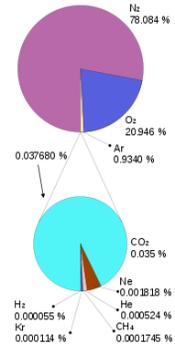


Take out a blank sheet of paper and thoughtfully answer the following question:

- 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

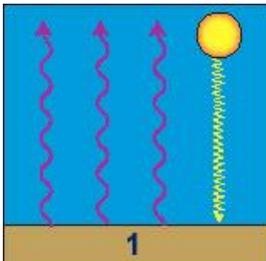
Carbon dioxide = 0.03 percent



LET'S LOOK AT: how carbon dioxide (CO<sub>2</sub>) is involved in Earth's regulating climate

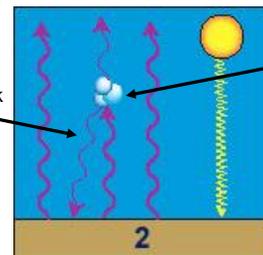
Sun radiates heat

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

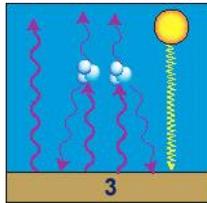
These molecules are actually greenhouse gases like:

CO<sub>2</sub> (carbon dioxide)

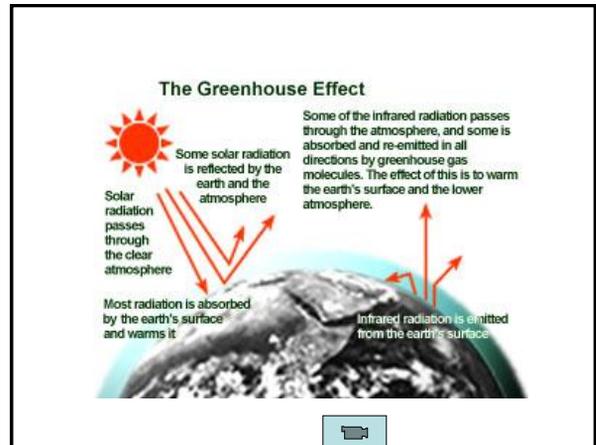
CH<sub>4</sub> (methane)

H<sub>2</sub>O (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



### Greenhouse effect

*Average temperature w/o greenhouse effect:*

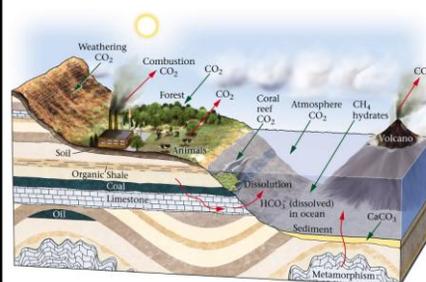
*-18 C (0 F)*

*Average temperature with Greenhouse Effect:*

*15 C (59 F)*

And now....some practice

### Carbon cycle: an example of a biogeochemical cycle

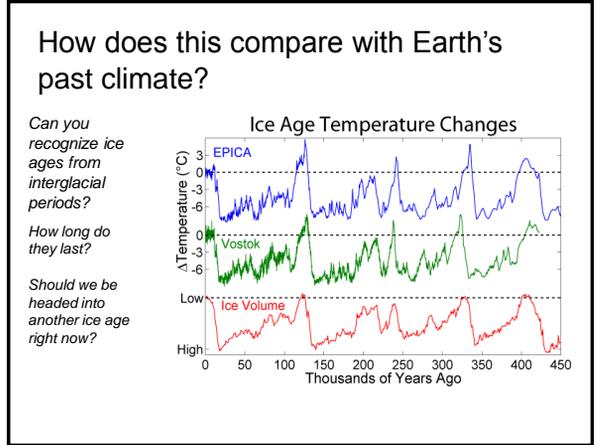
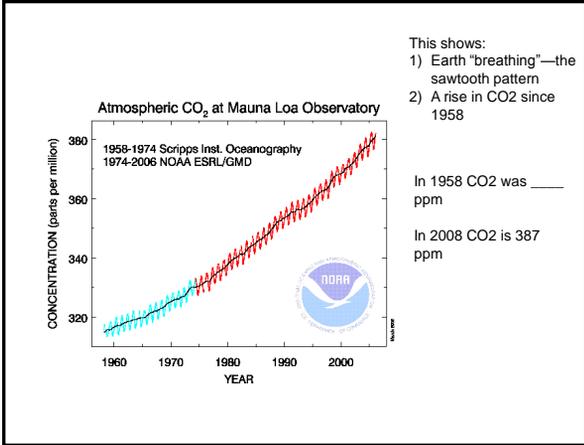


Involves the passage of carbon between living and non-living reservoirs

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

FIGURE 19.5

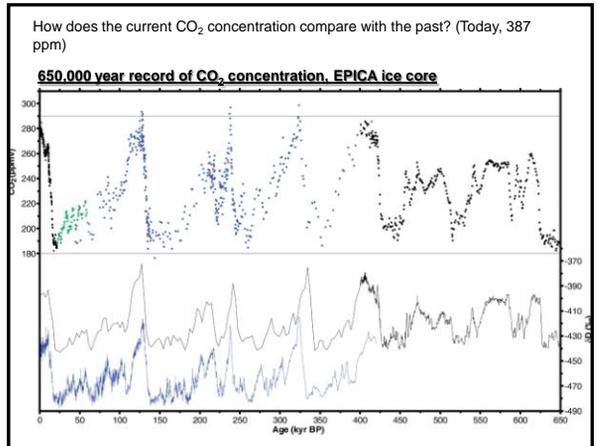
Essentials of Geology, 2nd Edition  
Copyright © W.W. Norton & Company



**How can we study Earth's past climate?**

Here's some examples

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



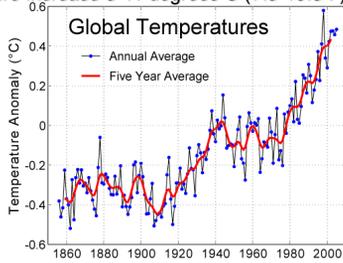


**1906-2006 average surface temperature rose**

**~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

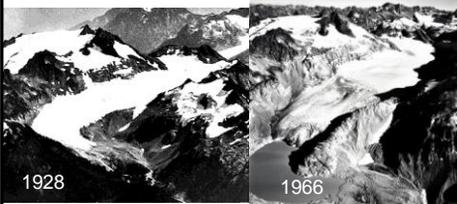
For ~150 yrs most Glaciers = melting/retreat



1928

South Cascade Glacier

For ~150 yrs most Glaciers = melting/retreat



1928

1966

South Cascade Glacier

For ~150 yrs most Glaciers = melting/retreat

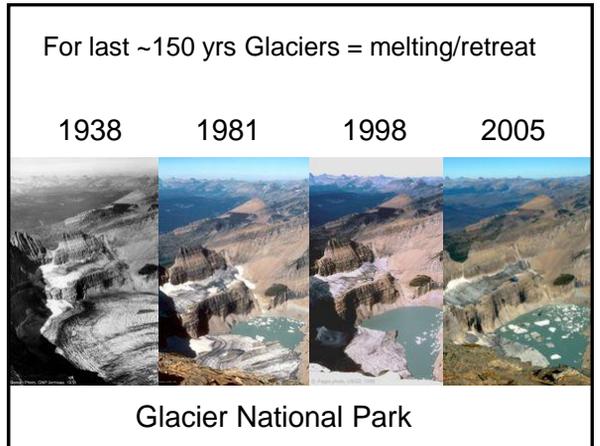
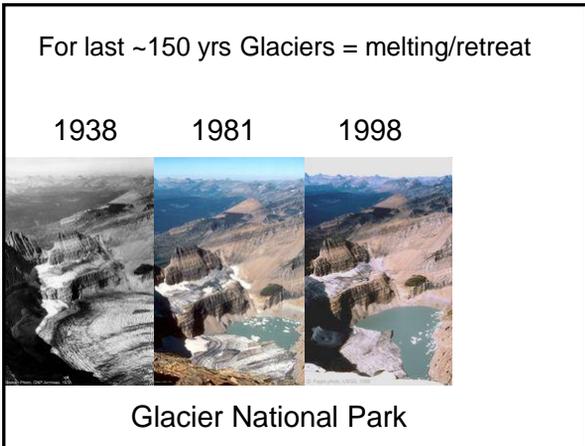
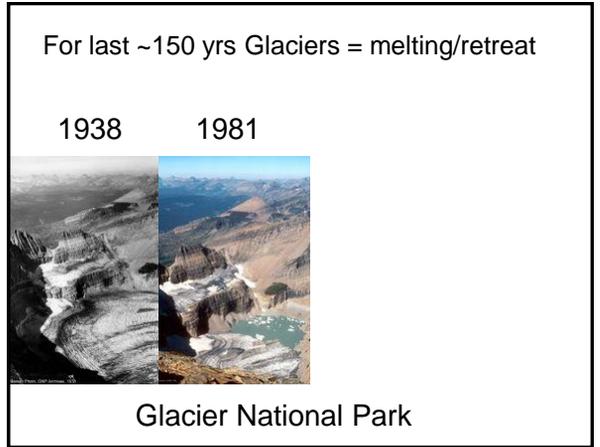
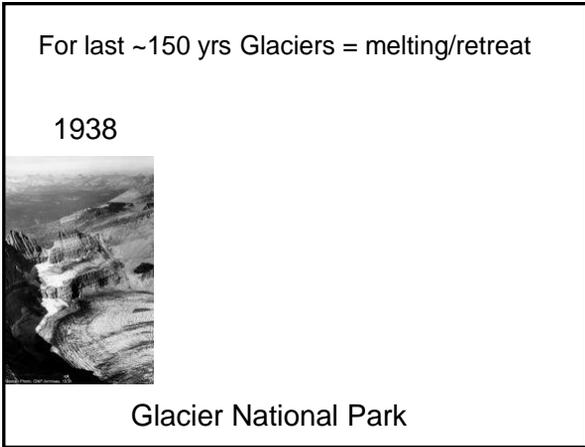


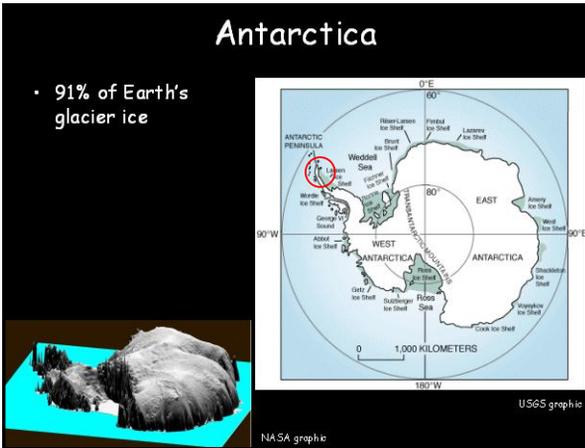
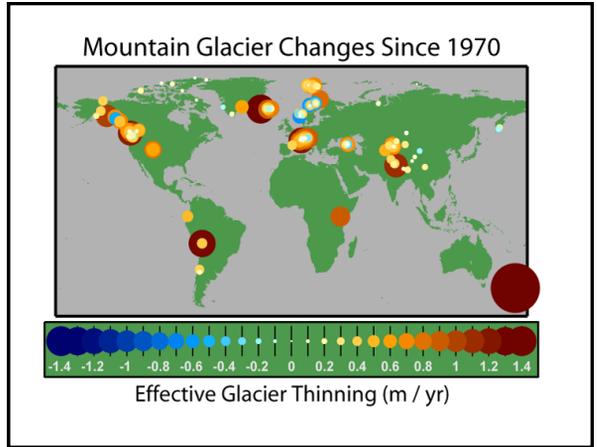
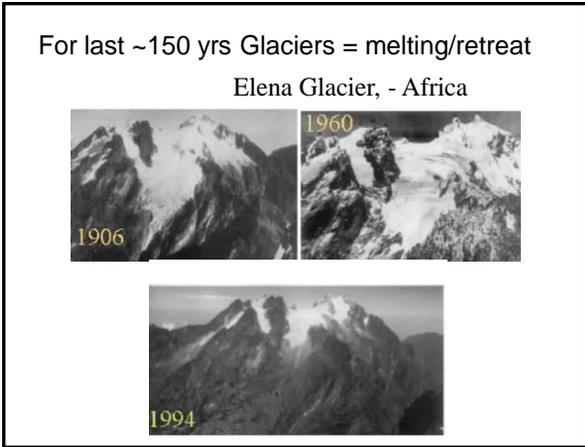
1928

1966

2006

South Cascade Glacier





## 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>

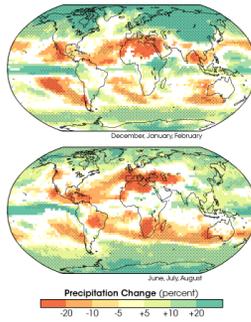
## Possible consequences: sea level rise

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

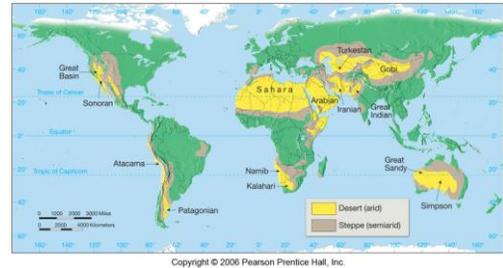
### Possible consequences: severe weather

- 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