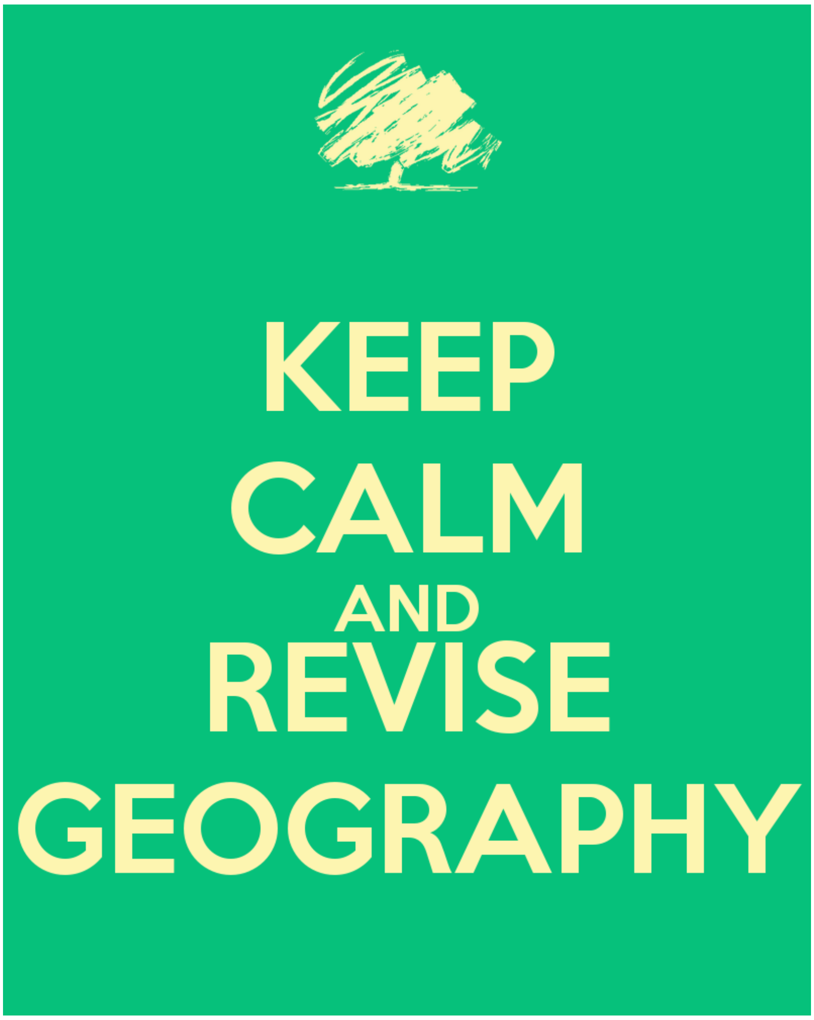
Year 9 Geography

Revision Booklet



Everything you need to succeed in your geography exam.

It is recommended that you produce your own revision resources such as definition lists, flash cards and mind maps to help you learn and remember information for exams.

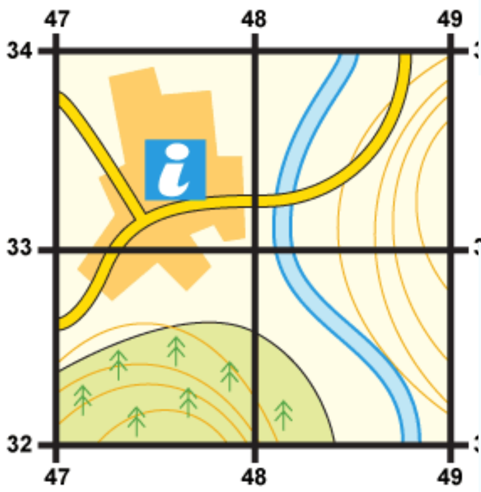
Get revising and remember to ask your teacher if you need any help.

Geographical Skills

4 and 6 figure grid references

A grid of squares helps the map-reader to locate a place. The horizontal lines crossing the map from one side to the other are called *northings*. They are numbered – the numbers increase to the north. The vertical lines crossing the map from top to bottom are called *eastings* as the numbers increase in an easterly direction.

Things to remember: On an OS map **each grid square** is 1 km x 1 km or **1 sq km**.



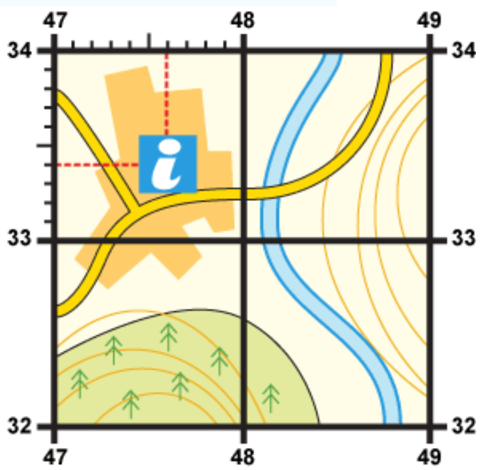
- When you give a grid reference, always give the easting first... "**Along the corridor and up the stairs**".

Four-figure grid references can be used to pinpoint a location to within a square measuring 1 sq km. To find the number of the square:

- Start at the left-hand side of the map and go east until you get to the easting crossing through the bottom-left-hand corner of the square you want. Write this number down.
- Move north until you get to the northing crossing the bottom-left-hand corner of the square you want. Look at the number of this grid line and add it to the two-digit number you already have. This is your four-figure grid reference.

In this case, the tourist information office is in grid square **4733**.

Sometimes it is necessary to be even more accurate. In this case you can imagine that each grid is divided into 100 tiny squares. The distance between one grid line and the next is divided into tenths.



- First, find the four-figure grid reference but leave a space after the first two digits. When you get to the easting at the left-hand side of the grid square you want, keep moving east and estimate or measure how many tenths across your symbol lies. Write this number after the first two digits.
- Next, move north from the bottom-left-hand corner of your grid square and estimate how many tenths your symbol is from this point. Put them together to create a six figure grid reference.

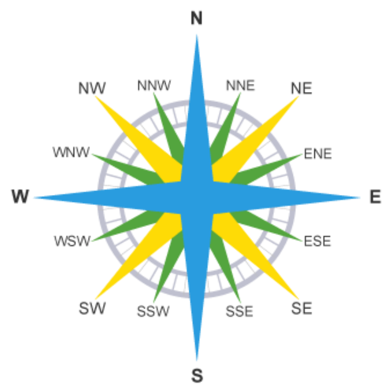
In this instance, the tourist information office is located at **476334.**

Direction, scale, distance and height

Direction

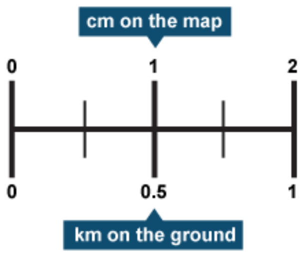
Try to remember the main compass points by using a mnemonic, eg

Naughty **E**lephants **S**quirt **W**ater –
North **E**ast **S**outh **W**est



The four main points of the compass are north, east, south and west. Half way between each of these there are four other points: north-east, south-east, south-west and north-west. This makes an eight-point compass. There are a further eight points between these... remember the names of these are a mix of the two closest compass points but they always start with the main compass point, i.e. north, east, south or west.

Ordnance Survey maps are always printed so that north is at the top of the map.



Scale and distance

Most maps have a scale. These help us to work out distances on maps. This is given by the scale statement (eg 1:25,000) and/or by showing a scale bar.

The scale shows how much bigger the real world is than the map. If the scale is 1:50,000 it means that the map is 50,000 times smaller than the real world. For example, every 1 cm on the map represents 50,000 cm in the real world.

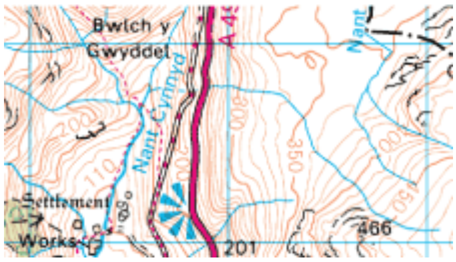
Height on maps

Maps show height in a number of different ways:

Spot heights and triangulation pillars

This map extract shows exact heights by a black dot with a number next to it. The number is the height above sea level in metres. The blue triangle represents a *triangulation pillar*.

Contours



These are lines drawn on maps that join places of the same height. They are usually an orange or brown colour. Some contour lines have their height above or below sea level written on them. It is possible to use them to see the shape of the land – if contour lines are close together the slope is steep, if they are far apart the slope is gentle.

Contour lines are usually drawn at 10 metre intervals on a 1:50,000 scale map and at 5 metre intervals on a 1:25,000 scale map.

Layer shading

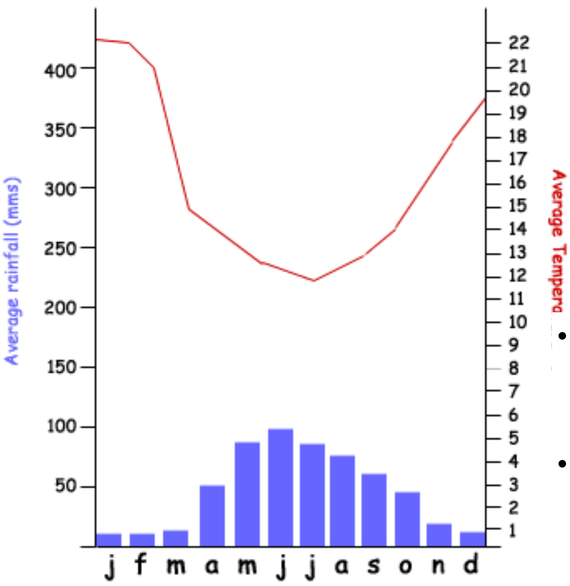
Maps are sometimes shaded to show the height of land.

Weather and Climate Change

The difference between weather and climate

Weather is the day to day variations in the atmosphere around us for example today it may be sunny and warm. Whereas climate is the long term or average weather condition for a place for example Britain has cool, wet winters.

Climate graphs



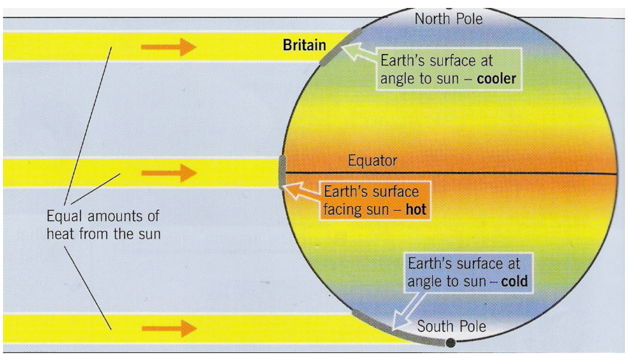
These show the average temperature and rainfall for each month of the year in a given place. The line graph is always red and shows average temperature in ^{0}C. The bar chart is always blue and shows rainfall in mm.

Interpreting and describing climate graphs

- Look at the overall **shape** of the graph. Is the temperature line steep or gentle? Does it change throughout the year and/or look almost flat?
- Look for **extremes** - quote the highest and lowest temperature and rainfall and the month in which it occurs. Remember to quote units, eg Celsius or millimetres.
- Can you identify the **seasons** when most rain or least rain falls? Or when the highest and lowest temperatures are experienced?
- Work out the **temperature range** by subtracting the lowest figure from the highest figure.
- Add the **rainfall totals** for each month together to work out the total annual rainfall.

Factors that affect climate

Latitude or distance from the equator



Temperatures drop the further an area is from the equator due to the curvature of the earth. In areas closer to the poles, sunlight has a larger area of atmosphere to pass through and the sun is at a lower angle in the sky. As a result, more energy is lost and temperatures are cooler.

In addition, the presence of ice and snow nearer the poles causes a higher *albedo*, meaning that more solar energy is reflected, also contributing to the cold.

Altitude or height above sea level

Locations at a higher altitude have colder temperatures. Temperature usually decreases by 1°C for every 100 metres in altitude. This is due to the atmosphere becoming thinner with height above sea level. This means that the air becomes less dense and cannot retain as much heat.

Distance from the sea

Oceans heat up and cool down much more slowly than land. This means that coastal locations tend to be cooler in summer and warmer in winter than places inland at the same latitude and altitude. Glasgow, for example, is at a similar latitude to Moscow, but is much milder in winter because it is nearer to the coast than Moscow.

Prevailing wind

The prevailing wind is the most frequent wind direction a location experiences. In Britain the prevailing wind is from the south west, which brings warm, moist air from the Atlantic Ocean. This contributes to the frequent rainfall. When prevailing winds blow over land areas, it can contribute to creating desert climates.

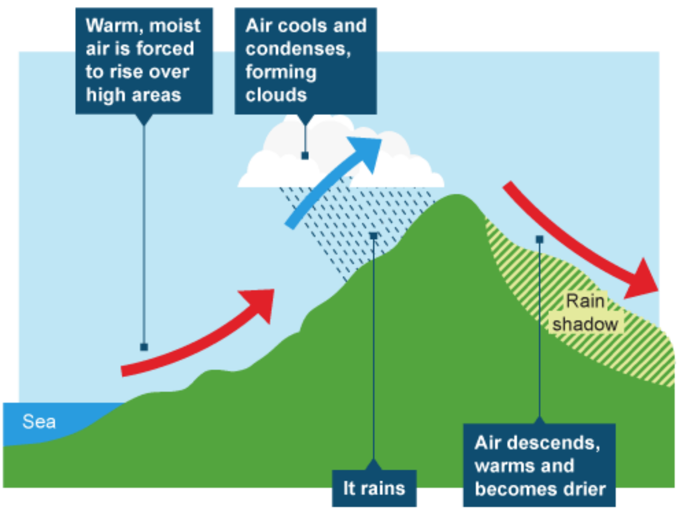
Types of rainfall

All rainfall occurs because of the 3 Cs:

- Convection
- Condensation
- Clouds form

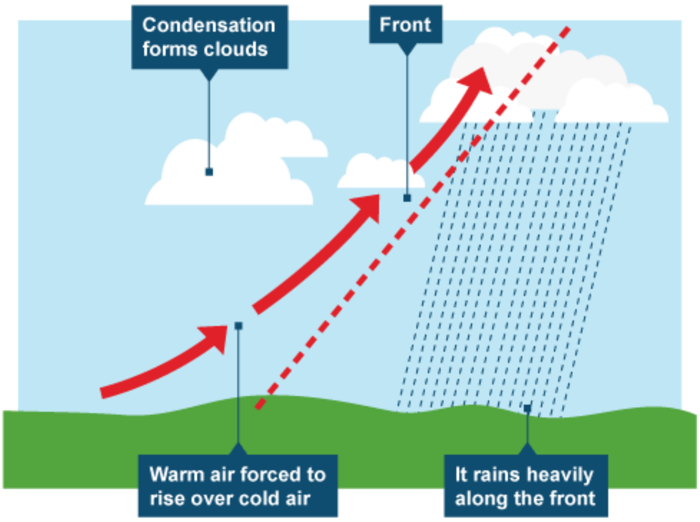
There are three different ways that this occurs to form rain:

Relief Rainfall



1. Prevailing winds bring warm, moist air to the western British Isles.
2. Air is forced to rise over high areas.
3. Air cools and condenses.
4. Clouds form and it rains.
5. Air descends on the other side of the mountains.
6. It warms up and therefore becomes drier.

Frontal Rainfall



The British Isles are affected by a number of different air masses. When warm and cold air meet, a depression forms:

When a cold polar air mass meets a warm tropical air mass they do not mix – they form fronts.

The colder air mass is heavier than the warmer air mass, therefore the lighter, warmer air rises over the top of the heavier, colder air.

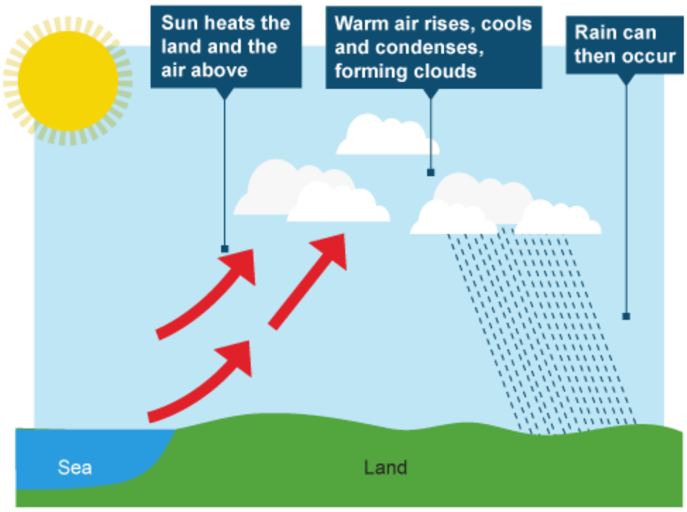
As the warm air is forced to rise it cools. Also, the warm air is in contact with the cold air along the fronts, and this also cools.

Condensation occurs and clouds form.

Rain occurs along the front.

In the UK, depressions often follow a similar pattern. First, a warm front passes over, bringing rain and then warmer air. Then a cold front follows, bringing more rain and cooler air.

Convectional Rainfall



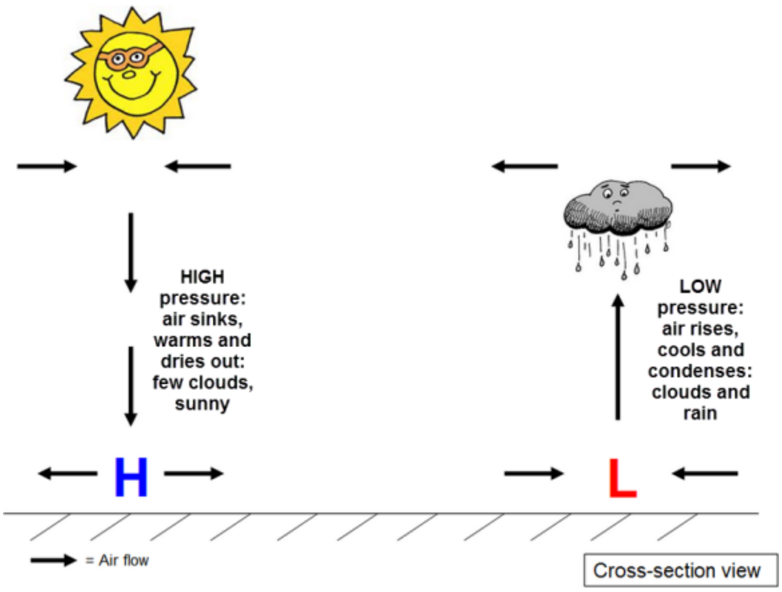
When the land warms up, it heats the air above it. This causes the air to expand and rise. As the air rises it cools and condenses. If this process continues then rain will fall. This type of rainfall is very common in tropical areas but also in areas such as South East England during warm sunny spells.

Global Atmospheric Circulation

Rules to remember:

Warm air is less dense and therefore rises = Low pressure

Cold air is more dense and therefore sinks = High pressure



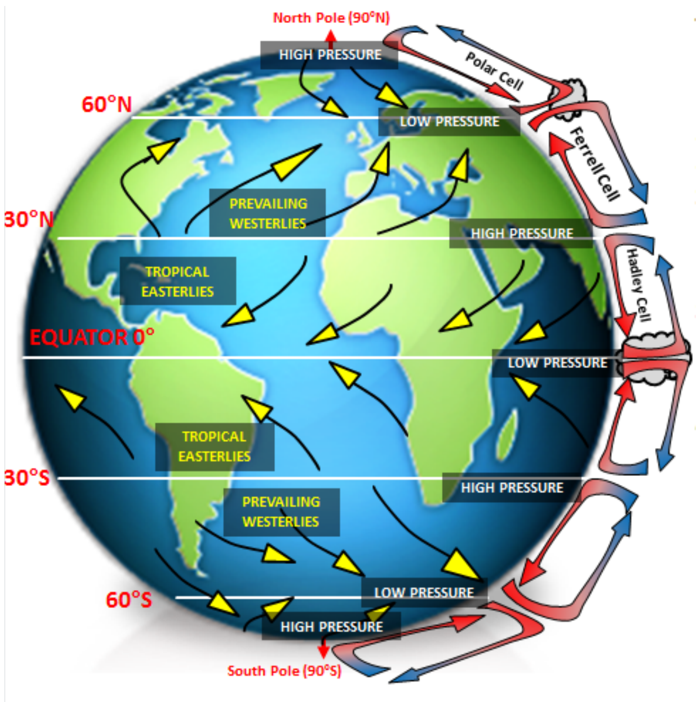


Diagram **B** shows global atmospheric circulation. This involves a number of circular air movements called cells. These cells all join together to form the overall circulation of the Earth's atmosphere.

- Air that is *sinking* towards the ground surface forms areas of *high pressure* (for example, at the North Pole). Winds on the ground move outwards from these areas.
- Air that is *rising* from the ground surface forms areas of *low pressure* on the ground, for example at the Equator. Winds on the ground move towards these areas of low pressure.
- Winds on the ground are distorted by the Earth's rotation. They curve as they move from areas of high pressure to areas of low pressure.
- Surface winds are very important in transferring heat and moisture from one place to another.
- The patterns of pressure belts and winds are affected by seasonal changes. The tilt and rotation of the Earth causes relative changes in the position of the overhead Sun. These seasonal changes cause pressure belts and winds to move north during our summer and then south during our winter.

How global atmospheric circulation affects weather

Cloudy and wet in the UK

The UK is located at about 55° North just below the 60° N line of latitude. This puts the UK close to the boundary of cold polar air moving down from the north and warm sub-tropical air moving up from the south.

The boundary between these two air masses is unstable. Here there is rising air and low-pressure belts (the *sub-polar low*) on the ground. Rising air cools, condenses and forms cloud and rain. This is why it is often cloudy and wet in the UK.

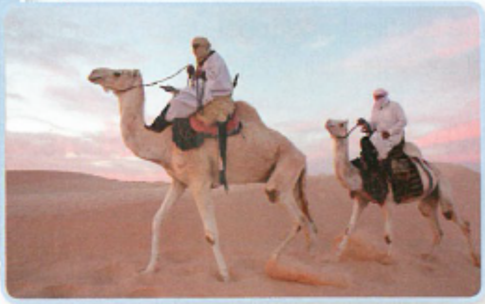
Surface winds in these mid-latitudes come from the south-west. These winds bring warm and wet conditions to the UK. But sometimes the cold polar air from the north moves down over the UK bringing snow and very cold winter weather.

C *Wet weather in the UK*

Hot and dry in the desert

Most of the world's hot deserts are found at about 30° north and south of the Equator. Here the air is sinking (diagram **B**), making a belt of high pressure (the sub-tropical high). Air isn't rising here, so there are few clouds forming and little rainfall. The lack of cloud makes it very hot during the day very cold at night, as heat is quickly lost from the ground.

D *Hot, dry weather in the desert*



Hot and sweaty at the Equator

At the Equator the air is rising (diagram **B**) and there is another low pressure belt (the *equatorial low*). This part of the world is very much hotter than the UK, with the sun directly overhead. Equatorial regions, such as central Africa and south-east Asia, experience hot, humid conditions. It is often cloudy with high rainfall. This is the region where tropical rainforests are found.

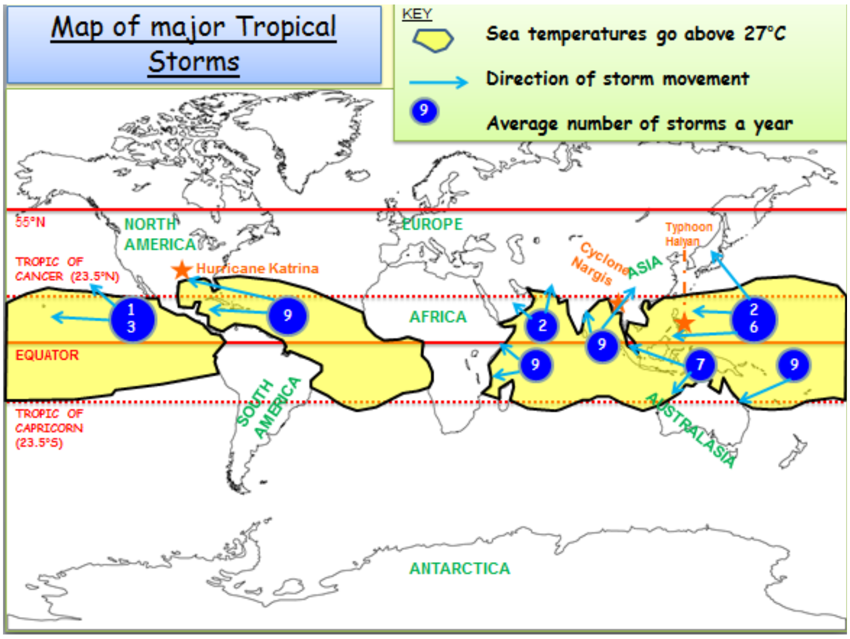
E *Hot, humid weather at the Equato*

Tropical storms – Distribution

Tropical storms have different names depending on the ocean they form over:

- Atlantic – Hurricanes
- Indian – Cyclones
- Pacific - Typhoons

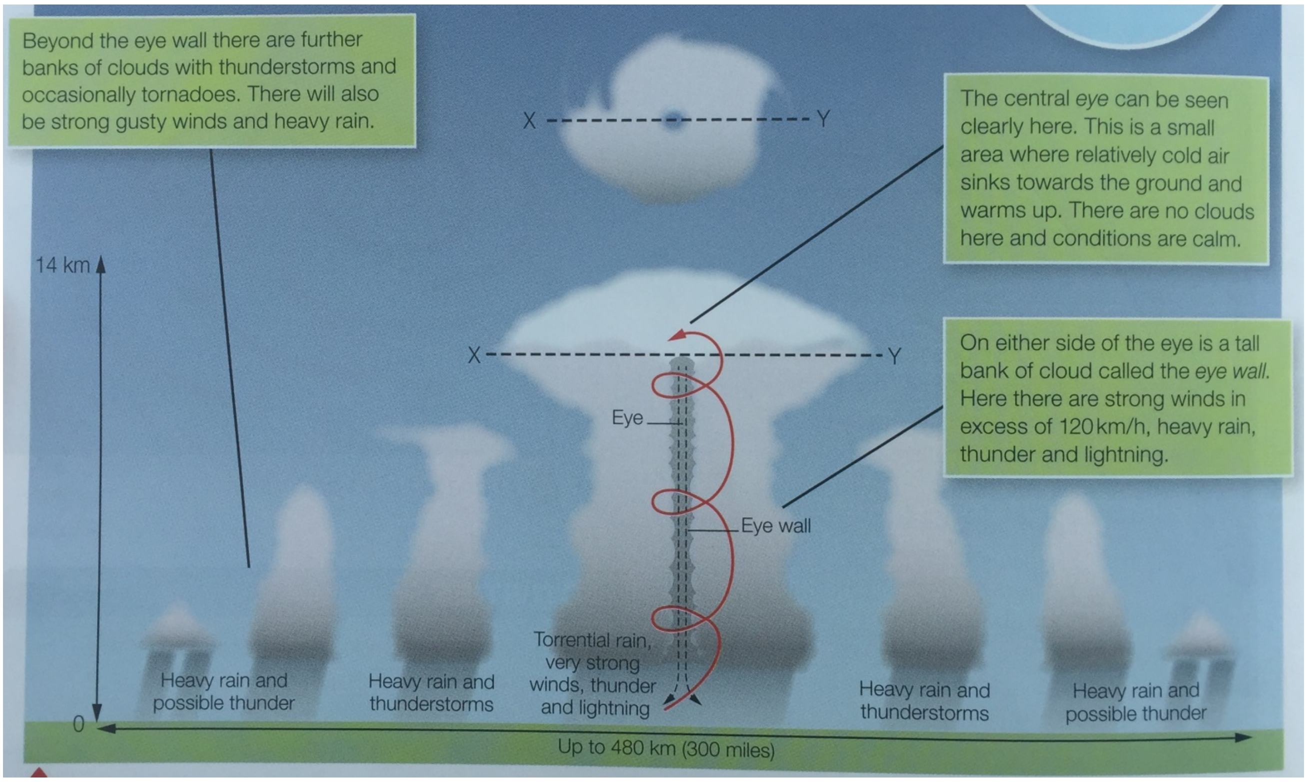
- Tropical storms form over warm oceans (above 27 °C), which explains why they are found in the Tropics.
- They form in the summer and autumn when sea temperatures are at their highest.
- Most tropical storms form 5–15° north and south of the Equator. This is because at the Equator there is not enough 'spin' from the rotation of the Earth. The effect of the Earth's rotation is called the *Coriolis effect*. A tropical storm is a spinning mass of clouds (photo **A**).
- In tropical regions the intense heat makes the air unstable causing it to rise rapidly. These unstable conditions are important in the formation of hurricanes.



How do they form?

- As air rises over warm oceans, a huge quantity of water is evaporated quickly.
- This evaporated air cools as it rises and condenses to form towering thunderstorm clouds.
- As the cloud condenses and releases heat, which serves to power the tropical storm and draw up more and more water from the ocean.
- Several smaller thunderstorms may join together to form one giant spinning storm (due to the rotation of the Earth).
- The storm ow develops an eye at its centre where air descends rapidly. The outer edge of the eye is the eyewall where the most intense weather conditions (strong winds and heavy rain) are felt.
- When the surface winds reach an average of 125kph (75mph) the storm officially becomes a tropical storm.
- On reaching the land the storm's energy supply (evaporated water) is cut off. Friction with the land slows it down and it begins to weaken.

Characteristic/cross section of a tropical storm

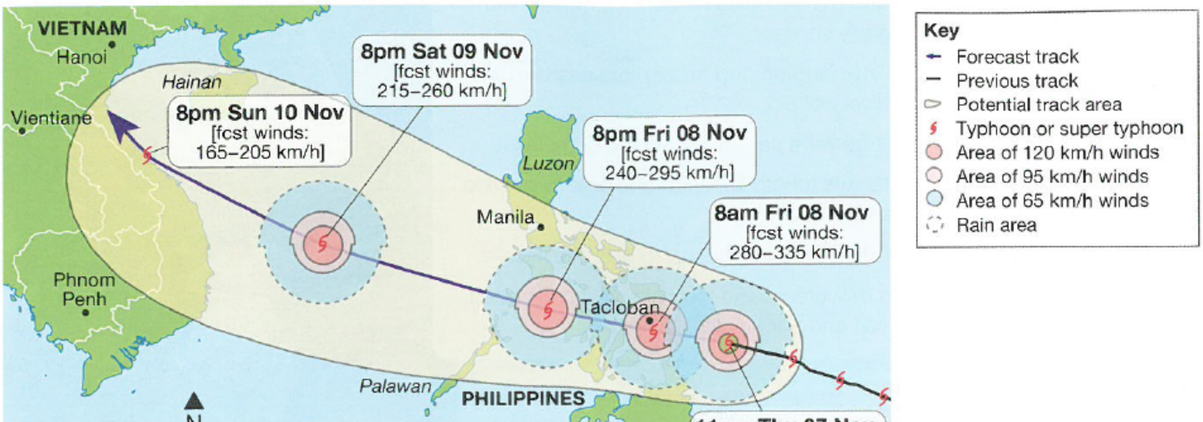


How climate change will affect tropic storms

	Impact of climate change in the future?
Tropical Storm **frequency** – how often tropical storms occur	As global temperatures rise so do average sea temperatures – this is increasing the frequency of tropical storms.
Tropical storm **intensity** – how strong tropical storms are	With higher average sea temperatures there is greater energy fuelling the storms as more evaporation will occur. Evidence shows that as a result tropical storms as becoming more intense and powerful. Higher winds and rains are causing more damage to vulnerable areas.
Tropical storm **distribution**- where tropical storms occur	Over the last few decades sea surface temperatures in the Tropics have increased by about 0.5^{0}C. This may mean that tropical storms affect areas outside the current hazard zone – areas in the North Atlantic may be affected.

Typhoon Haiyan case study

November 2013 'super' Typhoon Haiyan – a category 5 storm – hit the Philippines. Huge areas of coastline and several towns were devastated by winds up to 170mph and waves up to 15 metres.



A The predicted track of Typhoon Haiyan

Effects

Social, economic and environmental effects of Typhoon Haiyan in the Philippines

Economic	• The major rice, sugar and coconut producing areas for the Philippines was destroyed which reduced trade. • Between 50,000 tonne and 120,000 tonne of sugar may have been lost, the Sugar Regulatory Administration estimated. • The Philippine government estimated that about 71,000 hectares (175,000 acres) of farmland were affected; 3.7 billion pesos ($85 million) was lost from farm damage. • The cost of the disaster ran into billions of dollars.
Social	• 8,000 people were killed. • 1.9 million homeless and more than 6,000,000 displaced. • Over one million farmers in the Philippines have been impacted by Typhoon Haiyan according to the UN. • The spread of disease occurred due to the lack of food, water, shelter, and medication.
Environmental	• Recent studies suggest that the trail of uprooted trees and environmental devastation they leave behind bumps up global warming by releasing a pulse of carbon into the atmosphere. • Environmental devastation and The Food and Agriculture Organisation (FAO) says that hundreds of thousands of hectares of rice have been destroyed. • Fishing communities have also be severely affected with the storm destroying boats and gear.

You should also be able to categorise effects into primary and secondary – you could code the information.

Responses

Immediate responses

- International government and aid agencies responded quickly with food aid, water and temporary shelters.
- US aircraft carrier *George Washington* and helicopters assisted with search and rescue and delivery of aid.
- Over 1200 evacuation centres were set up to help the homeless.
- UK government sent shelter kits (photo **D**), each one able to provide emergency shelter for a family.
- French, Belgian and Israeli field hospitals set up to help the injured.
- The Philippines Red Cross delivered basic food aid, which included rice, canned food, sugar, salt and cooking oil.

C *A survivor in Tacloban*

Long-term responses

- The UN and countries including the UK, Australia, Japan and the US donated financial aid, supplies and medical support.
- Rebuilding of roads, bridges and airport facilities.
- 'Cash for work' programmes – people paid to help clear debris and rebuild the city.
- Foreign donors, including the US, Australia and the EU, supported new livelihood opportunities.
- Rice farming and fishing quickly re-established. Coconut production – where trees may take five years to bear fruit – will take longer.
- Aid agencies such as Oxfam supported the replacement of fishing boats – a vital source of income.
- Thousands of homes have been built away from areas at risk from flooding.
- More cyclone shelters built to accommodate people evacuated from coastal areas.

D *The contents of a Shelter Box*

Reducing the effects of tropical storms

Prediction (Monitoring)

Developments in technology have made it possible to predict and monitor tropical storms more accurately and effectively.

In the North Atlantic, there are two levels of warning issued by the National Hurricane Center in Miami:

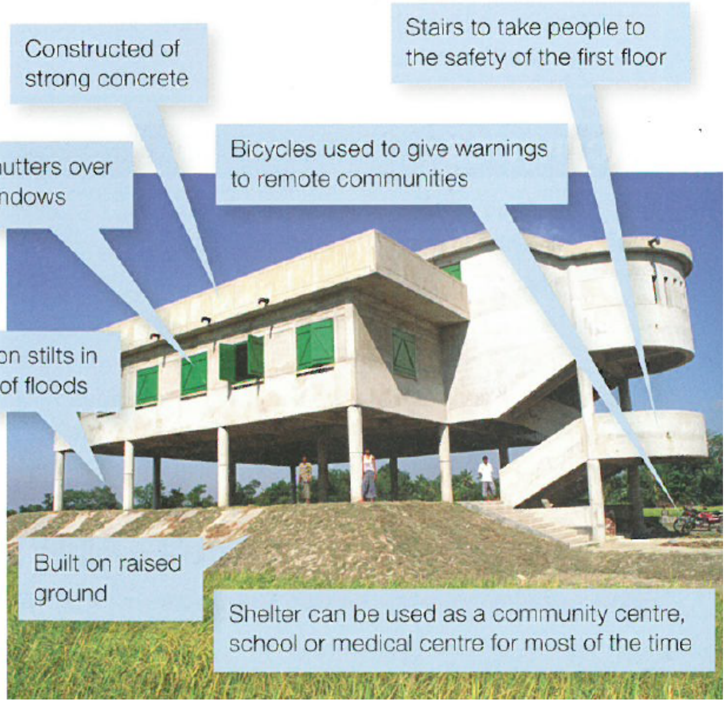
- Hurricane Watch – advises that hurricane conditions are possible.
- Hurricane Warning – advises that hurricane conditions are expected and that people should take immediate action (e.g. evacuate to high ground or take shelter).

Protection

Protection

There are a number of options available to protect people from the hazards associated with tropical storms.

- Windows, doors and roofs reinforced to strengthen buildings to withstand strong winds.
- Storm drains constructed in urban areas to take away excessive amounts of rainfall and prevent flooding.
- Sea walls built to protect key properties from storm surges.
- Houses close to the coast constructed on stilts so that a storm surge will pass beneath.
- In Bangladesh nearly 2000 cyclone shelters have been built (photo **B**).

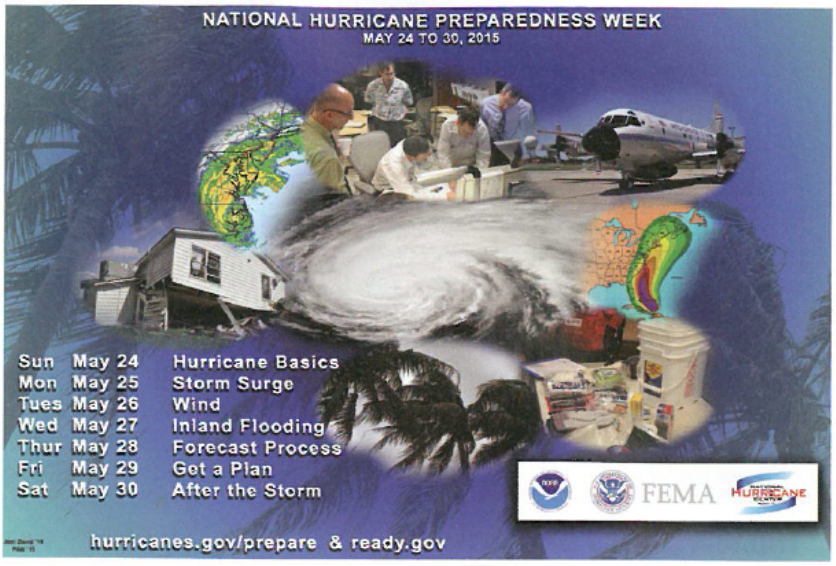


B *Cyclone shelter in Bangladesh*

Planning

Planning

It is unrealistic to stop the tens of millions of people living and working in coastal areas that are at risk from tropical storms. Many people rely upon fishing or tourism to make a living. Even in rich countries like the USA, vast urban developments have been allowed to take place on vulnerable barrier islands off the coast of Florida, for example Miami Beach. South Miami was hit by a powerful hurricane in 1992. However, building developments have still taken place on land at risk from flooding. It's only a matter of time before Miami gets hit again.



Planning to reduce the tropical storm hazard is mostly about raising individual and community awareness. People need to understand the potential dangers and be able to respond. In the USA there is a National Hurricane Preparedness Week (image **C**) which focuses on educating people about potential dangers ahead of the next hurricane season. Families are encouraged to devise their own plan of action should a warning be issued.

C *National Hurricane Preparedness Week (USA)*

D *Bikes carry cyclone warnings to rural communities in Bangladesh*

Extreme weather in the UK

Examples of extreme weather events in the UK:

- **Drought** - caused by a lack of rain.
- **Flash floods** - caused by too much rain in a short period of time.
- **Strong winds and storms**.
- **An extreme cold spell**.
- **An extreme heat wave**.

All of these have happened in the UK between 2000 and 2010:

A lack of rainfall leading to drought

- During 2004-06 the UK received below average rainfall. This meant that reservoirs and groundwater supplies were not recharged with the water needed.

Flash flooding

Emergency services on the scene of flooded village of Boscastle

- Boscastle in Cornwall suffered a flash flood in August 2004. Nearly three times the average rainfall for the whole of August fell in just one day. The rain ran down the steep valley sides causing flooding in the village. The floodwater picked up cars and trees in its path.

Strong winds and storms

- In January 2005 stormy weather brought havoc to roads in the North of England as lorries overturned. Power was also cut off in 80,000 homes. Winds of over 100 mph were recorded.

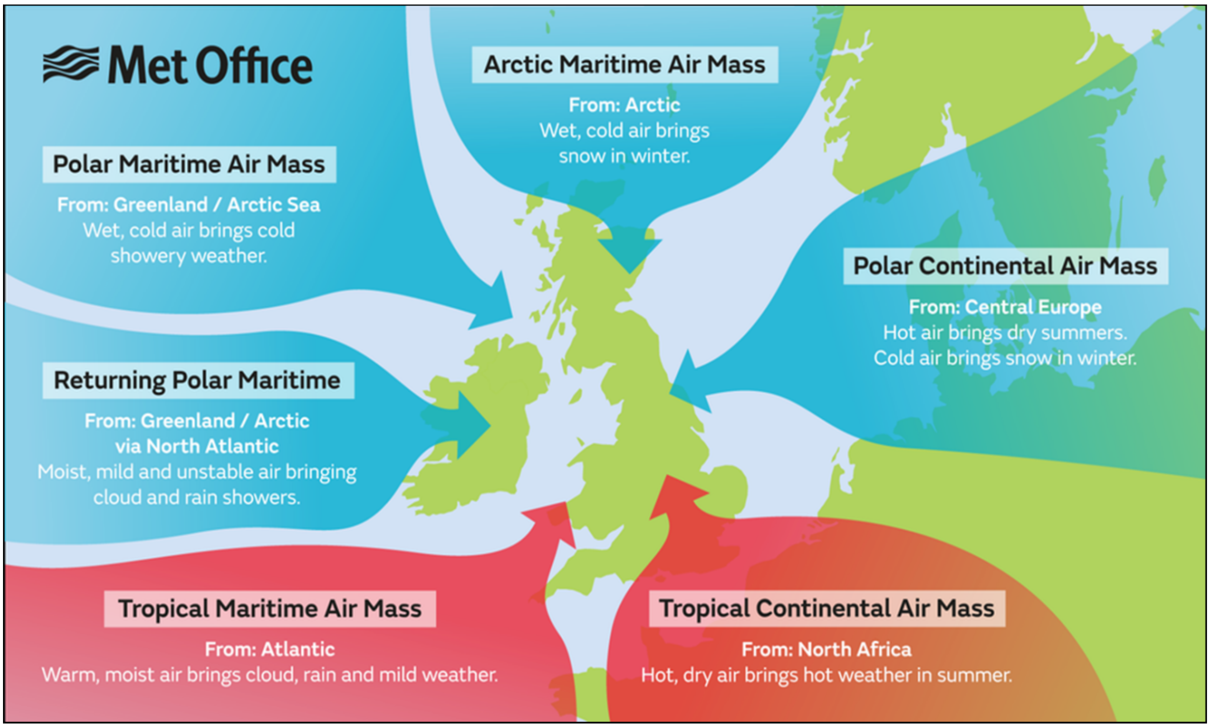
An extreme cold spell

- In December 2010 much of the UK was under snow. Arctic air caused the temperatures to drop significantly below the average. At night temperatures of -10°C were not uncommon.

An extreme heat wave

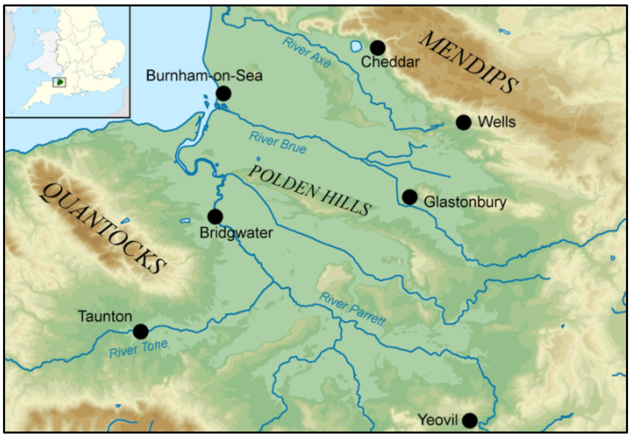
- In summer 2003 Europe suffered from an intense heat wave. In the UK the temperature of 38.5°C was the highest ever to be recorded.

Why does the UK get this weather?



Case study: extreme weather in the UK – Somerset Levels Flooding 2014

Where are the Somerset Levels?



- A county in south-west England.
- Extensive area of low-lying farmland bordering the Bristol Channel and the Quantock Hills. To the west and the Mendip Hills to the north.
- The area is drained by many rivers, most notably the Parret and the Tone.

What caused the floods?

There were several factors that led to extensive flooding of the Somerset Levels.

- It was the wettest January since records began in 1910. A succession of depressions (areas of low pressure) driven across the Atlantic Ocean brought a period of wet weather lasting several weeks. About 350 mm of rain fell in January and February, about 100 mm above average.
- High tides and storm surges swept water up the rivers from the Bristol Channel. This prevented fresh water reaching the sea and it spilled over the river banks.
- Rivers had not been dredged for at least 20 years, and had become clogged with sediment.

What were the impacts of the flood?

Between December 2013 and February 2014, the Somerset Levels hit the national headlines as the area suffered extensive flooding. It was the most severe flooding ever known in the area.

B *Rescuing a resident from Moorland*

Social	Economic	Environmental
• Over 600 houses flooded • 16 farms evacuated • Residents evacuated to temporary accommodation for several months • Villages such as Moorland and Muchelney cut off. This affected people's daily lives, e.g. attending school, shopping, etc. • Many people had power supplies cut off	• Somerset County Council estimated the cost of flood damage to be more than £10 million • Over 14 000 ha of agricultural land under water for 3–4 weeks • Over 1000 livestock evacuated • Local roads cut off by floods • Bristol to Taunton railway line closed at Bridgwater	• Floodwaters were heavily contaminated with sewage and other pollutants including oil and chemicals • A huge amount of debris had to be cleared • Stagnant water that had collected for months had to be reoxygenated before being pumped back into the rivers

C *The impacts of the Somerset Levels floods*

Managing the floods

Immediate responses

As the floodwaters spread out over the Somerset Levels, homeowners coped as best they could. Villagers cut off by the floods used boats to go shopping or attend school. Local community groups and volunteers gave invaluable support.

The village of Burrowbridge almost cut off by the floods **D**

Longer-term responses

A £20 million Flood Action Plan has been launched by Somerset County Council who will work together with agencies such as the Environment Agency to reduce the risk of future flooding.

- In March 2014, 8 km of the Rivers Tone and Parratt were dredged to increase the capacity of the river channel (diagram **E**).
- Road levels have been raised in places to maintain communications and enable businesses to continue during future flood events.
- Vulnerable communities will have flood defences.
- River banks are being raised and strengthened and more pumping stations will be built.
- In the longer term – by 2024 – consideration will be given to a tidal barrage at Bridgwater.

E *How dredging works*

Climate Change – Evidence

The history of the planet is split up into different periods of time:

Eon	Era	Period		Epoch	Time Began (Million Years)
Phanerozoic	Cenozoic	Quaternary		Holocene	0.01
				Pleistocene	1.8
		Tertiary	Neogene	Pliocene	5.3
				Miocene	23.0
			Paleogene	Oligocene	33.9
				Eocene	55.8
				Paleocene	65.5
	Mesozoic	Cretaceous			146
		Jurassic			200
		Triassic			251
	Paleozoic	Permian			299
		Carboniferous	Pennsylvanian		318
			Mississippian		359
		Devonian			416
		Silurian			444
		Ordovician			488
		Cambrian			542
Proterozoic					2500
Archean					4000
Hadean					4560

The Quaternary period began about 2.6 million years ago, and continues today.

In the Quaternary were the glacial periods known as the Ice Age.
Also, anatomically modern humans evolved.

During the Quaternary, many large mammalian species became extinct. This was due to climate change and hunting by humans.

The current warming period is known as the Holocene.

In the lesson you completed a table about the following as evidence of climate change (you should revise the table):

- Radiation
- Stratosphere
- Warm nights
- Ice cores
- Oceans

Other evidence includes:

What is the evidence for climate change?

Temperature is measured directly using an instrument called a thermometer. Reliable measurements using thermometers go back only about a hundred years. In the UK, for example, reliable weather records began in 1910. So, how do we know what temperatures were in the distant past?

Without the use of thermometers, scientists use indirect data stored as a fossil record. These are found in deep ocean sediments and frozen ice cores.

When layers of sediment or fresh falls of snow become buried they trap and preserve evidence of the global temperature at that time. Scientists can study the oxygen in ocean sediments or water molecules in ice to calculate temperature. They can be accurately dated and this information used to plot graphs such as graph **A**. Ice cores have been used to reconstruct temperature patterns from as long as 400 000 years ago (photo **C**).

C *Extracting ice cores from the Antarctic ice sheet*

Things are heating up!

Direct measurements of temperature using thermometers have indicated a clear warming trend (graph **B**). There is other evidence that climate change is taking place.

Shrinking glaciers and melting ice

Glaciers throughout the world are shrinking and retreating. It is estimated that some may disappear completely by 2035. Arctic sea ice has thinned by 65 per cent since 1975 and in 2014 its extent was at an all-time low (photo **D**).

What is the recent evidence for climate change?

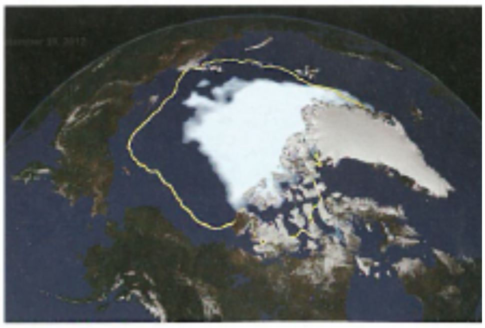
Rising sea level

According to the Intergovernmental Panel on Climate Change (IPCC), the average global sea level has risen between 10 and 20 cm in the past 100 years. There are two reasons why sea levels have risen.

- When temperatures rise and freshwater ice melts, more water flows to the seas from glaciers and ice caps.
- When ocean water warms it expands in volume – this is called thermal expansion.

Seasonal changes

Studies have suggested that the timing of natural seasonal activities such as tree flowering and bird migration is advancing. A study of bird nesting in the mid-1990s discovered that 65 species nested an average of 9 days earlier than in the 1970s. Could this be evidence of a warming world?



D *Shrinkage of Arctic sea ice, 1979–2012 (yellow line indicates extent in 1979)*

<u>**Natural causes of climate change**</u>

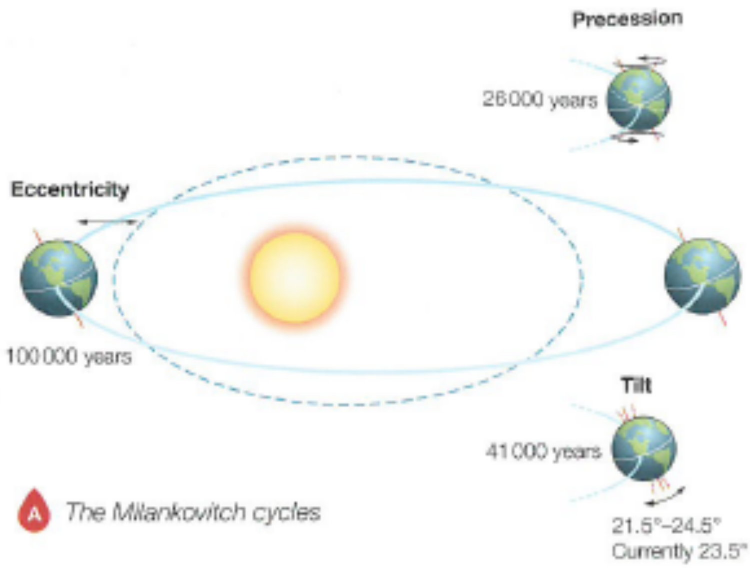
Natural causes of climate change

Scientists believe that there are several natural causes for climate change. These include:

- changes in the Earth's orbit
- variations in heat output from the Sun
- volcanic activity.

Orbital changes

Milutin Milankovitch was a Serbian geophysicist and astronomer. Whilst he was imprisoned during the First World War (1914–18) he studied the Earth's orbit and identified three distinct *cycles* that he believed affected the world's climate. These are known as *Milankovitch cycles* (diagram **A**).



A *The Milankovitch cycles*

Scientists believe that these cycles affect the timings and seasons of the Earth's climate. In particular, the 100 000-year eccentricity cycle coincides closely with the alternating cold (glacial) and warm (inter-glacial) periods in the Quaternary period.

The Milankovitch cycles

Eccentricity
This describes the path of the Earth as it orbits the Sun. The Earth's orbit is not fixed – it changes from being almost circular to being mildly elliptical. A complete cycle – from circular to elliptical and back to circular again – occurs about every 100 000 years.

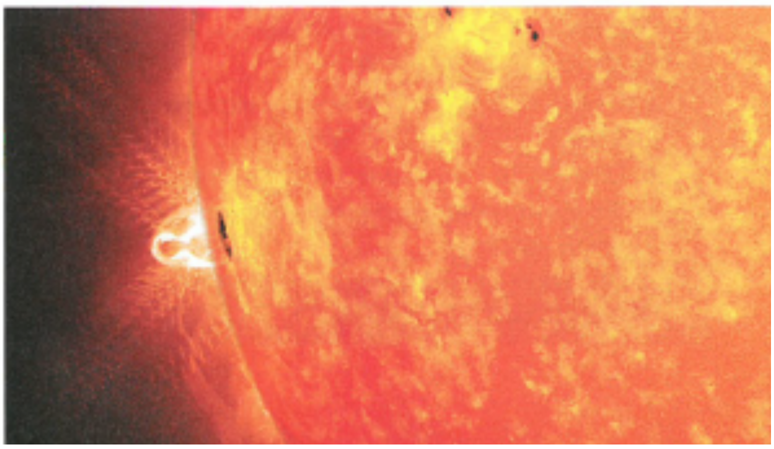
Axial tilt
The Earth spins on its axis, causing night and day. The Earth's axis is currently tilted at an angle of 23.5 degrees. However, over a period of about 41 000 years, the tilt of the Earth's axis moves back and forth between two extremes – 21.5 degrees and 24.5 degrees. You can see this on diagram **A**.

Precession
This describes a natural 'wobble' rather like a spinning top. A complete wobble cycle takes about 26 000 years. The Earth's wobble accounts for certain regions of the world – such as northern Norway – experiencing very long days and very long nights at certain times of the year.

Solar activity

Scientists have identified cyclical changes in solar energy output linked to the presence of *sunspots*. A sunspot is a dark patch that appears from time to time on the surface of the Sun (photo **B**). The number of sunspots increases from a minimum to a maximum and then back to a minimum over a period of about 11 years. This 11-year period is called the *sunspot cycle*.

B *Sunspot and solar flare on the surface of the Sun, 2014*



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- When sunspot activity is at a *maximum*, the Sun gives off more heat. Large explosions occur on the surface of the sun resulting in solar flares.
- When sunspot activity is at a *minimum* the solar output is reduced. This can lead to lower temperatures on Earth.

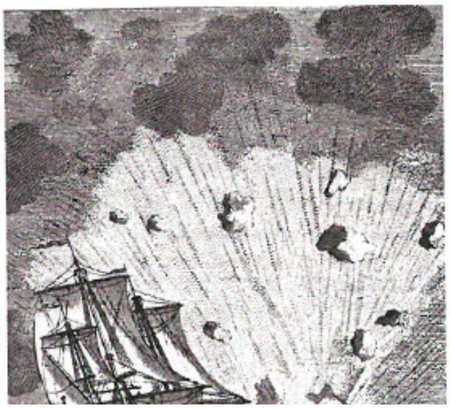
For example, very few sunspots were observed between the years 1645 and 1715. This coincided with the coldest period during the so-called 'Little Ice Age', when Europe experienced a much colder climate with severe winters (image **C**).

C *A 'Frost Fair' on the River Thames during the 'Little Ice Age'*

Volcanic activity

Violent volcanic eruptions blast huge quantities of ash, gases and liquids into the atmosphere.

- Volcanic ash can block out the Sun, reducing temperatures on the Earth. This tends to be a short-term impact.
- The fine droplets that result from the conversion of sulphur dioxide to sulphuric acid act like tiny mirrors reflecting radiation from the Sun. This can last a lot longer and can affect the climate for many years.



The cooling of the lower atmosphere and reduction of surface temperatures is called a *volcanic winter*.

Human causes of climate change

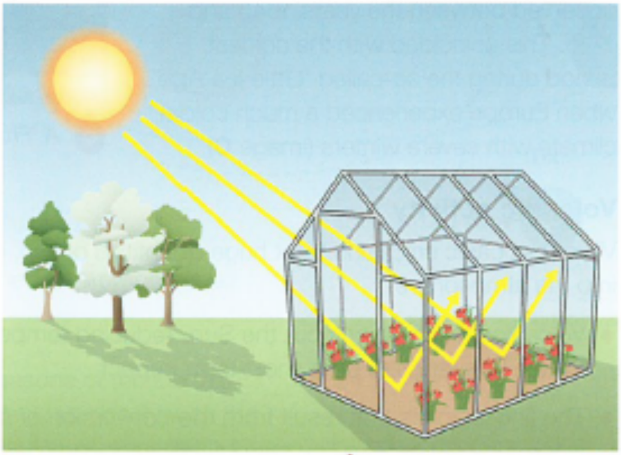
Many scientists believe that human activities are at least partly to blame for the rapid rise in temperatures – known as global warming – since the 1970s. To understand how this is possible you need to understand a natural feature of the atmosphere called the *greenhouse effect*.

Think about your own ***carbon footprint****. How do you as an individual contribute to the production of greenhouse gases in your everyday life?*

What is the greenhouse effect?

You probably know that a greenhouse is a small building entirely made of glass and used by gardeners to create warm conditions to grow plants. So how does it work?

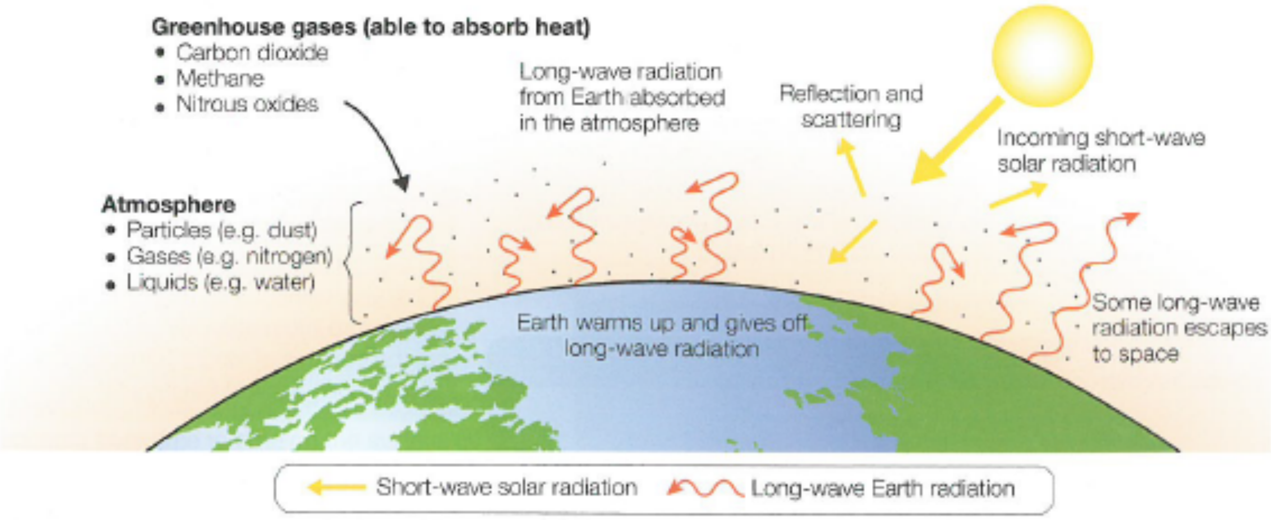
Glass allows radiation (heat) from the Sun to enter the greenhouse (diagram **A**). However, this heat cannot escape through the glass. As a result, the greenhouse becomes warmer than the air outside and is ideal for growing tomatoes and vegetables which need constant warm conditions.



A *The greenhouse effect*

Like a greenhouse, the atmosphere allows most of the heat from the Sun (short-wave radiation) to pass straight through it to warm up the Earth's surface (diagram **B**). However, when the Earth gives off heat in the form of long-wave radiation, some gases such as carbon dioxide (CO_2) and methane are able to absorb it. These gases are called *greenhouse gases*.

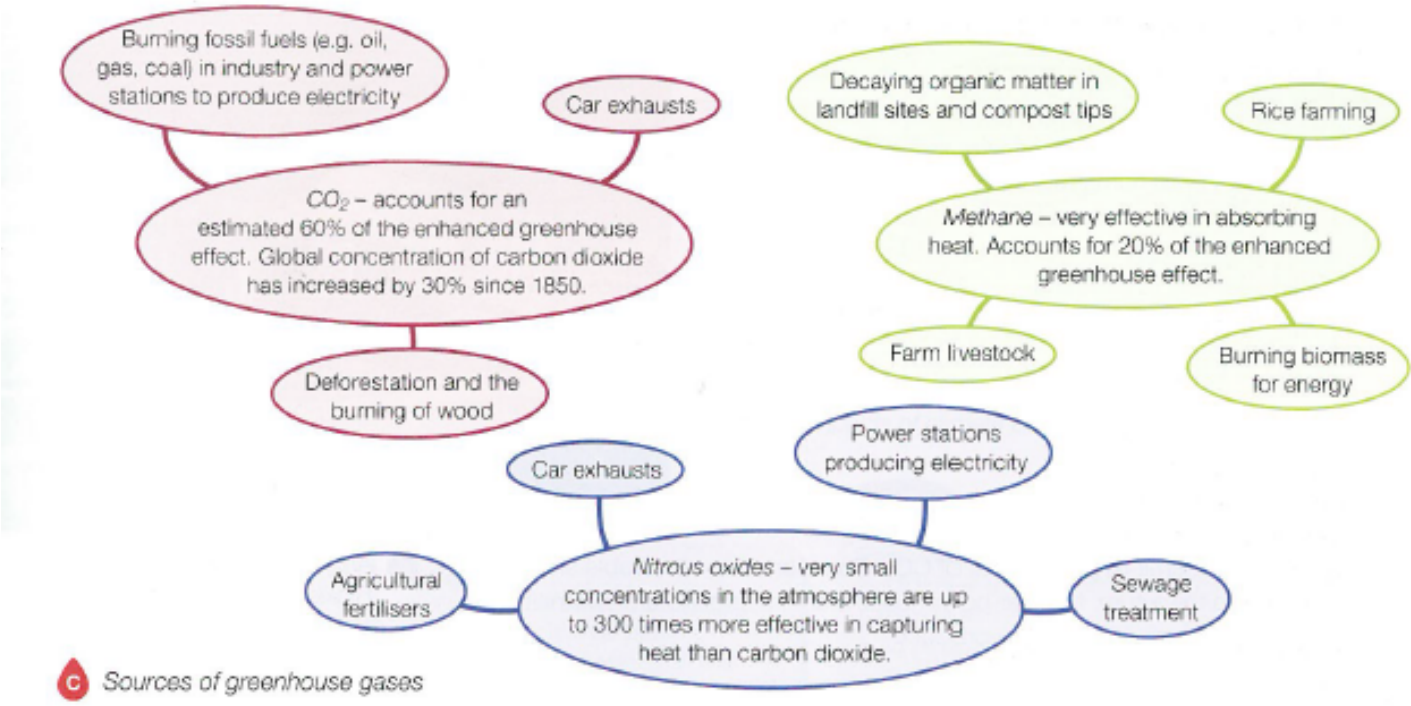
In the same way that glass traps heat inside a greenhouse, the greenhouse effect keeps the Earth warm. Without this 'blanketing' effect it would be far too cold for life to exist on Earth.



B *How the greenhouse effect works*

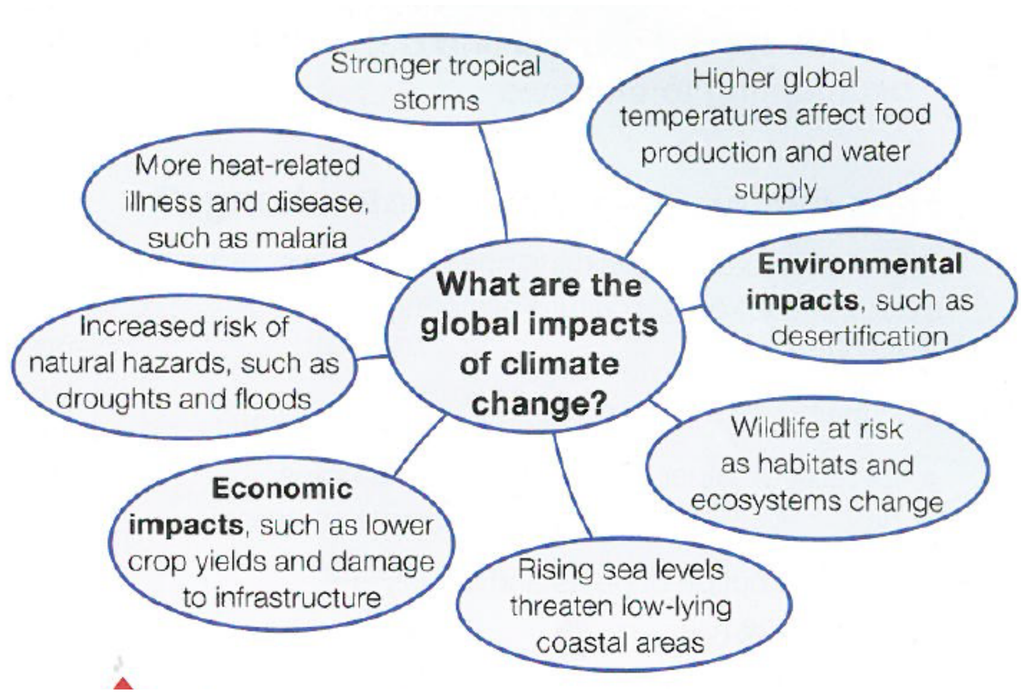
Human causes of greenhouse gases

In recent years, the amounts of greenhouse gases in the atmosphere have increased. Scientists believe that this is due to human activities (diagram **C**).



C *Sources of greenhouse gases*

Effects of climate change



Local effects of climate change?

- Coastal erosion will increase in areas such as Norfolk due to rising sea levels and increased frequency and intensity of storms.
- Economic impacts such as being able to grow different crops in the south of England due to a warmer climate. For example vineyards for wine making.
- Ski resorts worth £21 million in the Scottish highlands could close.
- More frequent and intense storms.
- Some native species could die out as temperatures increase.
- Cities such as London could face extreme flooding as sea levels rise.

Managing the effects of climate change

How can climate change be managed?

Alternative energy sources

The burning of **fossil fuels** (coal, oil and gas) to produce electricity, fuel vehicles and power industry contributes 87 per cent of all human-produced CO_2 emissions. The rest comes from land use changes – mostly deforestation (9 per cent) and industrial processes like making cement (4 per cent).

To help reduce carbon emissions many countries are turning to alternative sources of energy such as:

- hydro-electricity
- nuclear power
- solar, wind, and tides.

A *Artist's impression of the new Hinkley Point nuclear reactor*

These do not emit large amounts of CO_2. Some are also renewable and will last into the future. Nuclear power uses uranium to generate electricity but does not emit CO_2 as a by-product.

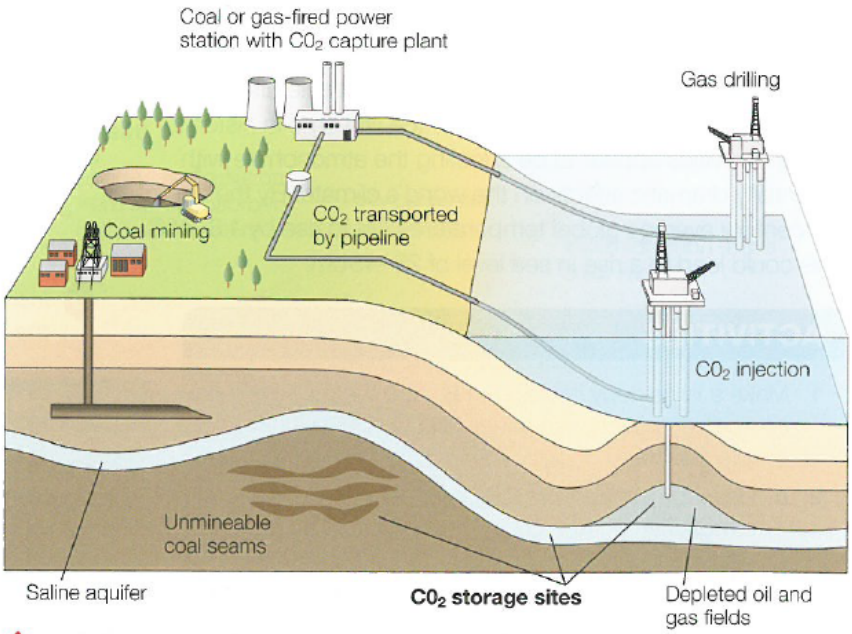
The UK aims to produce 15 per cent of its energy from renewable sources by 2020. There has been investment in renewable energy projects like wind power. Power companies are encouraged to use renewable sources. A new nuclear reactor is being built at Hinkley Point in Somerset (photo **A**).

Carbon capture

Coal is the most polluting of all fossil fuels. China gets 80 per cent of its electricity from burning coal, India 70 per cent and the USA 50 per cent. How can coal continue to be used in a less damaging way?

Carbon capture and storage (CCS) uses technology to capture CO_2 produced from the use of fossil fuels in electricity generation and industrial processes. It is possible to capture up to 90 per cent of the CO_2 that would otherwise enter the atmosphere.

Diagram **B** shows how carbon capture works. Once captured, the carbon gas is compressed and transported by pipeline to an injection well. It is injected as a liquid into the ground to be stored in suitable geological reservoirs.



B *Carbon capture and storage*

Reducing risk from rising sea levels

Did you know that average sea levels have risen by 20 cm since 1900? By 2100 sea levels are expected to rise by a further 26–82 cm. This will flood important agricultural land in countries such as Bangladesh, India and Vietnam.

As sea levels rise, rates of coastal erosion will increase. Fresh water supplies will become contaminated by saltwater and coastal areas will be prone to damage from storm surges.

Managing rising sea levels in the Maldives

The Maldives are a group of tiny islands in the Indian Ocean some 500 km south-west of India. The highest point on the islands is just 2.4 m. Some climate models suggest that the islands may be uninhabitable by 2030 and submerged by 2070.

The 380 000 inhabitants have a very uncertain future as sea levels rise.

How can the Maldives manage sea-level rise? **D** http://www.economist.com/news/asia/21679313-bangladesh-highly-susceptible-climate-change-floods-cyclones-and-droughts-are-likely-increase

The link above is an excellent clip about how communities in Bangladesh are managing climate change.

In the exam you will be asked a variety of different questions. Some of them will be skill based and involve you interpreting different geographical stimulus such as OS maps, choropleth maps, infographics, diagrams, data etc.

Some questions you will have to describe and explain processes to show knowledge.

Some questions will ask you to evaluate, where you have to provide a well-balanced argument supported in evidence.

Remember to read questions carefully, underling the key words to help you.

You will also be marked for the quality of your written communication in one extended question (SPaG).