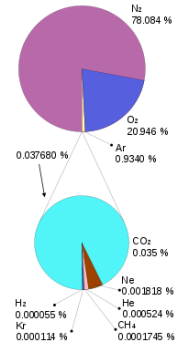


Take out a blank sheet of paper and thoughtfully answer the following question:

- 1) What is global warming
- 2) What specific activities and processes (human or natural) are causing global warming
- 3) What are some consequences (if any) related to global warming

Atmospheric composition

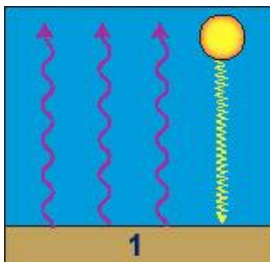
Carbon dioxide = 0.03 percent



LET'S LOOK AT: how carbon dioxide (CO₂) is involved in Earth's regulating climate

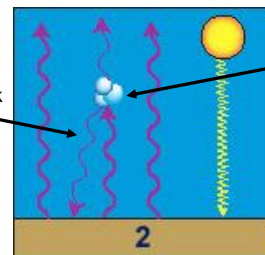
Sun radiates heat

And then some heat is re-radiated into the atmosphere



When it reaches the surface some of it is absorbed by Earth

Gas molecules heat up and re-radiate heat back towards Earth, causing Earth to heat up



Certain molecules absorb outgoing radiation from Earth

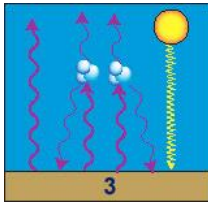
These molecules are actually greenhouse gases like:

CO₂ (carbon dioxide)

CH₄ (methane)

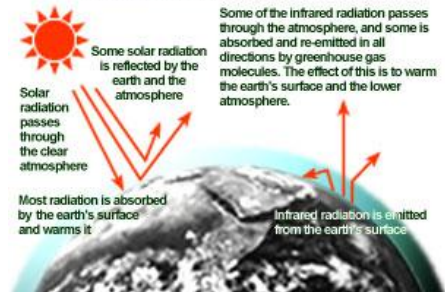
H₂O (water vapor)

While one molecule re-radiates only a small amount of energy back to Earth, many molecules produce the warming GREENHOUSE EFFECT



Without the Greenhouse Effect, Earth would be too cold to support life as we know it

The Greenhouse Effect



Greenhouse effect

Average temperature w/o greenhouse effect:

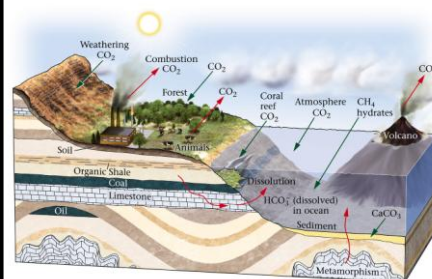
-18 C (0 F)

Average temperature with Greenhouse Effect:

15 C (59 F)

And now....some practice

Carbon cycle: an example of a biogeochemical cycle

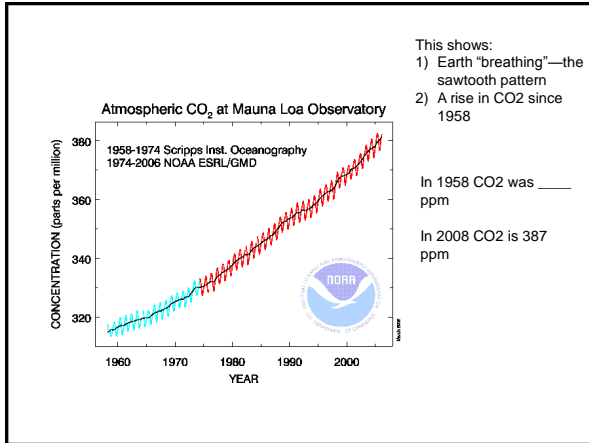


Involves the passage of carbon between living and non-living reservoirs

- 1) Is the carbon cycle in balance?
- 2) If not, what is causing it to be out of balance?

FIGURE 19.5

Essentials of Geology, 2nd Edition
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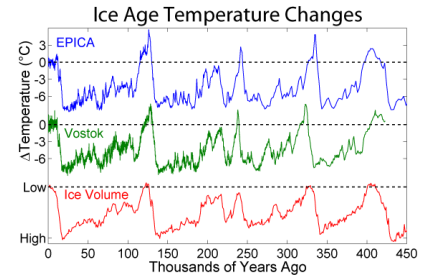


How does this compare with Earth's past climate?

Can you recognize ice ages from interglacial periods?

How long do they last?

Should we be headed into another ice age right now?



How can we study Earth's past climate?

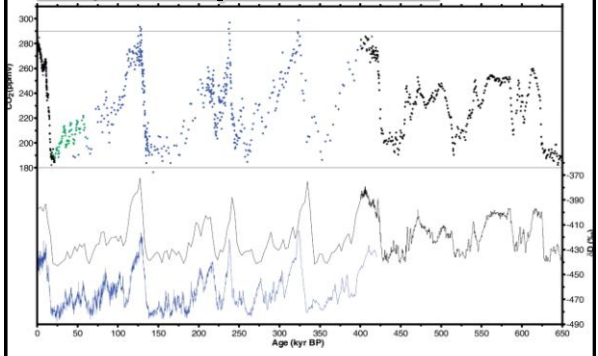
Here's some examples

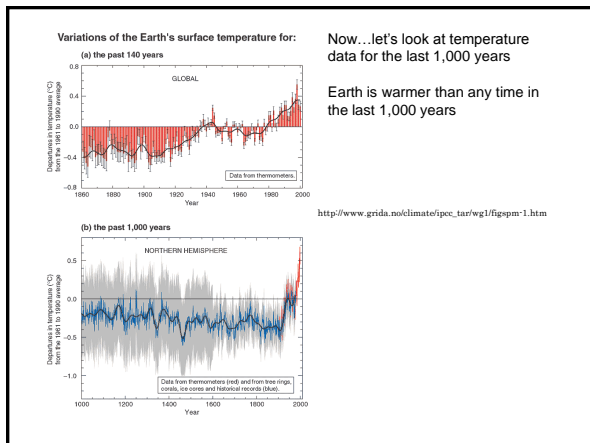
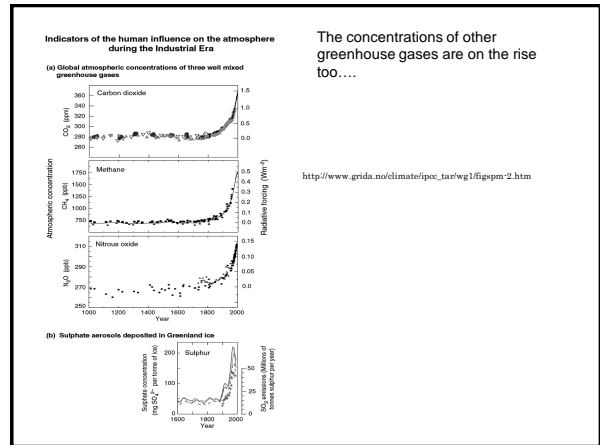
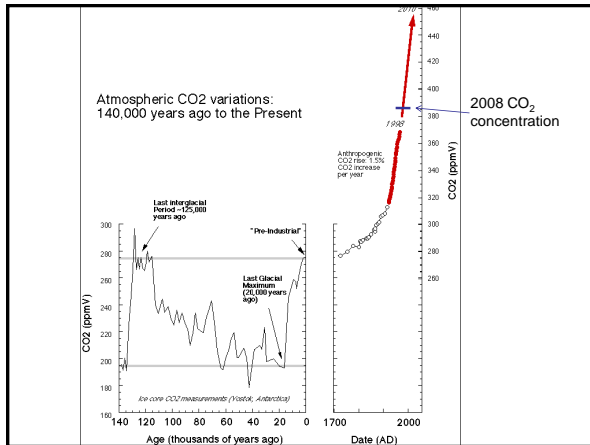
- Air bubbles in ice cores
- Paleontological evidence (marine organisms)
- Tree rings



How does the current CO₂ concentration compare with the past? (Today, 387 ppm)

650,000 year record of CO₂ concentration, EPICA ice core

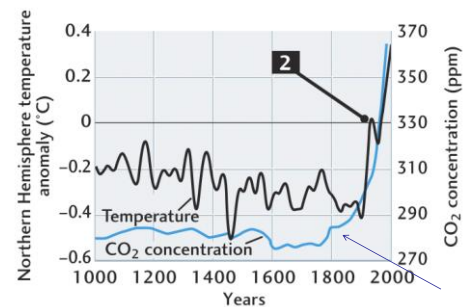




Now...let's look at temperature data for the last 1,000 years

Earth is warmer than any time in the last 1,000 years

Comparing CO₂ concentration and temperature



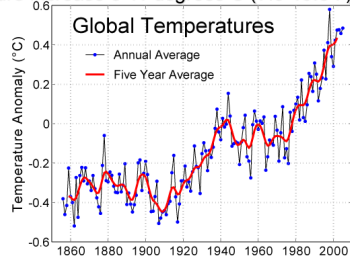
1906-2006 average surface temperature rose

~1 degree F

Extrapolating this...

- 2050 temperature increase 1.5-2 degrees C (2.7-3.6 F)
- 2150 temperature increase 5-11 degrees C (7.5-19.8 F)

If the model for 2150 is correct, Earth would be the warmest it's been in 40 million years

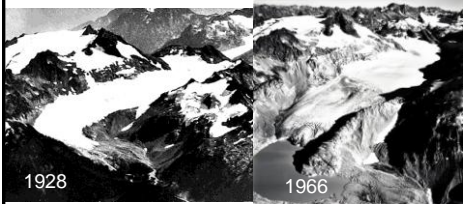


For ~150 yrs most Glaciers = melting/retreat



South Cascade Glacier

For ~150 yrs most Glaciers = melting/retreat



South Cascade Glacier

For ~150 yrs most Glaciers = melting/retreat

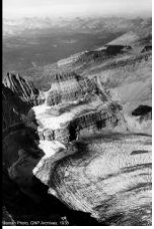


South Cascade Glacier

2006

For last ~150 yrs Glaciers = melting/retreat

1938



Glacier National Park

For last ~150 yrs Glaciers = melting/retreat

1938



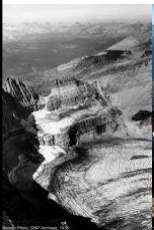
1981



Glacier National Park

For last ~150 yrs Glaciers = melting/retreat

1938



1981



1998



Glacier National Park

For last ~150 yrs Glaciers = melting/retreat

1938



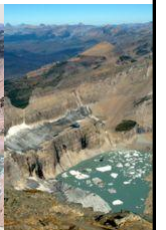
1981



1998



2005



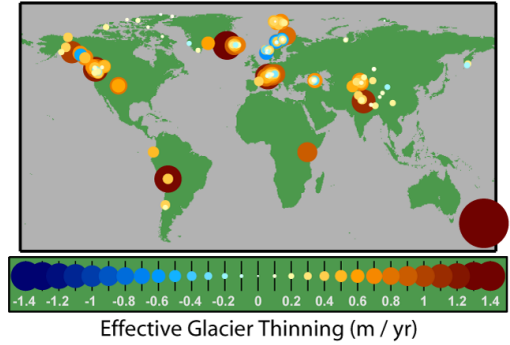
Glacier National Park

For last ~150 yrs Glaciers = melting/retreat

Elena Glacier, - Africa

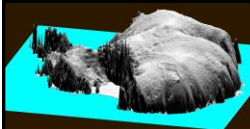
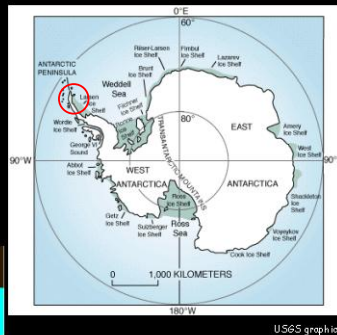


Mountain Glacier Changes Since 1970



Antarctica

- 91% of Earth's glacier ice



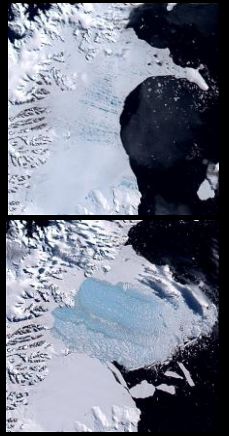
What's next?

breakup of Larsen B Ice Shelf,
Antarctica March 2002
images from NASA's MODIS sensor



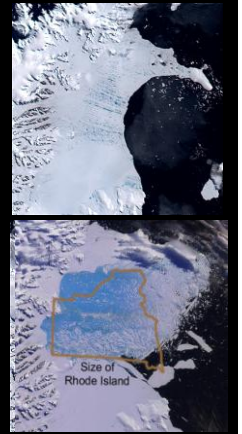
What's next?

breakup of Larsen B Ice Shelf,
Antarctica March 2002
images from NASA's MODIS sensor



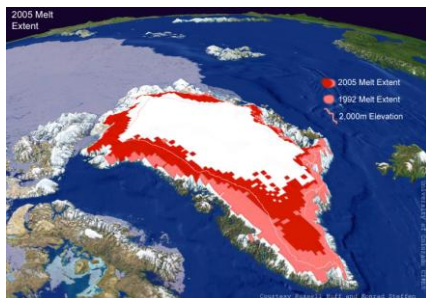
What's next?

breakup of Larsen B Ice Shelf,
Antarctica March 2002
images from NASA's MODIS sensor



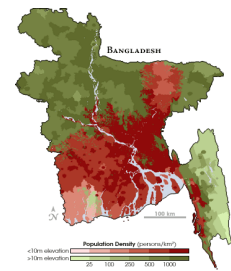
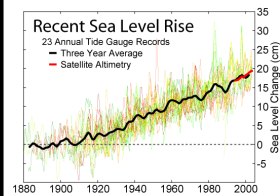
Greenland ice-sheet is melting

Cooperative Institute for Research in Environmental Sciences
<http://cires.colorado.edu/steffen/>



Possible consequences: sea level rise

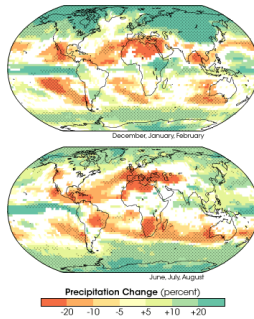
Sea level will continue to
rise where 10% of the global
population lives



Countries like Bangladesh will be
affected by sea-level rise; already
impoverished

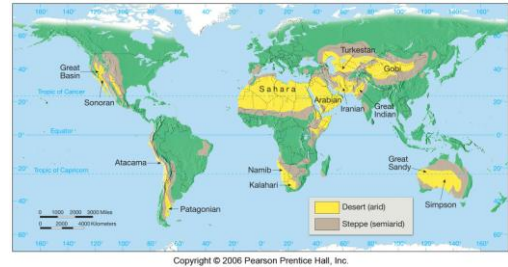
Possible consequences: severe weather

- Ocean S.S.T. increases, causing more evaporation, and larger storms
- Tropics will receive less precipitation, polar regions more



Global warming: a shift in climate belts

- Cause changes in habitat affect species migration
- Prolonged drought, deserts expand
- Disrupt agriculture



Glaciers continue to melt

i.e. Himalayan glaciers supply freshwater to hundreds of millions of people



Over the last five years, 600 scientists from the Intergovernmental Panel on Climate Change sifted through thousands of studies about global warming published in forums ranging from scientific journals to industry publications and distilled the world's accumulated knowledge into these conclusions:

"Warming of the climate system is unequivocal."

"Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (human) greenhouse gas concentrations."

Source: IPCC, 2007