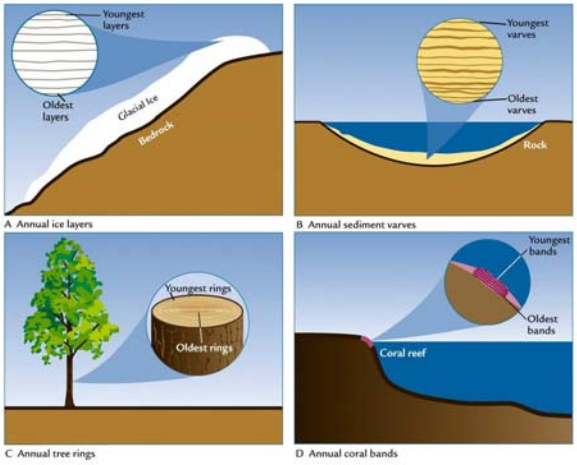
Grade 10 Science

Climate Change

Class 17

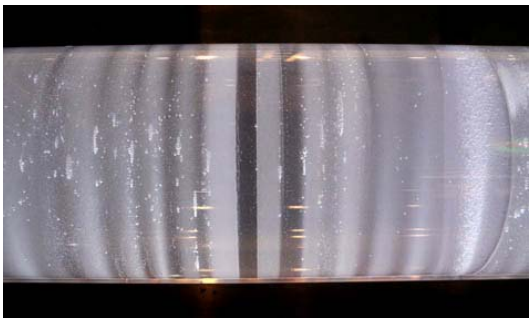
Studying Climate Using History

- **Proxy Records** – stores of natural information that we measure today to tell us what the climate was like in the past
  - Ice cores
  - Tree Rings
  - Coral Reefs
  - Rocks
  - Ocean sediments
  - Caves



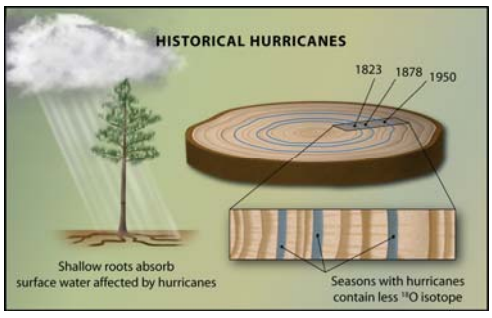
Ice Cores

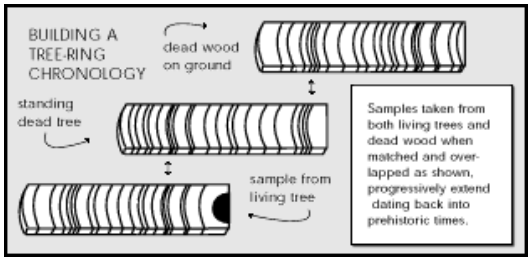
- Ice sheets are formed from thousands of years of snowfall, compacted into layers
- Air bubbles trapped inside the layers tell us the composition of the atmosphere in the past
- Ions and isotopes can be detected to indicate global events such as volcanic eruptions and global temperatures



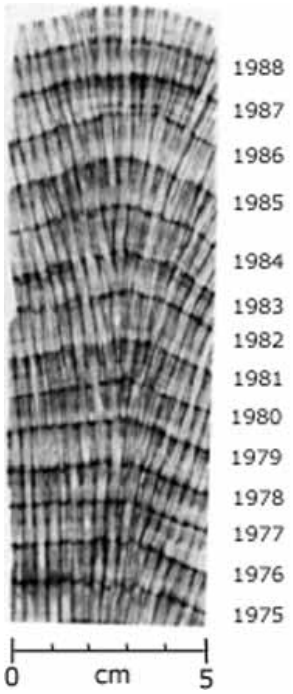
Tree Rings

- **Dendrochronology** – study of climate change as recorded by tree growth rings
- Warm, wet years produce thicker rings
- Drier, cooler years produce thinner rings
- Samples taken from both living tree and dead wood when matched and overlapped can provide information dating back to prehistoric times





Coral Reefs



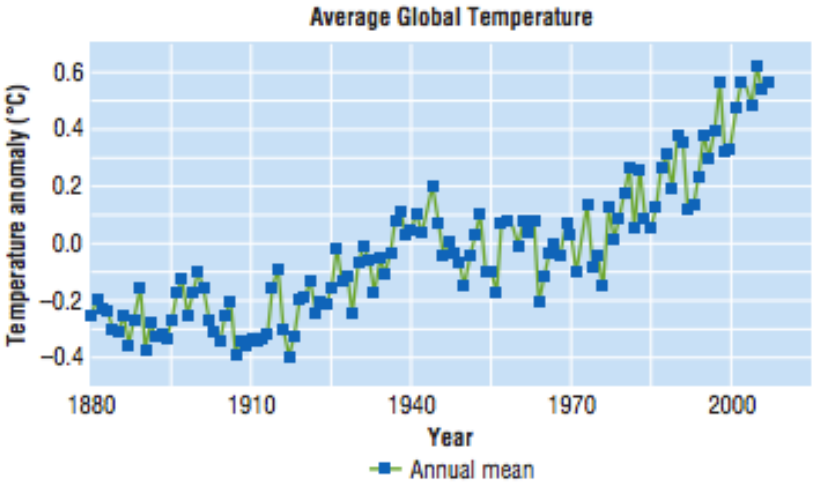
- Coral reefs grow in a yearly pattern called **laminations;** visible only under UV light
- Samples of coral analyzed for oxygen isotopes to indicate temperature of the oceans

Rocks, Ocean Sediments, and Caves

- Lithosphere was formed layer by layer, often trapping evidence of climate records:
  - Plant materials like pollen can be used to identify tree species and the temperature it needed to survive
  - Ocean sediment cores can be analyzed for fossils of marine plants and animals
  - More rock formation in caves indicate rainy weather

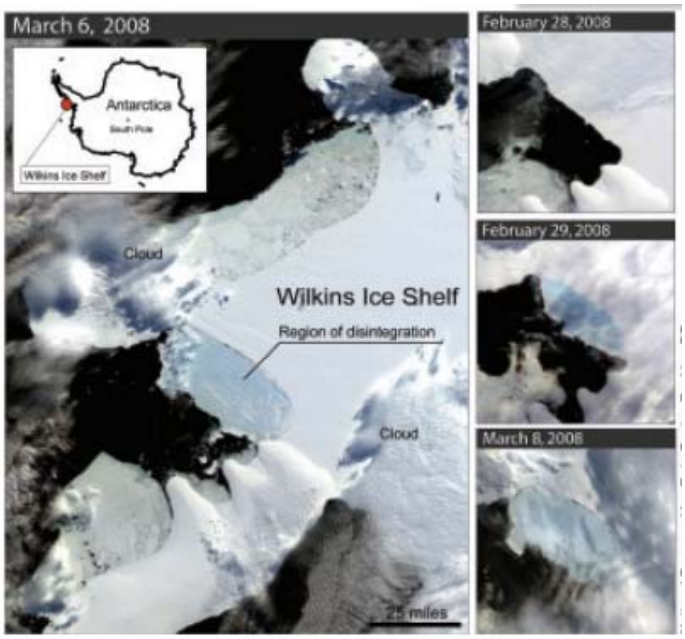
Evidence of Climate Change

- Rising Temperatures



Temperature Anomaly = the difference between a long-term average temperature and the data point. Ex: a +0.1 means that the the data point is 0.1 above the average temperature

- Melting Glaciers, Ice Sheets and Sea Ice



- 50% of the world depend on glaciers for their water
- Melting glaciers could lead to a water shortage
- Ice sheets are melting
- Arctic sea ice are melting. Arctic could be ice-free in the summer within a few years

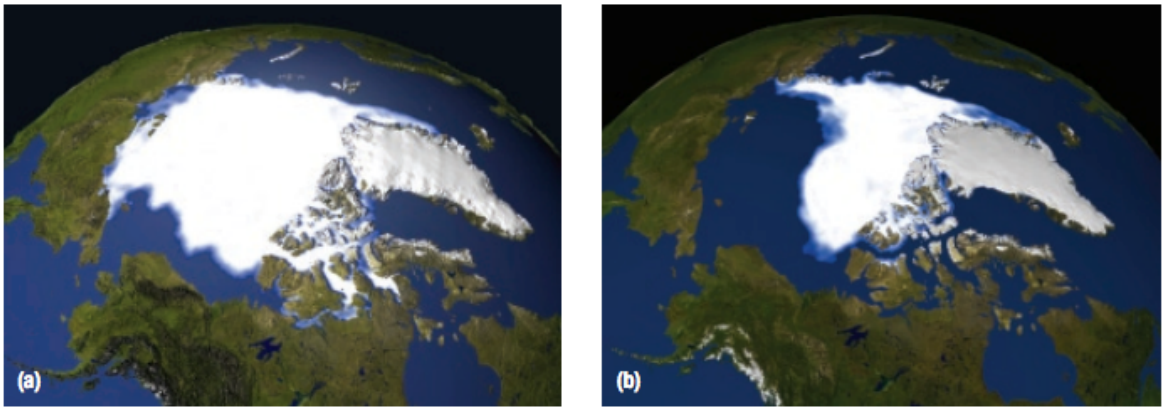


Figure 4 These satellite images show decreases in sea ice between (a) September 1979 and (b) September 2007. This month holds the record for the smallest area of sea ice in the Arctic, at the time of publication, since records were first started in 1979.

Evidence of Climate Change

- Rising Sea Level
  - Global sea level rose 2X faster in the last 30 years
  - Small increases in sea level can lead to floods
- What is causing rising sea levels?
  - Melting glaciers – but not enough to cause a significant rise in sea level
  - Thermal Expansion – water expands when warmed up
  - Transfer of Groundwater

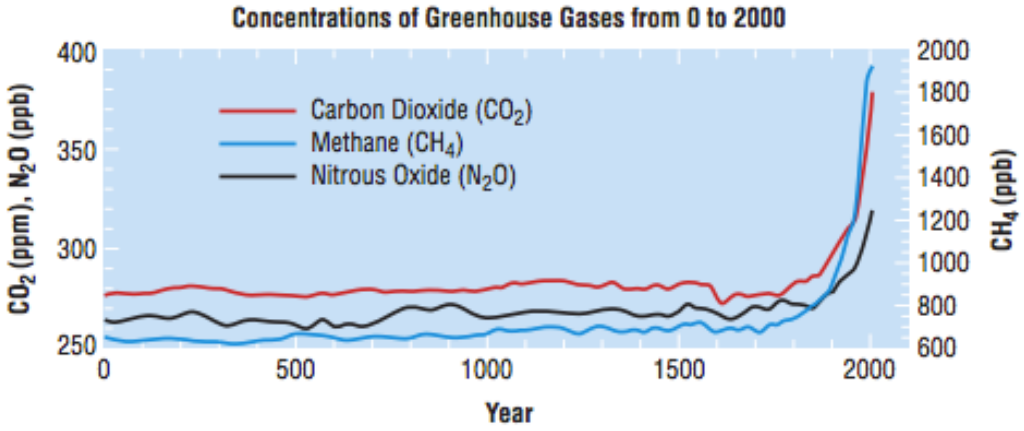
Evidence of Climate Change

- Severe weather – more intense heat waves, hurricanes
- Changing precipitation patterns
  - Northern Hemisphere: more rain than snow; more heavy precipitation (large rainstorms, snowstorms)
  - Other parts of the world have little/no precipitation

Evidence of Climate Change

- Changes in Ecosystems
  - Plants bloom earlier in the spring
  - Animals breed earlier in the year
  - Migration of animals and pests due to changes in climate

Impact of Greenhouse Gases



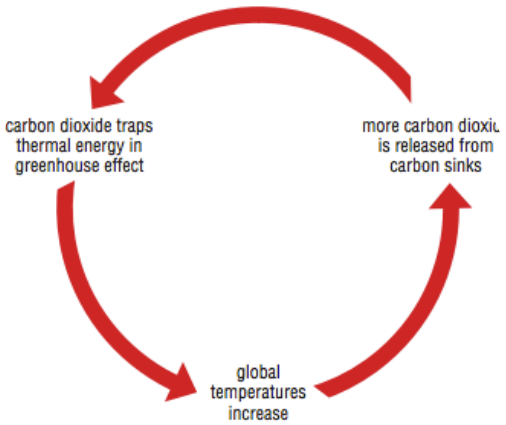
- Anthropogenic Greenhouse Gases – human-produced greenhouse gases

- What are the sources of Greenhouse Gases?
  - **Carbon Dioxide** – most significant due to the burning of fossil fuels (coal, gasoline, natural gas)
    - 10% due to deforestation – stops forest from absorbing carbon and releases the carbon back into the atmosphere

- **Methane**
  - Caused by rice farming, cattle ranching, decay of organic materials in landfills and sewage treatment plants
- **Nitrous Oxide (N_2O)**
  - Caused by livestock feed and waste, nitrogen fertilizers, industrial processes
- **Chlorofluorocarbons (CFCs)**
  - Caused by the gases that leak out of refrigerators and air conditioners
  - Depletes the ozone

Feedback Loop: CO_2 and Temperature

- Increased CO_2 → Increased temperature and cycles (Positive Feedback Cycle)

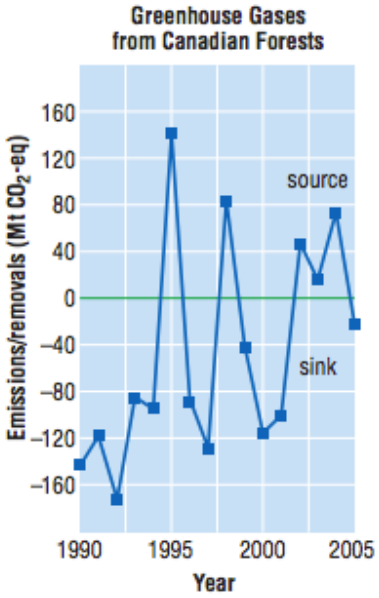


- If humans continue to produce greenhouse gases at a similar rate, the Earth's average temperature can increase by 2-6°C

Canadian Emissions of Greenhouse Gases

- Each Canadian emits more greenhouse gases than most people in the world
- Ontario release over 200 million tonnes of greenhouse gases per year

Source	Examples	Quantity per year based on data from 2006 (Mt (megatonnes) CO_2-eq)
producing and using energy	generating electricity and heat, fossil fuel industries, mining, lighting and heating buildings, manufacturing	324
transportation	exhaust from cars, trucks, airplanes, trains	190
fugitive emissions	gases released during fossil fuel extraction and processing	67
agriculture	production of nitrogen fertilizers, farm machinery exhausts	62
industrial processes	mineral and metal production, chemical industry	54
waste management	sewage treatment, landfills	21
land use and forestry	forests, crops, grassland, wetlands, settlements	20



- Canadian Forests
  - Healthy Canadian forests are carbon sinks (removes and stores CO_2 from atmosphere)
  - Pest damage, wildfires, deforestation can cause Canadian forests to become a source of greenhouse gases as well

Computer Modeling

- Use computer modeling to study an identical earth without humans

Scenario 1: Natural Changes Only

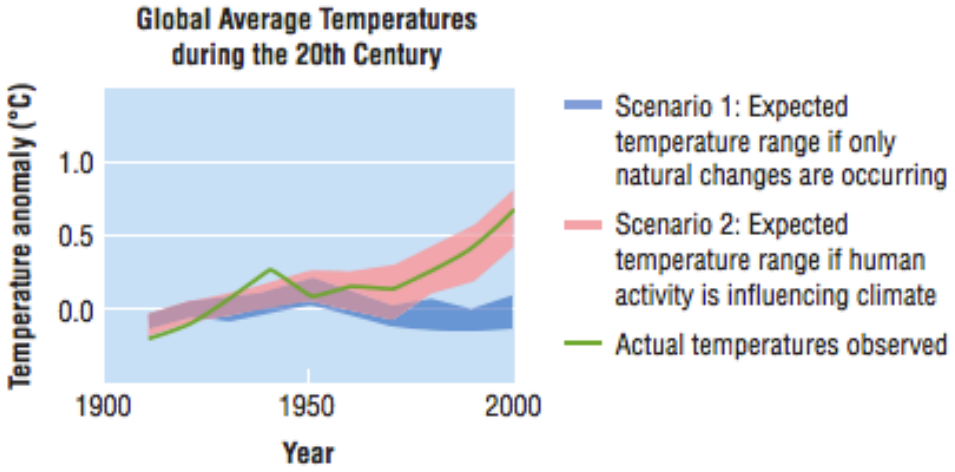
  - Changes in energy from the Sun
  - Volcanic eruptions
  - Natural processes and variability

- Result: Earth's average global temperature stays about the same

Scenario 2: Natural and Anthropogenic Factors

- Natural changes
- Human activity

- Result: Earth's average temperature increases



How can we help?

- Clean Energy Sources
  - Wind Power
  - Geothermal Energy
  - Solar Power
  - Hydroelectricity
  - Biofuels
  - Nuclear Power

DID YOU KNOW?

Disappearing Country

The tiny country of Tuvalu is in danger of disappearing. Tuvalu is a series of islands in the Pacific Ocean. At its highest, Tuvalu is only 4.5 m above sea level. This country could disappear within decades if the sea level continues to rise. Where will the 11 000 people from Tuvalu go?

- We cannot stop climate change but we can at least stop the serious consequences:
  - Disintegration of the Greenland and West Antarctic Ice Sheets would raise sea level by 15m and displace over a billion people
  - Extinction of 50% of the world's species
  - Increases in extreme weather events

Global Impacts of Climate Change

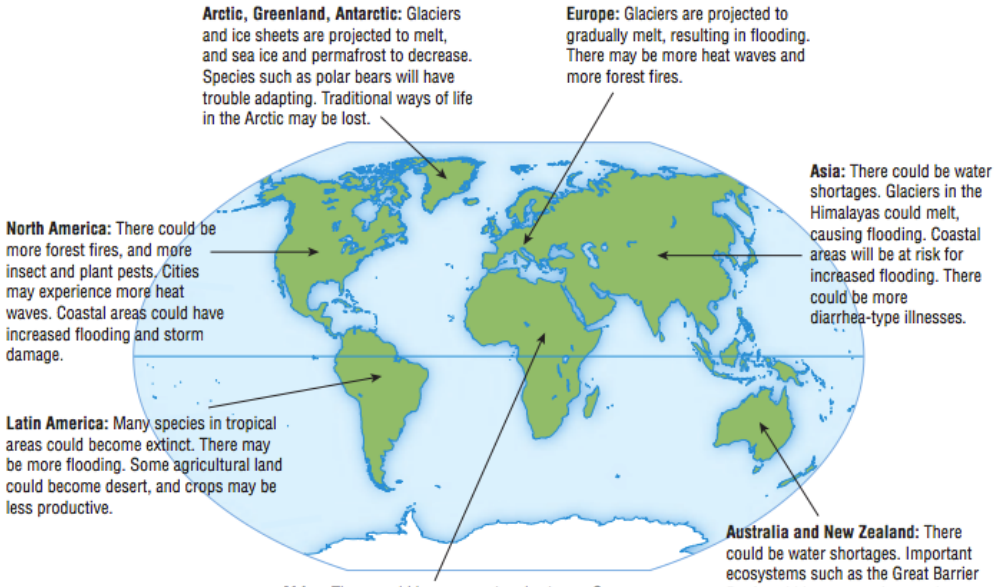


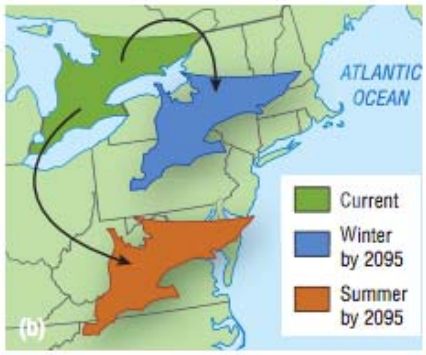
Figure 7 Possible global impacts of climate change projected by the IPCC

Canadian Arctic

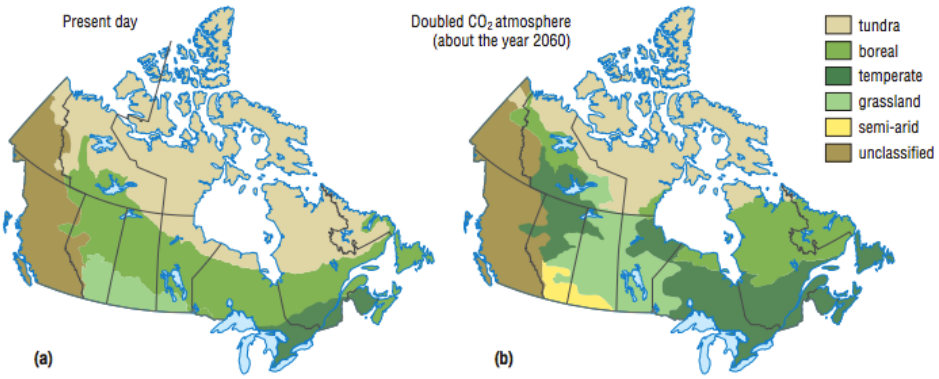
- Less ice means it is harder for polar bears to reach their food
- People who hunt for food are also affected by displacement in animal populations
- Melting permafrost creates sinkholes and shifting foundations for structures

Climate Change on Ontario

- The climate of southern Ontario has already become similar to the climate of New York 20 years ago
- By 2100, Ontario's winters might match those in Pennsylvania



- **Changing Lake Levels**
  - Water levels in the lakes are dropping due to temperature increase
  - Fish may migrate north or die out
  - Algae grows faster in warm weather
- **Ecosystems**



- **Disease and Illness**
  - Disease-carrying organisms may increase as average temperatures rise and precipitation patterns change
    - West Nile
    - Lyme Disease
  - Heat Stroke/Smog/Air pollution

- **Agriculture**
  - Growing season for crops would lengthen
- **Forests**
  - Boreal forests would shrink and may become more of a carbon source than a carbon sink

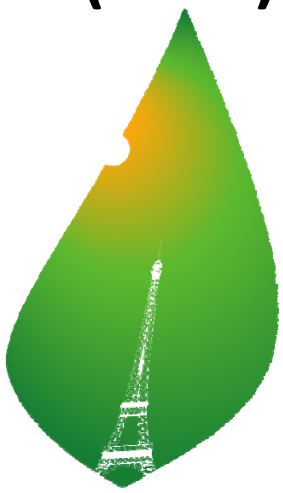
- **Electricity Use**
  - Warmer summers = more electricity for air conditioning
  - Milder winters = less energy use for heat

What can we do?

- Mitigation – actions taken to reduce unwanted change by deliberate actions and decisions
- To stabilize greenhouse gas concentrations at 450ppm, all industrialized nations have to cut their annual emissions by 80%
  - Ontario has committed to this 80% reduction
  - Canadian federal government has not

Paris Climate Agreement (2015)

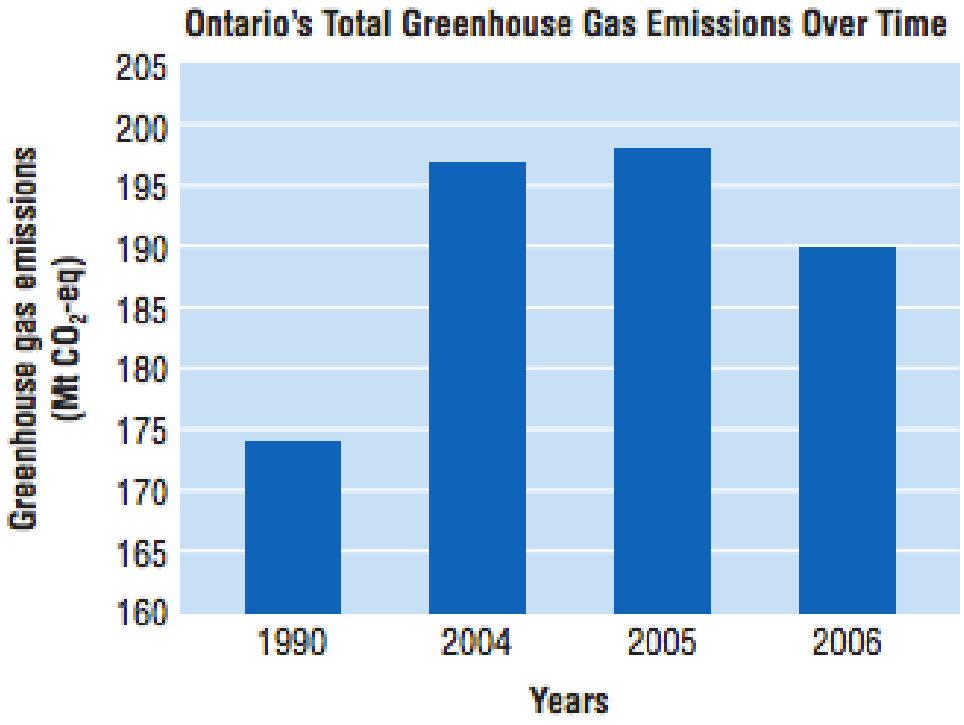
- Global climate deal adopted by 195 countries
- Key points:
  - Keep global average temperature to below 2°C above pre-industrial levels
  - Global emissions need to peak as soon as possible and then undertake rapid reduction thereafter



PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Provincial and Municipal Governments

- Go Green: Ontario's Action Plan on Climate Change (2007)
  - Stop burning fossil fuel by 2014
  - Reduce gas emissions by 6% in 2014, 15% in 2020, 80% in 2050
  - A public transportation plan for routes in the GTA
  - Plant 50 million trees
  - Fast-track the approval of renewable energy projects


Ontario's Total Greenhouse Gas Emissions Over Time
Greenhouse gas emissions (Mt CO_2-eq)
205
200
195
190
185
180
175
170
165
160
1990
2004
2005
2006
Years