3.1 Global atmospheric circulation

You need to know:

- how global atmospheric circulation works to affect global weather and climate
- examples of the effects in the UK, deserts and at the Equator.

Student Book
See pages 22–3

What is global atmospheric circulation?

The atmosphere is the air above our heads (Figure **1**) on which we depend for life.

Atmospheric circulation involves a number of interconnected circular air movements called cells (Figure **2**).

- Sinking air creates high pressure, and rising air creates low pressure.
- Surface winds move from high to low pressure, transferring heat and moisture from one area to another.
- These winds curve due to the Earth's rotation and change seasonally as the tilt and rotation of the Earth causes relative changes in the position of the overhead sun.

Add a WOW! factor

In the exam, use an annotated sketch or diagram if it makes your answer clearer. But remember that the marks are in your annotation, not in the quality of the drawing.

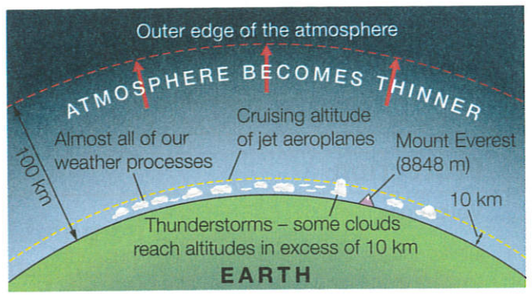

Figure 1 *The atmosphere*

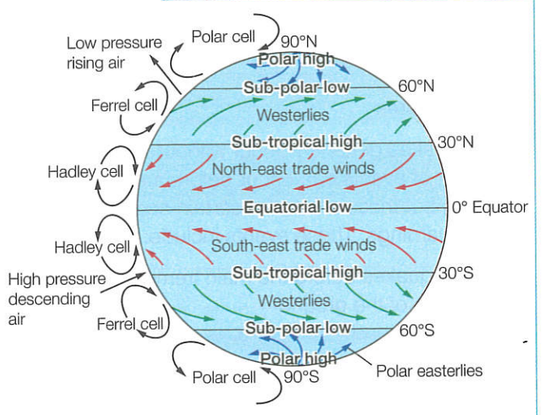

Figure 2 *Global atmospheric circulation*

How does global circulation affect the world's weather?

Global atmospheric circulation drives the world's weather:

- *Cloudy and wet in the UK* because 60° north is close to where cold polar air from the north meets warm subtropical air from the south. These surface winds from the south-west usually bring warm and wet weather, because rising air cools and condenses forming clouds and rain.
- *Hot and dry in the desert* because most deserts are found at about 30° north and south where sinking air means high pressure, little rain, hot daytime temperatures and very cold nights.
- *Hot and sweaty at the Equator* because low pressure marks where the sun is directly overhead. Hot, humid air rises, cools and condenses, causing heavy rain – hence the tropical rainforests.

Six Second Summary

- Atmospheric circulation involves interconnected cells of air.
- Atmospheric circulation drives the world's weather.

Over to you

Practise drawing **two** annotated sketches – one to explain tropical rainforests, and another to explain deserts.

Where and how are tropical storms formed?

3.2

You need to know:

- what a tropical storm is
- where tropical storms form
- how tropical storms form.

Student Book
See pages 24–5

What is a tropical storm?

Tropical storms are huge storms called hurricanes, cyclones and typhoons in different parts of the world (Figures **1** and **2**). They form 5–15° north and south of the Equator, in summer and autumn, where:

- ocean temperatures are highest (above 27 °C)
- the spinning (Coriolis) effect of the Earth's rotation is very high
- intense heat and humidity makes the air unstable.

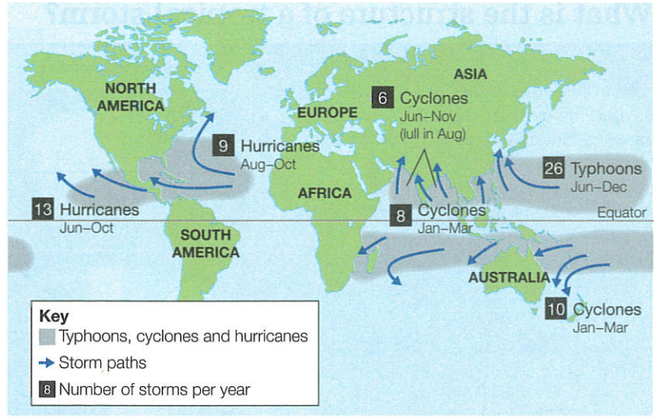

Figure 1 *The distribution of tropical storms*

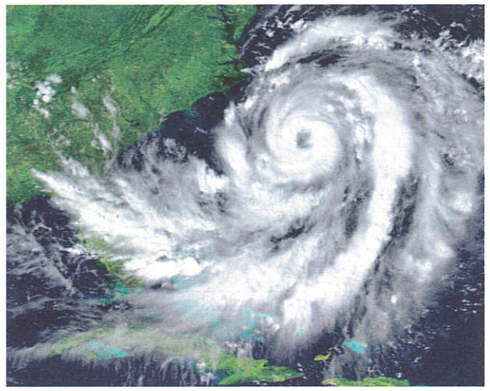

Figure 2 *Satellite image of Hurricane Sandy off the coast of Florida, USA, 2012*

How do tropical storms form?

It is not certain how tropical storms are formed, but this sequence is always involved:

- Rising air draws evaporated water vapour up from the ocean surface which cools and condenses to form towering thunderstorm clouds.
- The condensing releases heat which powers the storm and draws up more water vapour.
- Multiple thunderstorms join to form a giant rotating storm.
- Coriolis forces spin the storm at over 120 km/h (75 mph) creating a vast cloud spiral with a central, calm eye of rapidly descending air.
- Prevailing winds drift the storm over the ocean surface like a spinning top, gathering strength as it picks up more and more heat energy.
- On reaching land the energy supply (evaporated water) is cut off and the storm will weaken.

Six Second Summary

- Tropical storms form 5–15° north and south of the Equator, in summer and autumn, when ocean temperatures are highest.
- They are triggered by the upward movement of evaporated air and moisture.
- They gather strength drifting over the ocean surface, but weaken over land.

Over to you

Make sure you can locate and name tropical storms associated with different parts of the world.

3.3 The structure and features of tropical storms

You need to know:

- the structure and features of tropical storms
- how climate change might affect tropical storms in the future.

Student Book
See pages 26–7

What is the structure of a tropical storm?

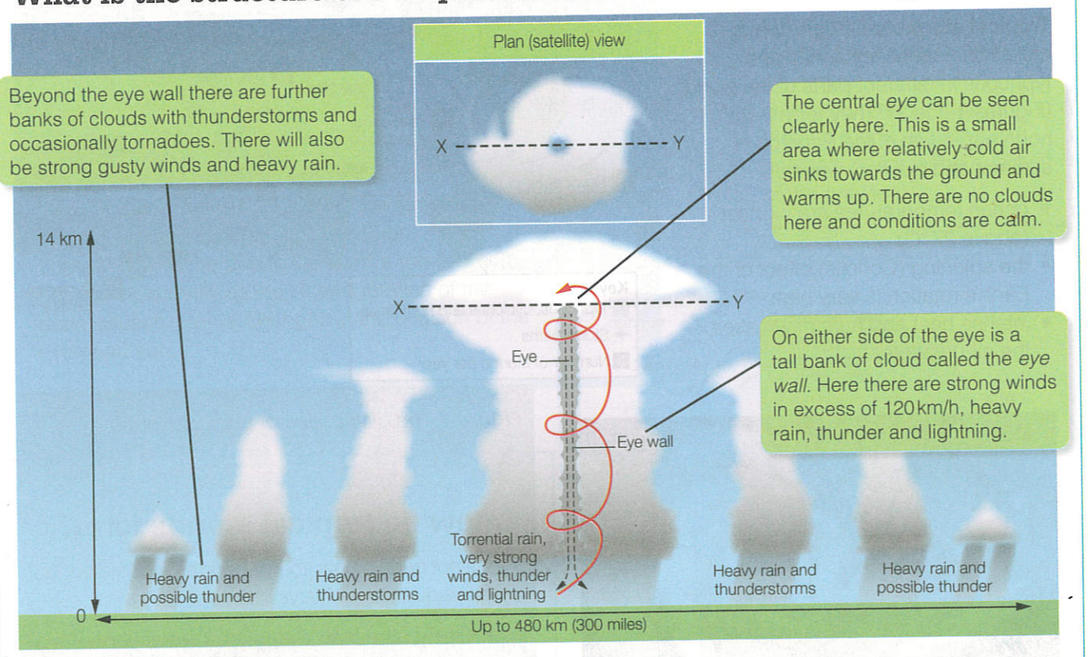

Figure 1 *The structure of a tropical storm*

Will climate change affect tropical storms?

There is strong scientific evidence of global warming and that this may be impacting on natural systems including the distribution, frequency and intensity of tropical storms:

- Over the last few decades sea surface temperatures in the Tropics have increased by 0.25–0.5 °C.
- In the future, tropical storms *may* extend into the South Atlantic and parts of the sub-tropics.
- In the future, tropical storms *may* become more powerful (as measured on the Saffir-Simpson scale).
- In the North Atlantic, six of the ten most active years since 1950 *have* happened since the 1990s.
- In the North Atlantic, hurricane intensity *has* risen in the last 20 years.

But currently there is no clear evidence that the numbers or intensities of storms are increasing. More data will be needed over a longer period of time.

Six Second Summary

- Tropical storms are the most destructive storms on Earth.
- There is strong scientific evidence of global warming, including sea surface temperatures.
- Currently there is no clear evidence that the numbers or intensities of storms are increasing – more data is needed.

Over to you

Practise drawing a simplified, labelled sketch of Figure **1**. Important labels would include 'cloud spiral', 'eye' and 'eye wall'. The horizontal and vertical scales are also crucial.

Typhoon Haiyan – a tropical storm

3.4

You need to know:

- the primary and secondary effects of Typhoon Haiyan
- the immediate and long-term responses to Typhoon Haiyan.

Student Book
See pages 28–9

Example

'Super' Typhoon Haiyan, November 2013

- One of the strongest Category 5 storms ever recorded (Figure **1**).
- Very low air pressure caused 5 m storm surge swept on shore by winds up to 275 km/h (170 mph).
- Coastal devastation included 90% of Tacloban destroyed by storm surge.

Figure 2 *Destruction in Tacloban*

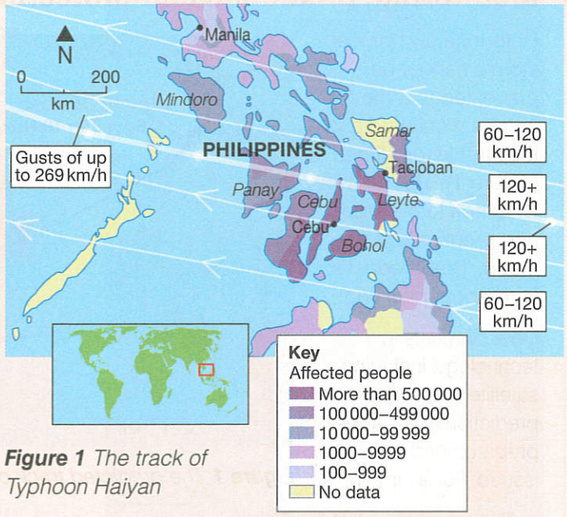

Figure 1 *The track of Typhoon Haiyan*

Primary effects (impacts of strong winds, heavy rain and storm surge)	Secondary effects (longer-term impacts resulting from primary effects)
• 6300 killed – most in storm surge • Over 600 000 displaced • 40 000 homes destroyed or damaged • Wind damage to buildings, power lines and crops • Over 400 mm of rain caused widespread flooding	• 14 million affected including 6 million jobs lost • Flooding caused landslides – blocking roads and restricting access for aid workers • Shortages of power, water, food and shelter, leading to outbreaks of disease • Infrastructure including schools destroyed • Looting and violence in Tacloban
Immediate responses	**Long-term responses**
• Rapid overseas aid included NGOs • US helicopters assisted search and rescue, and delivery of aid • Field hospitals helped injured • Over 1200 evacuation centres set up	• UN and international financial aid, supplies and medical support • Rebuilding of infrastructure • Rice farming and fishing quickly re-established • Homes rebuilt in safer areas • More cyclone shelters built

Figure 3 *Effects and responses of Typhoon Haiyan*

Six Second Summary

- Typhoon Haiyan was one of the strongest storms ever recorded, destroying farms, homes, buildings, infrastructure and jobs.
- UN, international governments and NGOs responded with immediate aid and longer-term help.

Over to you

- Study Figure **3**. Learn **three** bullet points in **each** of the four segments of the table.

3.5 Reducing the effects of tropical storms

You need to know:

- how the effects of tropical storms can be reduced by monitoring, prediction, protection and planning.

Student Book
See pages 30–1

Monitoring, prediction and protection

Unfortunately tropical storms cannot be prevented, but they can be monitored and their tracks predicted (Figure **1**). This allows warnings to be issued and preparations made. 'Preparedness' is all about planning.

Developments in technology, including satellite tracking, allow prediction maps to be prepared and warnings issued. For example:

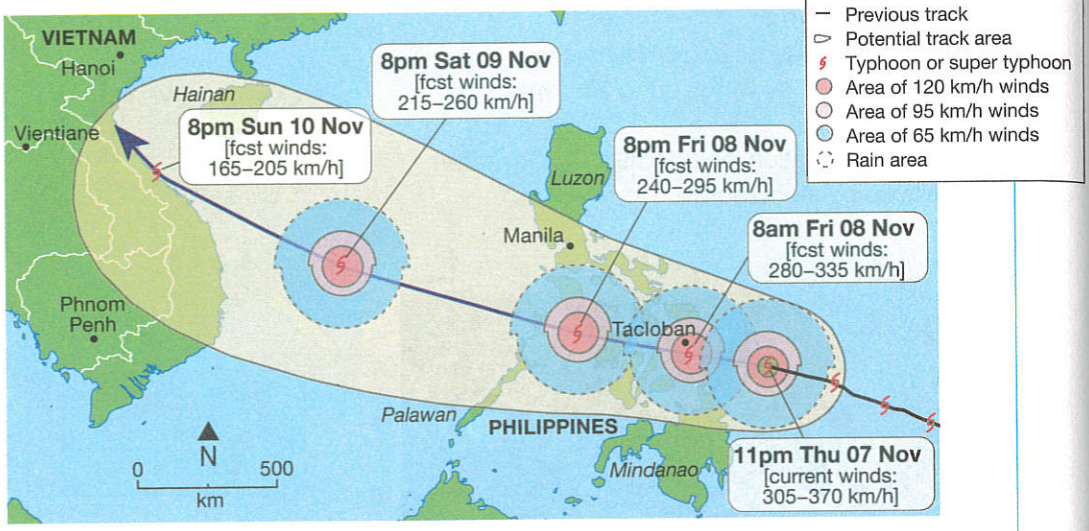

Figure 1 *The predicted track of Typhoon Haiyan*

- The government of the Philippines sending out Tropical Cyclone Warning Signals graded on the severity of winds and time frame expected.
- The National Hurricane Center in Miami, Florida, USA using a simpler two-scale warning system of Hurricane Watch (advised) and Hurricane Warning (expected).

Protection

Methods of protection usually involve anticipation in design – everything from reinforced walls, roofs and window shutters, to storm drains and sea walls. Cyclone shelters in Bangladesh are used as community centres, schools or medical centres for most of the time (Figure **2**).

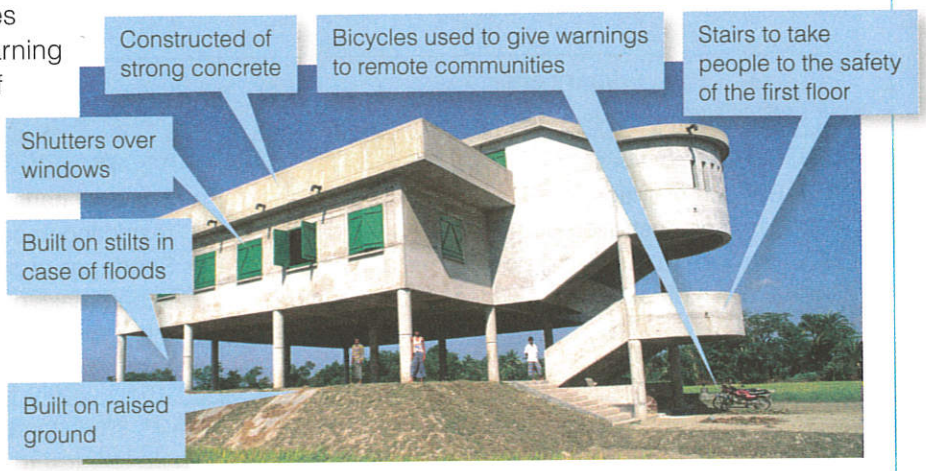

Figure 2 *Cyclone shelter in Bangladesh*

Planning

'Preparedness' is all about contingency planning for the inevitable. It is unrealistic to stop tens of millions of people living in coastal areas at risk from tropical storms, but they can be made safer. It mostly means education and media campaigns raising individual and community awareness in order that people understand the dangers, and are able to respond.

Six Second Summary

- Tropical storms can be monitored, their tracks predicted, and warnings issued.
- Buildings can be protected and cyclone shelters built.
- Contingency planning raises awareness allowing people to respond.

Over to you

Summarise what can, and what cannot be done in terms of monitoring, predicting and protecting from tropical cyclones.