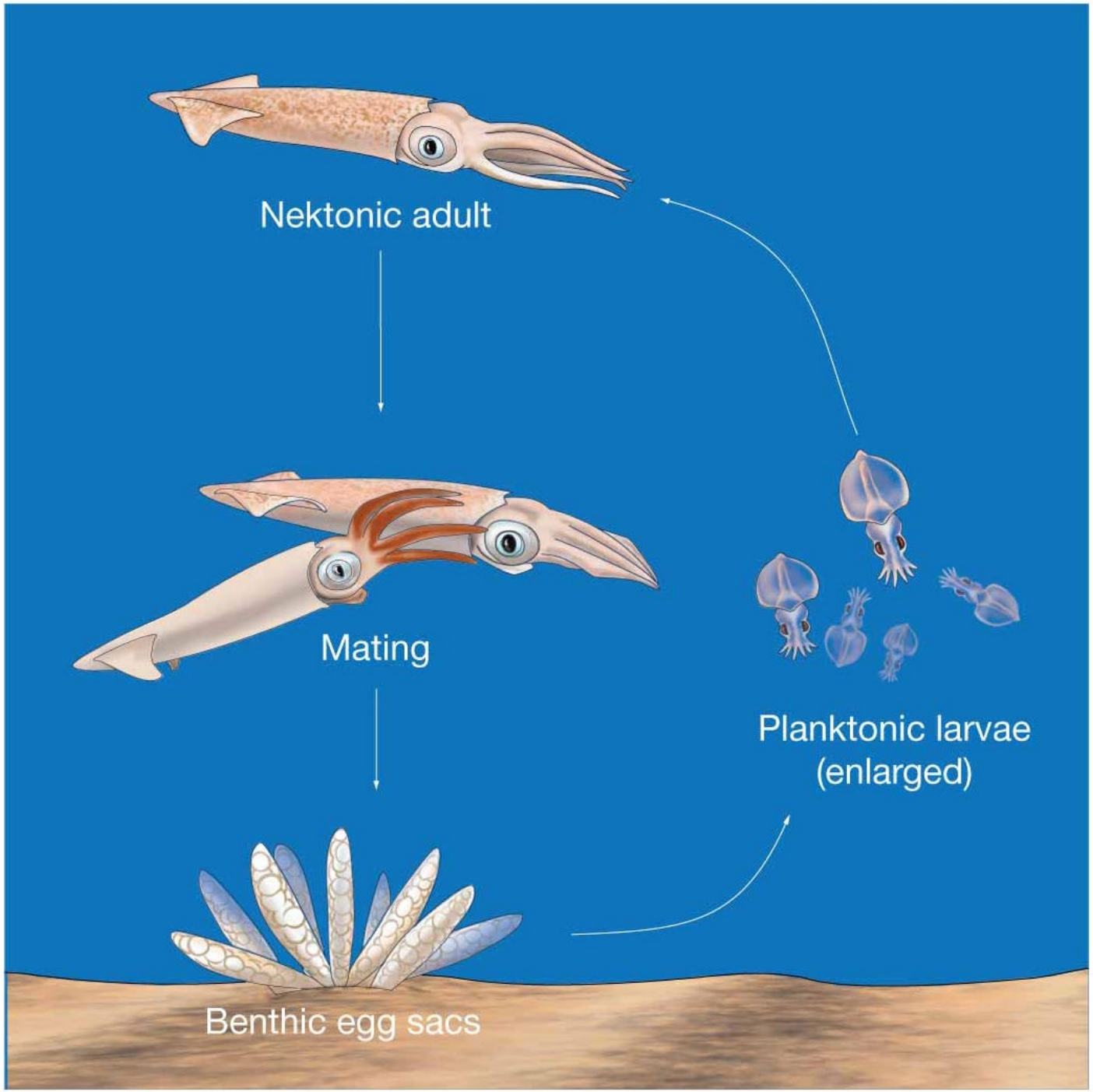


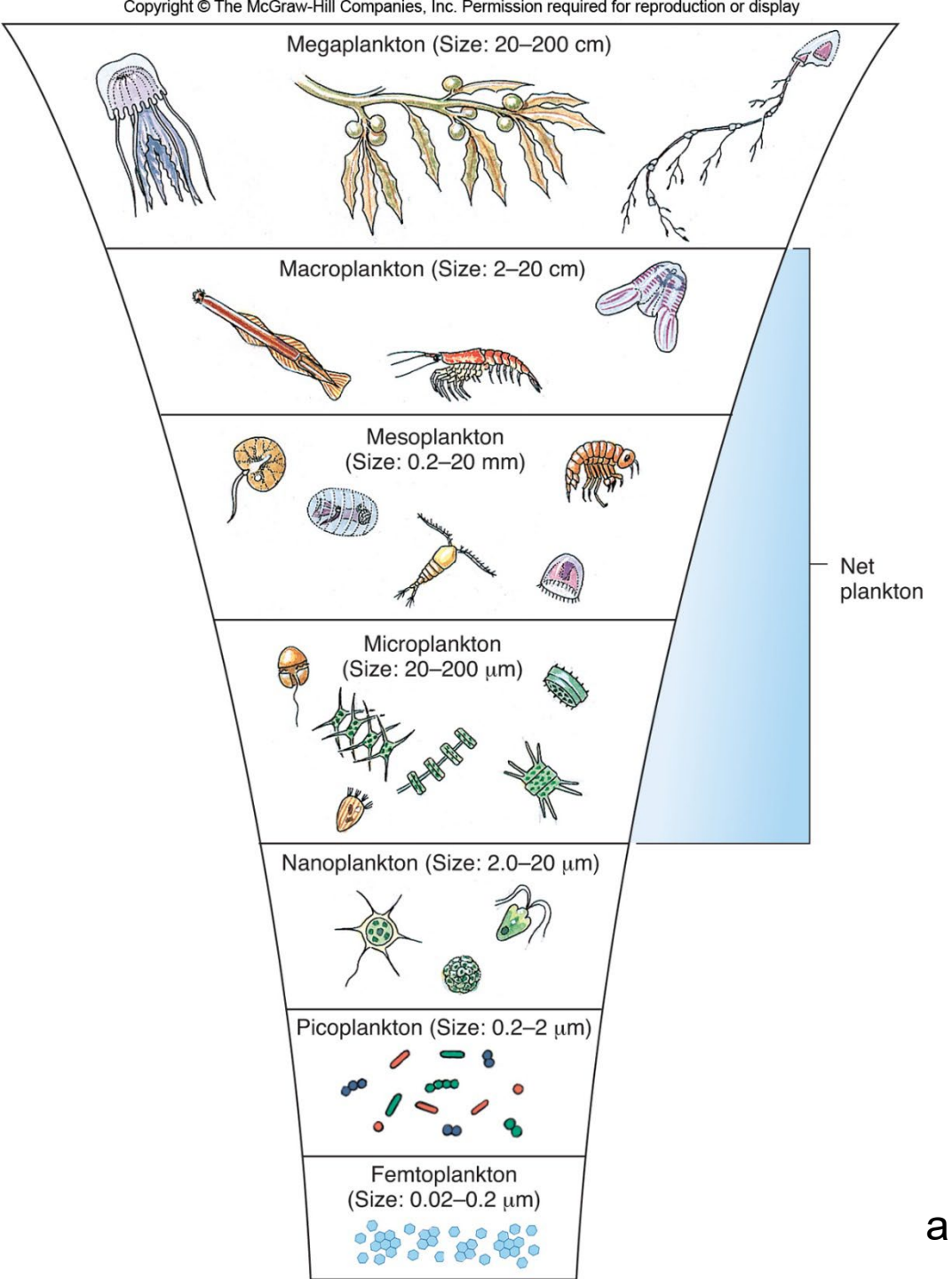

Eukarya
Archaea
Bacteria
Common ancestral community of primitive cells
Animalia
Fungi
Plantae
Protoctista
Monera
Common ancestral community of primitive cells

Marine organisms

Classified by

- Habitat
- Mobility
  - Plankton (floaters)
  - Nekton (swimmers)
  - Benthos (bottom crawlers)

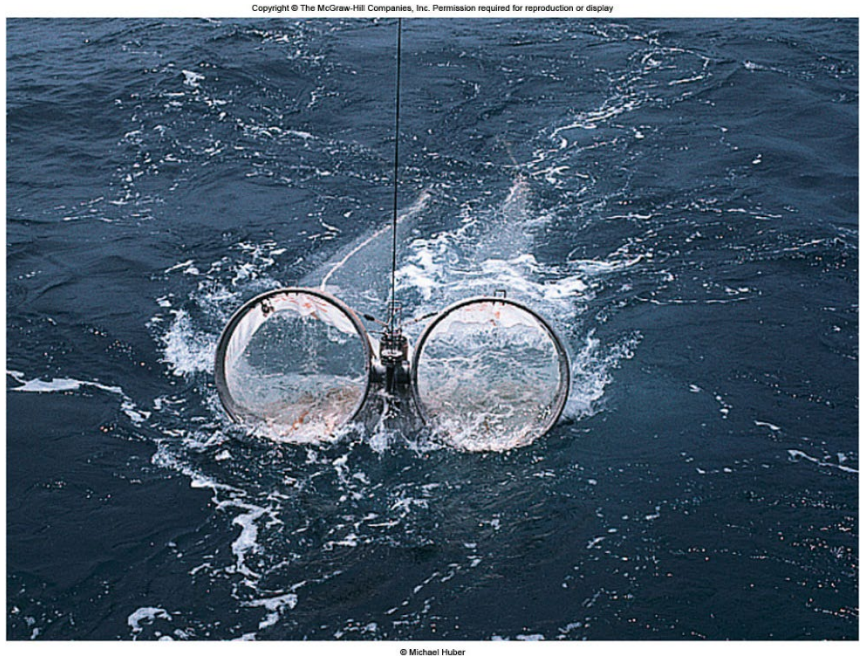




Plankton are organisms that drift with the currents (in other words, they can't swim against the currents). They don't have to be microscopic. They were traditionally captured in nets, thus the term "net plankton".

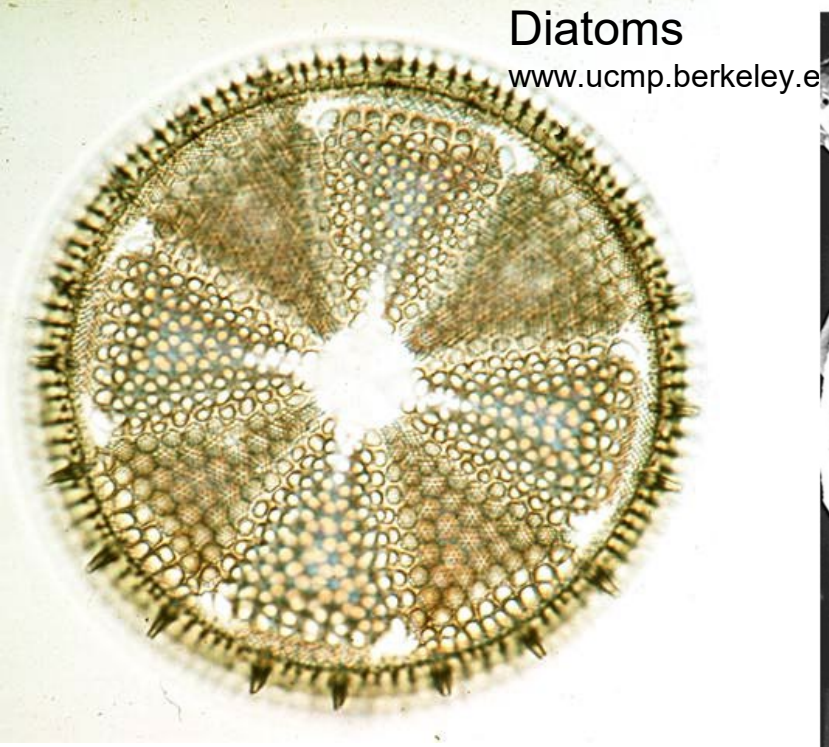
Phytoplankton (a) and zooplankton (b) nets.

a



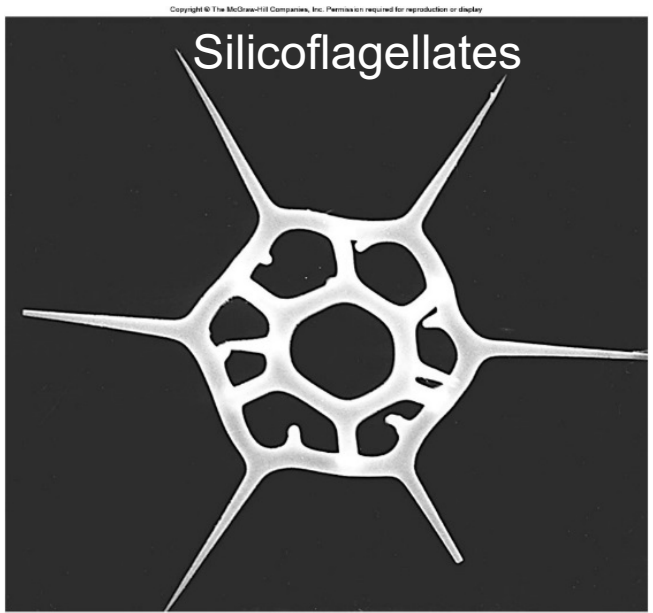
b

After Maureen Clayton


Diatoms
www.ucmp.berkeley.e

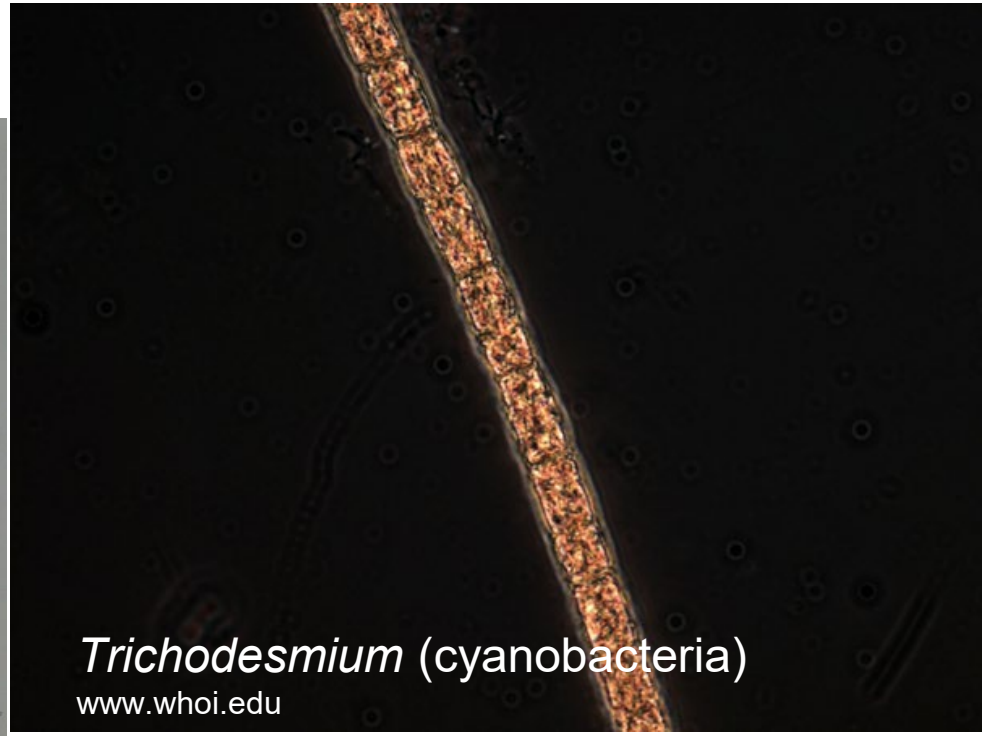
Coccolithophorid


Dinoflagellates
www.ecomare.nl



Silicoflagellates


Cryptophytes
www.dr-ralf-wager.de
10 µm
© Dr. R. Wagner


Trichodesmium (cyanobacteria)
www.whoi.edu

Plankton (floaters)

Phytoplankton

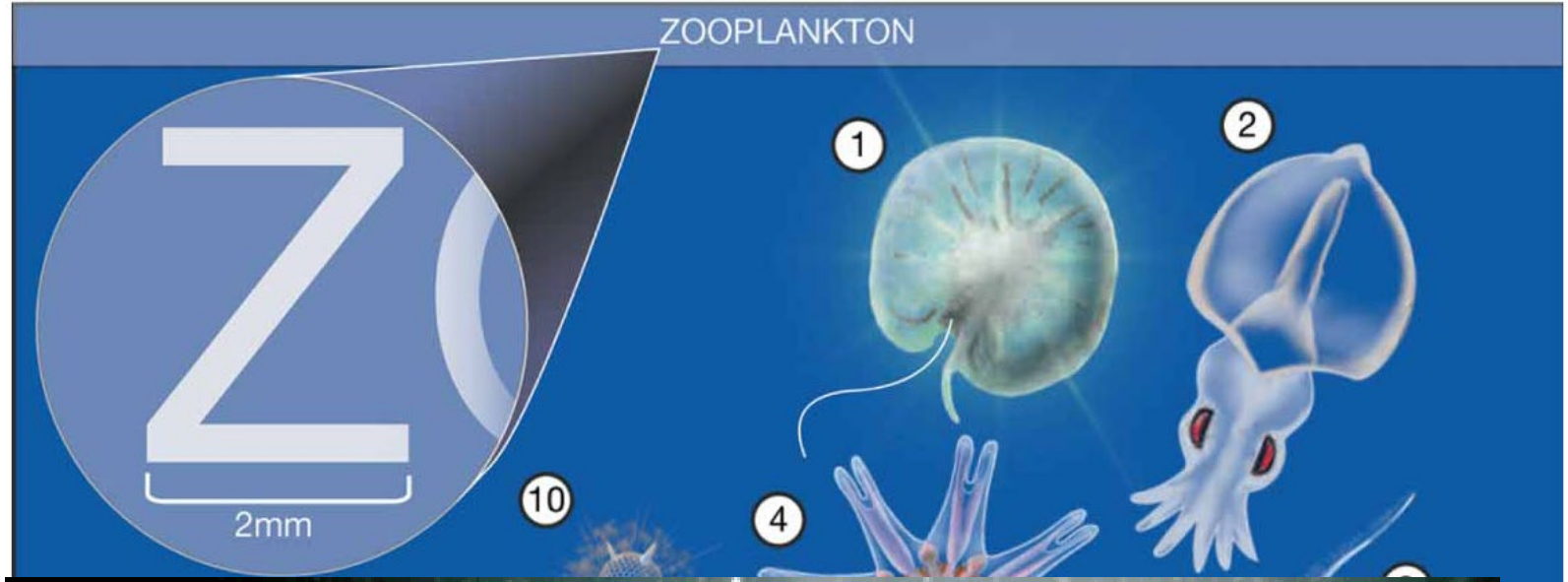
Photosynthetic algae

Zooplankton

NON photosynthetic organisms (mostly anim

Bacterioplankton

Smallest ½ a micrometer

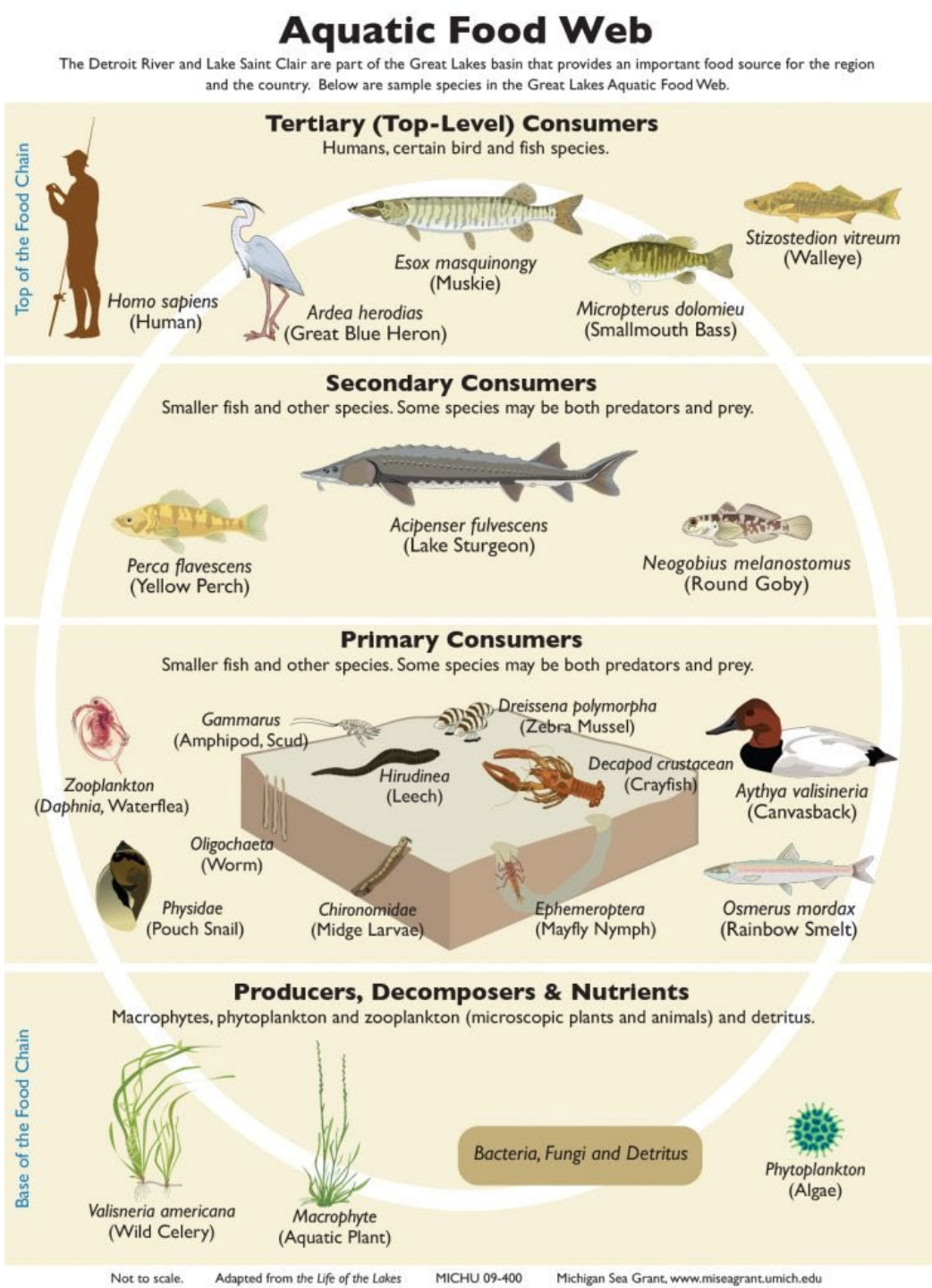


Importance

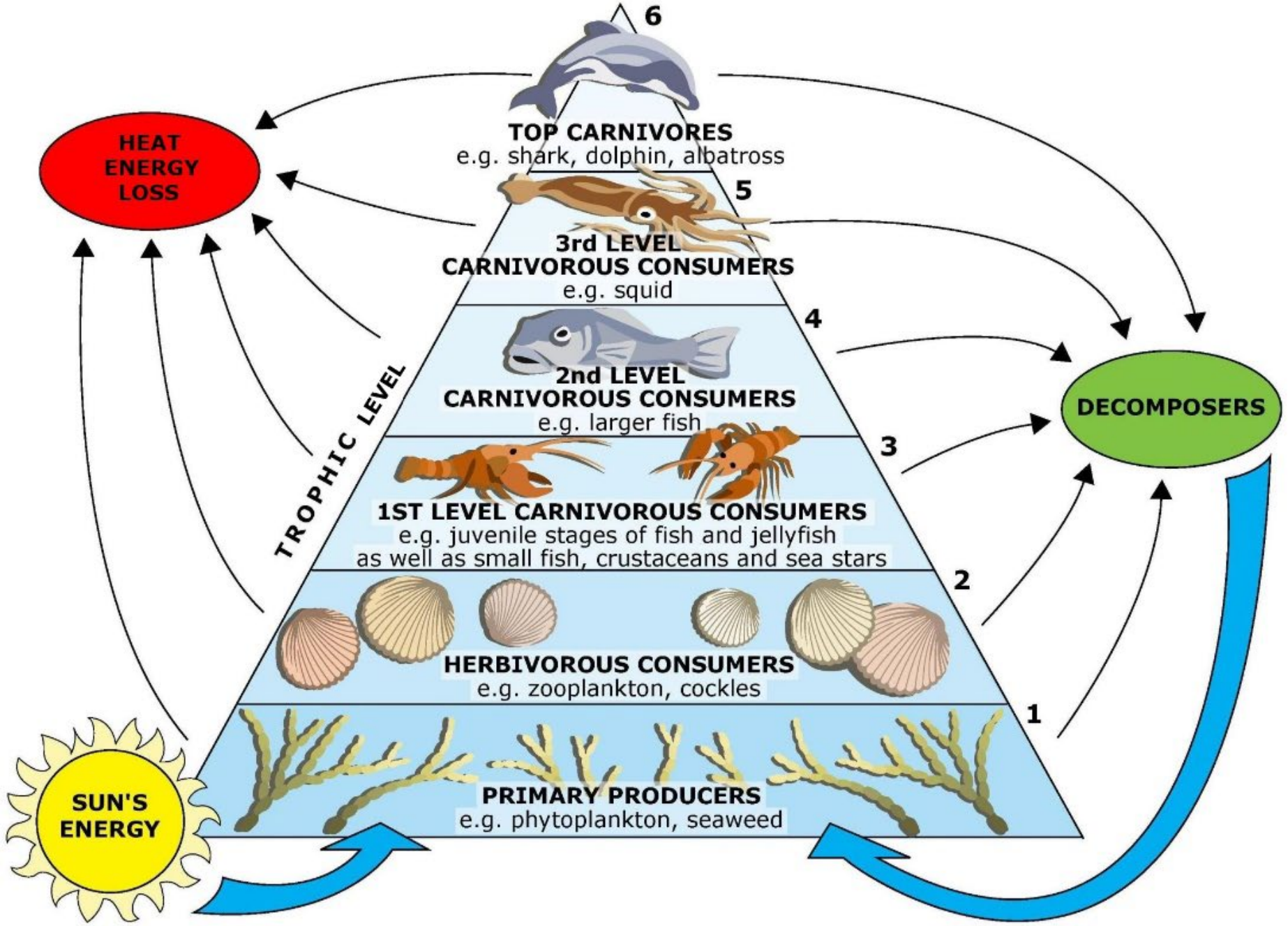
Make up the majority of the Earth's biomass (*total mass of organisms in a given area or volume*)

Climate: Absorb CO2 from the atmosphere and take it to the ocean floor when they die.

Food chain: The sit at the bottom of the aquatic food system. Phytoplankton support Zooplankton…

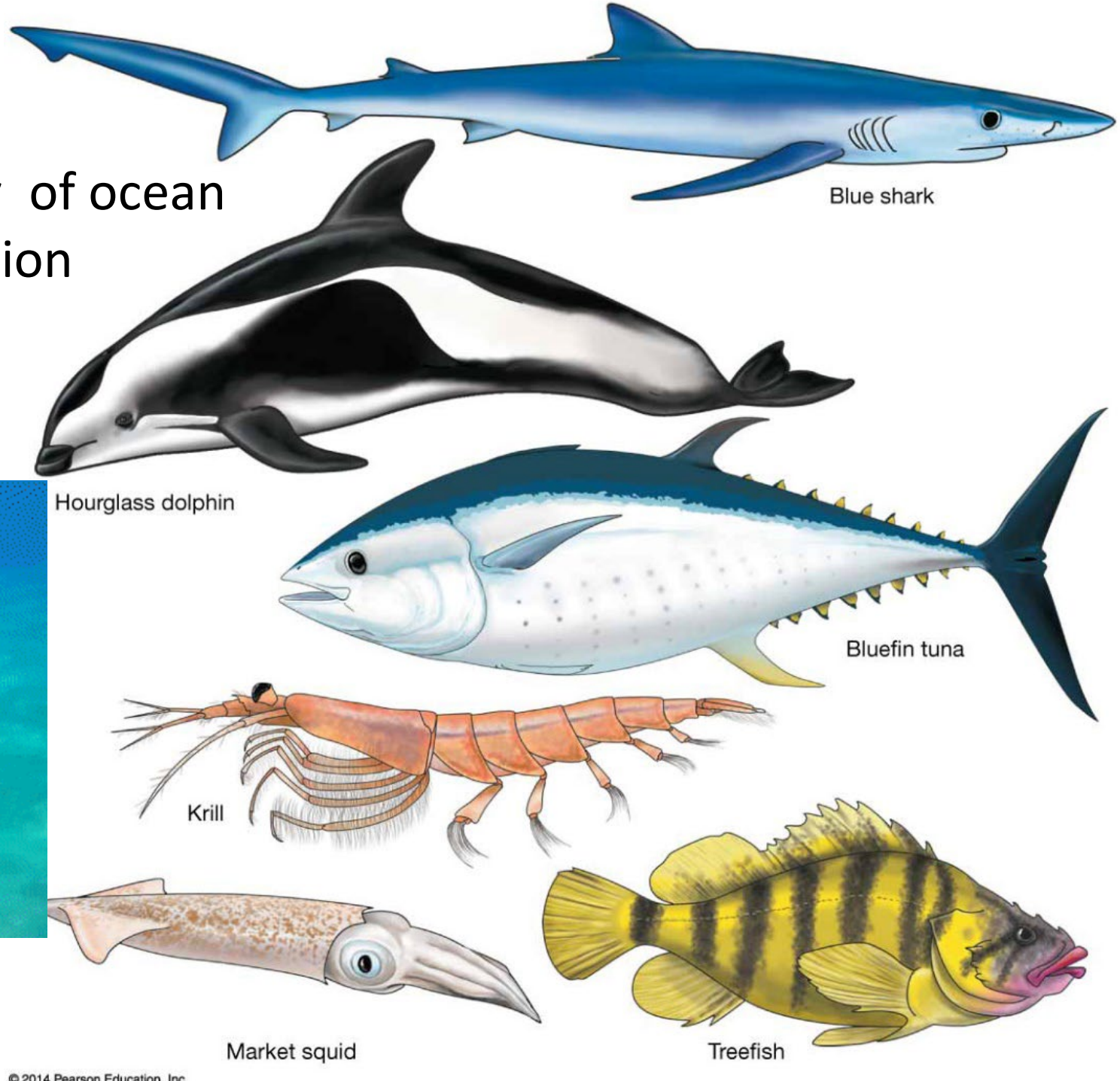


Trophic Levels



Nekton

Capable of moving independently of ocean currents, by swimming or propulsion

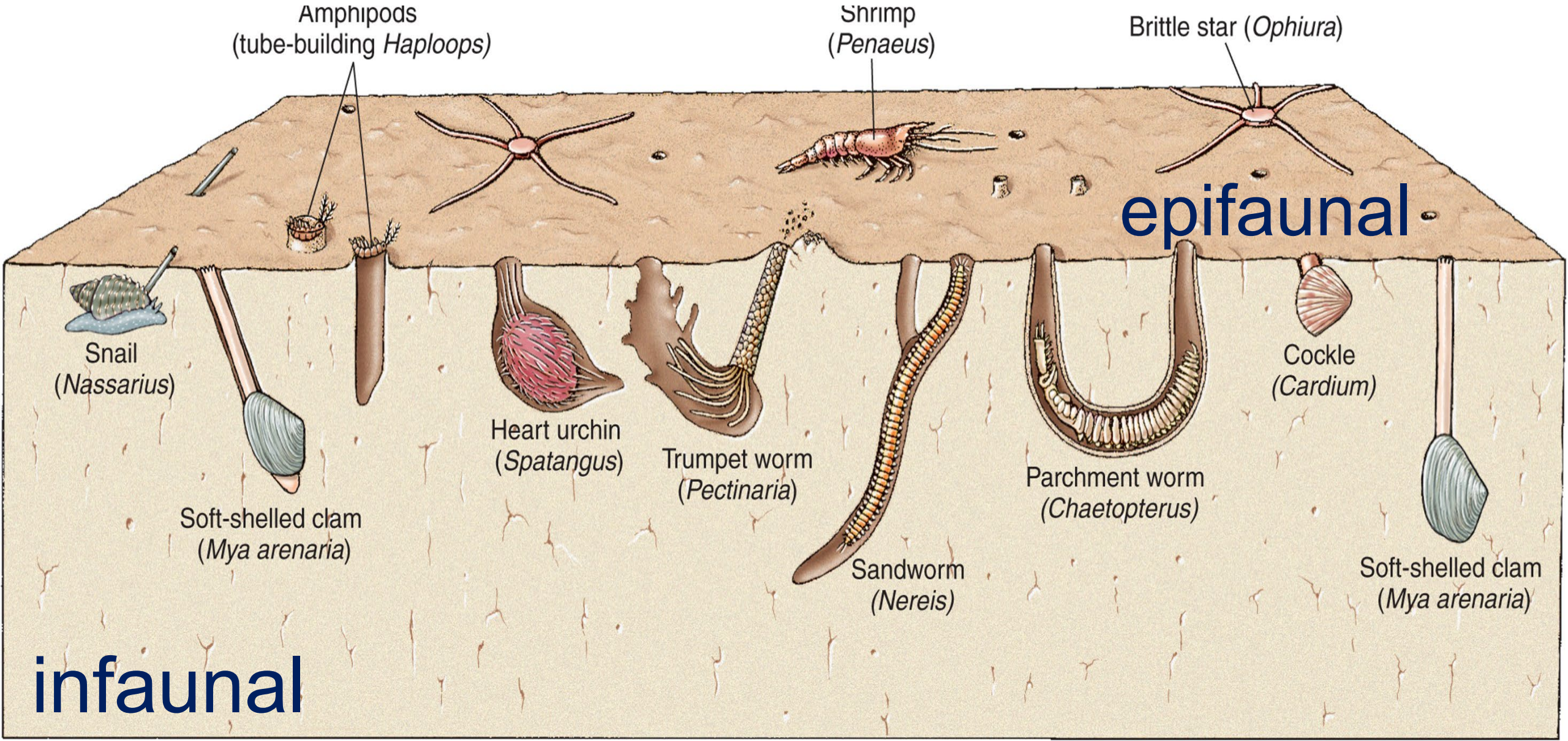


Organisms that live on the ocean's bottom…

Benthos

Soft substrate habitats (mud, sand)

Nektobenthos



Food sources

Diatoms and other phytoplankton

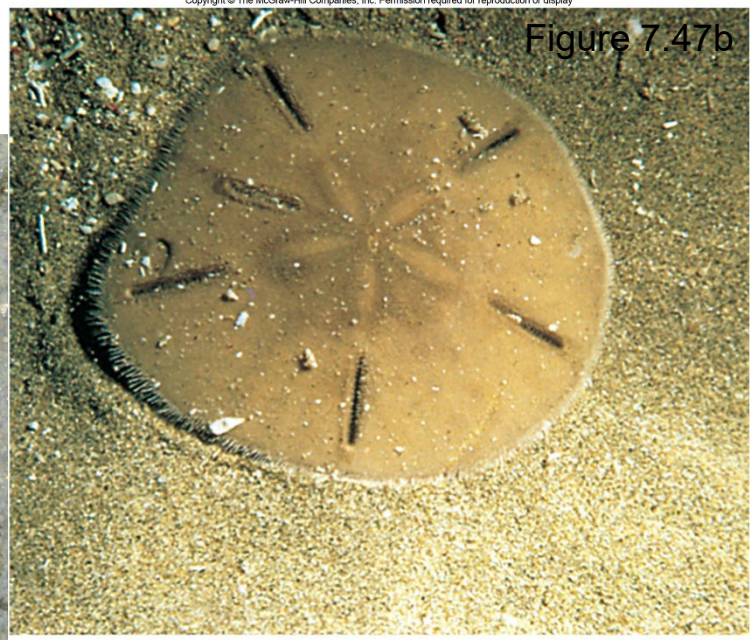
Detritus

dead and decaying plants/animals, feces, etc.

Macroalgae/seagrasses

Local animals (predation)

Deposit feeders



Suspension feeders

seadominica.com

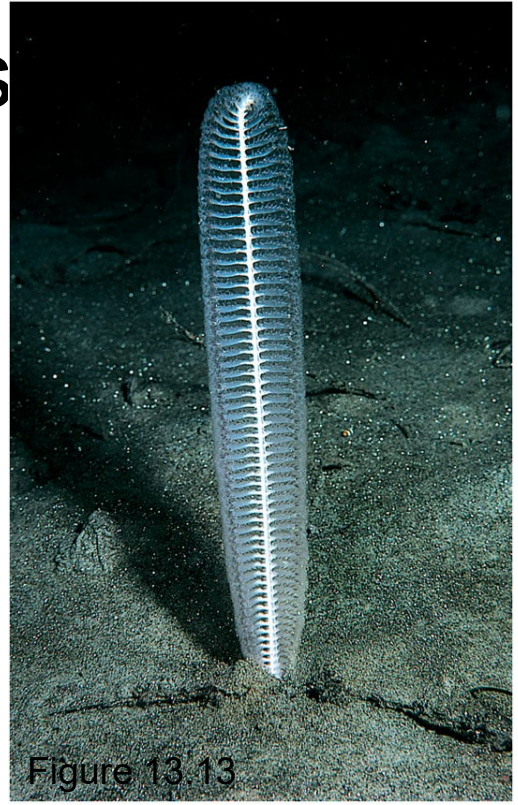


Figure 13.13

© Charlie Arneson

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www.flickr.com

Figure 13.11

© Chris Grossmann, diver.net

Predators

newscenter.berkeley.edu

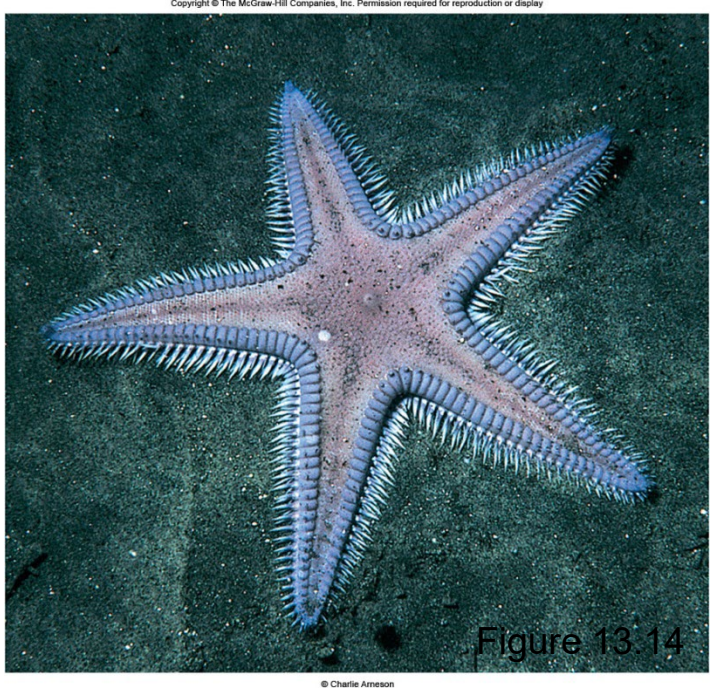


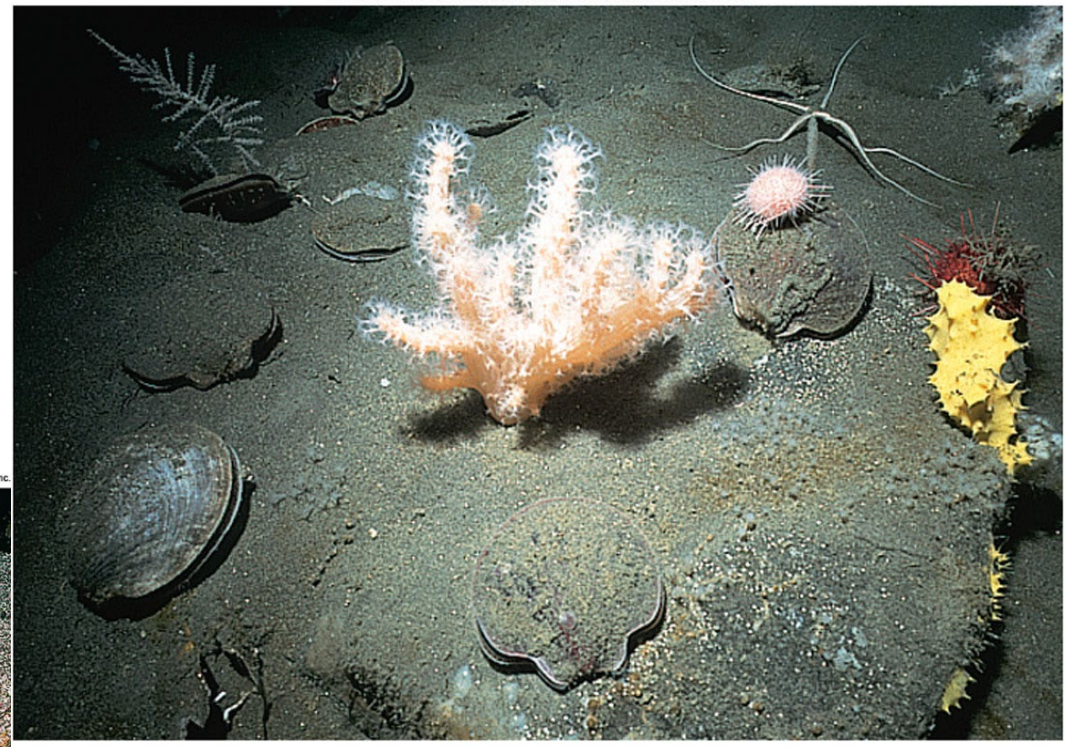
Figure 13.14

www.beachwatchers.wsu.edu

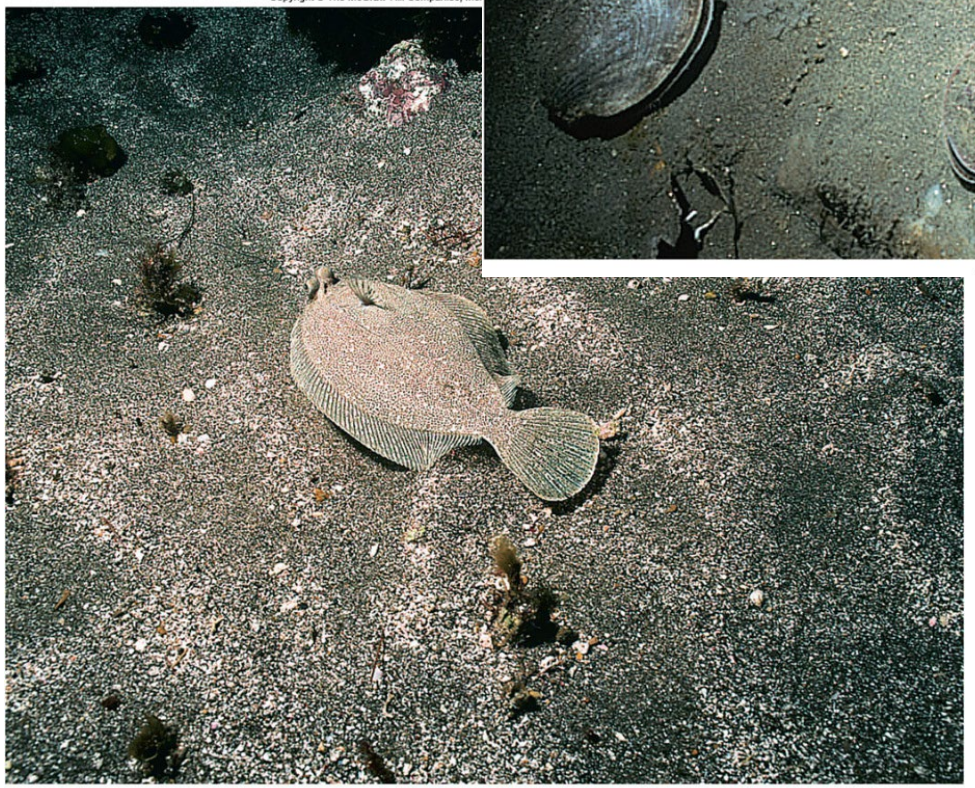
animals.nationalgeographic.com

What factors are important in determining the pattern of species distribution seen in the benthos?

Temperature, salinity, pressure
Sediment type
Food availability
Near-bed flow
Predation
Larval recruitment



© John Heine



© Charlie Arneson

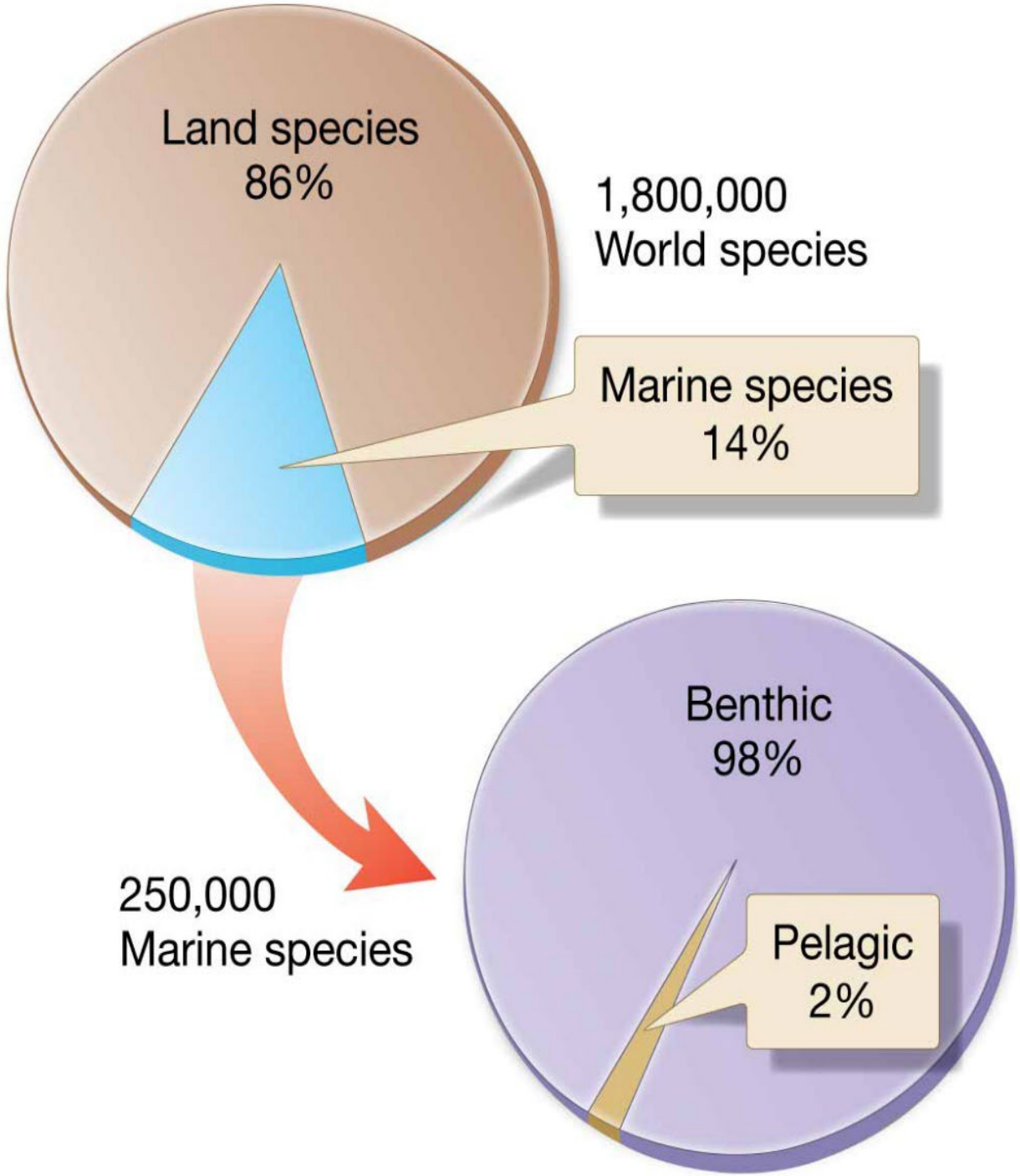
Marine life summary

Benthos make up 98% of Marine Species

Why?

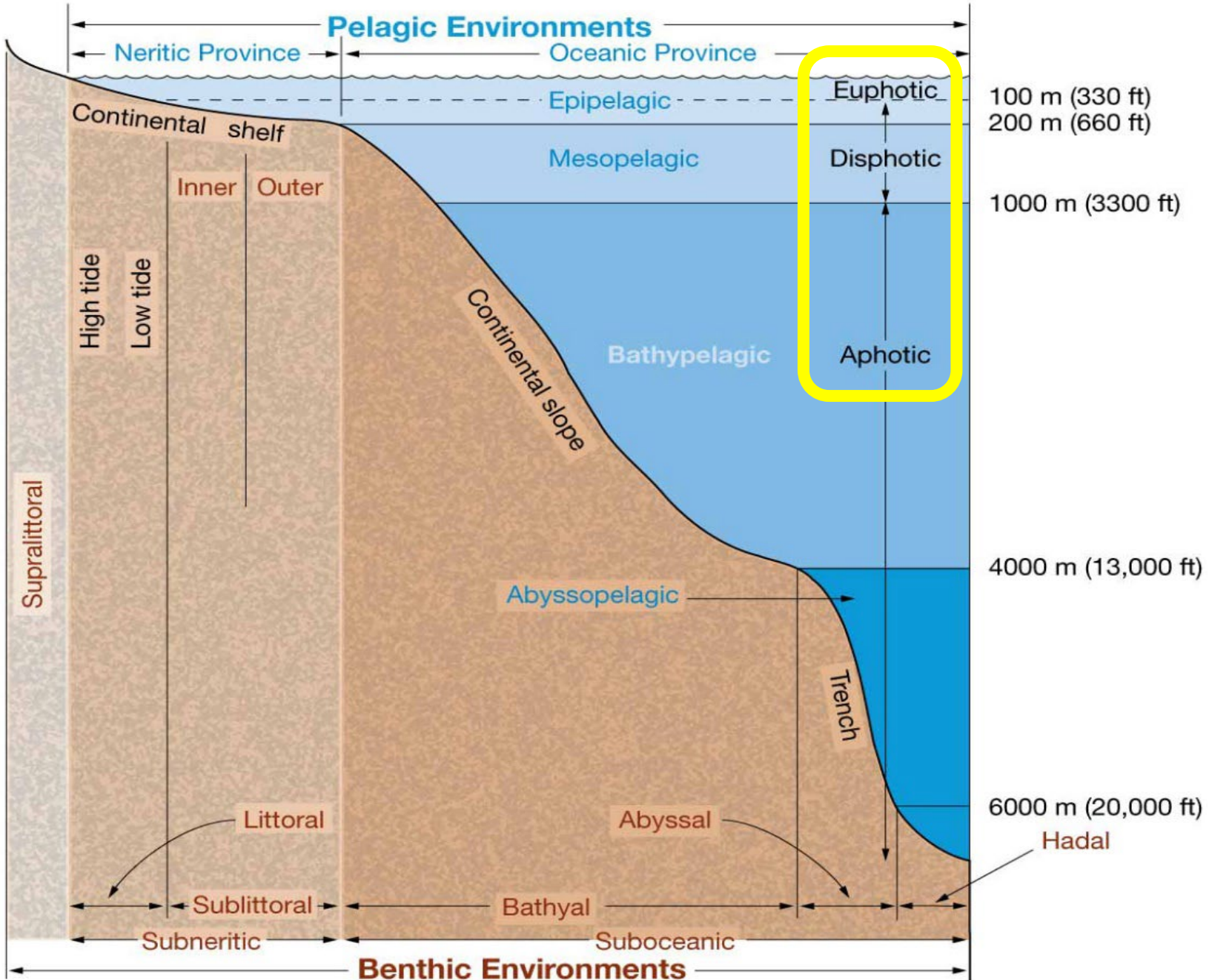
Environmental diversity (slope to flat, sandy to rocky, cool to hot etc.) animals needed to adapt to a variety of habitats.

The Pelagic environmental/water column are large, but relatively uniform

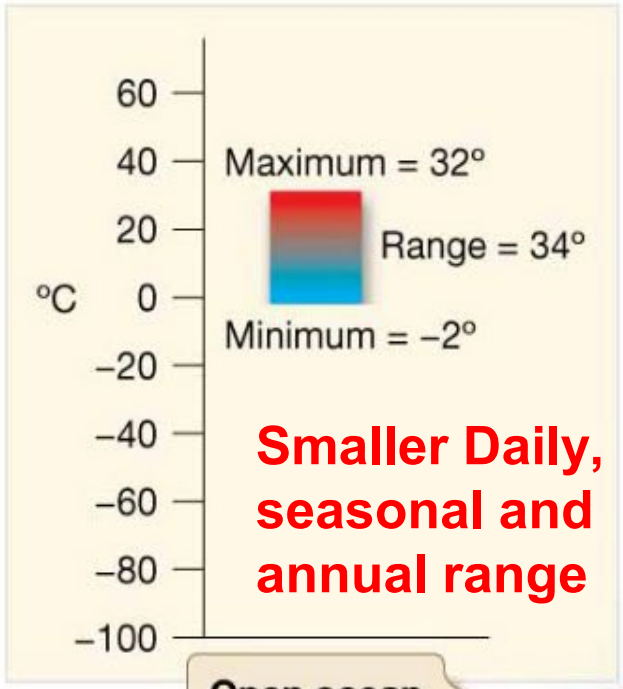


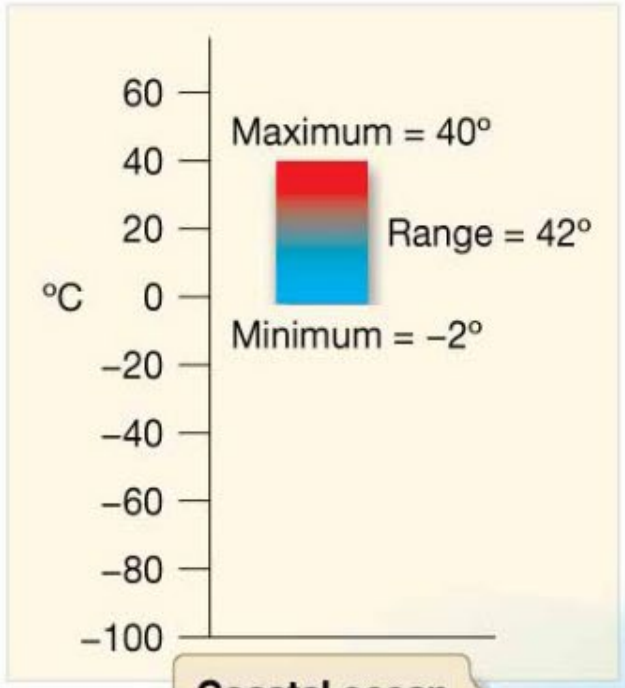
Ocean Environment conditions & Subsequent adaptations

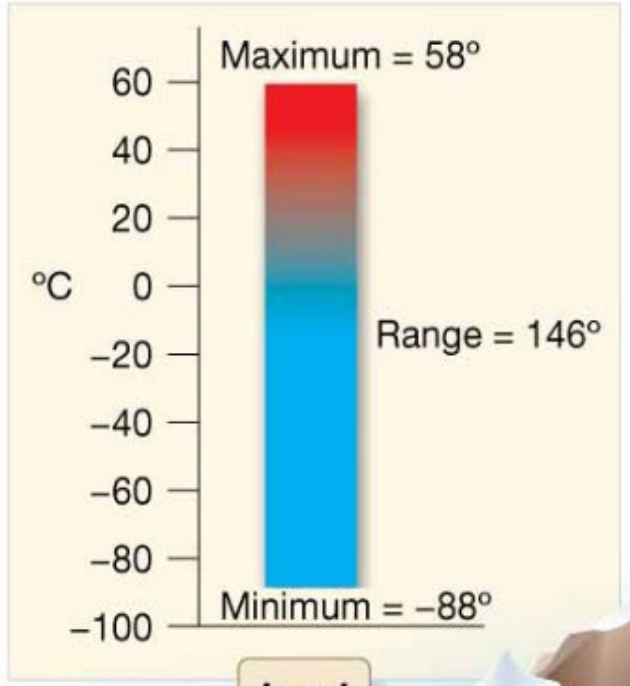
- Viscosity
- Temperature
- Salinity
- Dissolved gas
- Transparency/opacity
- Pressure
- Access to sunlight



Temperature







4x Greater variability on land

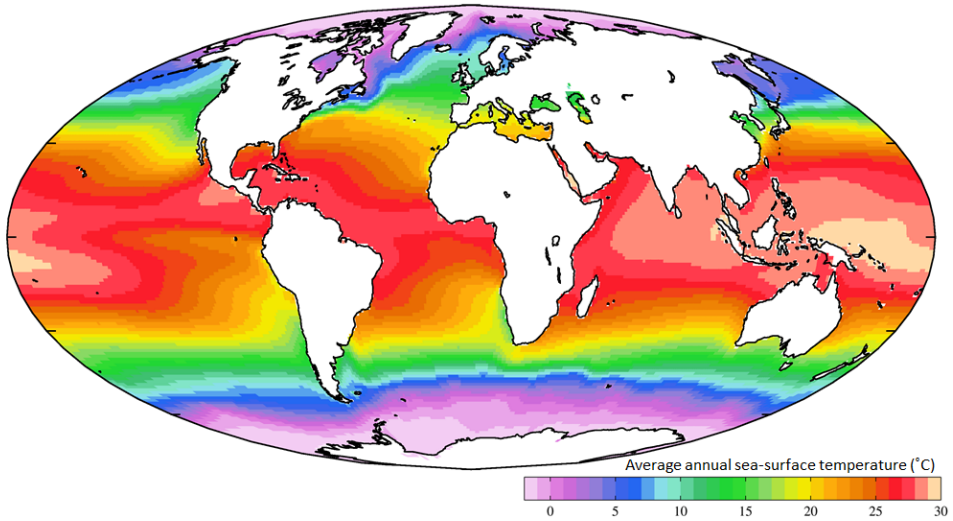
Factors – That act to stabilize ocean temps.

1. Water has a higher heat capacity than land, land achieve more heat, more quickly

2. Evaporation of water – a cooling process that stores excess heat as latent heat

3. Solar radiation penetrates water up to 100m, distributing the energy

4. Water has good mixing mechanisms e.g. waves, tides, currents further distributing the energy



Some like it hot, others like it cold

Floating organisms are smaller in warm water than cold. Smaller organisms are able to maintain position in warm water (*lower viscosity and density*)

Warm water species have ornate plumage to increase surface area, cold water species do not.

There are more species in warmer waters, but less biomass

Life divided into *zones of light* ability..

90% of all marine life lives in the Euphotic Zone

Euphotic

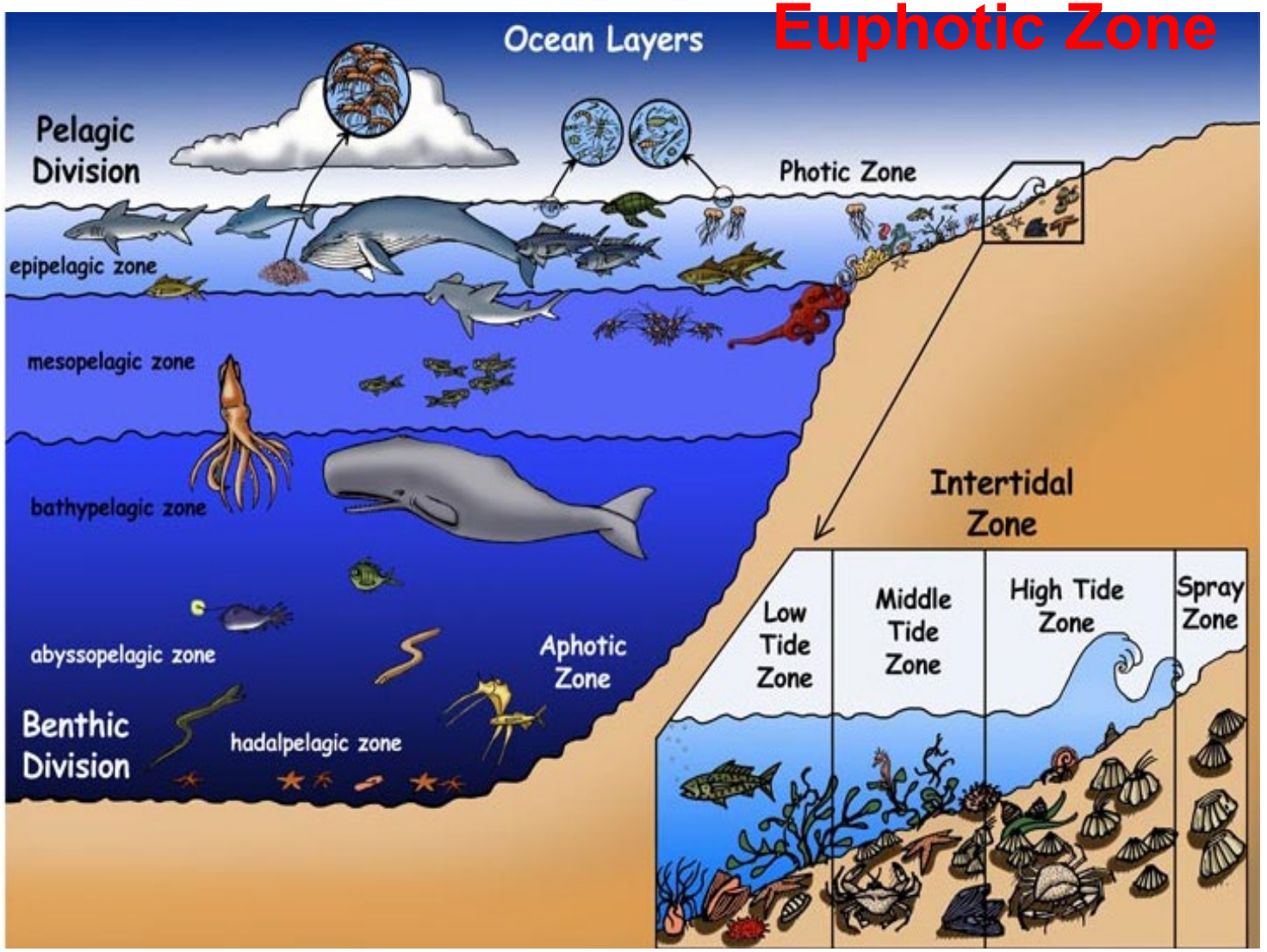
- Surface to approx. 100m
- Supportive of Photosynthesis

Disphotic

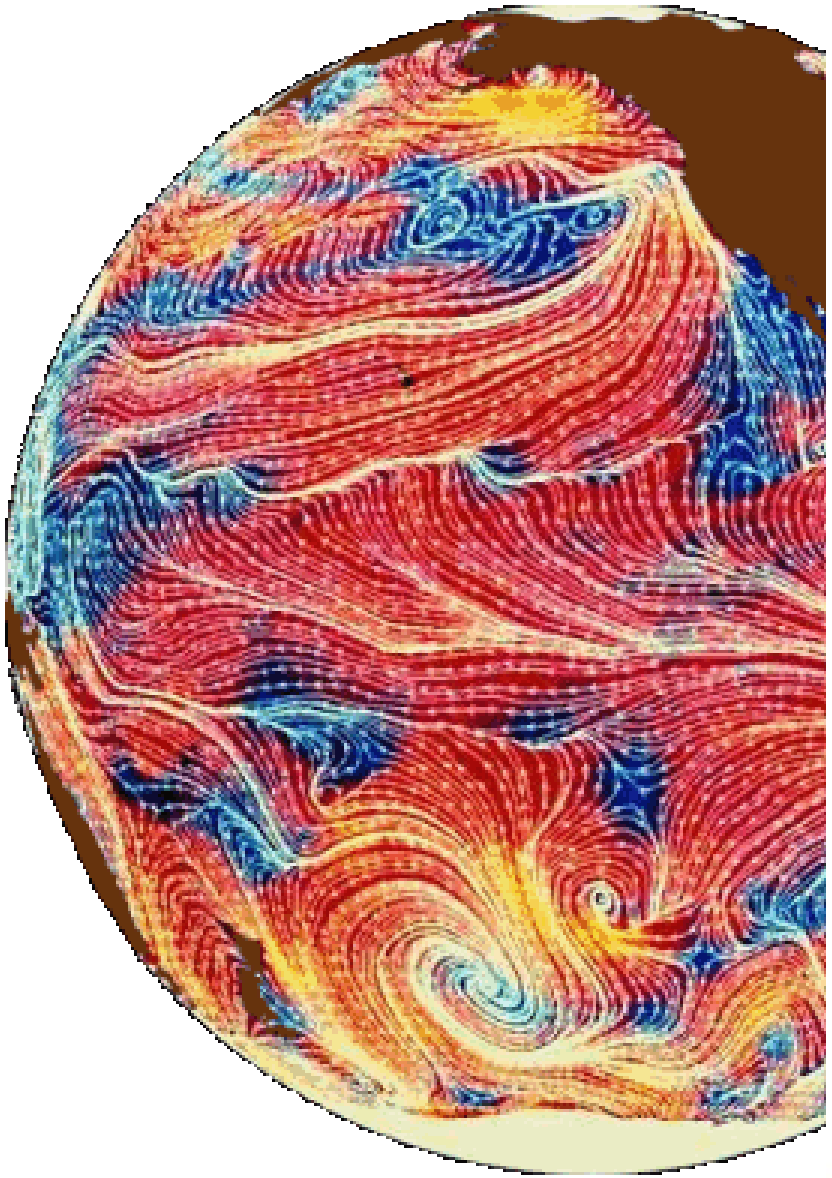
- Little light until approx. 1000m

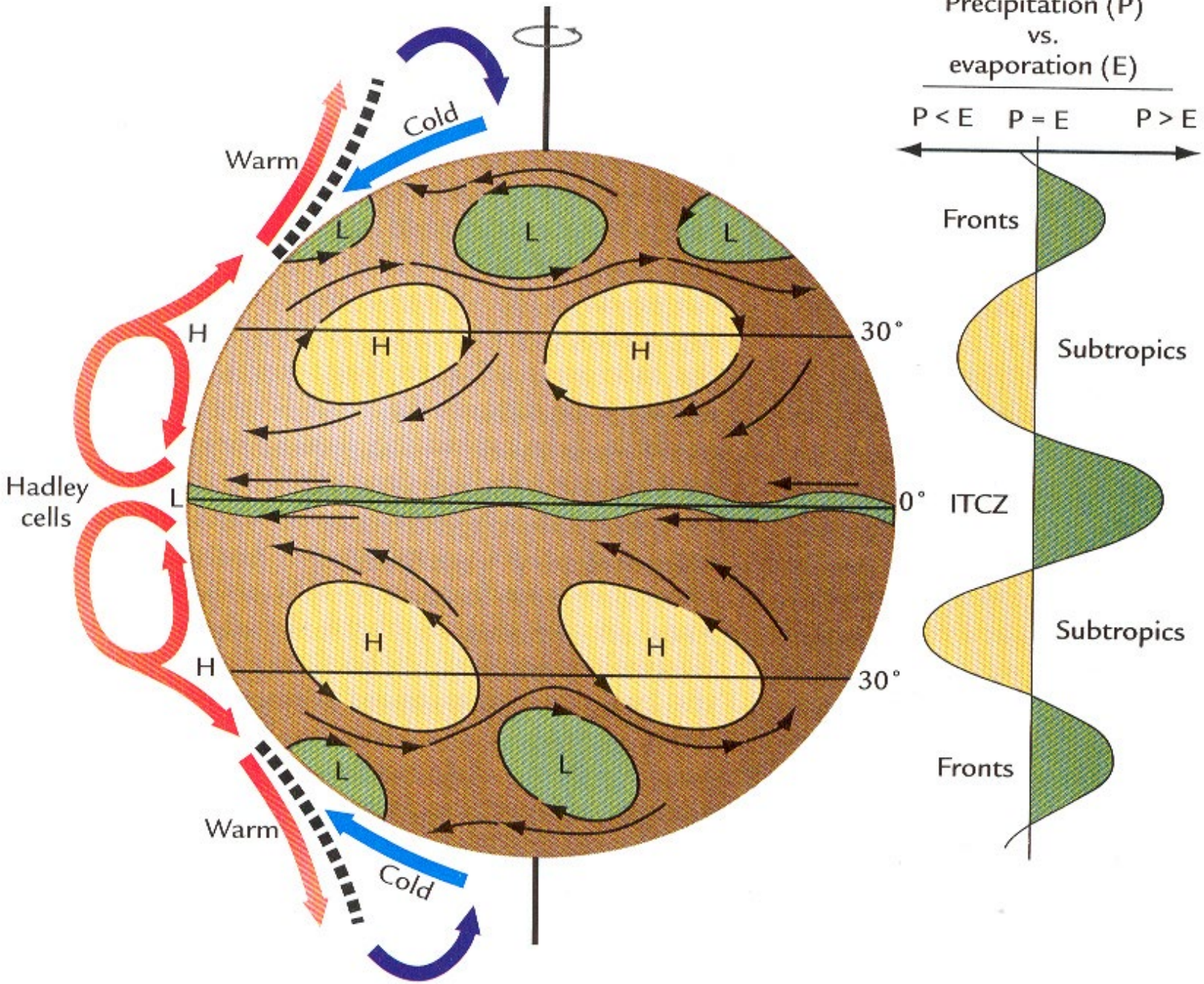
Aphotic

- No light below approx. 1000m



Sun's Energy




Warm
Cold
H
L
30°
Hadley cells
0°
ITCZ
Warm
Cold
Precipitation (P)
vs.
evaporation (E)
P < E
P = E
P > E
Fronts
Subtropics
Subtropics
Fronts

Change

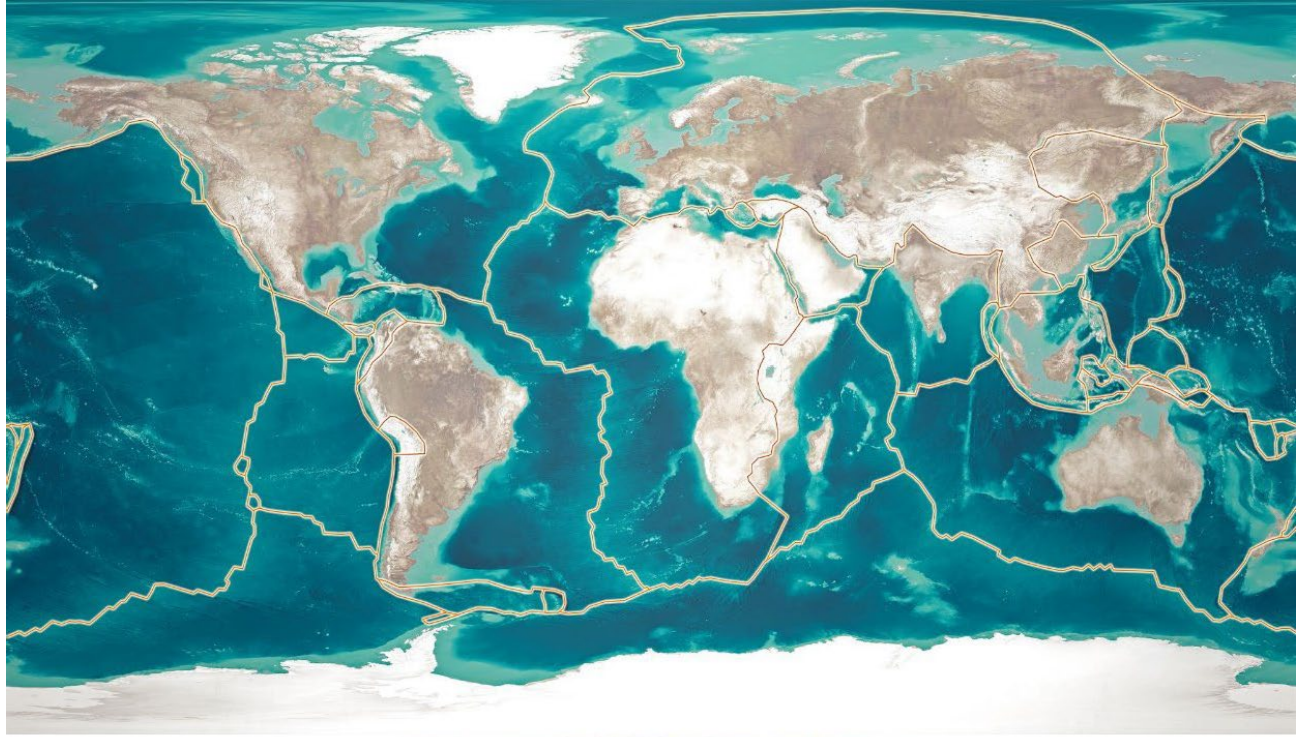
Natural Vs Anthropogenic

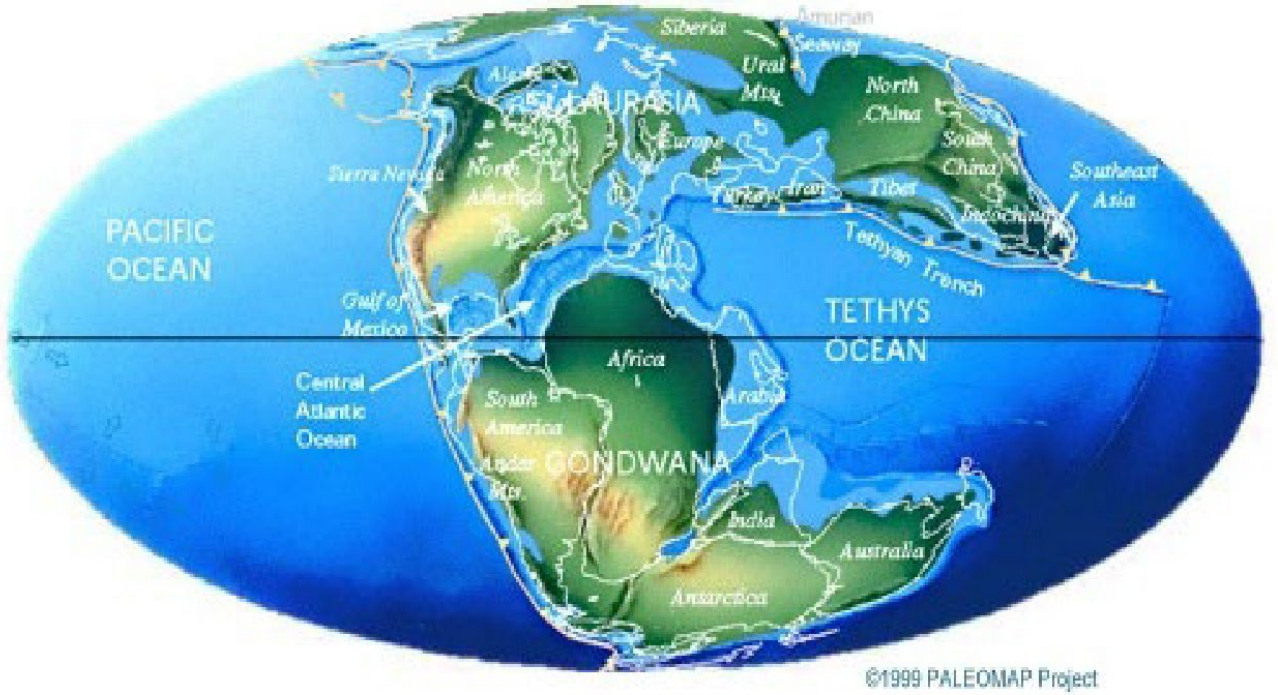
- How do we know?
  - Discover
  - Mitigate
  - Plan

Brendan Pattengale

Plate tectonics

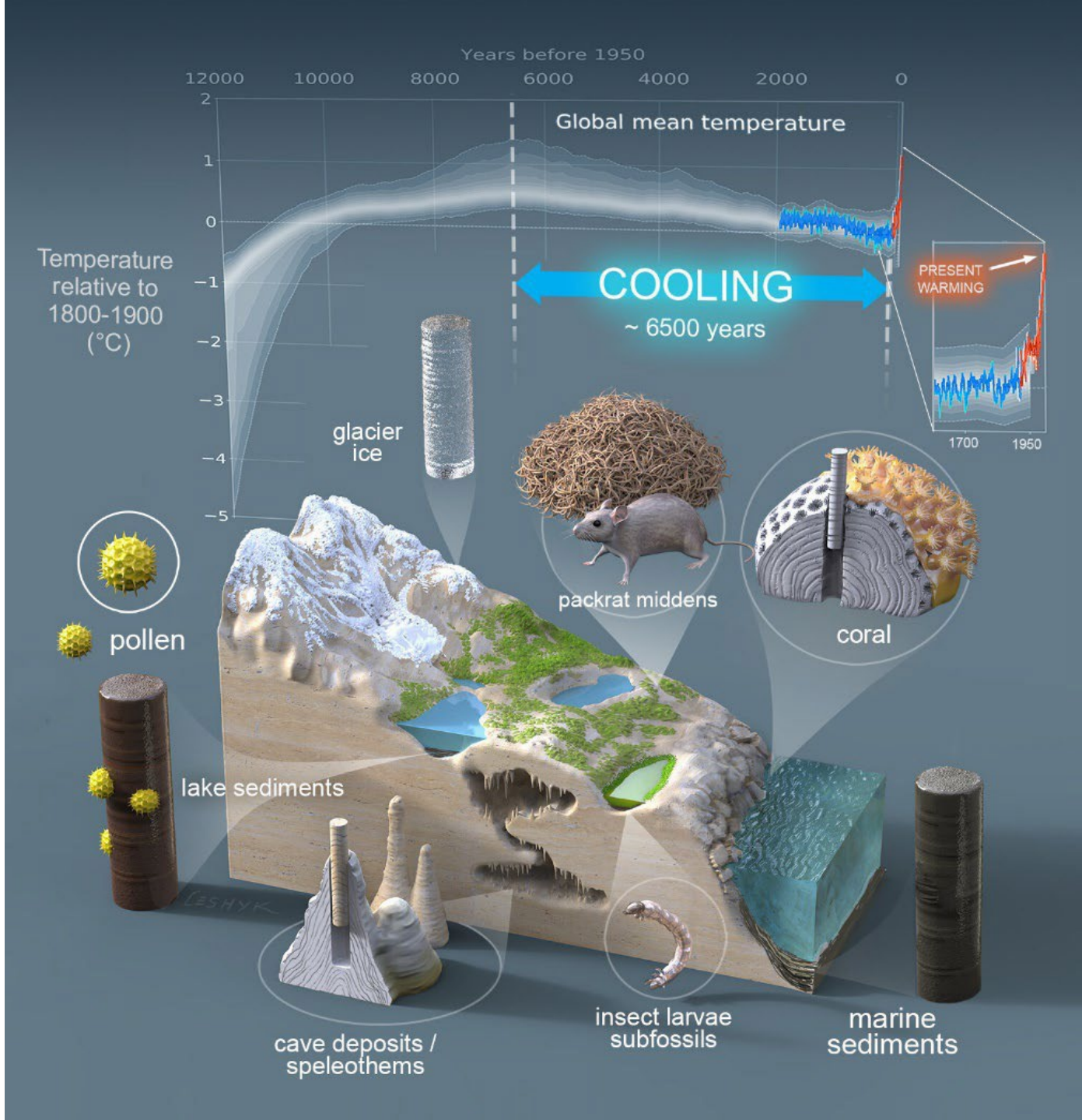
- Geologic time/movements
  - 2 to 20cm per year
- Major changes
  - Continent to ocean basin position
  - Ocean currents
  - Potential increased earthquake volcanoes
- Cannot account for rapid decadal change the Earth is experiencing today





Paleoclimatology

- Geologic Record
- Climate proxies
- Understanding of
  - Strengths
  - Weaknesses
  - Time



https://phys.org/news/2020-06-major-paleoclimatology-global-upended-years.html

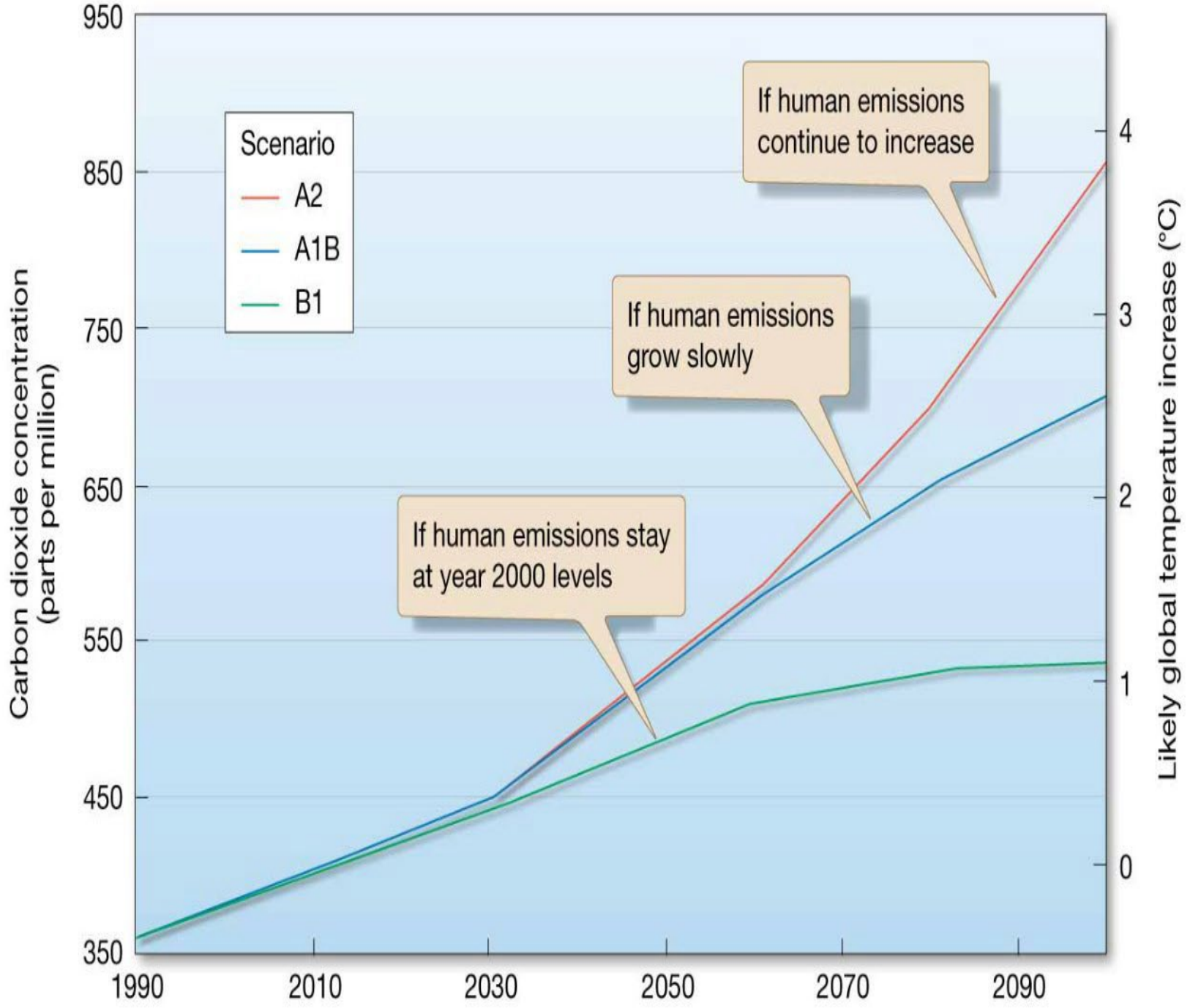
Climate

- Energy
- Systems/Processes
- Feedbacks
- Products

- Wild card/chaos - People

Modeling

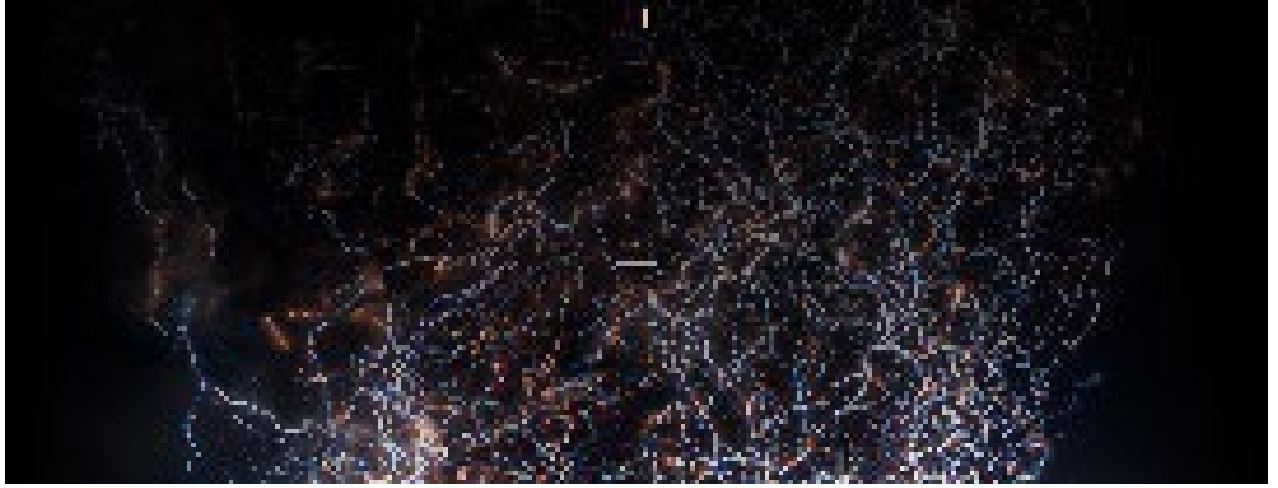
- Great models start with great field data
- An important tool to visualize complex earth systems interactions

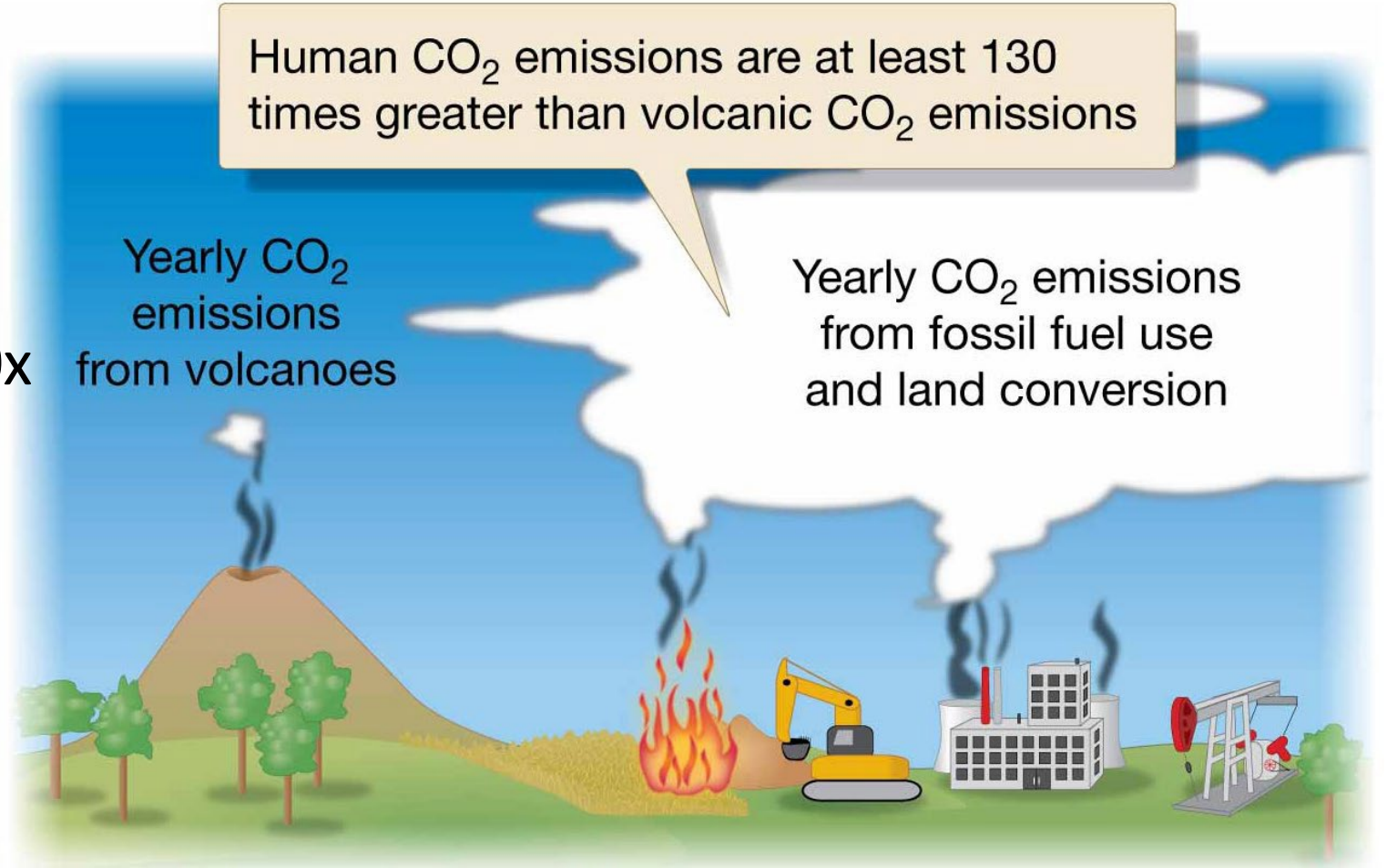


https://www.climate.gov/maps-data/primer/climate-models

Volcanic Eruptions

- Emits lava, gases, particles
- Sort term cooling
- Geologic evidence of volcanic contributions toward extinctions
- Human vs. Volcanic CO2
  - Humans release at least 130x more CO2



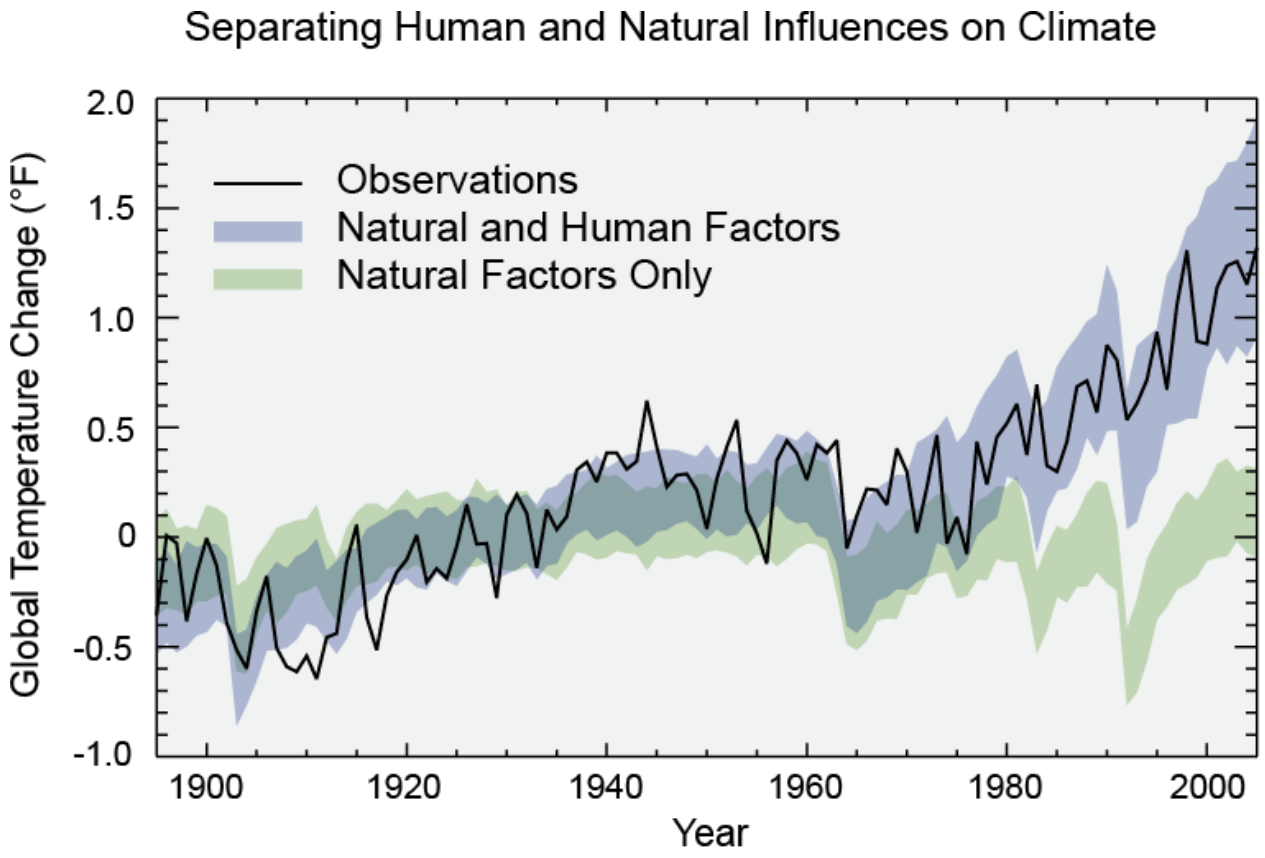


Laki, Iceland – 8 months

- *Iceland* 30% population decrease
- *Europe* HOT summer, little Ag, little food, unrest to French Revolution
- *Egypt* Nile drought, famine, 1/6 population decrease
- *North America* COLD winter Lower Mississippi River froze sending ice flows into the Gulf of Mexico

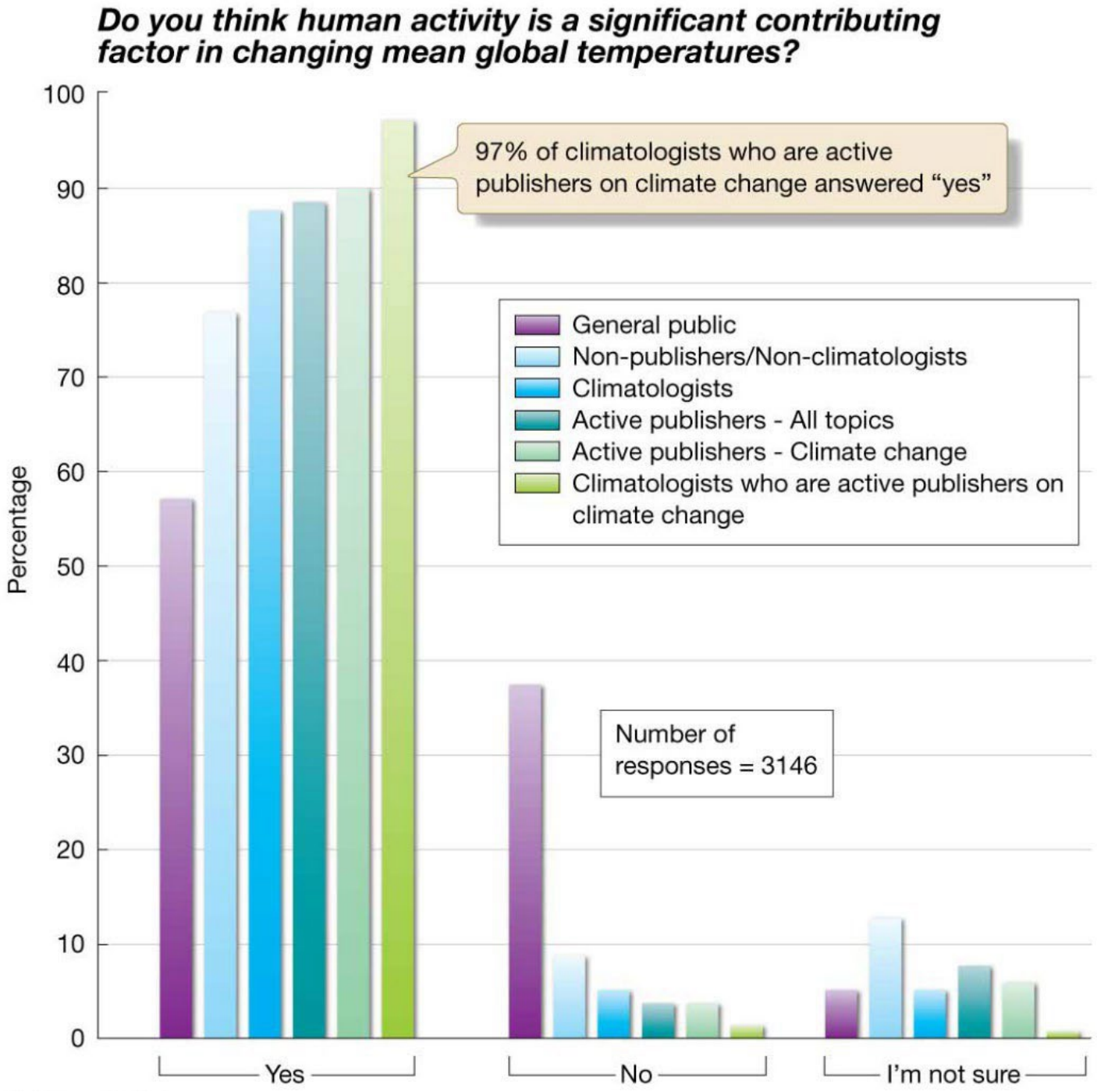
Natural Vs. Human caused climate change

- The Earth has warmed 0.8C this century.
  - 8x faster than warming off the L.G.M.
  - Paleoclimate proxies, Anthropogenic warming is 5000x faster than anything in the stratigraphic record.
- Wild card factor/ chaos



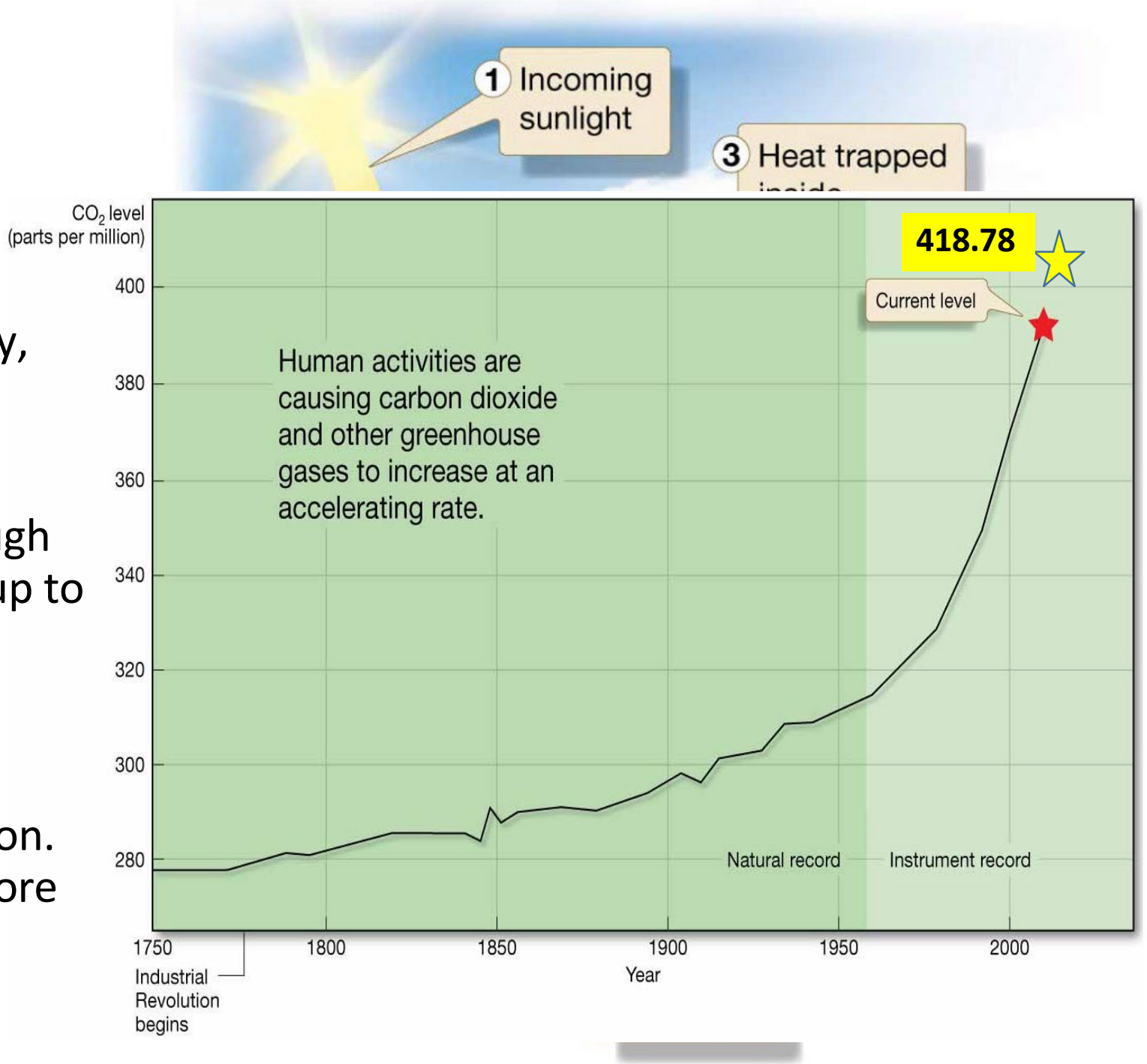
Clear Scientific Consensus

- The science is clear – The Earth's rapid warming cannot be explained without human contributions
- All major scientific organizations confirm presence of human-caused climate change.
- Human caused climate change, scientific consensus has been established for more than 35 years.
- Intergovernmental Panel on Climate Change (IPPC)



Greenhouse effect

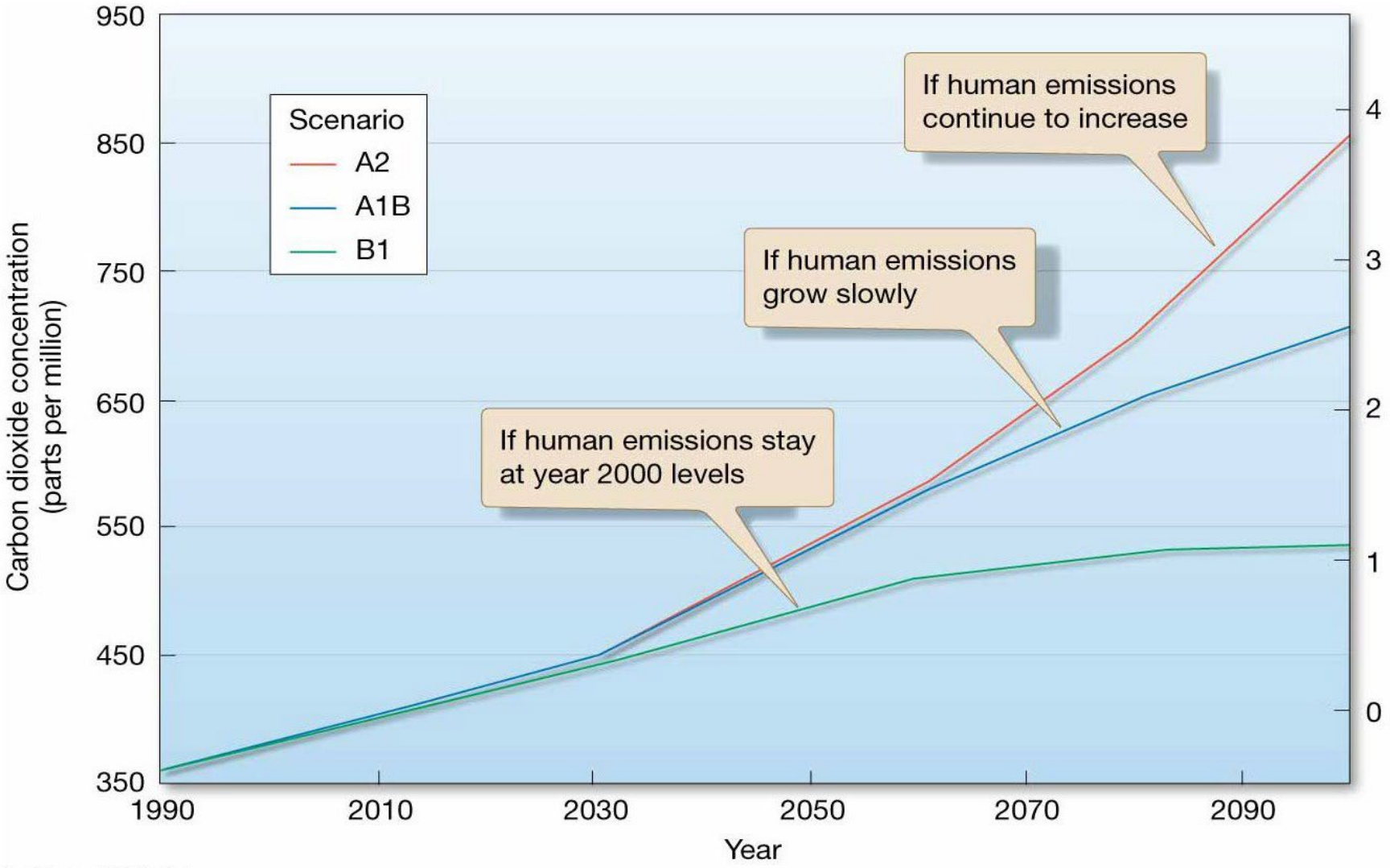
- Water Vapor, H_2O_v
  - Important, driven by evaporation, fluctuate seasonally and regionally, indirectly human influenced
- Carbon Dioxide, CO_2
  - Greatest human influence – through use of fossil fuels & combustion, up to 33billion metric tons per year!
- Methane, CH_4
  - 2nd most human influenced gas, landfill waste, cattle, rice cultivation. *Less abundant than CO2, BUT more potent! Up 250% since 1750.

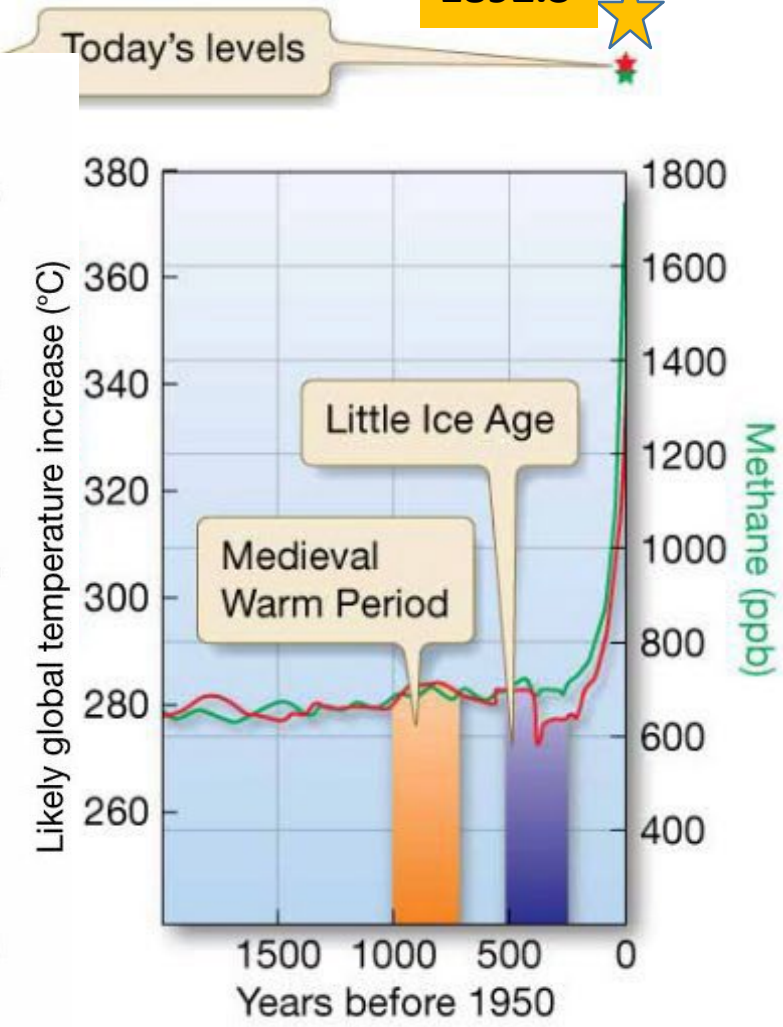


Greenhouse Gases past to Future

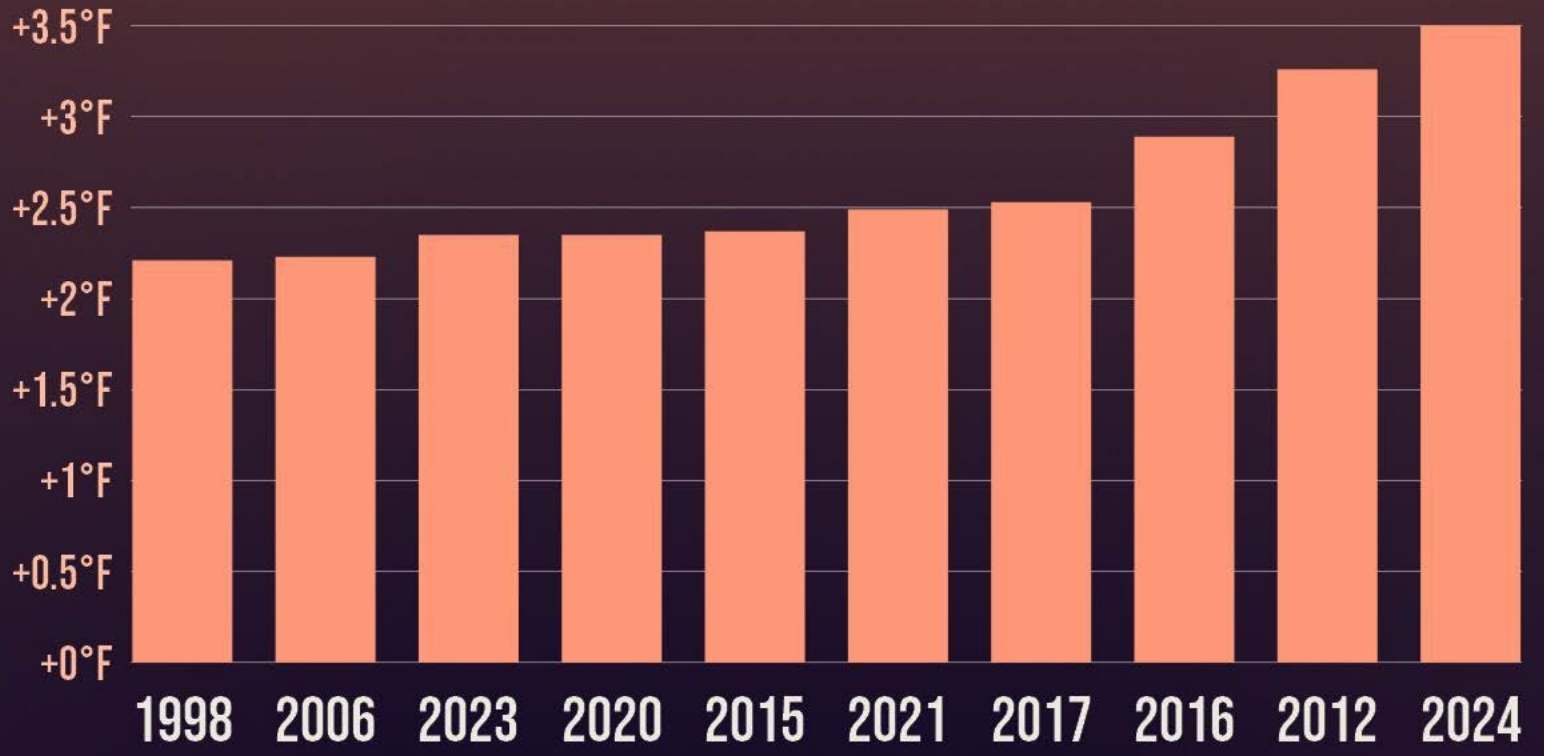
Highest levels in the past 800,000 yrs. **418.78**

1892.3





10 HOTTEST U.S. YEARS ON RECORD



Difference from 20th century average temperature (°F).
Data as of 1/10/2025.
Source: NOAA NCEI

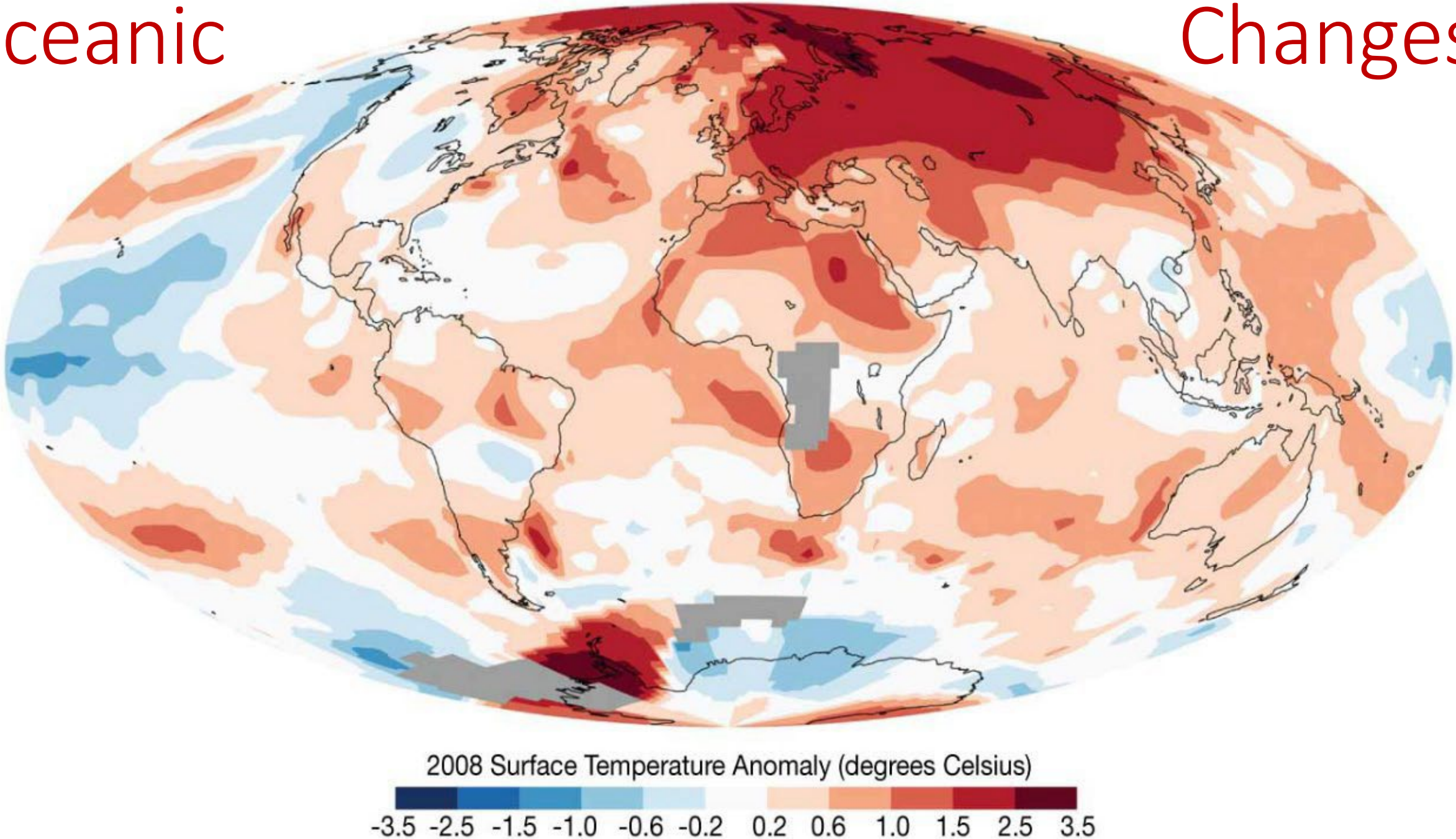
CLIMATE CENTRAL

Bi-products of a Warming Earth/Land

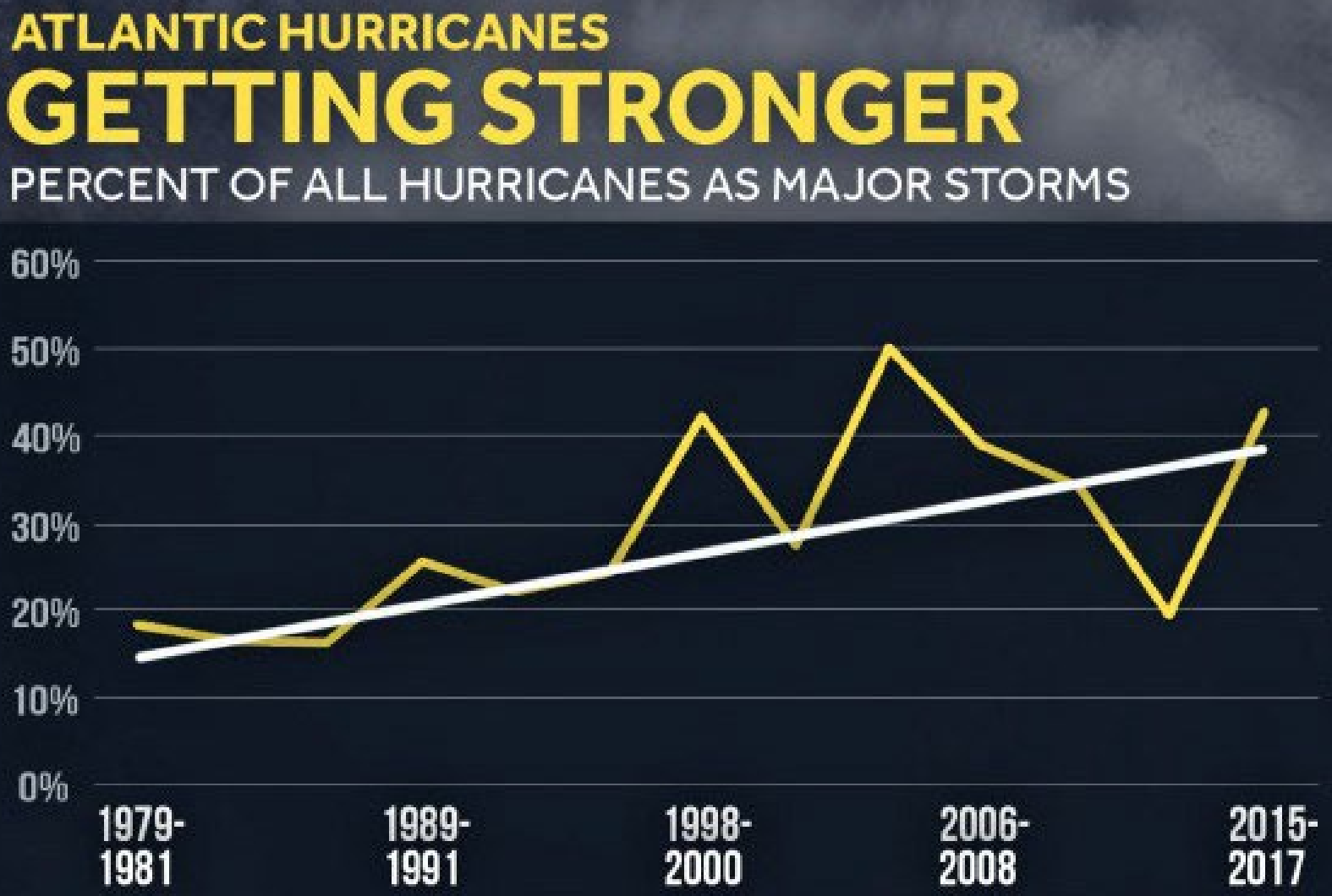
- Mild winters*
  - Polar vortex caveat
- Shorter winters/Earlier summers
- Increased extreme precipitation events
  - Drought
  - Floods
- Melting glaciers and snow fields
- Increased waterborne diseases
- Ecosystem shifts
  - Invasive species Proliferation

- Increased primary production

Oceanic Changes



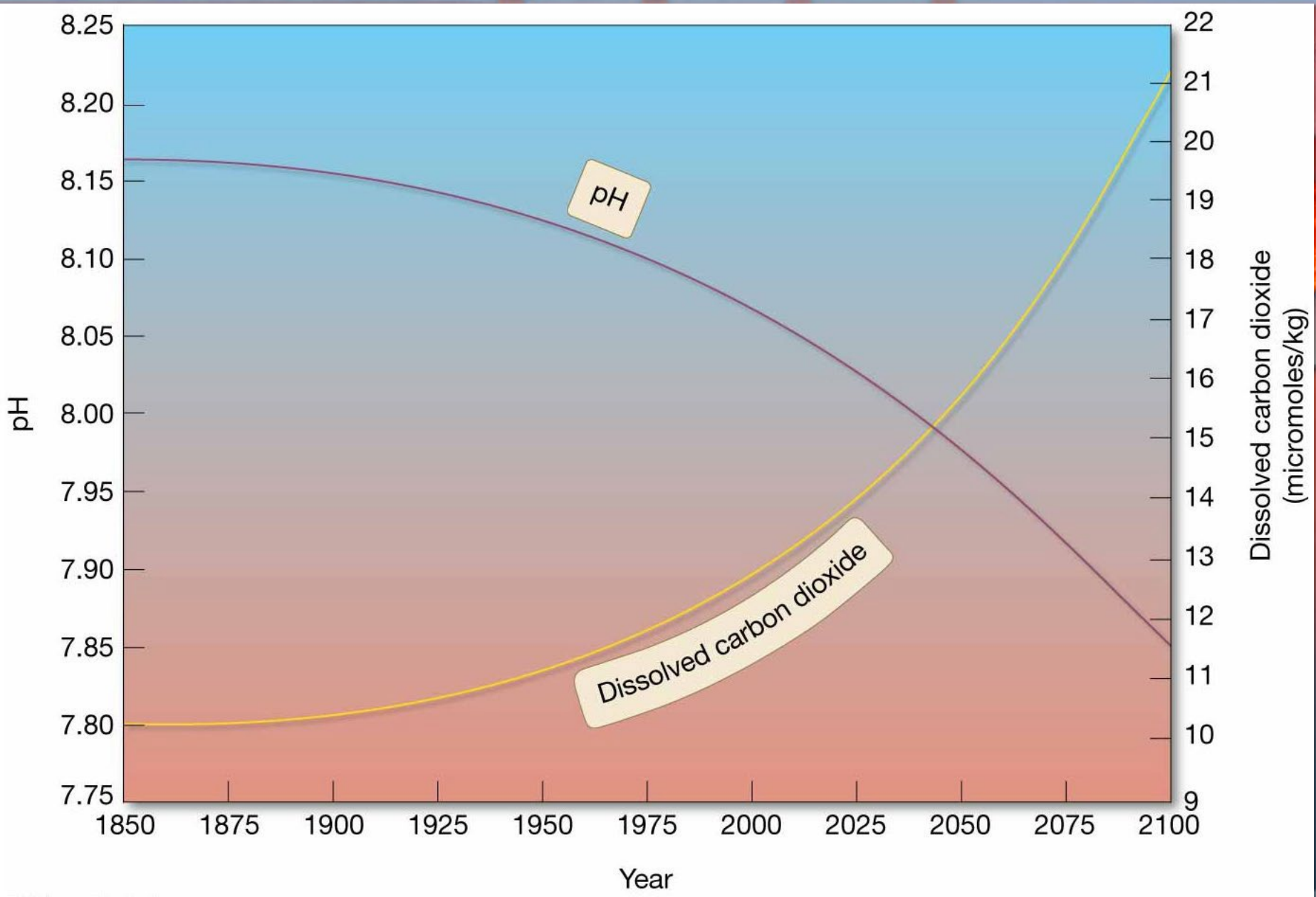
Hurricane activity

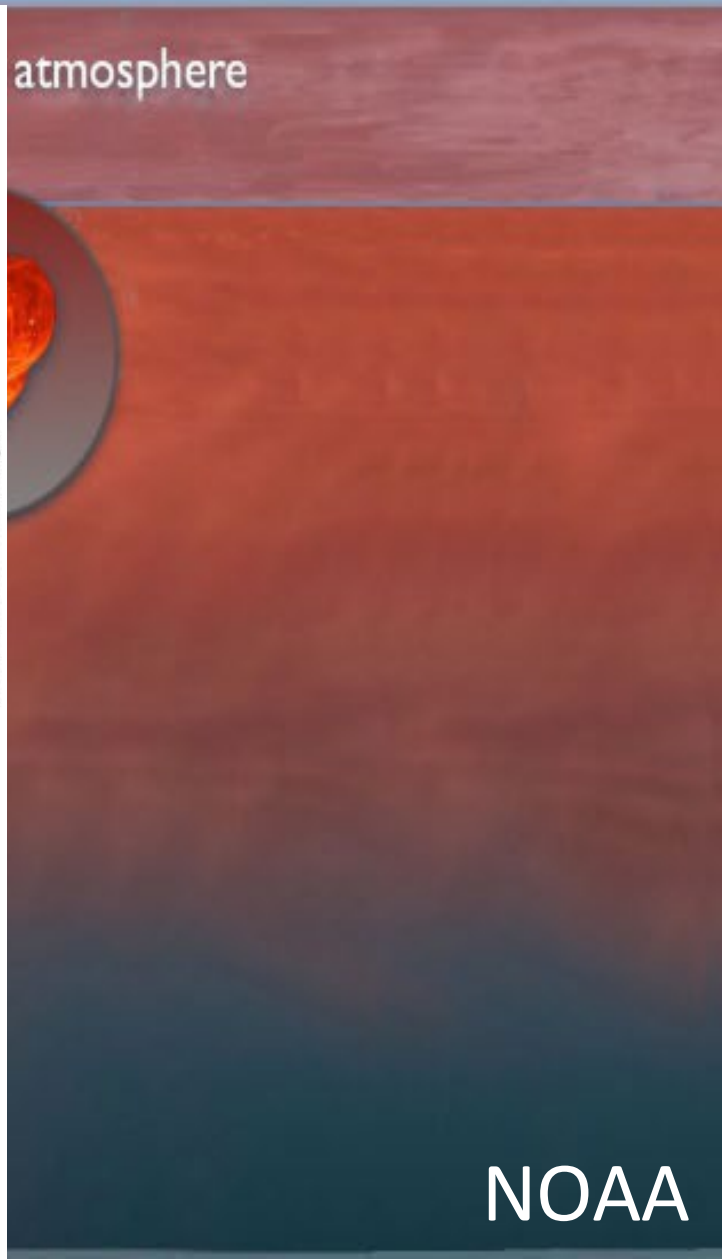


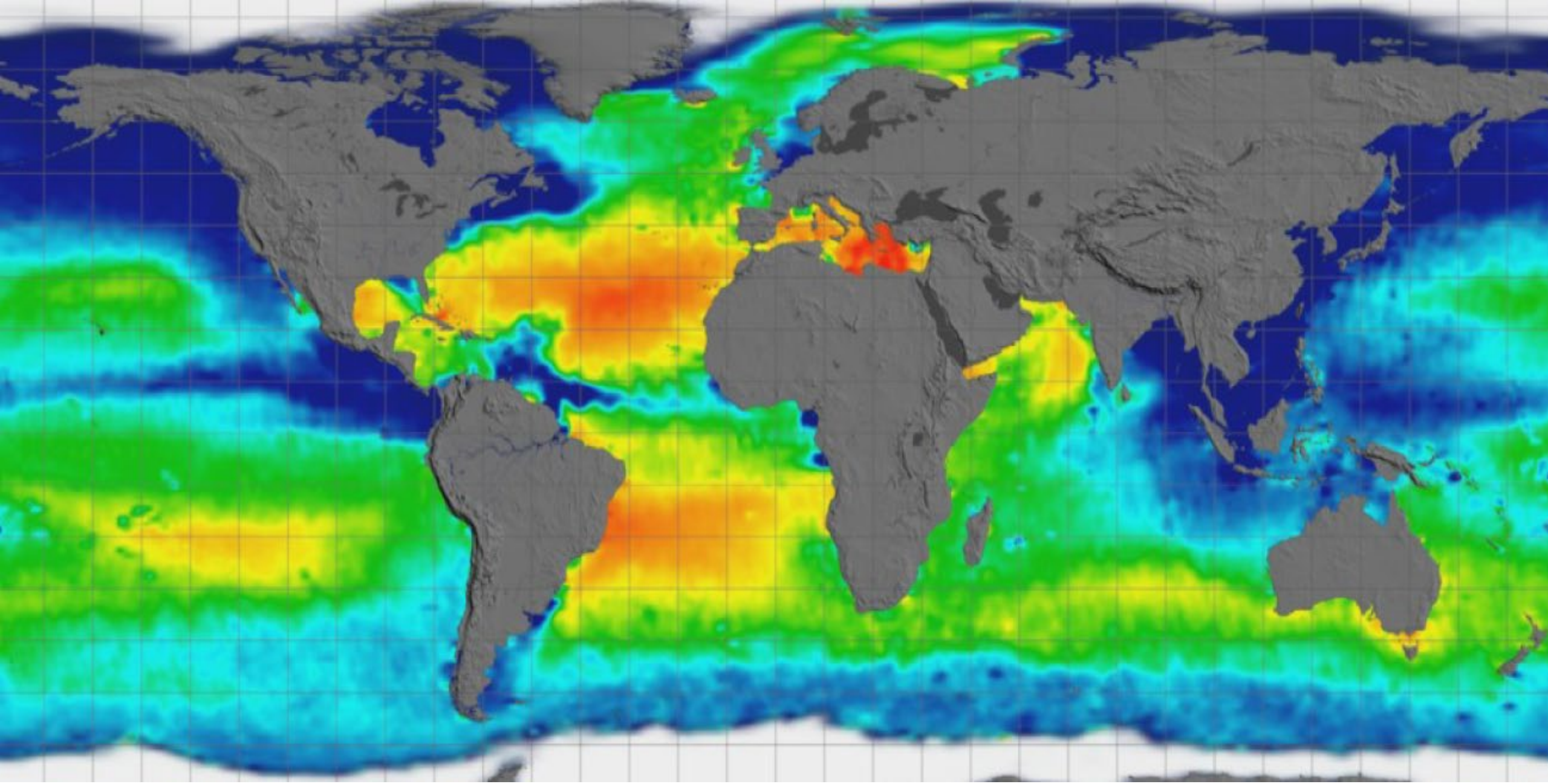
Melting polar ice

Sea level rise

Ocean Acidification





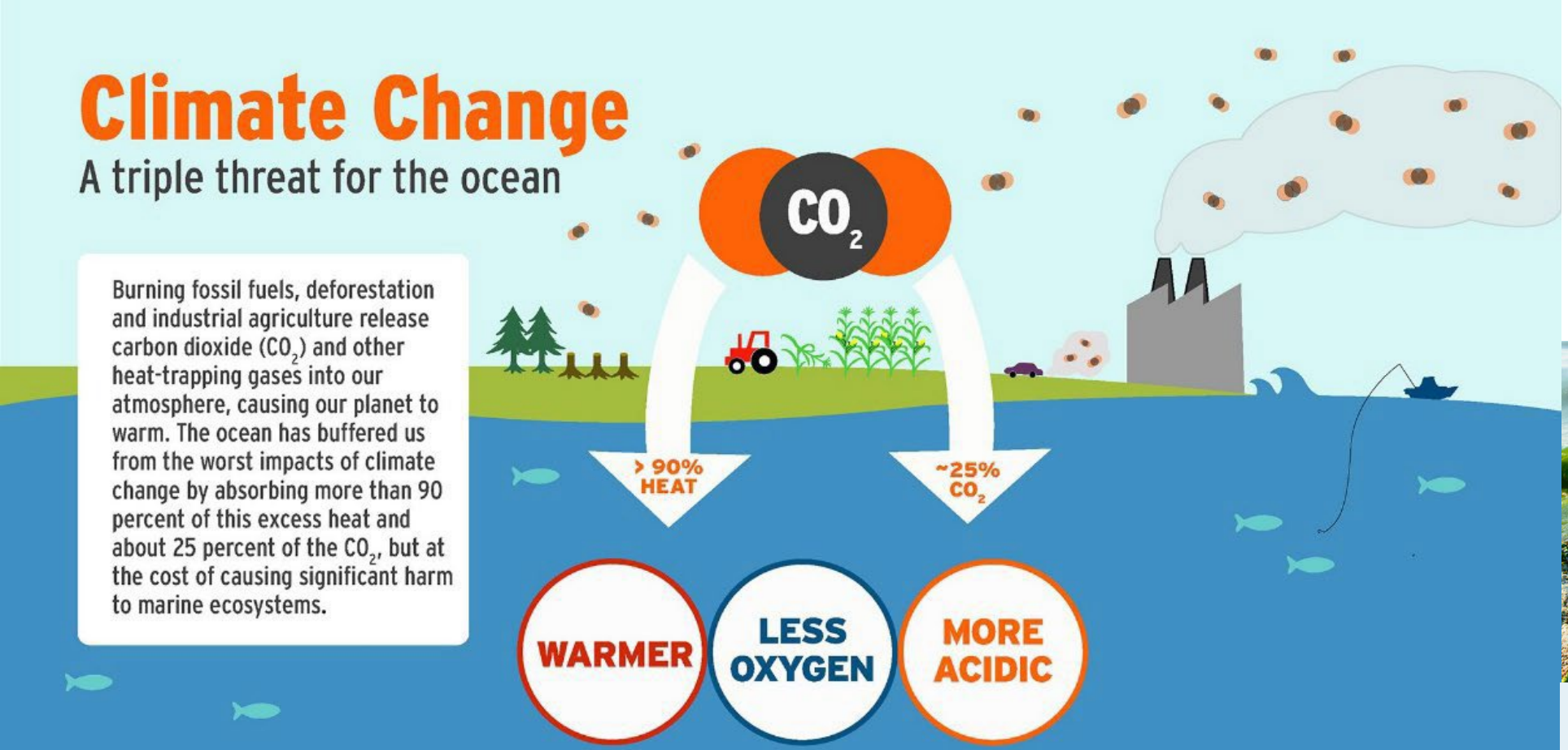


https://salinity.oceansciences.org/highlights03.htm

Climate Change

A triple threat for the ocean

Burning fossil fuels, deforestation and industrial agriculture release carbon dioxide (CO_2) and other heat-trapping gases into our atmosphere, causing our planet to warm. The ocean has buffered us from the worst impacts of climate change by absorbing more than 90 percent of this excess heat and about 25 percent of the CO_2, but at the cost of causing significant harm to marine ecosystems.



SEA LEVEL

Sea level rise is accelerating, flooding coastal communities and drowning wetland habitats.

BLEACHING

Warm-water coral reefs (marine biodiversity hotspots) could be lost if the planet warms by 2°C (3.6°F).

TOXIC ALGAE

Larger and more frequent blooms are making fish, birds, marine mammals and people sick.

HABITATS

Lower oxygen levels are suffocating some marine animals and shrinking their habitats.

ACIDIFICATION

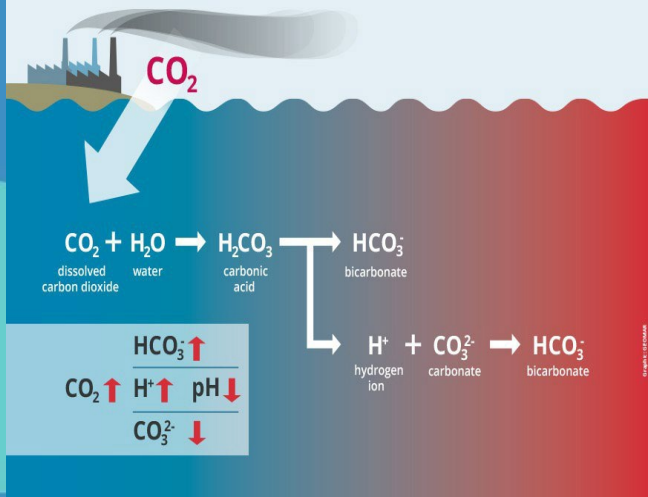
More acidic water harms animals that build shells, such as corals, clams, and oysters.

FISHERIES

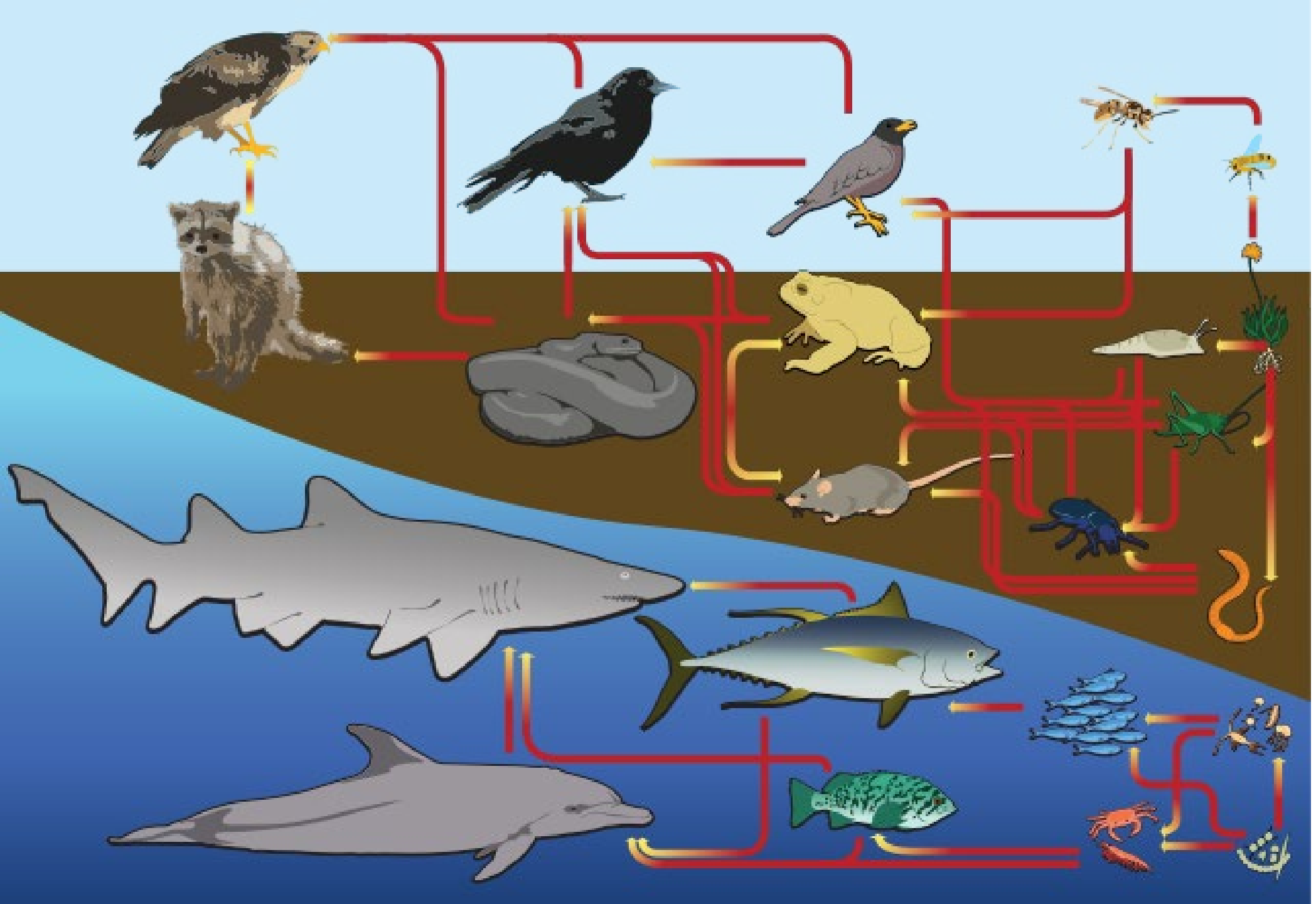
Disruptions in fisheries affect the marine food web, local livelihoods, and global food security.

Monterey Bay Aquarium Research Institute | Monterey Bay Aquarium

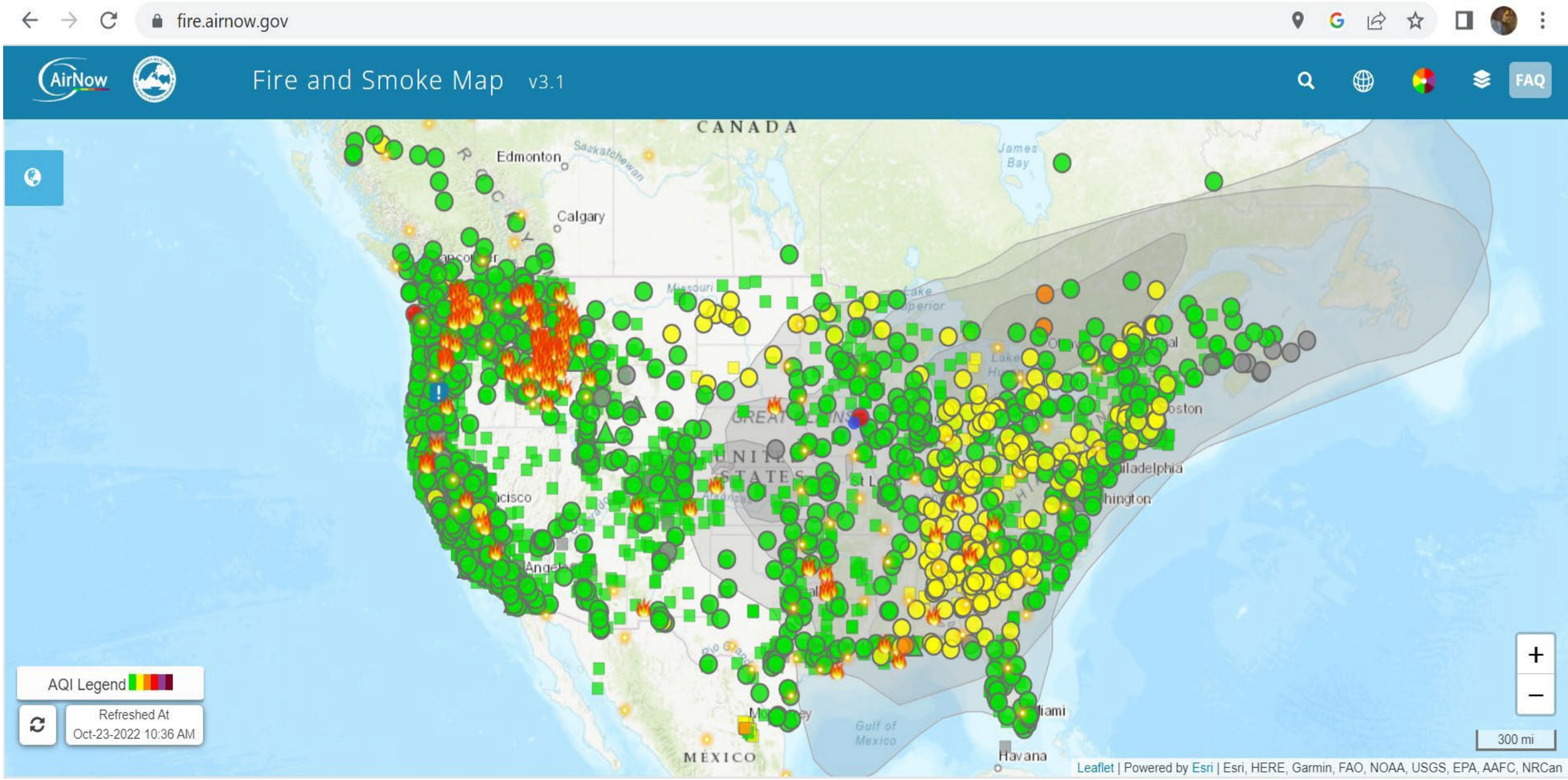
Source: IPCC, 2019: Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)



Food Web



Fire


fire.airnow.gov
AirNow
Fire and Smoke Map v3.1
FAQ
CANADA
Edmonton
Calgary
Saskatchewan
James Bay
Missouri
Lake Superior
Boston
Philadelphia
Washington
Miami
Gulf of Mexico
Havana
MEXICO
AQI Legend
Refreshed At
Oct-23-2022 10:36 AM
300 mi
Leaflet | Powered by Esri | Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, AAFC, NRCan

The Great Human Population Redistribution – Climate ~~Refugees~~ Migrants

In the USA too?

- https://www.youtube.com/watch?v=SByFy9R6320

One year apart

- https://youtu.be/M6DeToIYSG0

- Houghton, MI
- Marquette, MI
- Duluth, MN
- Madison, WI
- Burlington, VT