These notes are posted on my site for the following reasons:

- for students to copy in their own hand-writing
 - in order to complete their class notes
 - if student did not have enough time in class
 - if student was away and missed this section
- for assistants and tutors to follow progress of the concepts taught

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11.2 Human Activity and Climate Change



- Climate change is the change in long-term weather patterns in certain regions.
 - These changes can affect the flow of thermal energy over the entire Earth.
 - Several ice ages have occurred in the past million years.
 - Global warming refers to a global increase in average temperature.
 - Both the causes and effects of global warming are unknown and controversial.



The Enhanced Greenhouse Effect



- The enhanced greenhouse effect increases thermal energy absorbed.
 - More greenhouse gases in the atmosphere = increase of natural greenhouse effect.
 - Greenhouse gases include water vapour, CO₂, methane, nitrous oxide, CFCs and perfluoromethane.
 - Global warming potential (GWP) refers to the ability to trap thermal energy.
 - CO₂ is given a GWP of 1; perfluoromethane is 6500 9200.

Table 11.1 Green House Gases and Global Warming Potential				
Greenhouse Gas	Chemical Formula	Atmospheric Lifetime (years)	Source from Human Activity	Global Warming Potential (GWP)
carbon dioxide	C02	variable	 combustion of fossil fuels deforestation 	1
methane	CH4	about 12	 combustion of fossil fuels livestock agriculture waste dumps rice paddies 	25
nitrous oxide	N ₂ 0	174	 production of chemical fertilizers burning waste industrial processes 	298
chlorofluorocarbons	CFCs	45	 liquid coolants refrigeration air conditioning 	4750-5310
perfluoromethane	PFCs	10 000-50 000	production of electronics production of aluminum	6500-9200



Source: Intergovermental Panel on Gimate Change 2007

The Enhanced Greenhouse Effect: Carbon Dioxide and Methane



- CO₂ levels have increased greatly in the past 200 years.
 - Since the industrial revolution, humans have greatly increased their overall use of fossil fuels, which release CO₂ when burned..
 - Deforestation has changed carbon sinks forests into carbon sources.
 - Many people are attempting to reduce CO₂ emissions by using alternative energy sources, or by reducing their energy use.
 - Carbon offsets, like wind farms, can be purchased to offset CO₂ emissions.
- Methane is very efficient at trapping thermal energy.
 - 25X more efficient than CO₂
 - Methane is produced by bacteria breaking down wastes in oxygen-free environments, and also by animals digesting plant matter, rice paddies (and other natural wetlands), and the burning of fossil fuels.



The Enhanced Greenhouse Effect: Nitrous Oxide, Ozone and Halocarbons



- Nitrous oxide, N₂O, is the third largest contributor to the enhanced greenhouse effect.
 - Even though there are only small amounts, it has 300X more GWP than CO₂.
 - N₂O comes from bacteria, as well as fertilizers used by humans, and by improper disposal of human and animal waste.
- Ozone is an important UV radiation blocker in the stratosphere.
 - At lower altitudes, however, it is a very powerful greenhouse gas.
 - This ozone comes from solar radiation reacting with pollution from the burning of fossil fuels, and is released from photocopiers and certain air purifiers.
- Halocarbons, used as refrigerants, are strong greenhouse gases.
 - Chlorofluorocarbons (CFCs) are the most well-known halocarbons.
 - Halocarbons are also the main reason for ozone layer depletion.

See page 486

Albedo and Climate, Making Predictions About Climate Change

- The albedo at Earth's surface affects the amount of solar radiation that region receives.
 - Changes in a regions albedo for example, snow cover melts earlier in the season than it did previously - climate changes could follow.
 - Forests provide a low albedo (and deforestation increases albedo).
 - Forests also emit large amounts of water vapour, which reflects solar radiation back into space.
 - Deforestation's effects on climate change are unknown.



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The Role of Science in Understanding Climate Change



- Scientists use computers to model what Earth's climate might be like.
 - Although models differ, most appear to point to a decrease in the production of greenhouse gases is necessary to stop the apparent global warming trend.
- Global warming models attempt to be as accurate as possible.
 - Data is used from multiple locations over long periods of time.
 - General Circulation Models (GCMs) are computer models used to study climate.
 - GCMs take into account changes in greenhouse gases, albedo, ocean currents, winds and surface temperatures.
 - GCMs are also used for weather forecasting, climate analysis and climate change predictions.
 - Scientists are always trying to improve GCMs.
 - GCMs predict the future and the past.



The Role of International Cooperation in Climate Change

- BC SCIENCE 10
- It is believed human-induced climate change is a recent occurrence.
 - The United Nations (UNEP) and the World Meteorological Organization (WMO) created the Intergovernmental Panel on Climate Change (IPCC) to address global concerns about climate change and global warming.
 - The IPCC, formed in 1988, has members from 130 countries.
 - The IPCC examines possible climate change, highlights the cause, and suggests solutions.
 - The United Nations Framework Convention on Climate Change (UNFCCC) created a voluntary treaty to encourage governments to reduce greenhouse gas emissions.

Per capita emissions of greenhouse gases for various countries.



Global Impacts of Climate Change

Main Fisheries Affected

 changes in the food supply that will affect international trade

Sea-Level Rise

- the loss of coastal land due to rising sea levels
- the potential for flood damage to low-lying coastal areas
- the mass movement of people fleeing the worst-affected areas

Deforestation

 an increase in the risk of forest fires due to a drying climate

Water Conflicts

- changes to precipitation patterns, causing the demand for water to surpass the supply

Figure 11.27 This map shows how climate change could potentially affect all nations of the world.

Greater Disease Risk

 the occurrence of diseases, such as malaria and other tropical diseases, farther north

BC SCIENCE

Increased Severity and Frequency of Tropical Storms

 the mass movement of people fleeing the worst-affected areas

Decreasing Crop Yields

 changes in agriculture and the food supply that will affect international trade

See pages 489 - 490

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Global Impacts of Climate Change: Impacts of Climate Change on Canada



- Being in the northern hemisphere, Canada should expect to feel the effects of global warming quite severely.
 - Parts of Canada have had average temperature increases of 0.5 °C to 1.5 °C.
 - Southern, and Western, parts of the country have been most affected.
 - The Arctic regions are losing permafrost and Arctic ocean ice cover.
 - Growing seasons are getting longer, and more precipitation is falling.
 - There could be heavier Spring rains, and severe droughts, in the future.
 - Fisheries could be very negatively affected.
 - Pollution concerns could lead to health issues.
 - Being on the ocean, climate change in BC could be significant.
 - Most regions of BC will probably be warmer, sea levels will rise, and fresh drinking water may be harder to find as glaciers disappear.

See pages 490 - 492

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Global Impacts of Climate Change: Impacts of Climate Change on Canada



Elgure 11.28 Projected temperature change for Canada in 2050, summer (A). Projected temperature change for Canada is 2050, winter (B). The maps are based on the Coupled Global Climate Model developed by Environment Canada.



Figure 11.25 Changes projected for Canada's biomes if the concentration of CO₂ doubles from what it was before the Industrial Revolution.

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BC SCIENCE



Uncertainty and Decision, An Action Plan for the Global Community



Table 11.5 Strategies for Addressing Climate Change				
Sector	Strategy for Reduction of Greenhouse Gas Emission			
Industry	 switch to more energy-efficient electric equipment, heat, and power sources increase the amount of recycling monitor and control non-CO2 gas emissions 			
Phergy	 develop more efficient ways of producing energy research renewable energy sources (hydro-electric, wind, solar, biofuels, and geothermal power) store CO2 underground after it is removed from natural gas 			
Transportation	 improve fuel efficiency for vehicles introduce hybrid vehicles, which do not rely on fossil fuels alone introduce alternate fuels, such as hydrogen or biofuels shift from road transport to rail improve and promote the use of public transportation 			
Construction	 switch to high-efficiency lighting use energy-efficient appliances, heating systems, and air conditioning systems improve insulation of buildings use solar and geothermal heating and cooling 			
Agriculture	 improve fertilizer (nitrogen) use specify crops used for energy purposes (i.e. corn, soybeans) increased use of soil carbon storage improve management of livestock waste improve techniques for cultivating rice crops reclaim and reuse lands damaged by agriculture 			
Forestry	 promote world-wide planting of trees and re-forestation encourage efficient use of forest products for energy encourage better forest-management strategies 			
Waste Management	 promote recycling, composting, and minimizing waste encourage the burning of waste for energy recovery recover methane gas from decomposition in garbage dumps and landfills 			

- Although climate change is a controversial issue, change is needed.
 - Improving our environmental approach will help, no matter how bad climate change actually is.
 - No action could result in huge problems.
 - The UN wants country to act on the precautionary principle, ie. "better safe than sorry".
- Relatively small changes could have large positive impact on the climate in Canada.
 - Reduce vehicle greenhouse gas emissions.
 - Industries reduce greenhouse gas emissions.
 - Increase use of energy-efficient products.
 - Improve indoor air quality.