

Section 1: What Causes Wind?

• What is atmospheric pressure?



The isobars on this weather chart shows the atmospheric pressure

The layer of air that surrounds the Earth is called the atmosphere. The atmosphere is denser near the surface and thins out nearer space. The weight of the atmosphere pressing down at the Earth's surface is 'atmospheric pressure'.

At sea level atmospheric pressure is about '1 atmosphere' or '1 bar' or 1000 millibars (mb). So, on a synoptic chart (a weather map) 960mb is very low pressure and 1012mb is high pressure. At a depth of just 10m under water the pressure we experience is an additional 'bar'.

Atmospheric pressure changes with the passing of weather systems, such as depressions or hurricanes. Accurate weather forecasting depends on atmospheric measurements.

Extension Questions

Q1. What instrument measures atmospheric pressure?

A barometer.

Q2. What is the lower layer of the atmosphere called?

The lower layer of the atmosphere is called the troposphere, and this is about 10km high. The layer above it is the stratosphere.

• Suggested Film

- Types of Weather: Wind

• Why does atmospheric pressure vary?

Atmospheric pressure varies with altitude: the higher up we go, the less atmosphere there is above us, therefore, the lower the pressure, and vice versa.

Also, atmospheric pressure varies depending on whether air is rising or sinking within the atmosphere. Generally speaking, when the surface is warmed, air will be warm and rise. If air is rising, then the weight of the air column above that place is less so atmospheric pressure is low. High pressure occurs when air from the upper atmosphere sinks back to the surface.

Areas of high and low pressure tend to be associated with certain latitudes and whether the surface is land or sea. The greater the difference in atmospheric pressure between two places, the stronger the wind between those places will be.



Atmospheric pressure can be measured using a barometer

• Suggested Film

- Types of Weather: Wind

Extension Question

Q3. What is latitude?

Every point on the Earth's surface has a latitude which is a measure of how far north or south it is from the equator. The maximum it can be is 90° north or south (the North Pole and South Pole respectively). Lines of latitude circle Earth from east to west and are all parallel and different lengths. The largest line of latitude is the equator.



Lines of latitude circle the Earth from east to west

• What is wind and what causes it?

Wind is simply air moving from one part of the atmosphere to another. If one part of the Earth's surface is experiencing lower pressure than a neighbouring area, air will flow from the higher to the lower pressure area to try to balance out the difference.

You can imagine this is just like water moving in a tube. If one man raises his end of the tube he will cause the water to rise; the increase in pressure will make the water flow down the tube to equal out the levels.

In the atmosphere when air moves from one place to another we experience this as wind. Winds occur both at the Earth's surface and in the upper atmosphere.

• Suggested Films

- Types of Weather: Wind
- FactPack: Beaufort Scale

• Suggested Activity

- Discuss: If we lived in a world without wind, what would we miss?

Extension Questions

Q4. What instrument measures wind speed?

An anemometer

Q5. What instrument measures wind direction?

A wind vane.

Q6. What is a jet stream?

A jet stream is a narrow tube of high-level wind that circles the Earth. Jet streams can move very fast, up to 300km/h. Jet streams are found at the top of the troposphere. A jet stream 'snakes' about and has a strong influence on the location of weather systems below.

Section 2: Wind and Our Climate

• How do local winds affect day to day weather?



Wind is experienced all around the world to different extents

By local, we mean winds that occur over a small distance, maybe 5 to 50km or so. A local wind may be generated by the seaside, as land heats up more quickly than the sea. Air over the land will start to rise, creating a lower pressure than out at sea, and will begin to move from over the sea towards the land. This is known as an on-shore breeze. The reverse can happen at night when the land cools more than the sea, and this is known as an off-shore breeze. Local winds can also occur in mountain environments or next to large lakes.

• Suggested Film

- Factpack: Beaufort Scale

Extension Questions

Q7. On the Beaufort scale, what is a gentle breeze and how fast is the wind?

A gentle breeze would register as 3 on the Beaufort scale, which is 12-19km/h.

Q8. On the Beaufort scale, what is a gale and how fast is the wind?

A gale would register as 9 on the Beaufort scale, which is 75-88km/h.

Q9. What kind of wind do surfers prefer?

If the wind is blowing into the oncoming breaking wave it will 'hold the wave' up and give the surfer more time to surf the clean wave. If the wind is onshore, it will encourage the wave to crash into white water more quickly.

• How do regional winds affect the climate of whole regions?

A prevailing wind means the average direction from which a wind blows. So, if a wind blows from the south west 200 days a year, we say the prevailing wind is a south westerly.

Prevailing winds often affect the climate of a place for significant parts of the year. In western Europe, because the prevailing winds are south westerlies, the climate is influenced by the Atlantic Ocean over which these winds blow. The Atlantic stays about the same temperature all year. So, winds from the Atlantic moderate climate by bringing western Europe warm, not hot, temperatures in summer, mild (not cold) temperatures in winter, and a lot of rain. The Mistral wind that blows from the Alps down the Rhône Valley to southern France brings cold, dry weather.

Extension Question

Q10. What is the Sirocco?

The Sirocco is a regional wind that blows from the middle of the Sahara over North Africa, the Mediterranean, and into southern Europe in autumn or spring. It brings dust and can cause dry, windy weather in North Africa.

• Suggested Film

- Storm Surges

• How does global atmospheric circulation affect the Earth's climate?

The atmosphere moves energy (heat) from the equator toward the poles; these movements are winds. Without an atmosphere to move energy in this way then land and ocean between the tropics would be much hotter and the polar regions much colder.

The Earth's spin deflects winds, making them seem to move in large curves (this is the Coriolis effect).

The Earth's spin also creates three 'cells' of winds in each hemisphere that are connected to one another. At the Earth's surface it is these 'cells' that dominate the climate of a place. The calm, low pressure Doldrums exist near the equator, strong trade winds move toward the equator from the high pressure of 30° north and south, and mid-latitudes are dominated by windy, low pressure systems.



Around the equator there is an area of calm, low pressure called the Doldrums

• Suggested Films

- Coriolis Effect
- FactPack: Weird Weather

Extension Questions

Q11. What else moves energy from the tropics toward the poles?

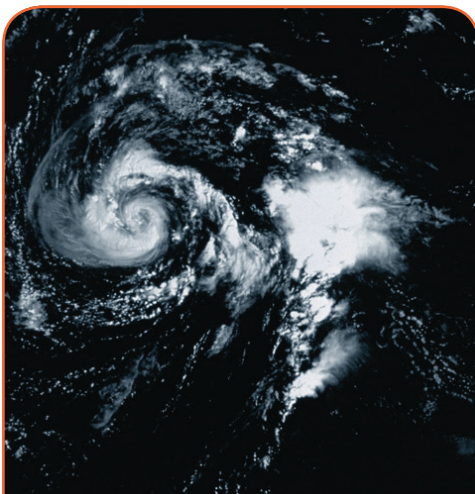
The oceans – especially currents like the Gulf Stream.

Q12. What causes the Coriolis effect?

The Coriolis effect is caused by the Earth's rotation, and it is used to explain why a wind (or ocean current) seems to be deflected from its actual course and takes a curved path. Winds blowing in the northern hemisphere will be deflected to the right of their path, and winds blowing in the southern hemisphere will be deflected to the left. It is strongest away from the equator, as winds travel across lines of latitude that are increasingly different lengths (and thus travelling at increasingly different speeds).

Section 3: Hurricanes

• What is a hurricane?



A satellite view of Hurricane Noel

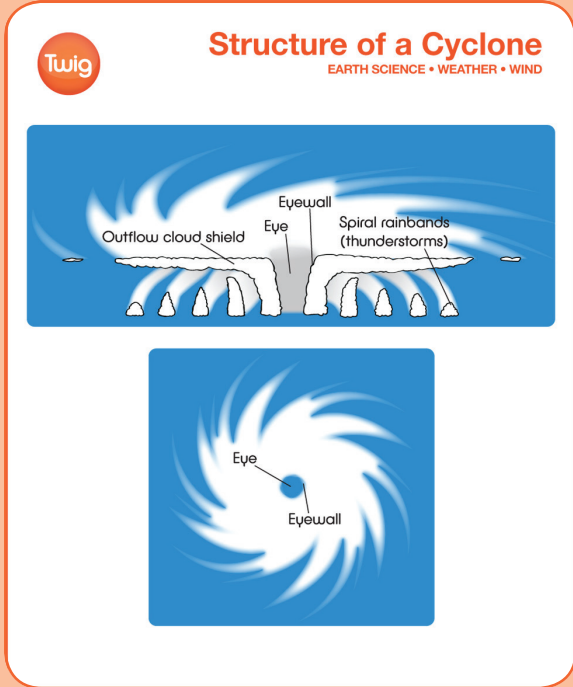
A hurricane is a huge, spinning system of rising air that can bring heavy rainfall, strong winds and storm surges to affected areas. To be classified as a hurricane, winds have to exceed 119km/h (74mph) or have a wind force measuring over 12 on the Beaufort scale.

Hurricanes are considered to be one of Earth's most powerful natural hazards. Hurricanes are tropical cyclones: tropical because they begin life in the tropics, and cyclone as they are a low pressure system. The word 'hurricane' is used in the Americas, and the words 'typhoon' and 'cyclone' are used in Asia, but they mean the same thing. These vast weather systems of low pressure can be hundreds of kilometres across. Found at the centre is often the 'eye', which is an area of relatively calm conditions without heavy rain or strong winds.

• Suggested Films

- Hurricanes
- Hurricane Katrina: Part 1
- Hurricane Katrina: Part 2

DIAGRAM 01:



Extension Questions

Q13. How are hurricanes classified in the USA?

Using the Saffir-Simpson Hurricane Wind scale (SSHWS), hurricanes are categorised into a 1–5 scale depending on wind speed. So, a category 5 hurricane is the strongest.

Q14. How are hurricanes named?

Hurricanes are named alphabetically so that the first hurricane of a season starts with 'A' and is a man or woman's name. There are six lists used for Atlantic hurricanes and if hurricanes are really destructive then new names replace the 'famous' one.

• **What conditions are needed in order for a hurricane to form?**

Hurricanes rely on the energy released when large amounts of water are evaporated from warm oceans. Oceans have to be 26.5°C or more, down to a depth of 50m. As air rises, this water vapour is condensed to form large clouds, and the energy given back out encourages further rising air and cloud growth. The effect of the Coriolis force (the Earth's rotation) encourages the whole system to spin and take the shape of a spiral. The Coriolis effect is weak at the equator, so hurricanes don't form within 5° north and south of the equator.

• **Suggested Films**

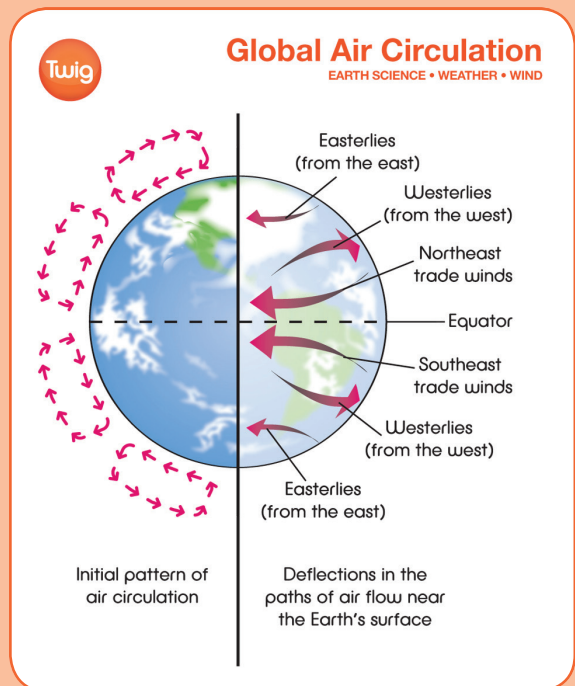
- **What is a Tornado?**

Extension Question

Q15. What are three differences between hurricanes and tornadoes?

Tornadoes are much smaller, they form over land, not sea, and they don't last as long or travel as far.

DIAGRAM 02:



• What are the effects of hurricanes and where are they felt?

DIAGRAM 03:



When hurricanes make landfall they batter the coastal areas with high winds that can reach 200km/h. Hurricanes bring heavy rainfall that can cause widespread flooding. Hurricanes also cause a storm surge in the ocean, which causes flooding of coastal areas. Hurricanes can kill thousands of people and cause widespread damage to property and farmland. The coasts of the southern USA, Caribbean islands, Central America, South Asia and Southeast Asia are commonly affected areas. Once a hurricane reaches a large area of land, it is starved of warm sea water and begins to lose power and is less destructive. Hurricanes also transport huge amounts of energy from tropical regions toward the poles.



Hurricanes are often accompanied by widespread flooding

• **Suggested Films**

- Hurricanes
- Hurricane Katrina: Part 1
- Hurricane Katrina: Part 2

• **Suggested Activity**

- Discuss: Why do hurricanes kill more people in Less Economically Developed Countries (LEDCs) but cause more damage in More Economically Developed Countries (MEDCs)?

Extension Question

Q16. Why is Chicago known as the 'windy city'?

Lake Michigan is so big it acts like a sea, and both on-shore and off-shore winds can develop in Chicago. Also, the tall skyscrapers can funnel winds into the downtown streets.

• Quizzes

Types of Weather: Wind

Basic

• Wind is air moving from

- A – low to high pressure
- B – high to low pressure
- C – high to low ground

• The Beaufort scale measures

- A – the time at which a wind blows
- B – the strength of a wind
- C – how far a wind blows

• “The Doldrums” is an area of

- A – sinking air near the equator
- B – light or no winds near the equator
- C – steady and strong winds near the equator

• Trade winds blow

- A – toward the equator
- B – away from the equator
- C – toward the poles

Advanced

• A force 10 wind is caused by air moving from

- A – very high to very low pressure
- B – very low to very high pressure
- C – a force 10 area to a force 1 area

• Between 5° north and south of the equator

- A – air is being forced to rise by intense heating of the Earth’s surface
- B – warm air moves away across the surface as trade winds
- C – high pressure is created by the warming of the Earth’s surface

• Winds blow from 30° north and south toward the equator:

- A – they are called the “Doldrums”
- B – they are strong but unreliable winds
- C – they are strong and reliable winds

• In general, the atmosphere’s circulation

- A – redistributes energy away from poles toward equatorial regions
- B – keeps the poles colder than they would be without winds
- C – redistributes energy away from equatorial regions toward polar regions

Types of Weather: Wind

Basic

- Generally, global winds move

A – warmth from the poles to the equator

B – warmth from the surface toward space

C – warmth from the equator toward the poles

Advanced

- The atmospheric circulation is best imagined as

A – six interconnected cells of winds that circle the Earth like latitude

B – six separate cells of winds that circle the Earth like longitude

C – six interconnected cells of winds that circle the Earth like longitude

Hurricanes

Basic

- Which is NOT another word for a hurricane?

- A – typhoon
- B – tornado
- C – tropical cyclone

- Hurricanes form over

- A – oceans over 27°C
- B – tropical rainforest
- C – oceans between 17°C and 27°C

- In a hurricane, warm moist air is

- A – causing high pressure
- B – rising
- C – evaporating

- The Coriolis effect

- A – is the intense evaporation caused by a hurricane
- B – is when large towering clouds are formed in hurricanes
- C – is the force that causes hurricanes to spin

Advanced

- Hurricanes are known by different names in different parts of the world:

- A – typhoons, tornadoes and tropical storms
- B – cyclones, tornadoes and typhoons
- C – tropical storms, cyclones and typhoons

- Hurricanes are more likely to form

- A – in the mid-Atlantic, where water is 28°C and the Coriolis effect is quite strong
- B – at the Equator, where ocean water is 32°C and the Coriolis effect is weak
- C – in the Atlantic, where ocean water is 17°C and the Coriolis effect is very strong

- Low pressure in the hurricane is a result of

- A – a high level of evaporation
- B – rising moist, warm air
- C – vast amounts of condensation

- The eye of a hurricane is characterised by

- A – calm weather, no rain and clear skies
- B – calm weather, high pressure and cloudy skies
- C – winds up to 200km/h

Hurricanes

Basic

• The eye of the hurricane

- A – is the most destructive part
- B – is calm
- C – is at the approaching edge of the system

Advanced

• When a hurricane 'makes landfall'

- A – it will get even stronger
- B – it will calm down because the Coriolis effect is weaker
- C – it will calm down because there is no warm ocean to provide 'fuel'

• Answers

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