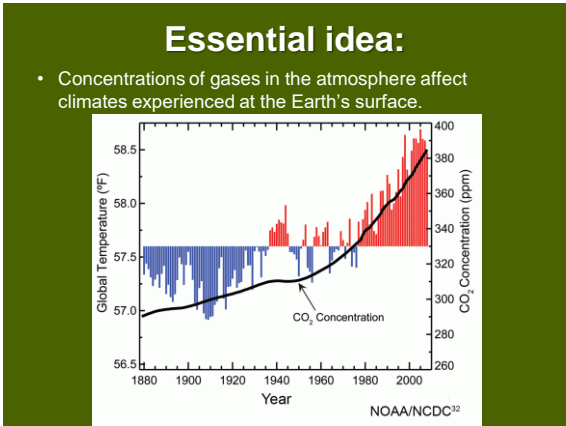


Ecology

4.4- Climate Change



Nature of science:

- Assessing claims
 - assessment of the claims that human activities are producing climate change. (5.2)

Changing Rain and Snow Patterns
 Changes in Animal Migration and Life Cycles
 Less Snow and Ice
 Higher Temperatures and More Heat Waves
 More Droughts and Wildfires
 Thawing Permafrost
 Stronger Storms
 Damaged Corals
 Rising Sea Level
 Warmer Oceans
 Changes in Plant Life Cycles

International-mindedness:

- Release of greenhouse gases occurs locally but has a global impact, so international cooperation to reduce emissions is essential.

GREENHOUSE GAS EMISSIONS

GHG EMISSIONS as % of global total
 PER CAPITA EMISSIONS Tonnes CO₂e

South Africa	1.1	India	1.7
South Korea	1.5	Brazil	2.7
Indonesia	1.5	China	5.4
Australia	1.5	World average	5.5
Mexico	1.7	Mexico	5.9
Canada	2	South Africa	6.3
Brazil	2.7	Japan	10.3
Japan	3.6	EU(27)	10.5
India	4.9	Australia	11.8
Russia	5.2	South Korea	13.7
EU (27)	13.3	U.S.	19.1
U.S.A.	18.3	U.S.A.	22.9
China	19.1	Australia	23.4
		China	27.4

Average level of emissions in 2020 estimated to be necessary to meet a 450ppm global outcome

Theory of knowledge:

- The precautionary principle is meant to guide decision-making in conditions where a lack of certainty exists.
- Is certainty ever possible in the natural sciences?

Precautionary Principle	Scientific discovery leads to experimentation initially the results are...	
	...withheld till risk assessment to environment and human health can be assessed	...put into immediate use and introduced into the environment and for consumption
Initially the potential for harm is unknown and unknowable so either row can be the outcome.	FALSE	TRUE
If the potential for harm proves to be...	Advantage: No harm done, liability avoided Downside: Delay in realizing benefits and Return on investment (ROI)	Advantage: Realizing potential benefits and ROI immediately Downside: None
	Advantage: No harm done, liability avoided Downside: None	Advantage: None Downside: Injury/harm to humans, animals or environment, liability assumed.

Understandings

- Carbon dioxide and water vapor are the most significant greenhouse gases (1% of atmosphere).
 - CO₂
 - Added through cell respiration, combustion of biomass and fossil fuels
 - Removed through photosynthesis and by its solubility in water

Respiration
 $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O + Energy$

CO₂ + H₂O → H₂CO₃ → H⁺ + HCO₃⁻

H⁺ ions attached to OH⁻ (hydroxide ions) make water
 Carbonate ion (CO₃²⁻) attracted to Ca²⁺ to make calcium carbonate

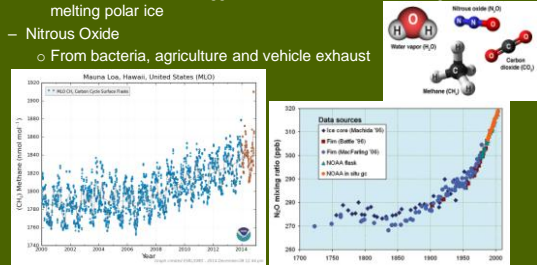
Understandings

- Carbon dioxide and water vapor are the most significant greenhouse gases (1% of atmosphere).
 - Water Vapor
 - Added through evaporation and transpiration
 - Removed by rainfall and snow



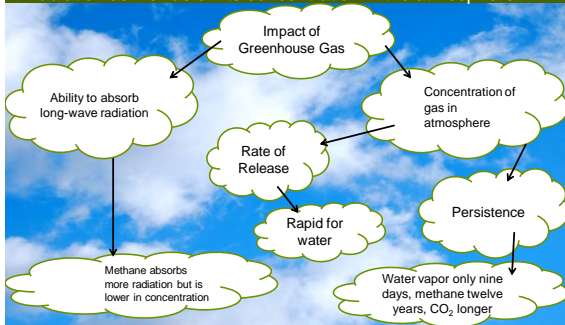
Understandings

- Other gases including methane and nitrogen oxides have less impact.
 - Methane (3rd)
 - From marshes, waterlogged habitats, landfills, extracting fossil fuels, melting polar ice
 - Nitrous Oxide
 - From bacteria, agriculture and vehicle exhaust



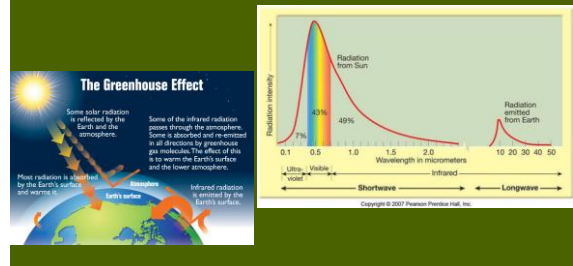
Understandings

- The impact of a gas depends on its ability to absorb long wave radiation as well as on its concentration in the atmosphere.



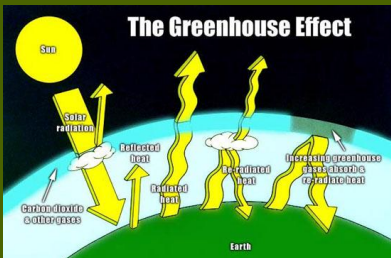
Understandings

- The warmed Earth emits longer wavelength radiation (heat).
 - Sun emits short wave radiation (400nm)
 - Earth reflects long wave radiation (10000nm)



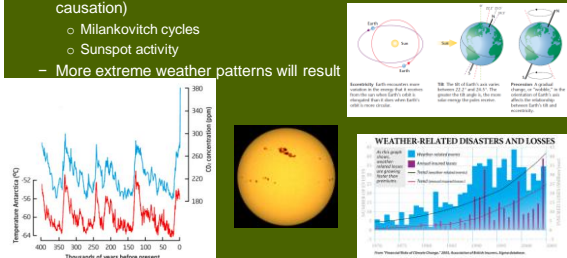
Understandings

- Longer wave radiation is absorbed by greenhouse gases that retain the heat in the atmosphere.
 - 70-75% of sun's radiation reaches earth's surface
 - 70-85% of reflected energy is captured by greenhouse gases
 - Greenhouse effect is good (otherwise surface would be -18°C)



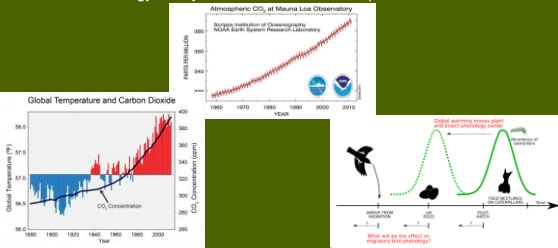
Understandings

- Global temperatures and climate patterns are influenced by concentrations of greenhouse gases.
 - Data from past comes from ice cores
 - Correlation between CO₂ and global warming (correlation is not causation)
 - Milankovitch cycles
 - Sunspot activity
 - More extreme weather patterns will result



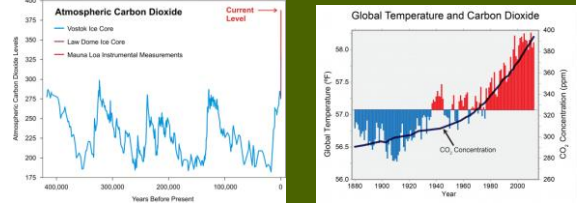
Applications and Skills

- Application: Correlations between global temperatures and carbon dioxide concentrations on Earth. (DBQ 233 and 234)
 - Patterns of warming
 - Phenology: study of seasonal activities in plants and animals



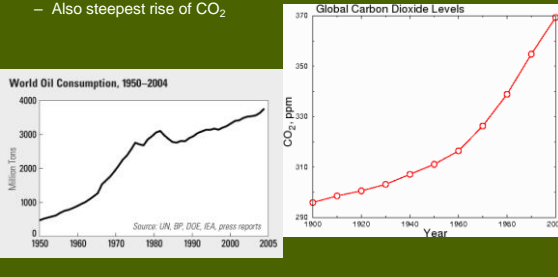
Understandings

- There is a correlation between rising atmospheric concentrations of carbon dioxide since the start of the industrial revolution 200 years ago and average global temperatures.
 - Glaciation lows of 180ppm
 - Interglacial highs of 300ppm
 - 260ppm to 280ppm until late 1800s
 - Recent highs of 400ppm



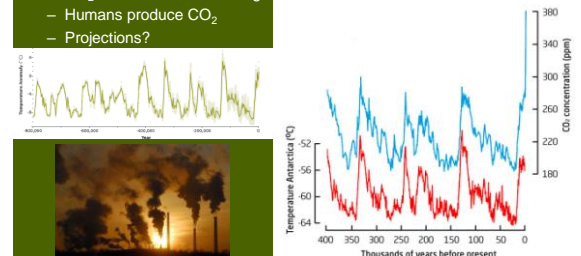
Understandings

- Recent increases in atmospheric carbon dioxide are largely due to increases in the combustion of fossilized organic matter.
 - 1950s was most rapid increase in burning fossil fuels
 - Also steepest rise of CO₂



Applications and Skills

- Application: Evaluating claims that human activities are not causing climate change. (Read 236-237, DBQ237)
 - Natural cycles of warming and cooling
 - CO₂ correlates with warming
 - Humans produce CO₂
 - Projections?



Applications and Skills

- Application: Threats to coral reefs from increasing concentrations of dissolved carbon dioxide. (Read 238 and do Activity)
 - Ocean surface pH from 1800s estimated to be 8.179
 - Coral absorb carbonate ions from seawater to make skeleton
 - CO₂ is soluble in H₂O and forms Carbonic acid
 - Hard to build reefs

