

## Is the Climate Changing?

- But...the current rate of change has never been evidenced before!
- Human actions are causing the climate to change **faster** than it ever has before!



## How do we know this?

- Scientists study past temperature records by analyzing rocks, fossils, tree rings, pollen grains, and ice.



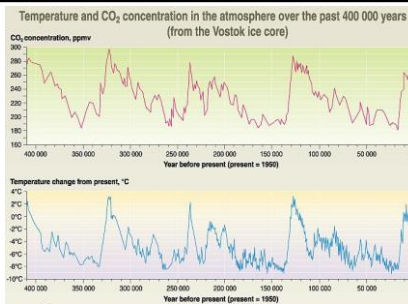
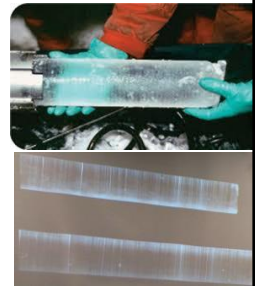
## Ice Cores

- Samples from ice fields show layers created by snowfall, which alternate with summer deposits of pollen and dust.
- These layers provide physical timelines of glacial cycles.

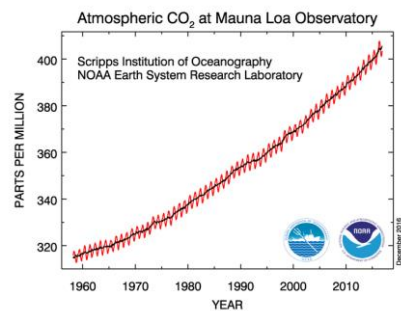


## Ice Cores

- Air bubbles in the ice can help measure atmospheric CO<sub>2</sub> levels at the time the ice was laid down.

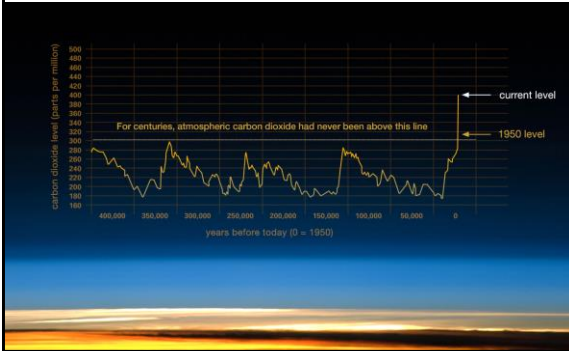


Ice cores show that atmospheric CO<sub>2</sub> levels have never exceeded **300 ppm** in the last 650,000 years.



Today's atmospheric CO<sub>2</sub> level is **404 ppm!**

## Atmospheric carbon dioxide is at its highest level in human history.



## Increasing CO<sub>2</sub> levels

14  
 □ Scientists believe the increase in CO<sub>2</sub> levels is caused by human activities such as:

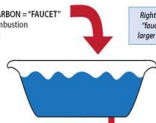
- Burning fossil fuels
- Deforestation
- Agricultural practices
- Industrial processes



## Increasing CO<sub>2</sub> levels

### The Carbon 'Bathtub' and its Components

SOURCES OF CARBON - "FAUCET"  
 • Fossil fuel combustion  
 • Deforestation



Right now, size of "faucet" is much larger than "drain."

As global temperature increases, size of "drain" decreases.

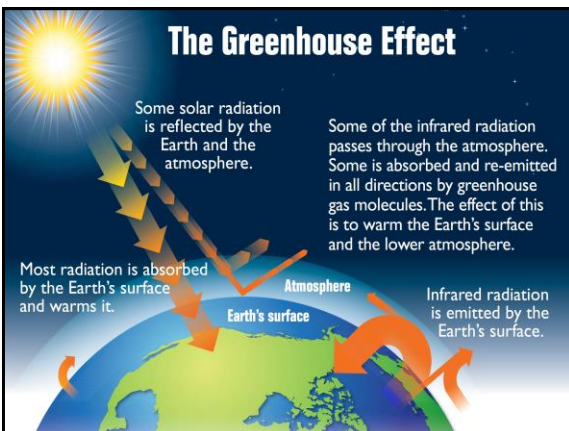
SINKS OF CARBON - "DRAIN"  
 • Land uptake  
 • Ocean uptake

- Some of the excess CO<sub>2</sub> ends up in carbon sinks such as oceans and forests.
- However, about half ends up in the atmosphere!

## Anthropogenic Greenhouse Effect

- 16  
 □ As the concentration of CO<sub>2</sub> and other greenhouse gases (GHGs) increase, more energy is trapped and absorbed by the atmosphere.

## The Greenhouse Effect



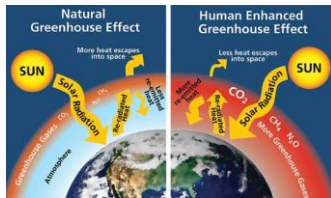
## Anthropogenic Greenhouse Effect

- 18  
 □ This process is called the anthropogenic greenhouse effect.
- Involves the same processes as the natural greenhouse effect but as human release more GHGs, Earth's energy balance changes.

## Anthropogenic Greenhouse Effect

19

- More thermal energy is trapped inside the atmosphere, raising temperatures beyond what they would be from the natural effect alone



## MAIN GREENHOUSE GASES

Greenhouse Gas	Chemical Formula	Pre-Industrial Concentration	Concentration in 2005	Atmospheric Life (years)	Anthropogenic Sources	Global Warming Potential (GWP)
Carbon-dioxide	CO <sub>2</sub>	280 ppm	379 ppm	Variable	Fossil Fuel Combustion Land Use Conversion Cement Production	1
Methane	CH <sub>4</sub>	700 ppb	1774 ppb	12	Fossil Fuel Rice Paddies Landfill Waste Livestock	21
Nitrous oxide	N <sub>2</sub> O	275 ppb	319 ppb	114	Fertilisers Combustion Industrial Processes	310

## Anthropogenic Greenhouse Effect

21

- The result is climate change!

## Climate Change

22

- Occurs when long-term weather patterns (i.e. temperature, precipitation, extreme events) are altered.



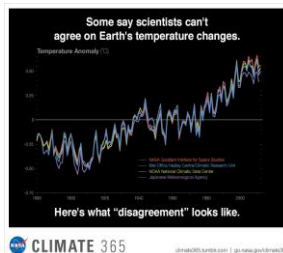
## Global Warming

23

- Is the rise in the average global temperature.

Data shows that the global average surface temperature has increased by 0.8°C since 1900.

And is forecasted to rise 1.8° and 4.0°C in the next century.



CLIMATE 365

## Global Warming

24

### So what...!?!

- Small changes in temp mean HUGE changes in the environment.
  - E.g. During the last ice age, the global temp was only 5 to 9°C cooler than today.
  - Other effects include...

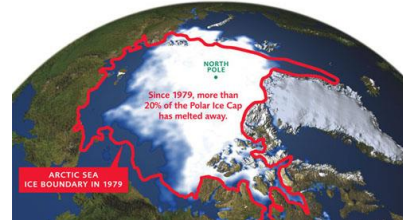
## Ice Sheets Melting

- The Greenland and Antarctic ice sheets have decreased in mass.



## Ice Sheets Melting

- Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades.



## Glaciers Retreating

27

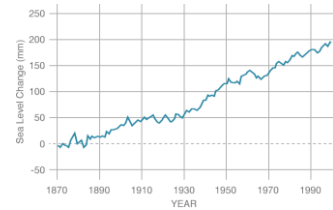
- Glaciers are decreasing in size almost everywhere around the world.



Pairing the 1914 historical image of Blackfoot - Jackson glacier with the contemporary image taken in 2009 dramatically illustrates glacier retreat in Glacier National Park.

## Sea Levels Are Rising

28



- Global sea level rose about 17 centimeters in the last century. The rate in the last decade, however, is nearly double that of the last century.

## Other Aspects of Climate Change

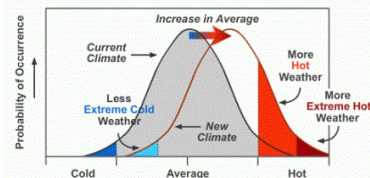
29

- Global Warming is only one measure of climate change!
- Climate change also alters temperature patterns, meaning:
  - more intense and frequent heat waves
  - less frequent and intense cold waves

## Other Aspects of Climate Change

30

- Precipitation patterns are also impacted:
  - increased frequency and intensity of hurricanes
  - regional changes in floods, droughts, and wildfires



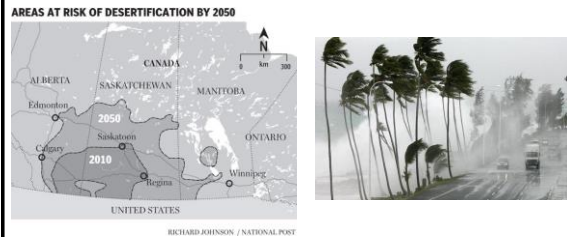
## Consequences of Climate Change

- More frequent wildfires



## Consequences of Climate Change

- Longer periods of drought and/or increased intensity of tropical storms depending on location



## Climate Change: Effects

- Frost-free season (and growing season) will lengthen
  - Change in biodiversity



## Climate Change: Effects

- Arctic likely to become ice-free
  - Loss of biodiversity
  - Change in food chains/webs



## Climate Change: Effects

- Sea level will rise 1-4 feet by 2100
  - Increase in Climate Refugees

