Edexcel Geography GCSE

Extreme Weather

Hazardous Earth

Detailed Notes

Tropical Cyclones

What is a Tropical Cyclone?

A tropical cyclone is a **very large**, spinning storm that forms in the **tropics**.

Tropical cyclones have **high winds** and **torrential rain**, and usually affect **small islands** and **coastal regions**.

Hurricane Florence (2018) from the International Space Station.

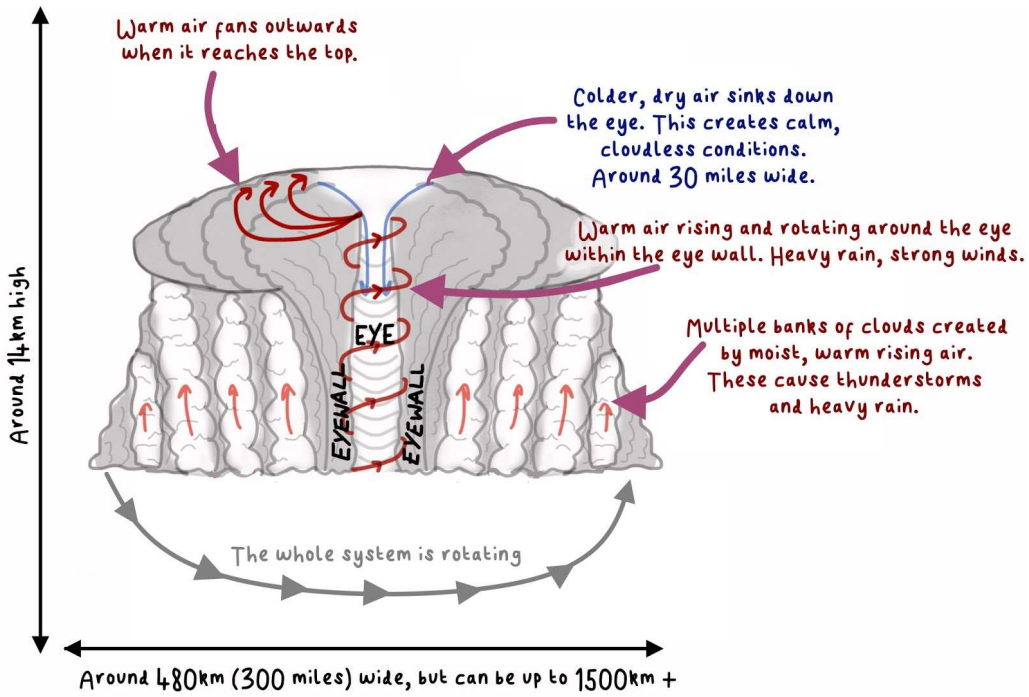
Characteristics of Tropical Cyclones

Tropical cyclones are characterised by their **low pressure**, **intense weather** and **spinning structure**.

- Warm air rises and creates an **updraught** during the formation of a **tropical cyclone**, causing an area of **low pressure** to form. The area inside a tropical cyclone is often as low as 950mb (the pressure on Earth is usually 1013mb). The centre of the storm, called the **eye**, can be **15% lower pressure** than areas outside of the storm.
- Tropical cyclones are characterised by **thunderstorms**, **strong winds** and **intense rainfall**. The area surrounding the centre, called the **eyewall** contains the **strongest winds, thunder and lightning, and torrential rain**. In very intense storms, **sustained winds** can reach **240km/hour** (150mph), and **gusts** can exceed **320km/hour** (200mph).
- Tropical cyclones **rotate** due to the spin of the Earth. In the **southern** hemisphere, the storms spin **clockwise**; in the **northern**, **anticlockwise**.

Tropical Cyclone Structure

There are **complicated processes** going on **inside a tropical cyclone**. Below is a **cross-section of a tropical cyclone** (imagine if you cut a tropical cyclone in half and looked in the middle).



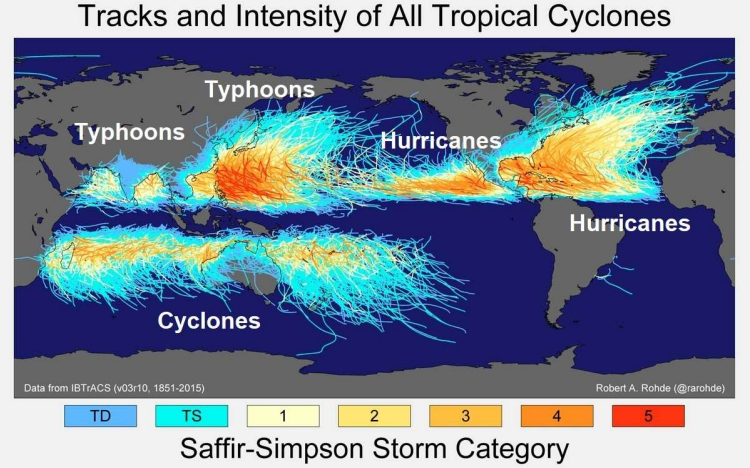
Global Distribution of Tropical Cyclones

Tropical cyclones are **named different things** in **different regions**.

Hurricane:
In the USA and Latin America/ The Caribbean. Usually form **mid-July to September**.

Cyclone:
Australia (Oceania) and Madagascar. Usually form **January - April** (summer - autumn in the Southern Hemisphere).

Typhoon:
India, Japan and the Philippines. Usually form from **July to October**.



Where do Tropical Cyclones Develop?

Tropical cyclones need **very specific conditions** to form, meaning they will only form in **certain areas.** Tropical cyclones form between **5-15° north or south of the equator**, in warm oceans. The location that a tropical cyclone forms in is known as its **source area**.

- **Temperature:** Ocean temperatures must be around **26 - 27°C** and at least 50 metres deep. Warm water provides the storm with **energy**. This is why storms form during late summer, when the ocean has had time to heat up.
- **Air pressure:** Must be in areas of **unstable air pressure** - usually where areas of **high pressure** and **low pressure** meet - so that warm air rises more readily and clouds can form (this air must also be humid for cloud formation). Warm air rises because it is **less dense** than cold air.
- **Wind shear:** Winds must be present for the **swirling motion** to form, but not too strong or the storm system will be **ripped apart** in the early stages.
- **Rotation:** Tropical cyclones only form around the equator, between 5-15° either side of the equator, but tropical cyclones **will not form on the equator**. The **Coriolis Effect** is the effect of the **Earth's rotation** on weather events. The storm spins because the Earth is spinning; but there is **no Coriolis Effect at the equator**, hence why these storms will only form a certain distance away from it.

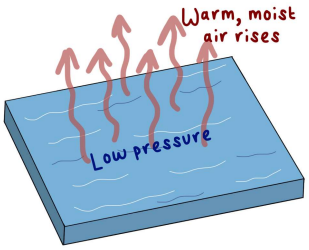
Tropical cyclones follow certain **pathways** that are driven by **global wind circulation**. These pathways are known as the cyclone's **track**. It is possible to follow the **track** of a tropical cyclone using **satellite imagery**, as the storms are so large they can be seen from space.

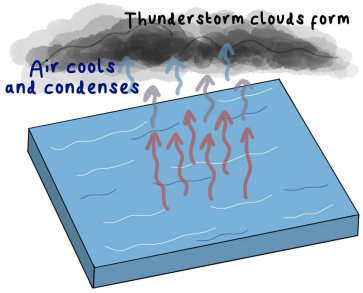
(Source: https://www.youtube.com/watch?v=3GBb7zSi_UA)

Tropical Cyclone Formation

1

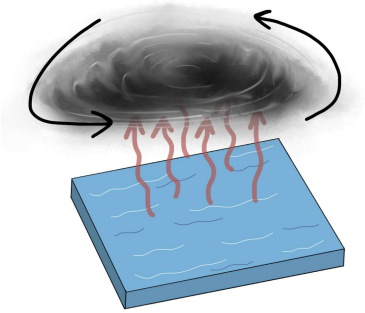
Warm, moist air rises, leaving an area of **low pressure below**. This causes warm air from the surroundings to **move into this low pressure area** and rise too. Overall, **warm air is constantly rising** and accumulating in the atmosphere.





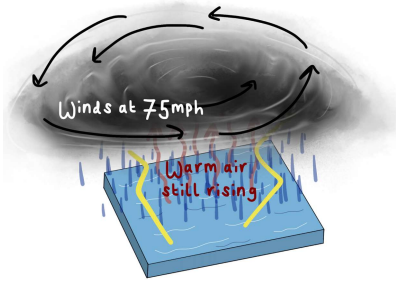
2

When the warm air rises, it eventually **cools**. This moist air will then **condense** and form large **thunderstorm clouds**.



3

The whole system is spinning due to the **Coriolis effect**. In the **southern** hemisphere, the storms spin **clockwise**; in the **northern**, **anticlockwise**.

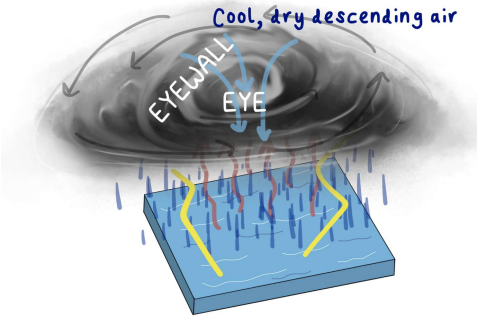


4

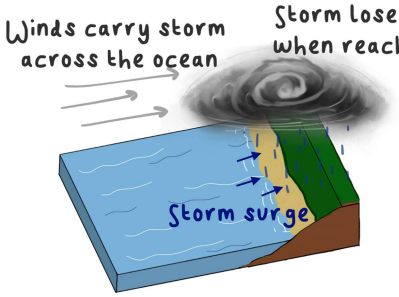
The **constant additions of energy** from the warm air causes the storm to spin faster and generate higher wind speeds. At **75 mph** the storm can be classed as a category 1 **tropical cyclone**.

5

The storm develops an **eye** in the centre. This is an area of **extremely low pressure** where cool, dry air descends. The weather within the eye is relatively **calm and cloud free**.



Surrounding the eye is the **eyewall**, the most **intense and powerful** area of the storm. **Warm, moist air rapidly rises** here, with extremely **high winds and torrential rain**.



When the tropical cyclone reaches a coast, the **low pressure and high winds** will cause a large amount of sea water to be pushed onto the coast, which is called a **storm surge**.

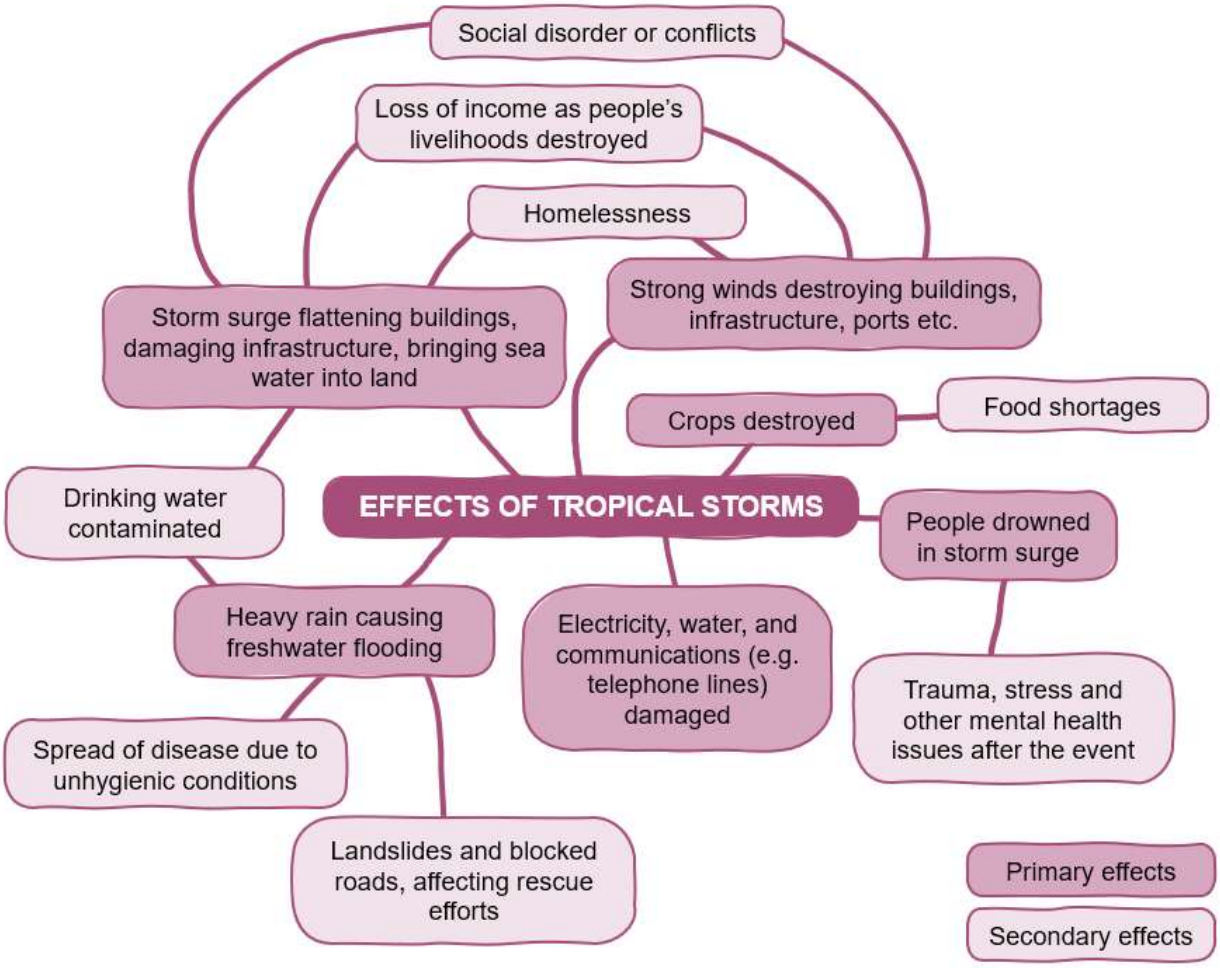
When the storm reaches **land**, it no longer has a **supply of energy** (warm, moist air from the sea) and the eye eventually **collapses** and the storm **dissipates**. Heavy rain can persist for days.

Effects of Tropical Cyclones

Tropical cyclones can be very damaging to **people, the environment, and the economy**. The **physical hazards** that tropical cyclones create have **impacts**, these hazards include:

- **High winds** - strong enough to lift roofs and bring down infrastructure, which can be very dangerous if they hit someone
- **Intense rainfall** - over 100cm of rain can fall in a single storm event (more than the UK's **annual** rainfall!)
- **Storm surges** - when the storm passes over the coast, it picks up a lot of water and causes an **abnormally high tide** called a storm surge. These can be anywhere from a couple of feet to tens of feet high.
- **Coastal flooding** - storm surges cause flooding on the coast, which can damage coastal infrastructure and contaminate near freshwater.
- **Landslides** - the large amount of rainfall as well as coastal flooding can oversaturate the ground and trigger landslides.

The devastation of **Typhoon Haiyan**, a Category 5 tropical cyclone that hit the **Philippines** in **2013**. (Source: Tigeryan—iStock/Thinkstock)



Vulnerability to Tropical Cyclones

Some countries are more **vulnerable** to tropical cyclones than others due to both **physical** and **socioeconomic** reasons. This means the **risk** the tropical cyclone poses to **life and property** in a vulnerable country is **greater**, and there's a **higher likelihood** of serious damage.

Different factors influence a population's **vulnerability**:

Factors Influencing Vulnerability to Tropical Cyclones

Education

Some people are less **educated** on the risk they face from tropical cyclones, making them **vulnerable** as they could be **unprepared**.

Being aware of **evacuation routes** and being **prepared** (e.g. having an emergency kit with first aid, food supplies, a whistle etc.) makes people less vulnerable if a tropical cyclone does hit.

Wealth

Poorer countries may not be able to **respond** to a tropical cyclone as effectively as a wealthier country. **Emergency services, reconstruction** etc. requires a lot of money (although the cost of rebuilding is usually lower in poorer countries). Poorer countries often rely on **international aid**.

Poverty can force populations to live in **unsafe housing** which is not built to withstand tropical cyclones, making them vulnerable.

Wealthier countries have the money to build **defences**, construct **cyclone resistant housing** and develop widespread **warning systems**, whereas poorer countries may not be able to afford this.

Climate Change

Sea level rise caused by climate change could make people **more vulnerable** to **storm surges** as the sea will be **higher**.

Climate change is also affecting the **intensity** of tropical cyclones and could affect the **distribution** in the future, potentially making more people vulnerable.

Location

Those living in **tropical cyclone prone** areas are more vulnerable to their impacts. Populations in **low-lying coastal areas** (i.e. not very high above sea level) are at higher risk of being affected by impacts such as **storm surges** compared to those living **further inland**, who may be more at risk of freshwater flooding.

Tropical Cyclone Management

Countries can **reduce the impacts** of tropical cyclones by ensuring they are **prepared** for the event, and **respond to the cyclone** effectively when it does hit. This can be done in different ways:

- Ensuring the cyclone is **monitored** using satellites and forecasting technology.
- Having **warming systems and evacuation strategies** in place for the population.
- Building **physical defences** to ensure the population is protected.

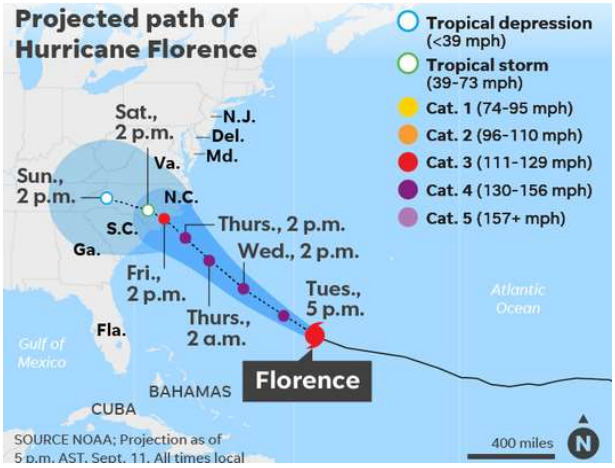
Weather Forecasting and Satellite Technology

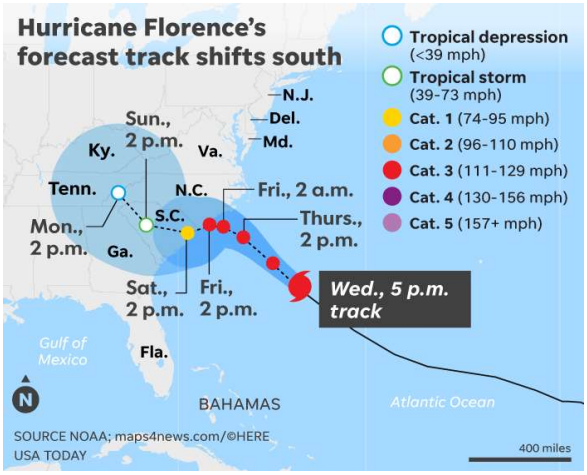
As tropical cyclones form away from land, it is possible to track **cloud formations** and **movements** using **satellite technology**. Scientists monitor source areas to see if one is on the way. Also, it is possible to monitor the **track a tropical cyclone is taking**, to see if there is potential for the tropical cyclone **to make landfall**.

Hurricane Igor forming off the coast of the Caribbean, 2010.

It is possible to predict **the track** a tropical cyclone is going to take as well as **its intensity** up to days in advance. The population can be informed of **the estimated time** that the tropical cyclone will hit them, and can take action accordingly.

These predictions become **more reliable** as the storm gets closer. For example, below is a typical **predicted** forecast of a tropical cyclone (Hurricane Florence, 2018). The forecast to the left was made a day earlier than the forecast to the right. Notice how the forecast changes as the tropical cyclone gets closer.





It is also possible to predict **how high a storm surge will be** by analysing the intensity of a storm, which is important for making decisions regarding who is at **risk** and needs to be **evacuated.**

Warning and Evacuation Strategies

Places that are frequently at risk to tropical cyclones usually **have plans in place** to ensure the population is safe.

- **Evacuation Routes and Safety Protocols:** Countries create **evacuation routes** and develop **warning systems** to ensure the population is **prepared** for a storm and will be **alerted** when one is coming. Warnings are often broadcast on different forms of **media** (radio, television, social media) to ensure they are reached by as many people as possible.

- **Raising awareness:** If the community is **aware of the risk** they face from **tropical cyclones**, they can **lower their risk** by getting prepared (sorting important supplies, organising documents, becoming aware of their local shelter).

  Some countries have **very rural communities** that do not have any **means of communication**, making these communities vulnerable. To reduce their vulnerability, countries like Bangladesh are training people to go into these rural communities and warn them of an incoming storm.

(Source: British Red Cross)

Physical Defences

Building and infrastructure design can help to **protect people and property** from **the effects of tropical cyclones**. For example:

- **Sea walls** can be built on coast lines to **block storm surges**
- **Storm drains** can be constructed to divert water after **high levels of rainfall** to reduce the risk of flooding
- Power lines, doors, windows, transformers etc. can be **reinforced** to be resistant to **high winds**
- Houses can be built **on higher ground** or even on **stilts** to reduce flooding risk.

This house is an example of a 'hurricane-proof' home. It is built on **stilts** to ensure it is high up and resistant to flooding from **storm surges**. The building is made out of **concrete** which is resistant to very strong winds. Windows and doors can also be **reinforced** to be resistant to heavy winds, and resistant to **breaking** if they are hit with flying debris.

Having many **tropical cyclone shelters** spread across vulnerable areas is also important, as this means people have a safe place to shelter, away from the effects of the tropical cyclone.

(Source: jorgefontan.com/hurricane-proof-house-design/)