Grade 10 Science

Climate Change

Class 12

Overall Expectations

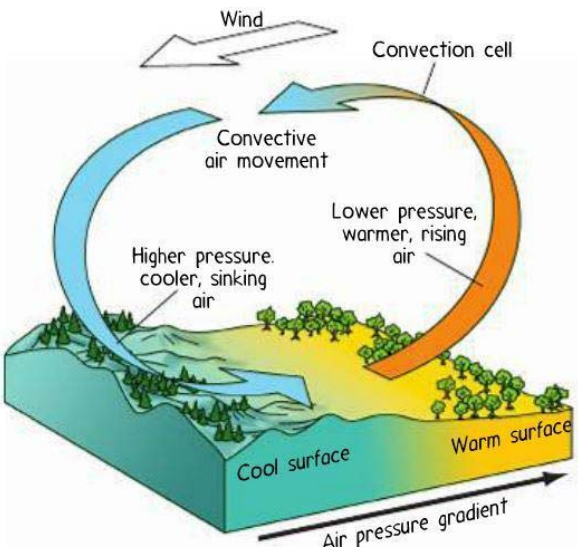
- Analyse some of the effects of climate change around the world, and assess the effectiveness of initiatives that attempt to address the issue of climate change
- Investigate various natural and human factors that influence Earth's climate and climate change
- Demonstrate an understanding of natural and human factors, including the greenhouse effect, that influence Earth's climate and contribute to climate change

Weather

- Weather – atmospheric conditions including temperature, precipitation, wind and humidity in a particular location over a **short period of time**
  - Temperature
  - Type and amount of precipitation
  - Wind speed
  - Humidity
  - Atmospheric Pressure

What Causes Weather?

- Weather is caused by **air movement** and **water movement** due to the Sun's energy affecting atmosphere and water
  - Sun's energy heats Earth's atmosphere creating air movement and clouds to produce precipitation
  - Ocean water moves from the poles to the equator



Climate

- Climate – the average of the weather in a region over a **long period of time**
- Climate Zones – categorized by temperature, precipitation and plant communities

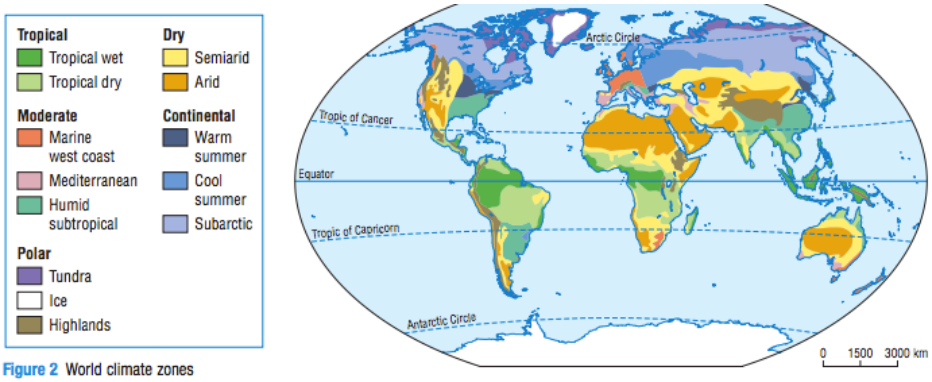
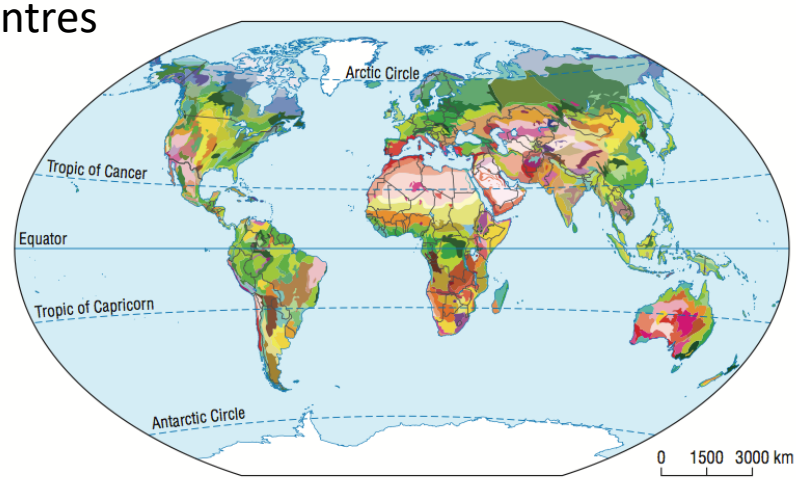


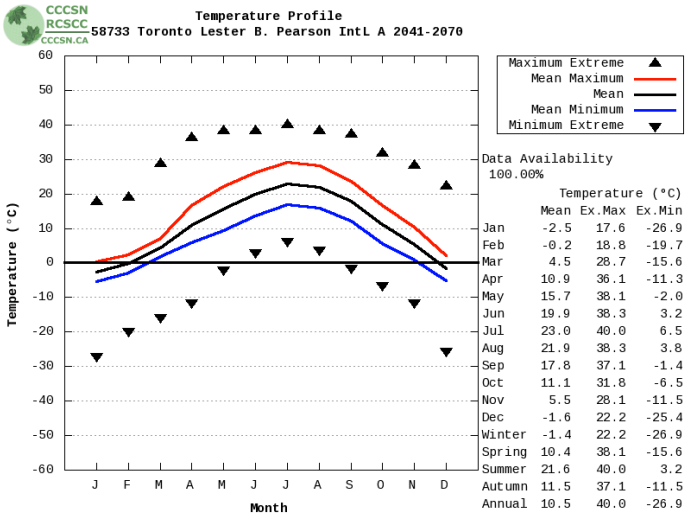
Figure 2 World climate zones

- **Ecoregions** – a new method of classifying climate that focuses on the ecology of the region
  - Based on landforms, soil, plants, animals and climate and even human factors such as crops and urban centres

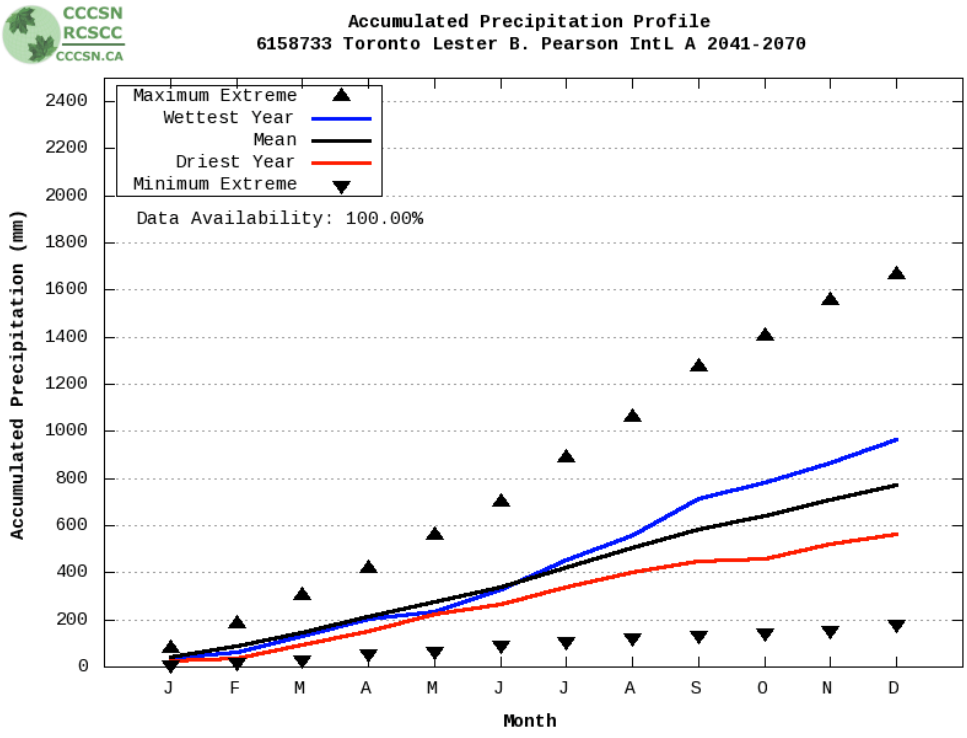


Bioclimate Profiles

- Graphs that how temperature and moisture conditions at a given location
- Used to predict a location's projected climate in the next 40-80 year



Bioclimate Profile - Temperature



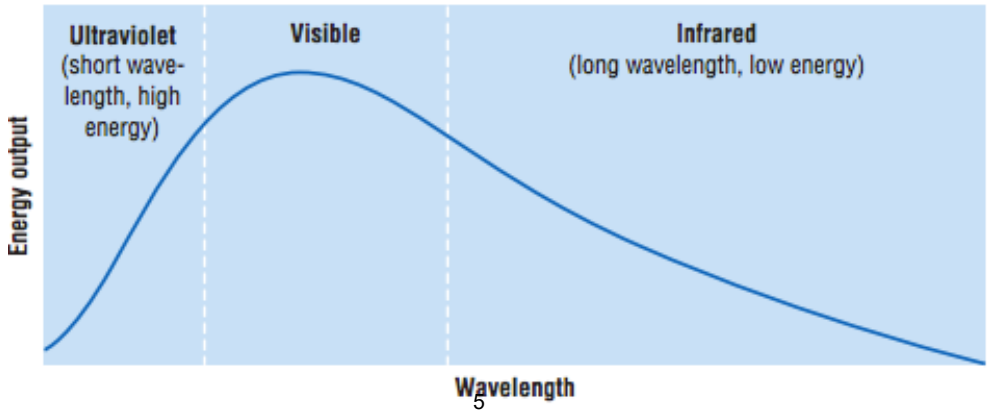
Bioclimate Profile - Precipitation

Factors Affecting Climate

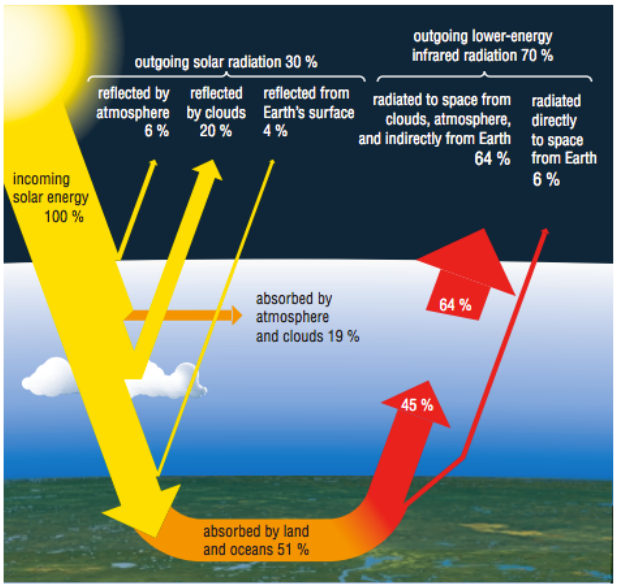
- Distance from the equator (Latitude)
- Presence of large bodies of water
- Presence of ocean or air currents
- Land formations
- The height above sea level (Altitude)

The Sun and Climate

- Sun emits different types of radiation:
  - UV radiation
  - Visible light
  - Infrared radiation



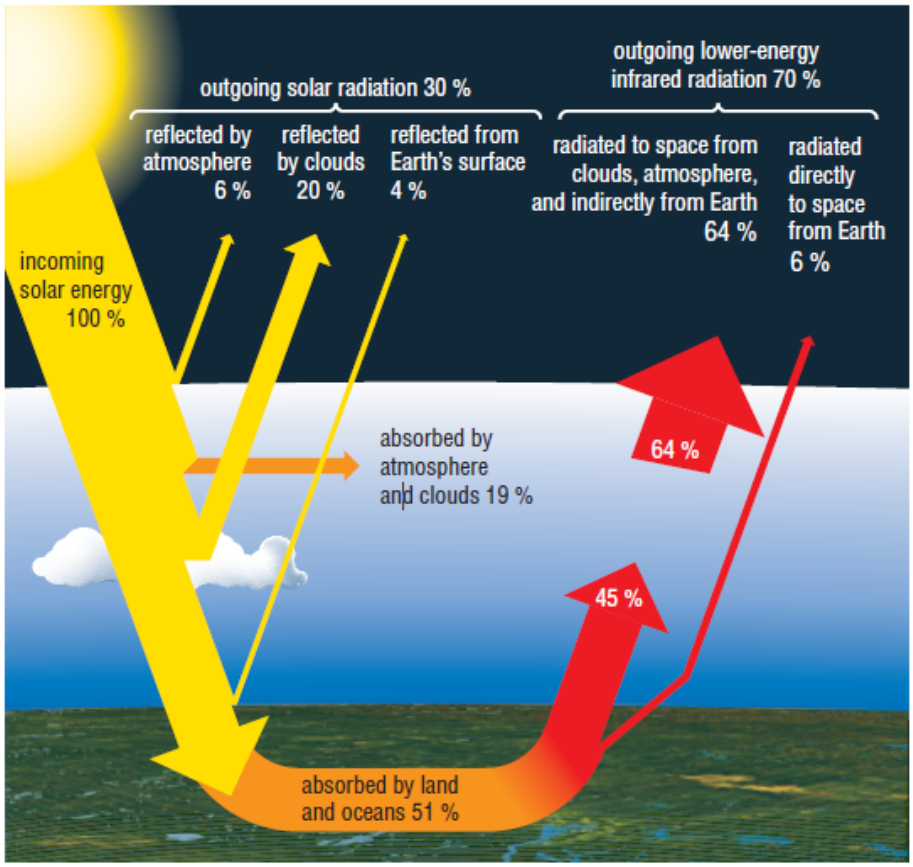
- When radiation hits a particle, one of the following happens:
  1) Particle absorbs the radiation and gains energy
  2) Particle transmits the radiation
  3) Particle reflects the radiation
- 30% of Sun's energy is reflected
- 70% is absorbed



Maintaining Balance

- How does Earth prevent overheating?
  - As energy is absorbed, Earth's surface gains thermal energy and infrared radiation is emitted out
  - Earth's surface both absorbs energy and emits energy

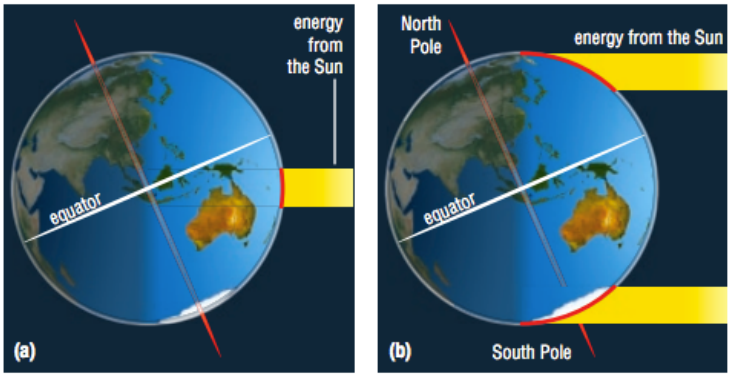
energy absorbed by Earth and atmosphere = energy radiated back again by Earth and atmosphere



Adapted from original material from NASA, available through the Atmospheric Science Data Center

Latitude

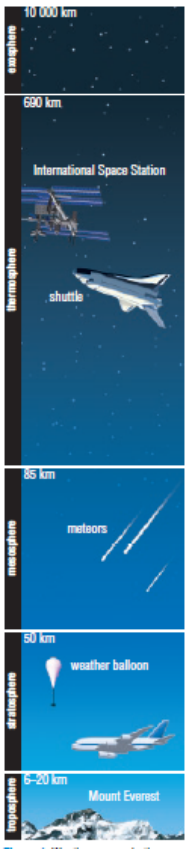
- The climate is warmer near the equator because the Sun shines directly overhead and colder at the Poles because the energy is spread over a larger area and more atmosphere



Climate System Components

- Atmosphere – layers of gases surrounding Earth
- Hydrosphere – the bodies of water (oceans, lakes, water vapour, glaciers, etc.)
- Lithosphere – the rocky layer, Earth's crust
- Biosphere – the region where living things grow

Atmosphere	Hydrosphere	Lithosphere	Living Things
			



Atmosphere

- Consists of 78% N_2, 21% O_2, 1% other gases
- Ozone gas in the stratosphere prevents harmful energy from the Sun from reaching us
  - Absorbs high-energy UV radiation
- Ozone gas in the troposphere is hazardous
  - Exhaust from vehicles and UV radiation produce ozone gas and toxic chemicals = smog

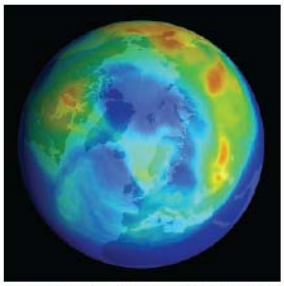


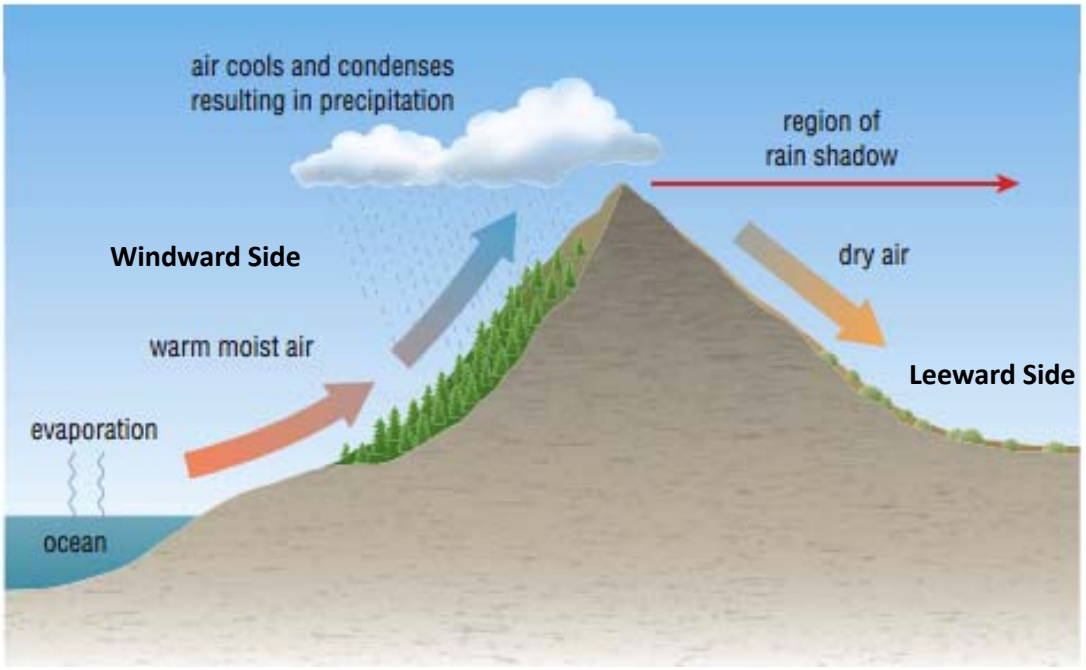
Figure 2 This is a view of Earth, looking directly down on the North Pole. The dark blue region over the Arctic has an ozone layer that is about 40 % thinner than normal.

Hydrosphere

- Water cycle is an important part of the climate system
  - Cools surroundings during precipitation
  - Warms surrounding during evaporation
- Large bodies of water heats up and cools down more slowly than land
  - Regions downwind from a large body of water have more snowfall
- Glaciers reflect lots of the Sun's energy

Lithosphere

- Mountains and other land formations affect how air moves over an area
- **Rain-shadow effect**
- High altitudes – atmospheric pressure is lower = cooler
  - Air from lower altitudes rises to high altitudes, it expands and cools down because there is less pressure pushing down



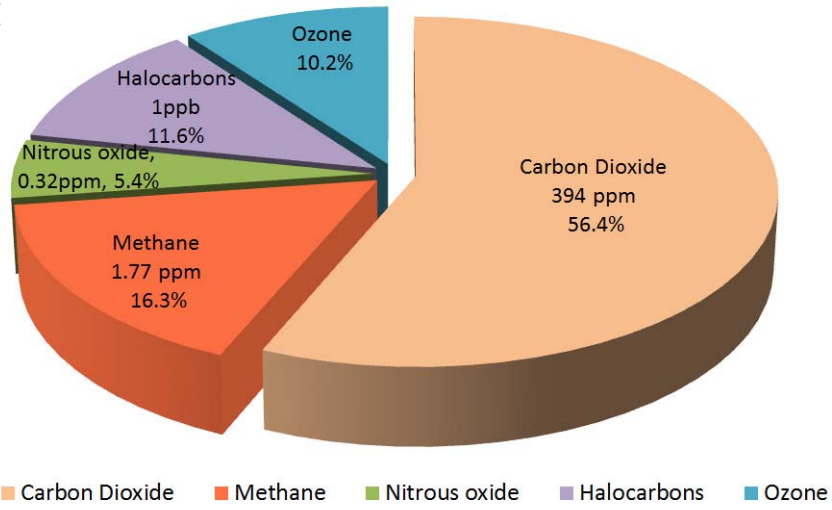
Biosphere

- Plants and animals change the relative amounts of gases in the atmosphere through photosynthesis and cellular respiration
- Gases such as methane and CO_2 absorb infrared radiation emitted by Earth's surface

The Greenhouse Effect

- Gases in the Earth's atmosphere traps much of the infrared radiation to keep the global temperature warm
  - Without the Greenhouse Effect, Earth would be -18°C on average but with greenhouse effect it is 15°C
- A natural process
- Greenhouse Gases: H_2O (g), CO_2, CH_4, O_3, N_2O

- It is the 1% of trace gases that are responsible for the greenhouse effect
- N_2 and O_2 do not absorb infrared radiation and do not contribute to the greenhouse effect

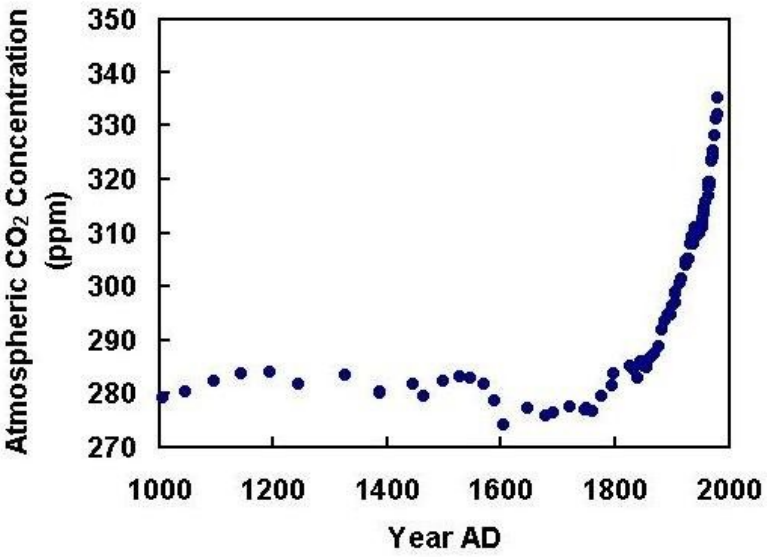


Greenhouse Gases

Carbon Dioxide (CO_2)

- Earth contains only 0.0394% CO_2 in the atmosphere but it is responsible for most of the greenhouse effect
- Natural Sources: Volcanic eruptions, cellular respiration, burning of organic matter
- Carbon cycle

- Before the Industrial Revolution (1750), CO_2 were around 280 ppm (parts-per-million)
- Risen dramatically to 394 ppm



- **Carbon Sink** – Remove CO_2 from the atmosphere and convert it into organic compounds (ex: terrestrial plants and algae in oceans and lakes)
- **Carbon Source** – Releases more CO_2 than it absorbs

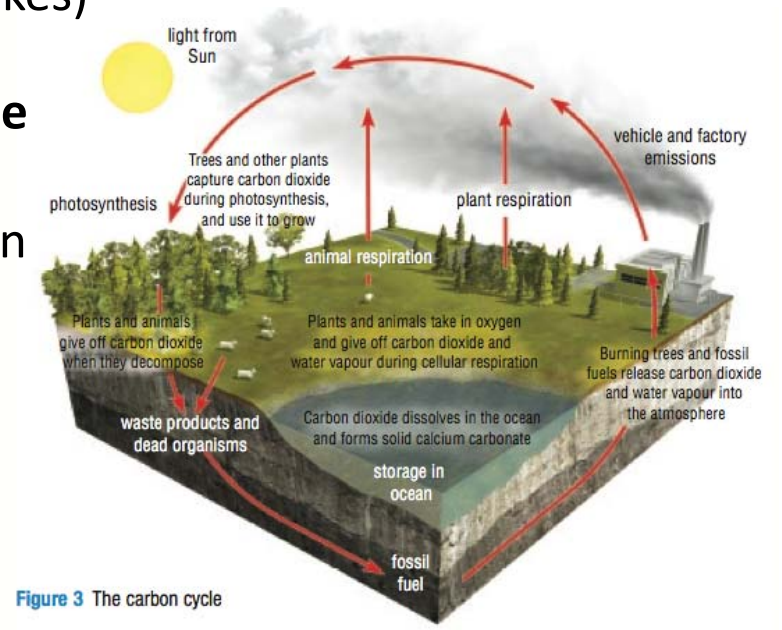
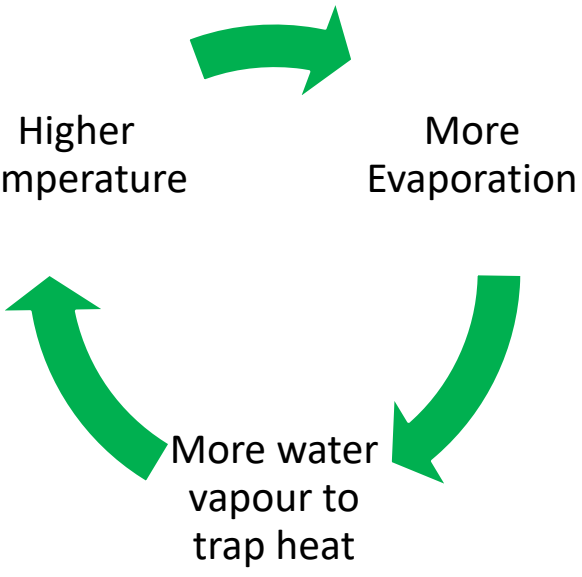


Figure 3 The carbon cycle

Water Vapour (H_2O)

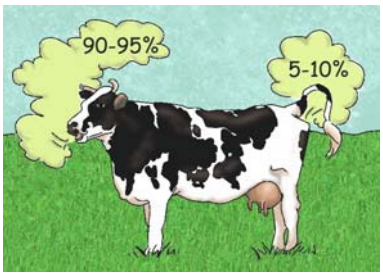
- Amount of water vapour in the atmosphere depends on the temperature

Positive Feedback Loop



Methane (CH_4)

- Since the Industrial Revolution, levels have increased from 0.700ppm to 1.785ppm due to use of fossil fuels and farming
- Produced naturally from plant decomposition and animal digestion
- Absorbs 23X more thermal energy than CO_2

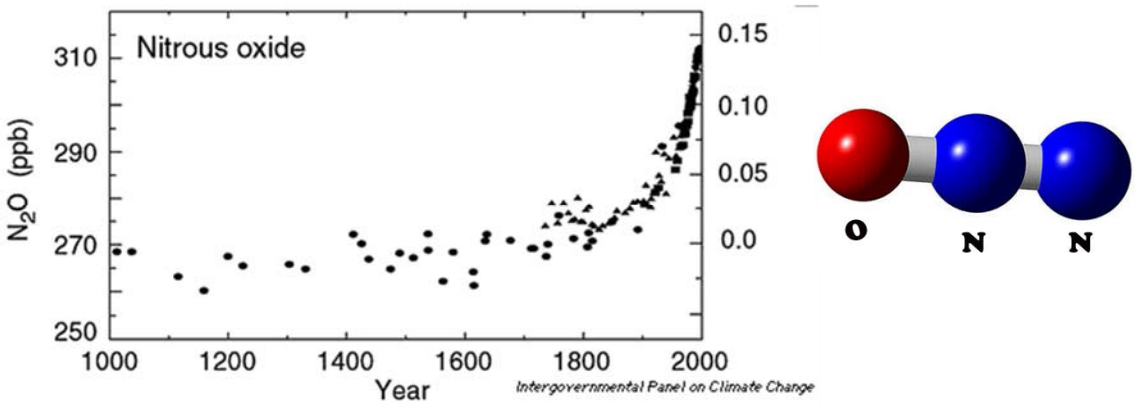


Methane Backpacks

- Dairy cows produce 800-1000 L of CH_4 emissions daily
- Harness the methane to power a car for 24 hours

Nitrous Oxide (N_2O)

- Can absorb about 300X more thermal energy than CO_2
- Natural Sources: Bacteria in soil and water
- Risen from 270 ppb (Pre-industrial) to 321 ppb



How do Greenhouse Gases Trap Heat?

- H_2O, CO_2 and CH_4 consist of three or more atoms that can vibrate and wiggle many ways to absorb energy
- They can trap the infrared energy and re-radiate back to emit heat