

8.4 Components of Earth's Climate System

- There are 4 main components in the Earth's Climate System: the atmosphere, the hydrosphere, the lithosphere, living things

The Atmosphere

- the layers of gases surrounding Earth
- these gases reach more than 100km above the Earth's surface; beyond this height they are present in very low concentrations
- Air: 78% - Nitrogen Gas
21% - Oxygen Gas
1% - Other (i.e. Argon, Carbon Dioxide, and traces of Helium, Hydrogen, and Ozone)
- this proportion of gases changes at different levels in the atmosphere
- the atmosphere reflects some of the Sun's energy, absorbs and radiates some of the energy, and transmits some of it to the Earth's surface
- once the energy of the Sun reaches Earth's surface, the atmosphere traps much of it, warming Earth

Ozone in the Stratosphere



- the Sun's energy is sometimes dangerous, ozone, O_3 , in the atmosphere prevents most of the harmful energy from reaching us
- there is more naturally occurring ozone gas in the stratosphere than any other part in the atmosphere
- in the Stratosphere, ozone absorbs high-energy UV radiation from the Sun, preventing it from reaching Earth's surface
- the decrease in the ozone in the Stratosphere is caused by human-made compounds called chlorofluorocarbons (CFCs), it can be found in refrigerators and air conditioners
- CFCs belong to the family of chemical compounds called halocarbons
- Halocarbons: molecules made up of carbon atoms linked by chemical bonds to fluorine, chlorine, bromine, or iodine. In this case, chlorine and fluorine are linked to the carbon atoms
- In the Stratosphere the chlorine atoms from the CFCs react with ozone molecules, destroying the protective ozone layer. Each CFC molecule can destroy hundreds or thousands of ozone molecules.
- With the help of the Montreal Protocol (the world agreed with the protocol on substances that deplete the ozone layer suggested by Montreal) the ozone layer is slowly recovering; however it will take 50 years before the ozone layer return its original thickness

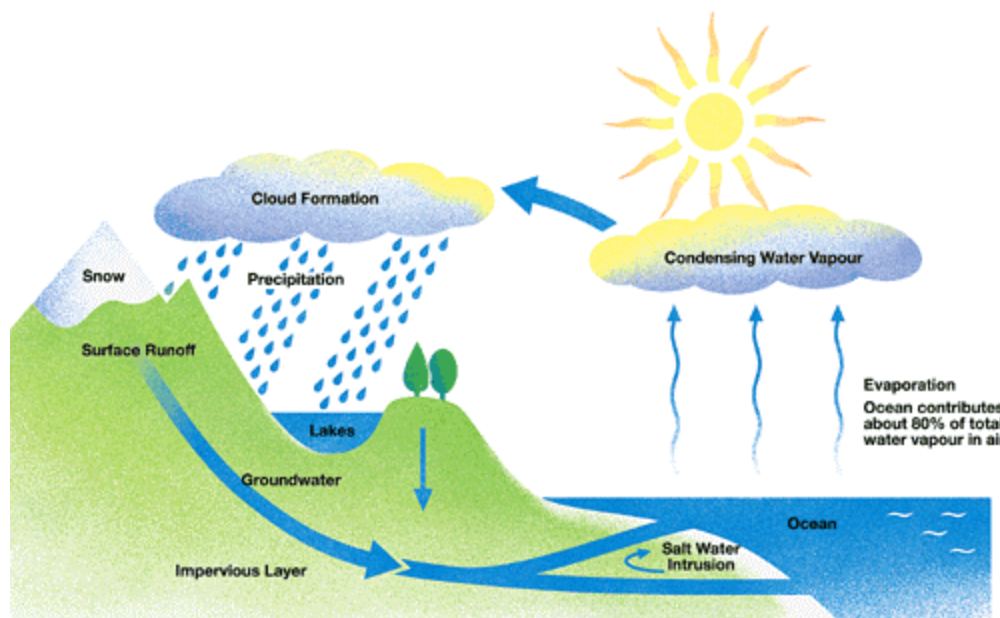
Ozone in the Troposphere

- ozone in the Troposphere has a toxic and corrosive effect
- UV radiation from the Sun combines with the exhaust from cars to produce toxic chemicals and ozone gas at ground level, this is called photochemical smog
- Photochemical smog is harmful to human health, damaged buildings, and affects plants and animals
- The ozone gas created this way does *not* move up into the stratosphere and offers no sign of UV protection

The Hydrosphere

- the part of the climate system that includes all water on and around Earth
- includes liquid water, water vapour, and ice

Water Cycle



- energy is absorbed when water evaporates from the oceans and lakes, this process has the effect of cooling its surroundings
- energy is given off when water vapour condenses into clouds in the atmosphere, this process warms the surroundings

Large Bodies of Water and Climate Zones

- large bodies of water have an effect on the climate of nearby regions
- water absorbs and stores more thermal energy than land, it also eats up and cools down more slowly than land
- regions near an ocean or large lake tend to be cooler in the summer than inland locations (the water takes a long time to warm up as it absorbs thermal energy), they also tend to be warmer in the fall (as the water slowly emits stored thermal energy)
- regions that are downward from a large body of water have more snowfall in the winter

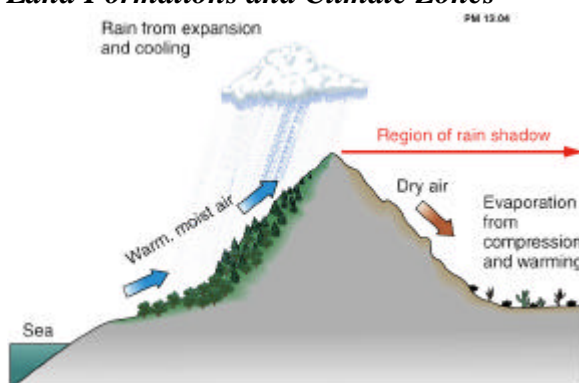
Ice and the Climate System

- about 2% of all Earth's water is frozen
- most of this ice located at the two poles
- sea ice or pack ice, only a few meters thick, formed from frozen sea water, floats in the ocean near the North and South Poles
- ice sheets are enormous areas of permanent ice several kilometres thick, stretching over land of the Antarctic and Greenland
- surfaces covered in ice and snow reflect more radiant energy than surfaces covered in soil, rock, or vegetation
- most of the Earth's polar regions are covered in ice, these regions reflect back a great deal of the Sun's energy, which is why the polar regions are so cold

The Lithosphere

- part of the climate system made up of the solid rock, soil, and minerals of Earth's crust
- together with the hydrosphere, the exposed lithosphere absorbs higher-energy radiation from the Sun, converts it into thermal energy, and then emits the energy back as lower-energy infrared radiation

Land Formations and Climate Zones



- mountains and other land formations affect how air moves over an area
- as clouds are blown upward over mountains, they lose their moisture as rainfall on the windward side; the leeward side of the mountain receives little rain, this process is called the rain shadow effect

Altitude and Climate Zones

- high altitudes: atmospheric pressure is lower because there is less air above pushing down – as the air from lower altitudes rises to high altitudes, it expands and cools down
- therefore, at high altitudes the air is cooler than at low altitudes

Living Things

- plants and animals change the relative amounts of gases in the atmosphere
- through photosynthesis, plants take in carbon dioxide and release oxygen
- through cellular respiration, plants, animals, and other organisms take in oxygen and release carbon dioxide
- some organisms produce methane
- some gases in the atmosphere, such as carbon dioxide and methane, absorb infrared radiation emitted by Earth

Assignment

- 1) a) List the four main components of the climate system on Earth.

- 1) b) Describe one way in which each component is important to the climate system.

- 2) What is the effect of the ozone in the Stratosphere? in the Troposphere?

- 3) How does permanent ice on Earth's surface affect Earth's climate?

- 4) What role do large bodies of water play on Earth's climate system and the flow of thermal energy?

- 5) How does each of the following affect a region's climate?
 - a) Altitude

 - b) Nearness to a mountain range

 - c) Near the ocean