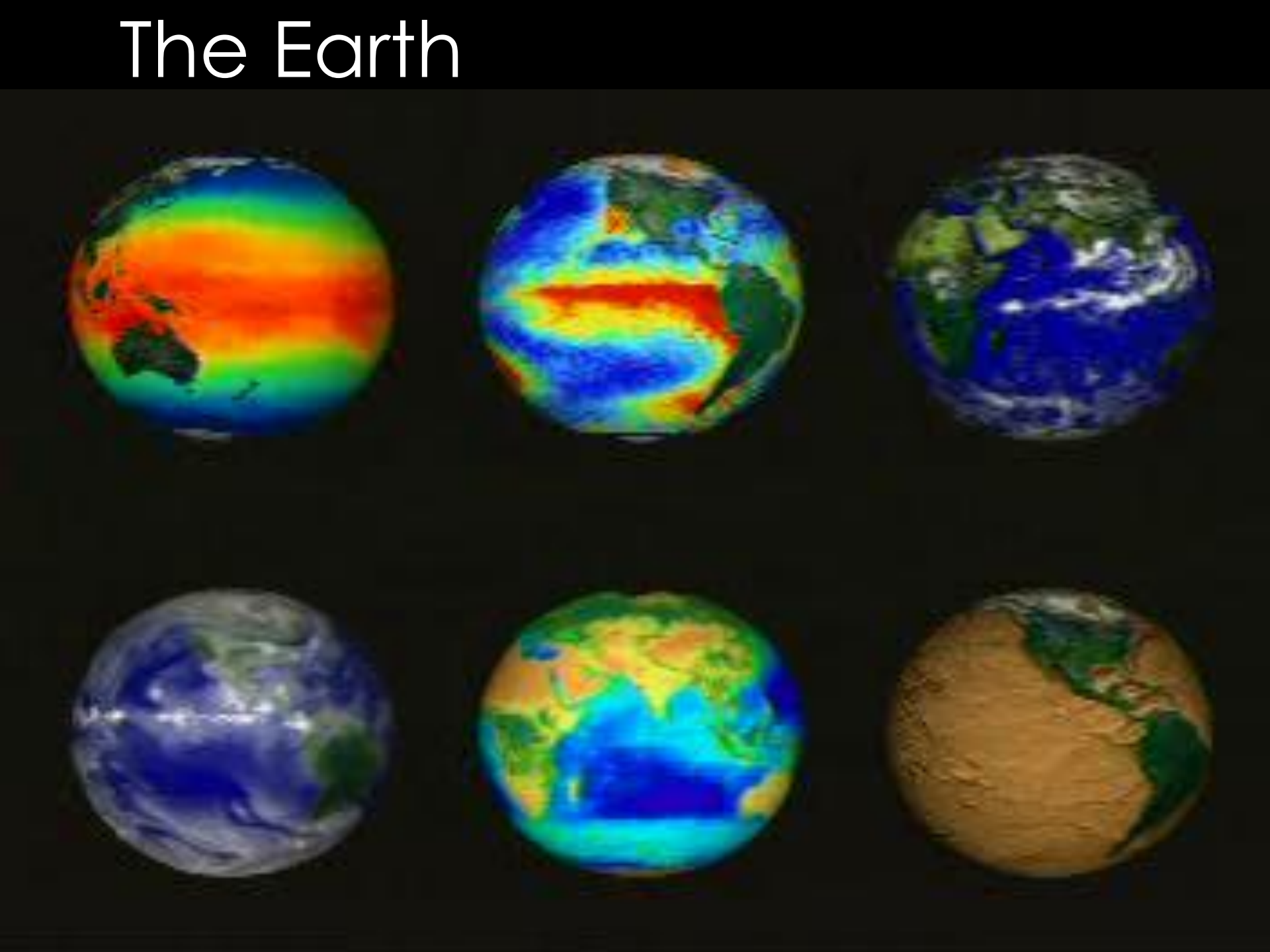
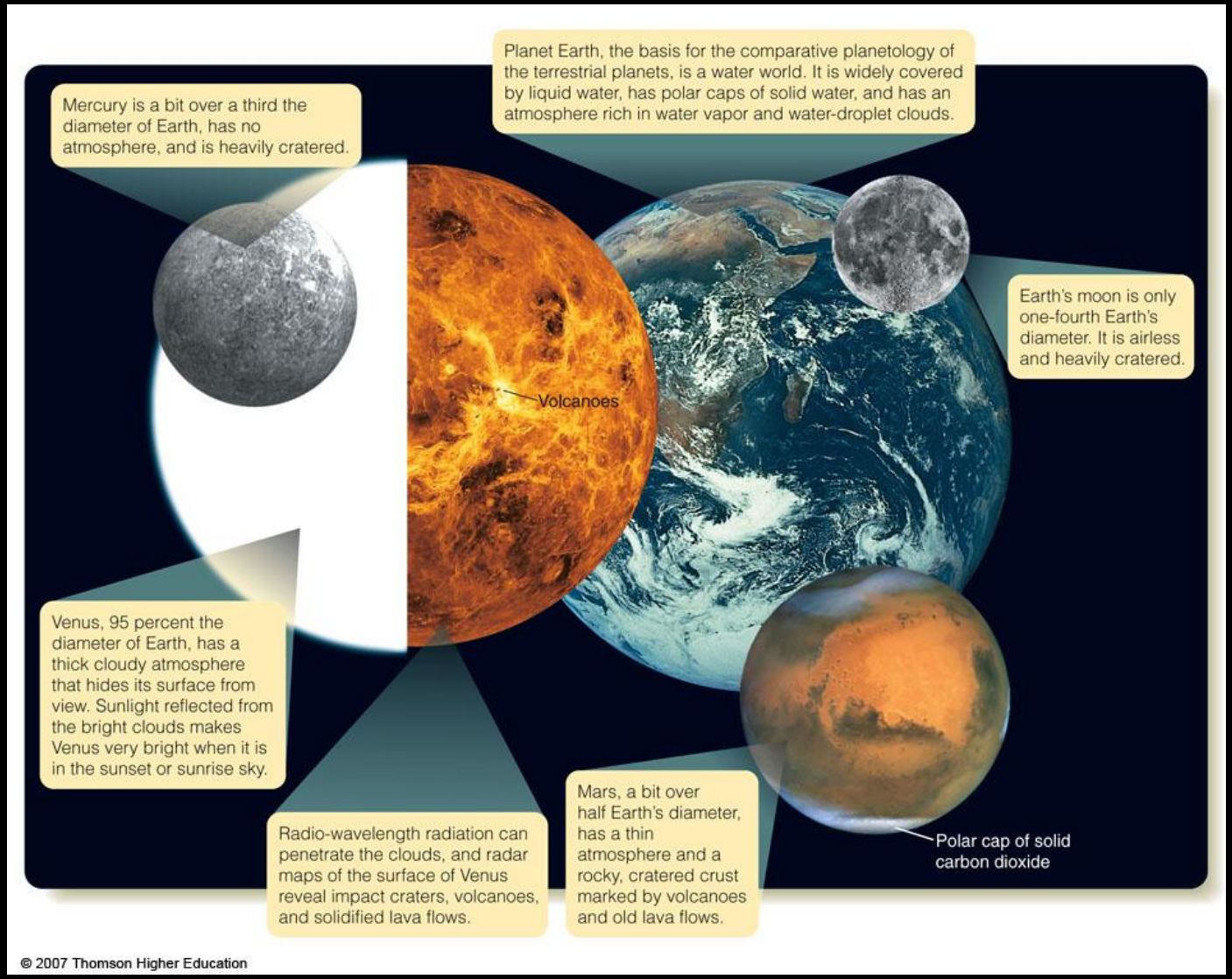
The Earth



Comparing Earth to the Terrestrial Planets



- Liquid heavy-metal core
- Liquid mantle of lighter rocks
- Solid, rocky surface
- High density
- Close to the sun
- Few moons

General Data for Earth

- Mass: 5.97 x 10^{24} kg
- Rotation period: 23.93 hours
- Orbital period: 365.26 days
- Avg. distance to sun: 149,600,000 km
- Avg. Diameter: 12,742 km
- Density: 5.5 g/cm^3 (densest in entire solar system)
- Inclination angle: 23.4°
- Surface Temperature:

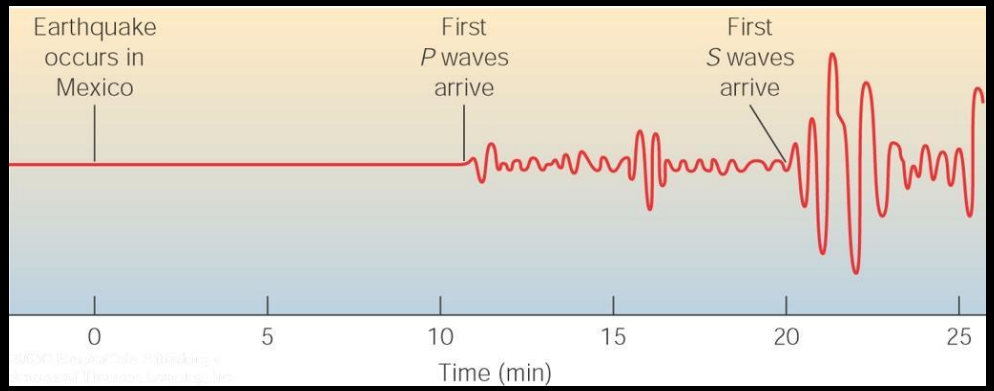
-126°F (min) / 136°F (max)

- Avg. Surface Temp: ~57°F
- Age of Earth from radioactive dating of zircons in rocks in Australia: 4.4 billion years old
- Age of oldest fossils: 3.5 billion yrs. old

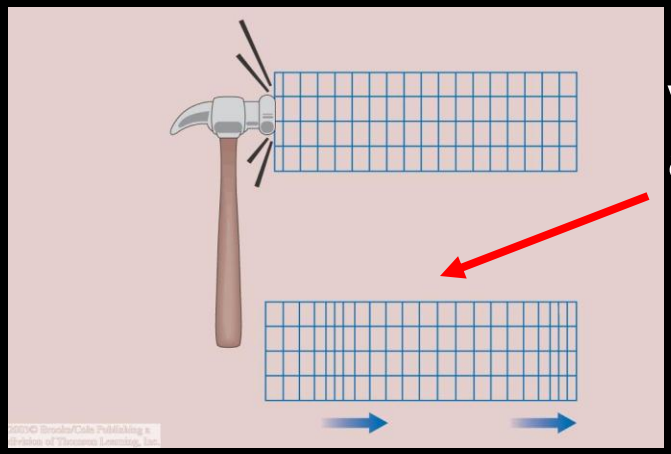
Earth's Interior

How do we know what's inside?

Direct exploration of Earth's interior (e.g. drilling) is impossible. Earth's interior can be explored through **seismology:**
earthquakes produce *seismic waves*.

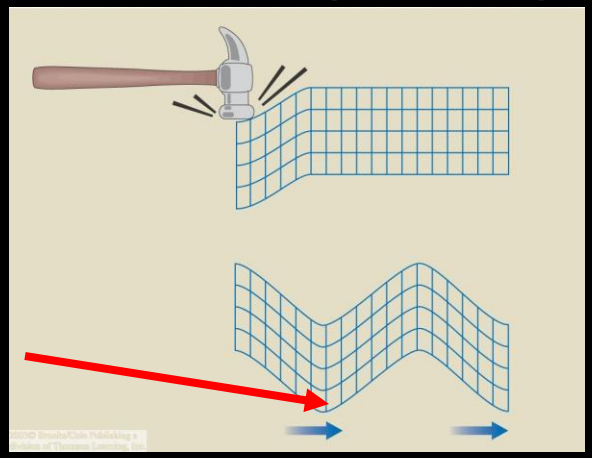


*P*ressure *waves (P waves):*



Particles vibrate back and forth

*S*hear *waves (S waves):*

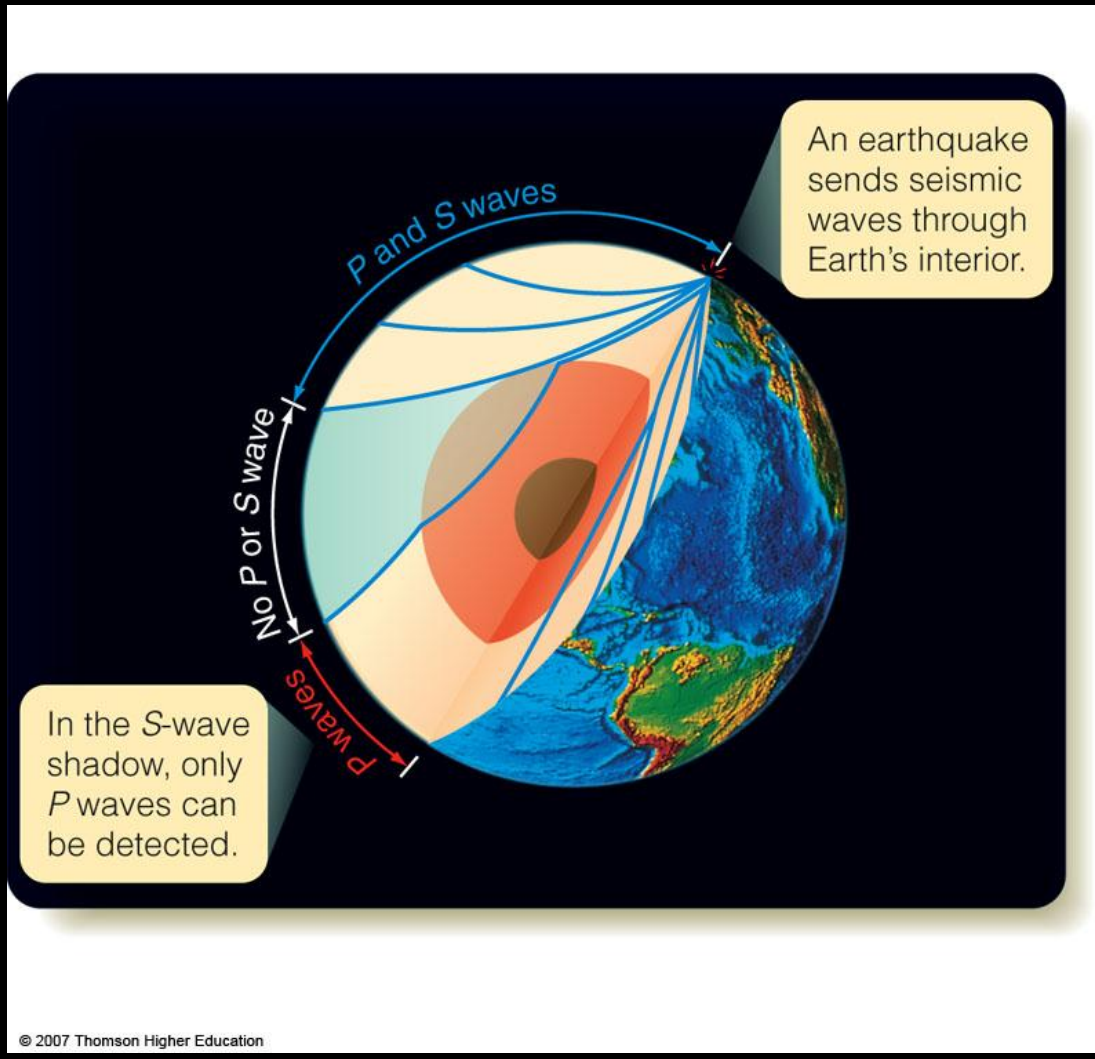


Particles vibrate up and down

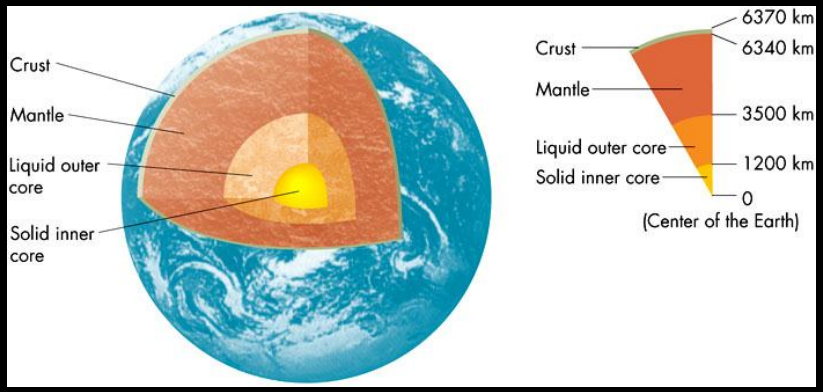
Seismology

Seismic waves are bent by or bounce off transitions between different materials or different densities or temperatures.

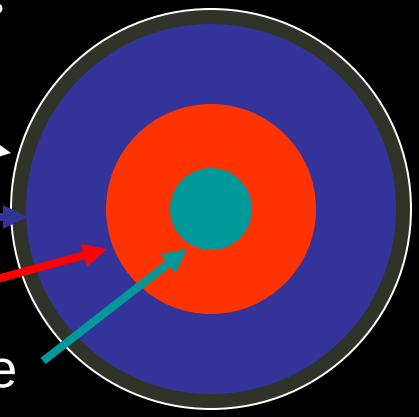
Such information can be analyzed to infer the structure of Earth's interior.



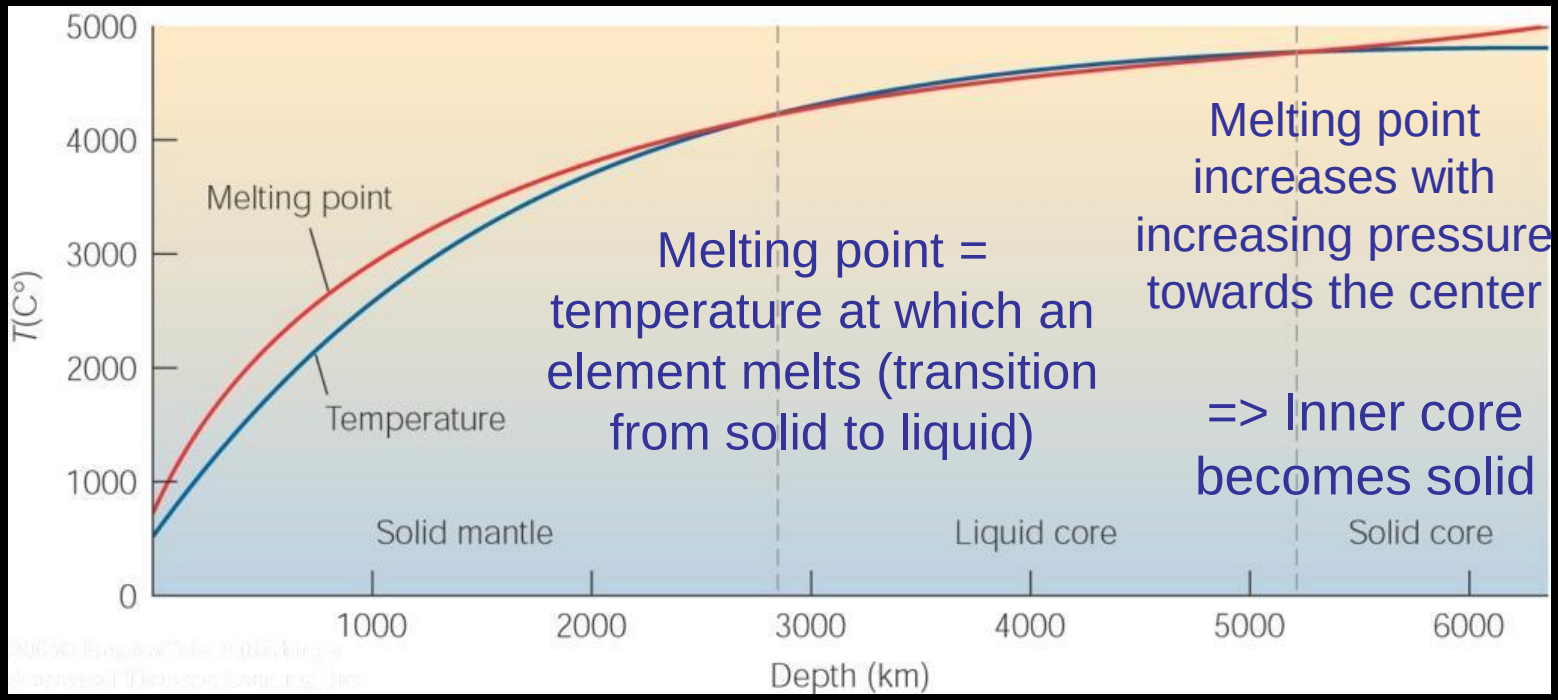
What does Earth's interior look like?



Solid crust
Solid mantle
Liquid core
Solid inner core



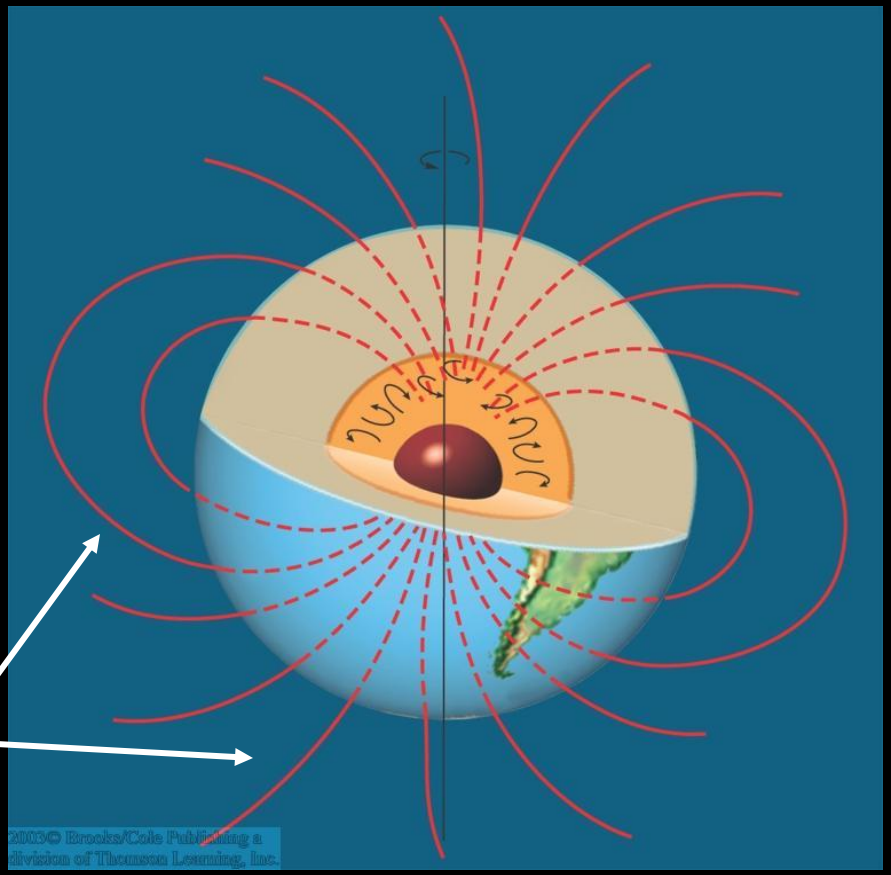
Earth's interior gets hotter towards the center.



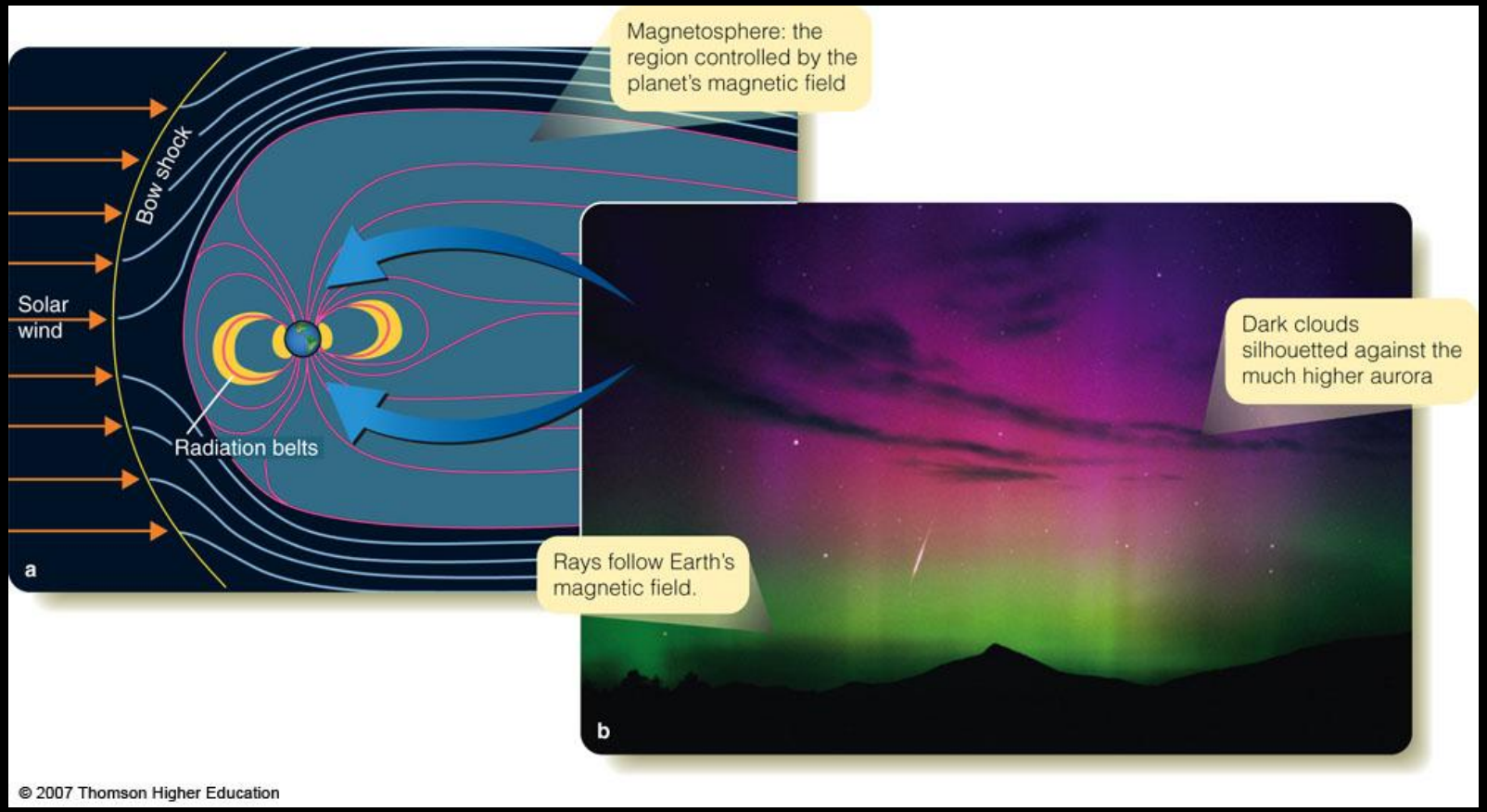
Why does Earth have a magnetic field?

Earth's core consists mostly of ***iron*** and ***nickel*.**

Convection currents and rotation of the core generate a dipole magnetic field



Earth's Magnetic Field & Auroras

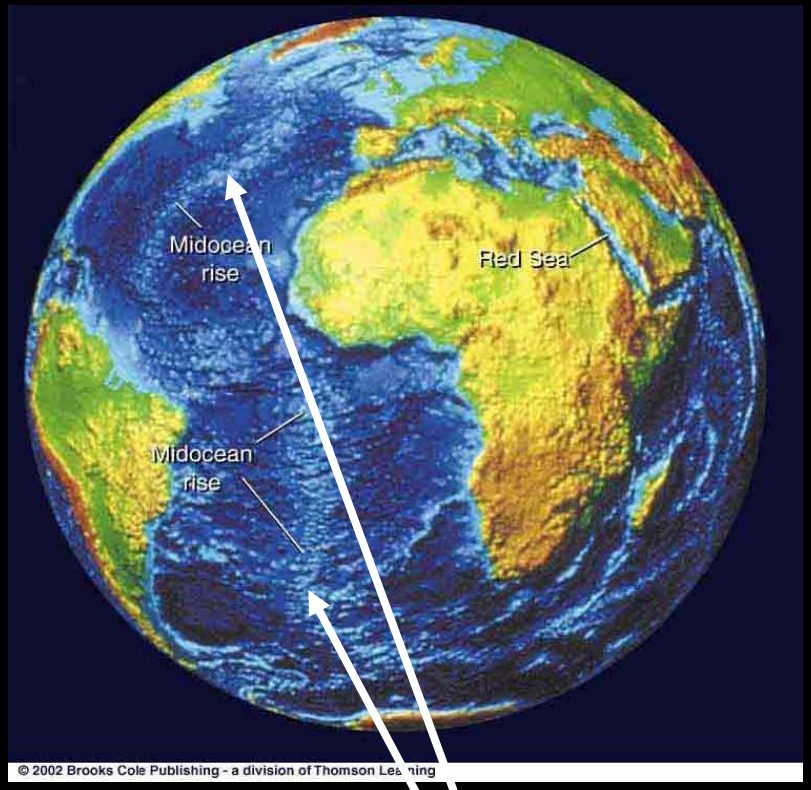


Earth's magnetic field protects Earth from high-energy particles coming from the sun (solar wind).

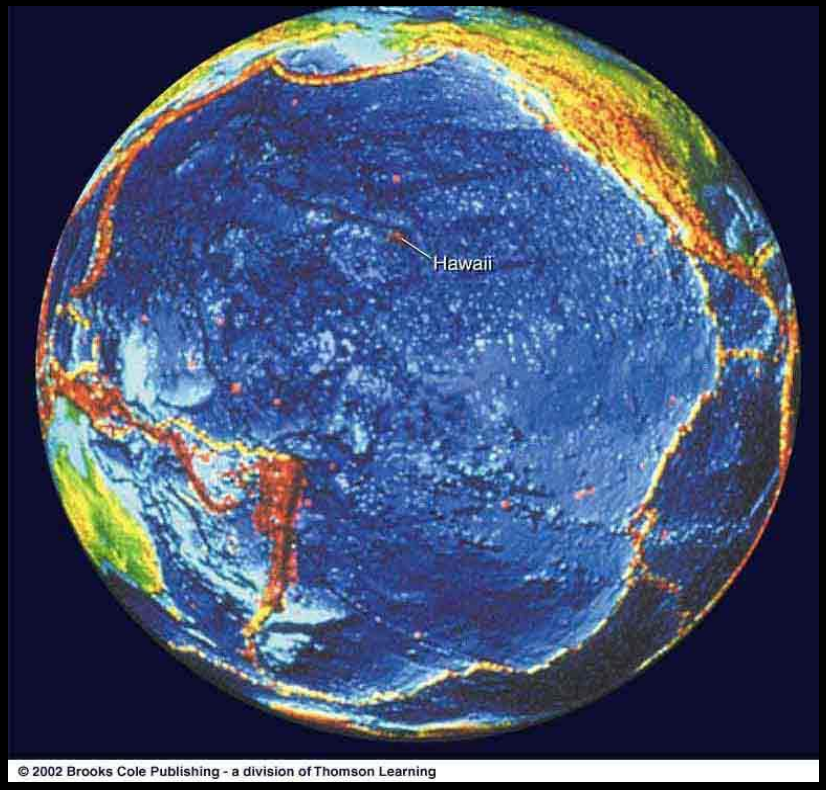
Some of these charged particles will spiral into the atmosphere and produce the Aurora Borealis (aka-the Northern lights).

Plate Tectonics on Earth

Earth's crust is composed of several distinct tectonic plates, which are in constant motion with respect to each other → **Plate tectonics**



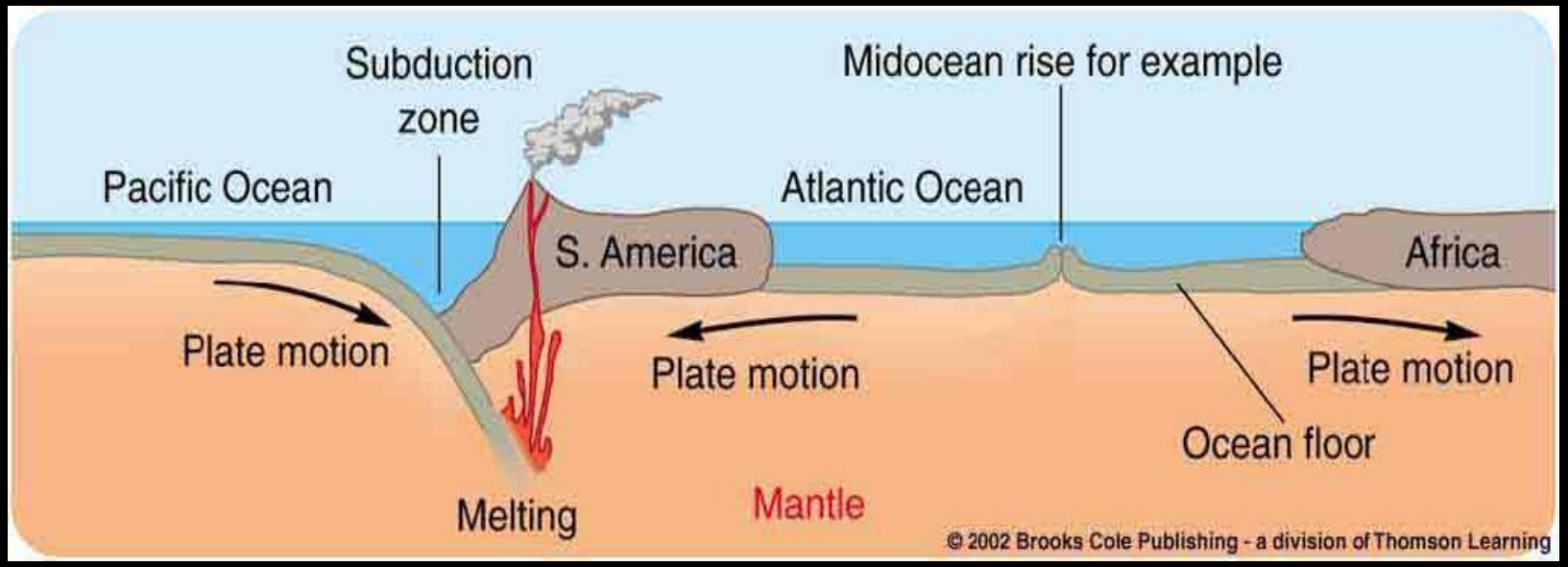
Evidence for plate tectonics can be found on the ocean floor



… and in geologically active regions all around the Pacific

Plate Tectonics & movements

Tectonic plates move with respect to each other and will exert forces on each other (bumping, sliding, slipping).



Up and down forces produce formation of mountain ranges, some with volcanic activity, earthquakes

Where plates move away from each other, molten lava can rise up from below → volcanic activity

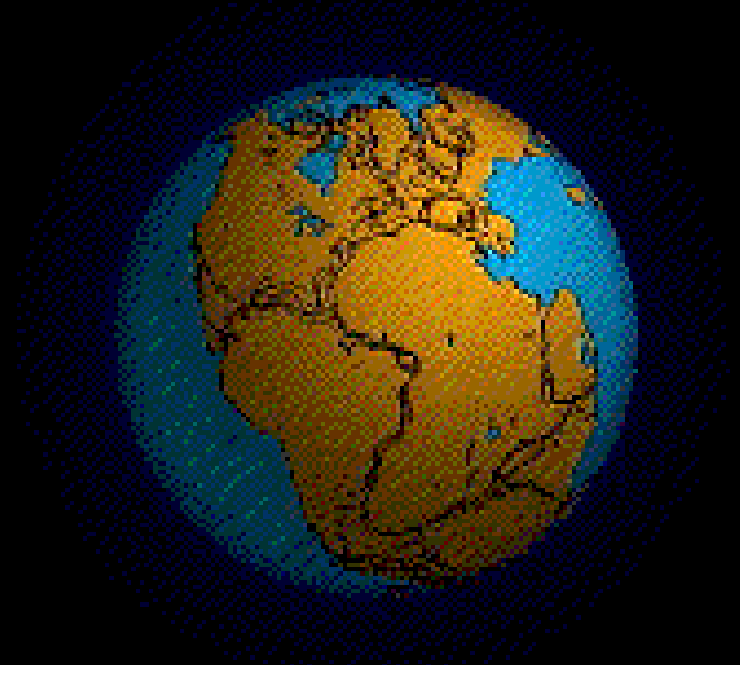
Plate Tectonics & continental drift

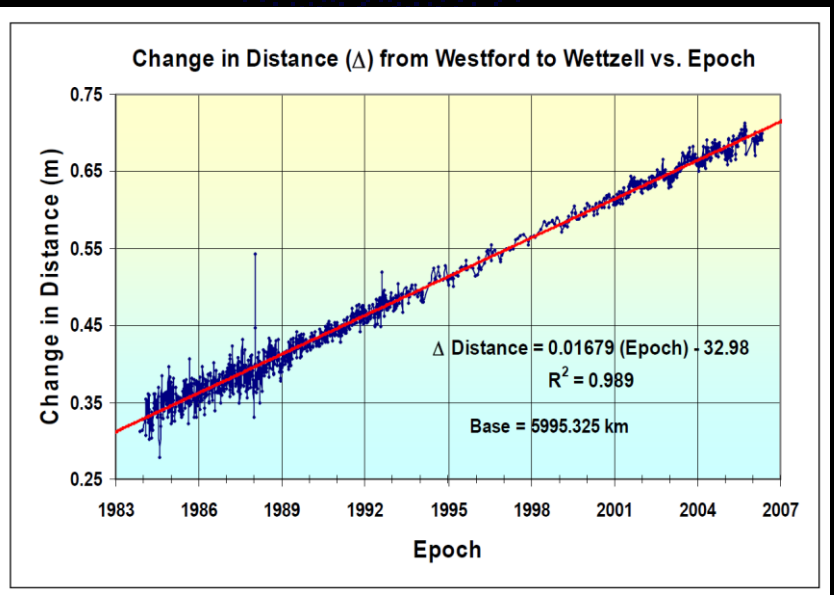
Earth's crust moves around on a liquid mantle layer.

The continents are moving and have not always been in the same location as you see them today.

Evidence of continental drift:

- Fossils on different continents
- Mountain chains continuing on different continents
- Geology of edges of different continents match up (S. America &Africa)
- Direct measurement (~2 cm per year for N. America & Europe)





Earth's Atmosphere

Atmospheric composition is primarily Nitrogen (78%) and Oxygen (21%).

Temperature differences result in atmospheric activity like rain, snow, lightning, tornados, hurricanes.

Layers are divided by temperature…

Thermosphere/Ionosphere

- Where auroras occur

Mesosphere

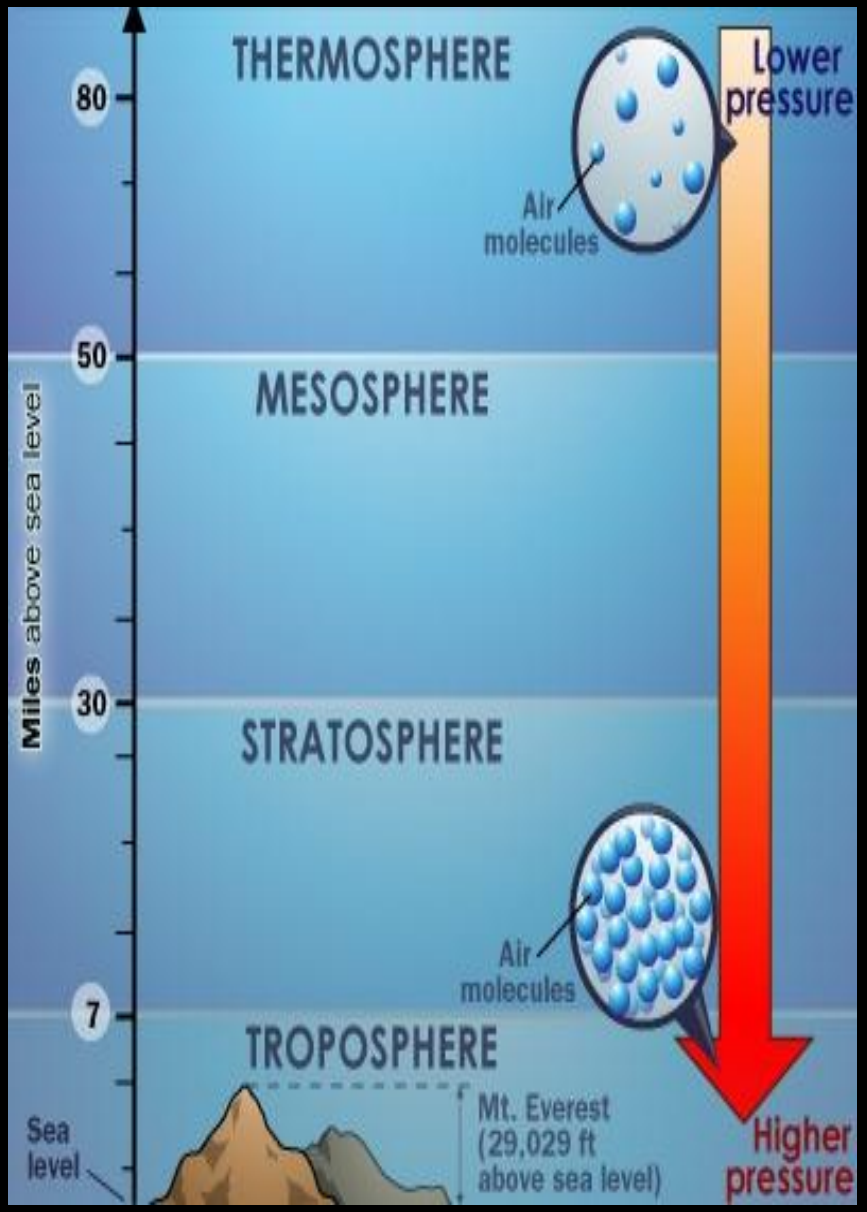
- Where meteorites burn up

Stratosphere

- 7-30 miles up
- Ozone (O_3) absorbs UV in this layer

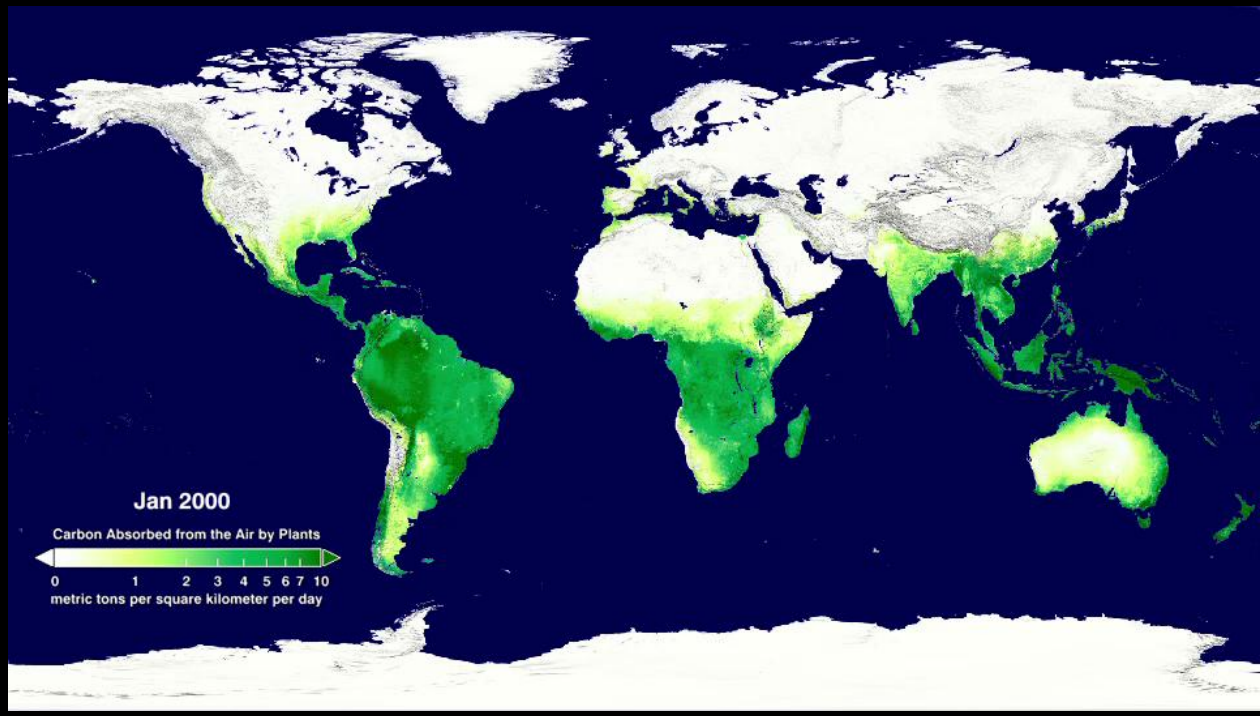
Troposphere

- 0-7 miles up
- weather occurs here



Earth's Atmosphere and Oxygen

- Oxygen is a reactive gas that will readily bond with other atoms
- None of the other terrestrial planets have as much oxygen in their atmospheres…why??????
- LIFE on Earth continues to replenish the oxygen content in the atmosphere
- Life produces oxygen through photosynthesis of plankton, trees, and plants.



Notice CO_2 levels in the atmosphere rise and fall with the seasons

Interdependence of systems

- Temperature differences over land and ocean causes circulation patterns
- Circulation patterns move water, heat, CO_2, and oxygen throughout the planet

- **Key point:** systems on Earth are interdependent and life depends on these circulation patterns (think water cycle or carbon cycle from biology)

Earth and H_2O

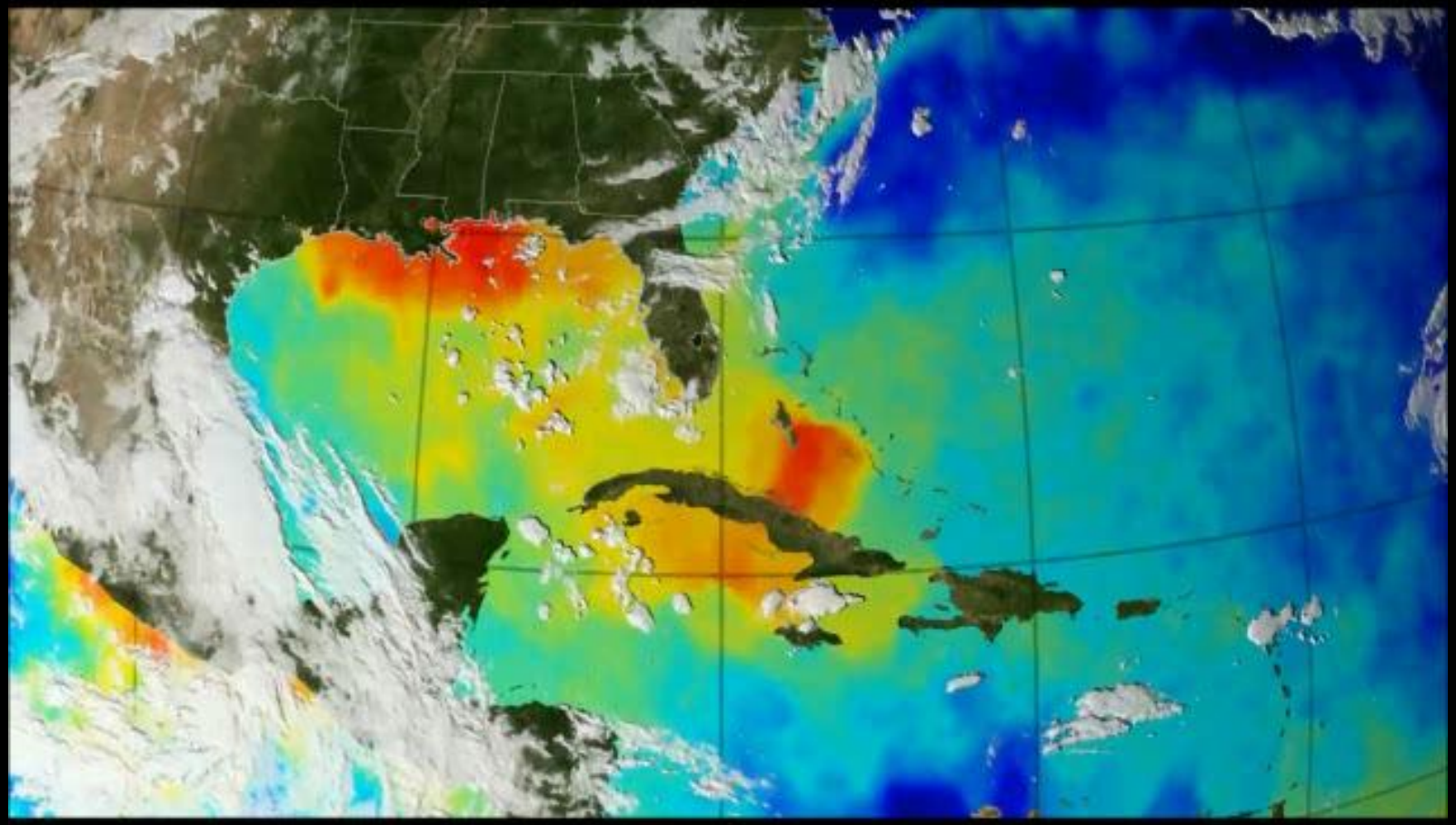
About 2/3 of Earth's surface is covered by water.

Earth's atmosphere maintains a stable temperature that keeps water in liquid form.

What if we didn't have an atmosphere?

2008 hurricane season

(notice circulation patterns and the connection to the warmer water)



What is the Greenhouse Effect?

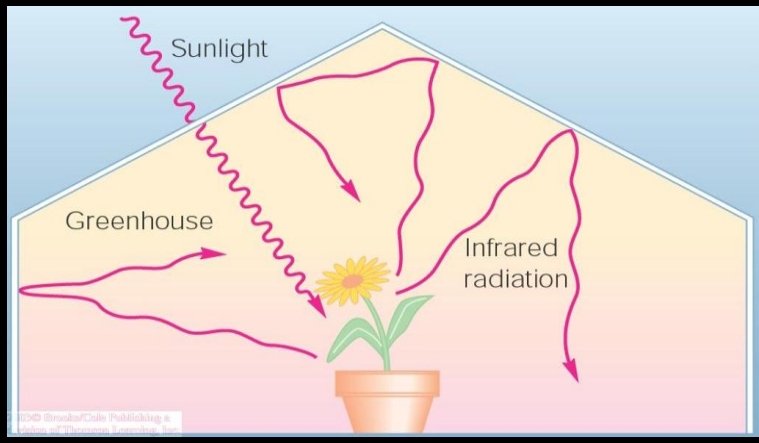
Earth's surface is heated by the sun's radiation.

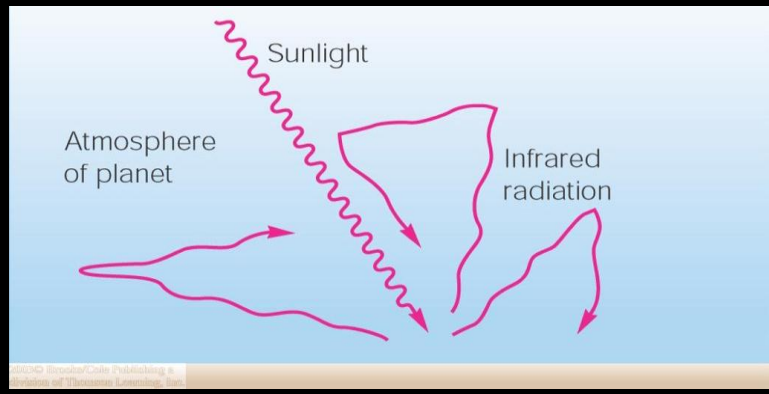
Heat energy is absorbed and then re-radiated from Earth's surface as longer wavelength infrared radiation.

Earth's natural CO_2 absorbs re-radiated infrared light

→ Heat is trapped in the atmosphere by CO_2 and water vapor.

This is the Greenhouse Effect.





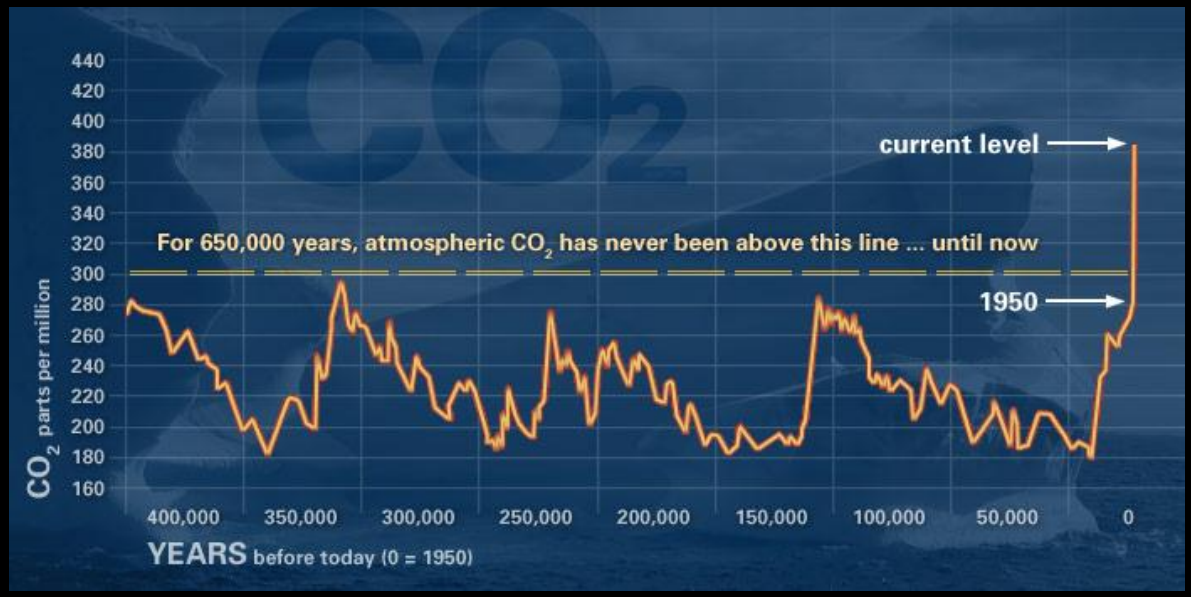
The Greenhouse Effect occurs naturally and is essential to maintain a comfortable temperature on Earth.

IT IS A GOOD THING FOR US because it stabilizes the Earth's temperature and we don't get wild temperature variations.

Greenhouse effect and Global Warming

If the Greenhouse Effect is a good thing for us, why do we always hear about it in negative terms?

…because since the Industrial Revolution, people have been putting more CO_2 into the atmosphere by burning oil, gas, and fossil fuels…this is no longer "natural" carbon dioxide



Greenhouse effect and Global Warming

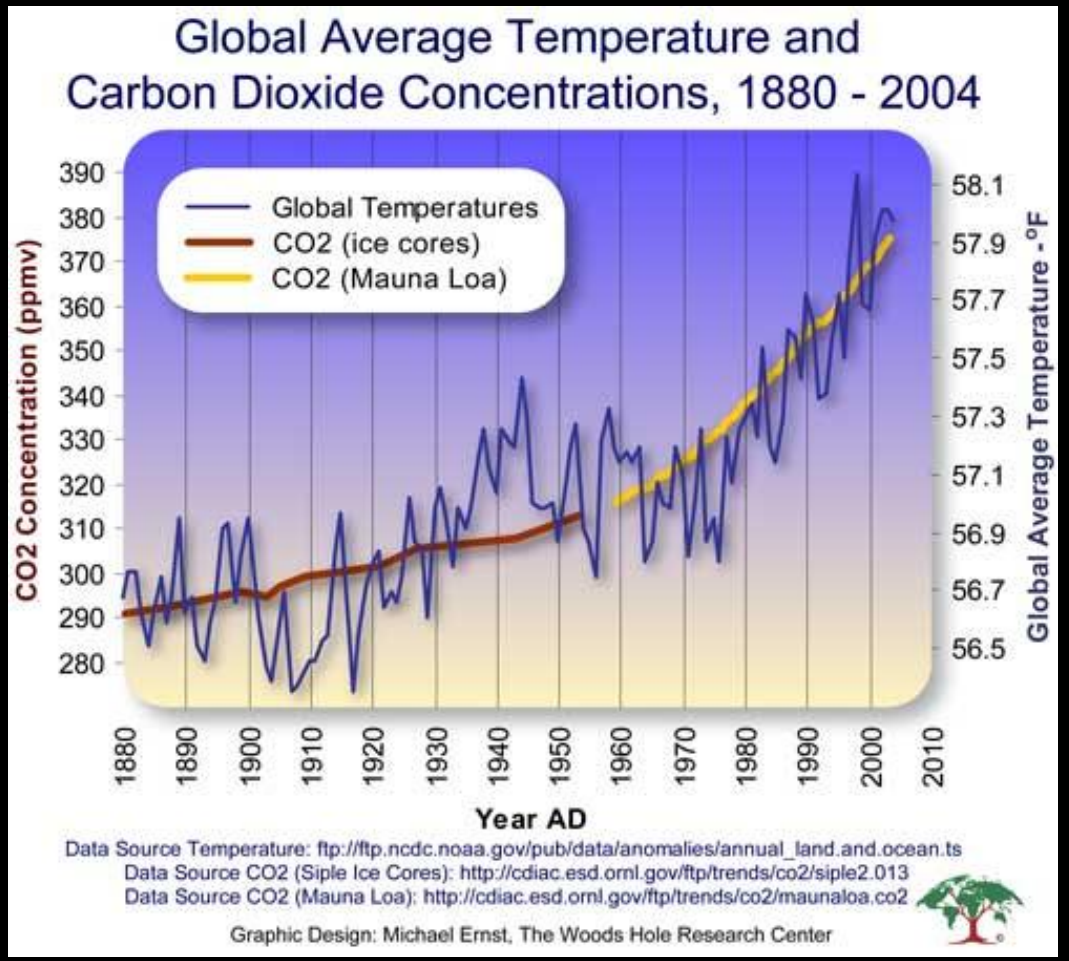
FACT: there is more CO_2 than we have seen in the last 400,000 years (never exceeded 300 ppm until now; currently at 391 ppm and going up)

FACT: we have observed a warming trend in the atmosphere that goes with the CO_2 levels

CONCERNS: warmer global temperatures affect ocean temperatures, the water cycle, sea ice and sea levels, rainfall amounts, crop production, circulation of ocean currents…..

…and how much are we cutting down on CO_2 production?

…… so this continues to increase



Take a look at Earth as a planet…

weather from space

hurricanes

sahara desert

sand dunes in namibia

antarctica

rainforest in congo

niagara falls

mount everest

the grand canyon

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Photograph courtesy U.S. National Park Service

owachomo bridge in Utah