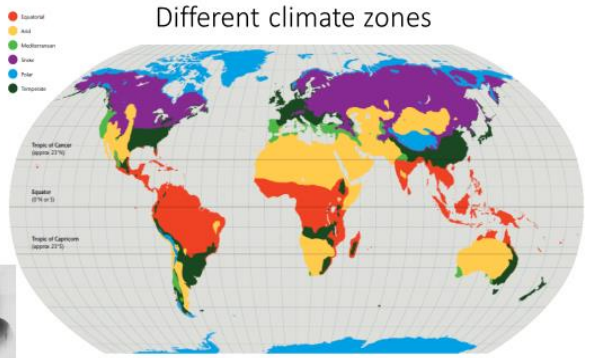
Weather, climate, weather hazards and climate change

Weather & climate	The weather is a description of the day-to-day conditions of the atmosphere. Climate is the average weather over a long period of time (usually 30 years).
Weather hazards	Weather hazards are extreme weather events such as hurricanes, flooding or drought.
Climate change	Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time i.e. decades to millions of years.

Key aspects of weather

- **TEMPERATURE-** it is measured by a thermometer. Several scales and units exist for measuring temperature, the most common being Celsius (denoted °C; formerly called centigrade), Fahrenheit (denoted °F).
- **PRESSURE-** atmospheric pressure, sometimes also called barometric pressure, is the pressure exerted by the weight of air in the atmosphere of Earth.
- **WIND**-caused by differences in the atmospheric pressure. When a difference in atmospheric pressure exists, air moves from the higher to the lower pressure area, resulting in winds of various speeds. On a rotating planet, air will also be deflected by the Coriolis effect, except exactly on the equator.
- **PRECIPITATION**-is any product of the condensation of atmospheric water vapour that falls under gravity. The main forms of precipitation include drizzle, rain, sleet, snow and hail.
- **CLOUD-** form when the invisible water vapour in the air condenses into visible water droplets or ice crystals. There is water around us all the time in the form of tiny gas particles, also known as water vapour.
- **HUMIDITY-** is the amount of water vapour present in the air. Water vapour is the gaseous state of water and is invisible. Humidity indicates the likelihood of precipitation, dew, or fog.

Climate zones

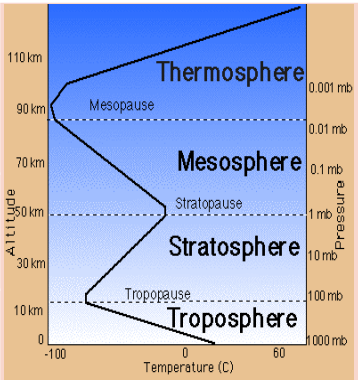


The **Köppen** Climate Classification **System** is the most widely used for classifying the world's climates. Most classification **systems** used today are based on the one introduced in 1900 by the Russian-German climatologist Wladimir **Köppen**.

Unit 1: weather, hazards & climate change

Structure of atmopshere

Thermosphere	The thermosphere extends upwards to altitudes of several hundred kilometres, where temperatures range from 250ºc to as high as 1,700ºc, getting warmer with increasing height
Mesosphere	Temperatures in the mesosphere decrease rapidly as there is no water vapour, cloud, dust or ozone to absorb incoming radiation.
Stratosphere	Temperatures in the stratosphere rise with increasing altitude (creating a temperature inversion) this is caused by concentrations on O_3 which absorbs ultraviolet radiation.
Troposphere	The troposphere contains about **80%** of the atmosphere and is the part of the atmosphere in which we live, and make weather observations.



Main Elements = 99%	
Nitrogen (N_2)	**78%**
Oxygen (0_2)	**21%**
Trace Elements = 1%	e.g. Xenon (Xe)

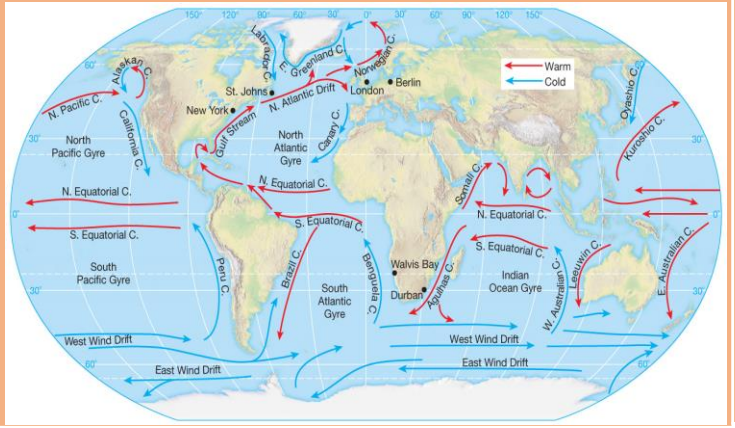
Climate change

Throughout the Quaternary period there have been major natural changes in the Earth's climate.
Climate cycles have moved through colder glacial periods and warmer interglacial periods. The ice ages have occurred at roughly 100,000-year intervals, and evidence from past glacial periods shows that temperatures were about five degrees colder than in interglacial periods.
The Quaternary period is a subdivision of geological time which covers the last 2.6 million years up to the present day.
The Quaternary and the Tertiary Periods together form the Cenozoic Era. The Quaternary is subdivided into two epochs; the Pleistocene (up to about 11,700 years ago) and the Holocene (about 11,700 years ago to the present day).

- Glacial periods are a time in the earth's history when polar and mountain ice sheets were unusually extensive across the earth's surface.
- Interglacial periods are a geological interval of warmer global average temperature lasting thousands of years.

Ocean currents

An ocean current is a horizontal movement of seawater at the ocean's surface.
Ocean currents are driven by the circulation of wind above surface waters.
Frictional stress at the interface between the ocean and the wind causes the water to move in the direction of the wind.
The **Gulf Stream** is a powerful current in the Atlantic Ocean driven by water density and wind patterns
It starts in the Gulf of Mexico and flows into the Atlantic at the tip of Florida, accelerating along the eastern coastlines of the United States and Newfoundland.
How does the Gulf Stream affect UK weather?
The Gulf Stream brings warmth to the UK and north-west Europe and is the reason the UK has fairly mild winters.



Natural causes of climate change

- **Milankovitch-** . 1. Change in orbital shape (eccentricity):95,000 yr. cycle. 2. Change in Earth's axial tilt: 42,000 yr. cycle. 3. Changes in the Earth's precession (wobble): 21,000 yr. cycle.
- **Volcanic activity-** can cause the atmosphere to become dustier and less transparent in incoming solar radiation, thus reducing temperatures. Un-predictable cycle
- **Sun-spot activity-** darker spots= more radiation. 11 yr. cycle.

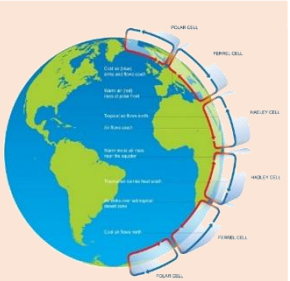
Evidence for climate change

Historical records- Observations of weather and climate conditions can be found in ship and farmers' logs, travellers' diaries, newspaper accounts and pieces of art or detailed weather reports by organisations such as the MET Office going back as far as 1861.
Ice cores- Layer upon layer of compacted snow and ice contain information about temperature and gases.
Tree rings (dendrochronology)- Tree growth rings are added each year the tree is growing. These rings are recording the growing season and the thicker the ring, the better the growing season. These rings can give information on temperature and moisture.
Glacial retreat- Photographic evidence of glacier retreat can be used to estimate ice loss.
Pollen grains- Pollen grains are washed or blown into bodies of water, their tough outer walls allow them to be preserved in sediment layers in the bottoms of ponds, lakes, or oceans. Because of their unique shapes, scientists can then take a core sample of the sediment layers and determine what kinds of plants were growing at the time the sediment was deposited.

Global pattern of air circulation

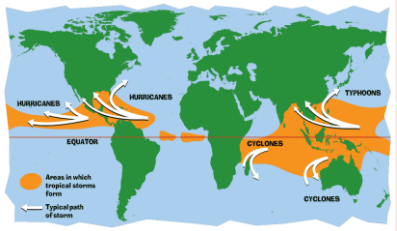
Atmospheric circulation is the large-scale movement of air by which heat (energy) is distributed on the surface of the Earth.

Hadley cell	Largest cell which extends from the **Equator** to between **30° to 40° north & south**.
Ferrel cell	Middle cell where air flows **poleward** between **60° & 70°** latitude.
Polar cell	**Smallest & weakness** cell that occurs from the poles to the Ferrel cell.



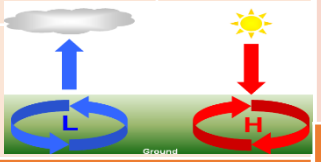
Distribution of Tropical Storms

They are known by many names, including hurricanes (North America), cyclones (India) and typhoons (Japan and East Asia). They all occur in a band that lies roughly 5-15° either side of the Equator.



High and Low Pressure

Low Pressure	High Pressure
Caused by hot air rising. Causes stormy, cloudy weather.	**Caused by cold air sinking. Causes clear and calm weather.**



Formation of Tropical Storms

1	The sun's rays heats large areas of ocean in the summer and autumn. This causes **warm, moist air** to rise over the particular spots
2	Once the **temperature is 27°**, the rising warm moist air leads to a **low pressure**. This eventually turns into a thunderstorm. This causes air to be sucked in from the **trade winds**.
3	With trade winds blowing in the opposite direction and the rotation of earth involved (Coriolis effect), the thunderstorm will eventually start to **spin**.
4	When the storm begins to **spin faster than 74mph**, a tropical storm (such as a hurricane) is officially born.
5	With the tropical storm growing in power, **more cool air sinks** in the centre of the storm, creating calm, clear condition called the **eye of the storm**.
6	When the tropical storm hits land, it **loses its energy source** (the warm ocean) and it begins to lose strength. Eventually it will 'blow itself out'.

Changing pattern of Tropical Storms

Scientist believe that global warming is having an impact on the frequency and strength of tropical storms. This may be due to an increase in ocean temperatures.

Management of Tropical Storms

HURRICANE EVACUATION ROUTE

Protection Preparing for a tropical storm may involve construction projects that will improve protection.	**Aid** Aid involves assisting after the storm, commonly in LIDs.
Development The scale of the impacts depends on the whether the country has the resources cope with the storm.	**Planning** Involves getting people and the emergency services ready to deal with the impacts.
Prediction Constant monitoring can help to give advanced warning of a tropical storm	**Education** Teaching people about what to do in a tropical storm.

Primary Effects of Tropical Storms

- The intense winds of tropical storms can destroy whole **communities, buildings** and **communication networks**.
- As well as their own destructive energy, the winds can generate abnormally high waves called **storm surges**.
- Sometimes the most destructive elements of a storm are these subsequent **high seas and flooding** they cause to coastal areas.

Secondary Effects of Tropical Storms

- People are **left homeless**, which can cause distress, poverty and ill health due to lack of shelter.
- **Shortage of clean water** and **lack of proper sanitation** makes it easier for diseases to spread.
- **Businesses are damaged** or destroyed causing employment.
- Shortage of food as **crops are damaged**.

Enhanced Greenhouse Effect

Recently there has been an increase in **humans burning fossil fuels** for energy. These fuels (gas, coal and oil) emit **greenhouse gases**. This is making the Earth's atmosphere thicker, therefore trapping more solar radiation and causing **less to be reflected**. As a result, the Earth is becoming warmer.

Managing Climate Change

Carbon Capture This involves new technology designed to reduce climate change.	**Planting Trees** Planting trees increase the amount of carbon is absorbed from atmosphere.
International Agreements Countries aim to cut emissions by signing international deals and by setting targets.	**Renewable Energy** Replacing fossil fuels based energy with clean/natural sources of energy.

Located example: USA- Hurricane Sandy 2012

- 24th-30th October 2012 (Reached New Jersey, USA on 29th October). Started in Caribbean Sea.
- Hit Jamaica, Cuba, the Bahamas then USA. Affected 24 US states. Caused severe damage in New Jersey and New York.

Impacts (effects)

- 117 killed.
- 9 million homes had power cuts. 650,000 homes damaged or destroyed.
- 250,500 cars destroyed by flood water. Streets of New York flooded, as was the subway.
- Power lines damaged.
- Insurance claims in New Jersey were US$3.3 billion.
- US$1.1 billion spent repairing damage to sewage and water pipes in New Jersey and New York.
- New York stock exchange forced to close due to loss of electricity.
- Total damage in New York: US$19 billion.
- New York marathon cancelled (4th November) affecting tourist income.
- Storm surge meant sea water got into fresh water habitats.
- Wildlife affected from Delaware Bay to Long Island.
- Prime Hook National Wildlife Refuge in Delaware damaged.
- 1.5 billions litres of sewage released into Raritan River, New Jersey.
- 90% beaches in New York and New Jersey destroyed-on average beaches were 9-12m narrower after hurricane.
- 1.5 million litres of oil spilt into Arthur Kill(stretch of water between New Jersey and New York) damaging habitats and killing fish and birds.

Management

- People moved in with relatives or into shelters.
- Builders rebuilt homes rather than people having to do it themselves.
- Americans used house insurance to help pay for this.
- Government and other organisations gave money and aid to those affected to help them to rebuild.
- US government gave US$60.3 billion in aid to victims.
- Government promised improved weather forecasting, especially of storms.
- FEMA teams and resources put into place before hurricane even hit.
- FEMA and US army worked to quickly reopen beaches in New Jersey.
- Department of Agriculture promised US$6.2 million for emergency food assistance and economic plans to help repair farmland.
- Erosion of beaches meant breeding ground for horseshoe crabs destroyed. Canadian Rivers Institute worked with NGOs to restore beaches to provide nesting area for crabs.
- Red Cross had 17,000 trained volunteers provide 300 response vehicles, 74,000 overnight stays and 17 million meals and snacks for victims.
- AmeriCares (an American charity) sent teams of relief workers with aid, funding and mobile medical clinics. In 2 years after Sandy, AmeriCare provided US$7.1million in aid benefiting 450,000 people.

Located example: Cuba- Hurricane Sandy 2012

- 24th-30th October 2012 Started in Caribbean Sea.
- Hit Jamaica, Cuba, the Bahamas then USA.
- Cuban government warned eastern states of the country on 23rd October. about approaching hurricane.
- Category 3 when it hit Cuba on 24th October.

Impacts (effects)

- No electricity or clean water.
- 11 killed.
- 17,000 homes destroyed.
- 226,000 homes damaged.
- 55,000 people evacuated because of storm surge.
- Total losses in Santiago de Cuba came to £50 million.
- Roads to the airport blocked so no tourists could arrive or leave island which led to loss of money.
- Total losses of US$2billion.
- 5% drop in GDP of Cuba.
- 2,600 hectares of banana crops destroyed.
- Trees uprooted and stripped of leaves.
- Coffee plantations in mountainous areas washed away.
- Areas close to coast flooded, beaches swept away and wildlife habitats destroyed

Make sure you can classify impacts further i.e. **environmental, social, economic & political.**

Make sure you can classify management further i.e. **individual, organisational and governmental responses.**

Unit 1: weather, hazards & climate change

Management (responses)

- Many people moved in with families and friends.
- Others took shelter in state worker holiday homes where basic food was provided.
- People used materials provided by the government to rebuild their homes.
- People of Cuba have no home insurance.
- Sent teams of electricians from across Cuba to Santiago within hours of hurricane hitting.
- Announced 50% price cut for construction materials and offered interest free loans to repair the damage.
- Made building materials available to residents such as corrugated iron sheets and cement.
- Military teams mobilised quickly to clear the streets of rubble and felled trees.
- United Nations provided US$5.5million to Cuba
- Venezuela sent 650 tonnes of aid including food and water.
- Cuban Red Cross was helped by Norwegian, Spanish and German Red Cross to deliver support. Aid went to 25,000 families and included roofing materials, mattresses and kitchen kits.
- World Food Programme gave US$1million to help the 788,000 people in worst affected areas.

Characteristics of arid environments

- An average rainfall of between 100-300mm
- Cattle farming, usually by nomadic herdsmen
- Natural vegetation is sparse- grasses, small shrubs and trees
- A short growing season of about 75 days
- Cold night temperatures
- Hot day temperatures (often above 30.c)
- Occasional intense downpours of rain
- Very little seasonal change

Definition of a drought

A drought is when there is a lack of precipitation over an extended period of time, usually a season or more, resulting in a water shortage for some activity, group, or environmental sector.

Drought- located example: Africa, Ethiopia 1980s+

Ethiopia is a developing country in Eastern Africa. Since the 1980s it has suffered many droughts. This has led to famine and huge loss of life. The worst periods have been 1984, 1994, 2004 and 2014-2016.

Impacts (effects)

- Death- approx. 1 million people have died since the 1980s.
- 85% of the population live in the countryside and depend on farming.
- Food prices rose due to crops failing meaning the poorest people suffered greatest leading to hunger and malnutrition.
- Disease was easily spread as people were more vulnerable due to being weak from lack of food.
- Death of livestock (animals)impacted farmers economically.
- Only 57% of Ethiopians had access to a secure water resource.
- Migration of people due to drought & impact on education- children searching for water instead of going to school.

Management (responses)

- 'Live Aid'- raised money and brought attention to the crisis- led by Bob Geldof.
- Overseas governments have given aid e.g. USA gave US$128.4 million in 2015.
- Non Governmental Organisations (NGO's) such as UNICEF and Oxfam provides support for communities by proving food, water and medical care. In the long term the organisations help develop new farming techniques that use less water.

Impacts on ecosystems

- Loss of habitat for fish and wildlife e.g. Borkena Wetland.
- Loss of 200,000 hectares of forest due to forest fires.
- Extinction of some species e.g. Grevy Zebras.
- Migration of wildlife.

Drought- located example: USA, California 2012+

California is one of the wealthiest states in the USA, famous for Los Angeles, San Francisco and San Diego. It is located on the west coast of the continent, bordering the Pacific Ocean. In June 2014 a state of emergency was declared meaning new laws and regulations where put in place to help deal with the impact of the drought

Impacts (effects)

- Subsidence (sinking) of land due to extraction of water from aquifers led to infrastructure and building damage in the SAN Joaquin Valley.
- Seawater intrusion in Santa Barbara meaning fresh water supplies became contaminated and unusable.
- Wetlands and rivers received less water due to increased demand. Impacts on birds and fish.
- Increased risk of wildfires as drought was accompanied by windy weather- risk to property and life & further contamination of water supplies due to ash.
- Impact on farming of fruit and vegetables. Total losses of US$1.8bn and 10,000 jobs.
- Increase in food prices of some products due to scarcity.
- Power supplies- output of hydroelectric power stations fell due to fall in river levels which impacted on the energy industry.

Management (responses)

- Since the state of emergency was declared various state and national government departments- Department of Water Resources, US Bureau of Reclamation and the State Water Resources Control Board have introduced new measures.
- Limiting flows during the winter to try to build up reserves to help when demand is higher.
- Issuing water warnings to some areas to make them aware that limits will be placed on water usage in an attempt to encourage people to use water sparingly.
- Reducing water supplies to the minimum allowed for public health and safety.
- Educating home and business owners on how to use as little water as possible.
- Increased monitoring of some rivers to check on number of endangered species and the impact of drought on them.

Causes of a drought

Natural causes

- Meteorological- areas receives less precipitation.
- Hydrological- lack of available water e.g. in a river basin.

Human causes

- Dams- restrict flow of water- impact downstream.
- Deforestation- climate change and weather systems.
- Agriculture- over abstraction of water for crops.