



# Weather Systems

EARTH SCIENCE • WEATHER • WEATHER SYSTEMS

## Section 1: Weather Systems

### • What is the difference between weather and climate?

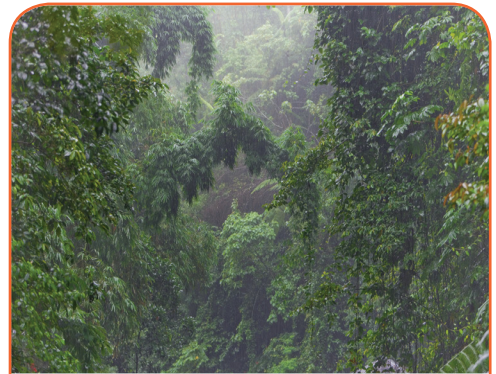
Weather is the current state of the atmosphere. If we describe the weather, we describe the temperature, wind speed and direction, precipitation (rain), cloud cover and visibility. Climate is the average weather conditions; it describes what the weather is usually like for a certain place at a certain time of year. It is worked out by taking the average of weather measurements over a 30 year period. A description of a country's climate might be warm dry summers and cold wet winters.

#### • Suggested Films

- Climate Zones
- Climate Influences

#### • Suggested Activities

- What would be the weather forecast for where you are today?
- Write a summary of the climate for your hometown.
- What would you expect the weather to be like on your birthday?



The tropical rainforest climate experiences daily thunderstorms

### Extension Questions

#### Q1. What is precipitation?

Precipitation is water in any form being transferred from the atmosphere to the Earth's surface. This includes rain, snow, hail, frost and dew.

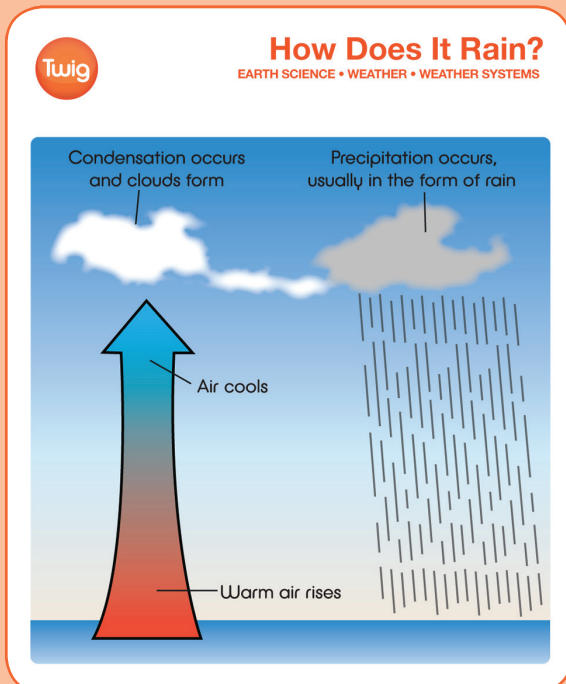
#### Q2. Which industries rely on accurate weather forecasting and where does this information ultimately come from?

The Met office is now the world's leading weather forecasting centre. It provides services to the Ministry of Defence, the Civil Aviation Authority, industry and commerce, the general public, and the Department of Environment.

#### Q3. Where does the saying "red sky at night, shepherd's delight; red sky in the morning, shepherd's warning" come from?

The Sun sets in the west. When the evening clouds are tinged light red by the setting Sun, it means that the clouds are drier to the west. The prevailing (general) wind direction in the UK is from the west or south west, this means that the drier weather that is in the west is on its way. If the sky is a darker red, the opposite is the case, the next day will be wet and stormy. This can occur at any time of day, but is most common in the hours after dawn, therefore a warning to shepherds in the morning.

### DIAGRAM 01:



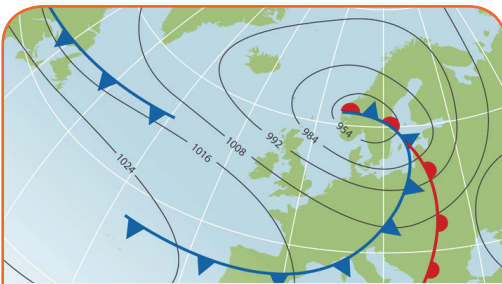
### Extension Question

#### Q4. Why do people say they are 'under the weather'?

People have always said that they are affected by the weather. The annual cycle of winter colds and flu, to the summer problems of hay fever and sunburn, are constant reminders of the effect the Sun has on our bodies. For years sceptics dismissed the idea that weather had any true impact on our health, but in 1984, SAD or Seasonally Affective Disorder was credited with being a medical condition suffered in winter time.

SAD is a mood disorder in which people who have normal mental health throughout most of the year experience depressive symptoms in the winter. Statistics on SAD in the US include that this disorder occurs in about 5% of adults, but almost 20% of people suffer some symptoms of the condition, but not enough to be officially diagnosed.

### • What do you look out for on a synoptic weather chart?



This weather chart shows isobars and fronts

A synoptic weather chart summarises all of the weather conditions symbolically. Isobars are the black lines that join points of equal atmospheric pressure at the Earth's surface. If the isobars are closer together you can expect strong winds, whereas, if they are far apart, you can expect gentle winds or calm conditions. Each isobar is labelled with the pressure in millibars (mb), 988mb for example. Fronts, or air masses, are represented by coloured lines, red for a warm air mass and blue for a cold air mass.

### • Suggested Film

- Types of Weather: Introduction

### Extension Questions

#### Q5. How is weather forecasted?

The study of weather is called meteorology. Meteorology has become increasingly advanced and accurate with technological improvements. At any one time the weather is being measured all around the world by sophisticated equipment based on weather stations out at sea, on land, on planes, ships, weather balloons and satellites. Satellites have become particularly useful because they can see weather systems developing and moving many kilometres away.

#### Q6. Can you trust the weather forecast?

The 24 hour weather forecast is now accurate 86% of the time, that's six days out of seven. The three day forecast is now as accurate as a one day forecast was 20 years ago.

#### Q7. Why is air pressure important in weather?

Because differences in pressure, or the weight of the air above us, makes air move around the planet, and this gives rise to all of our different weather systems.

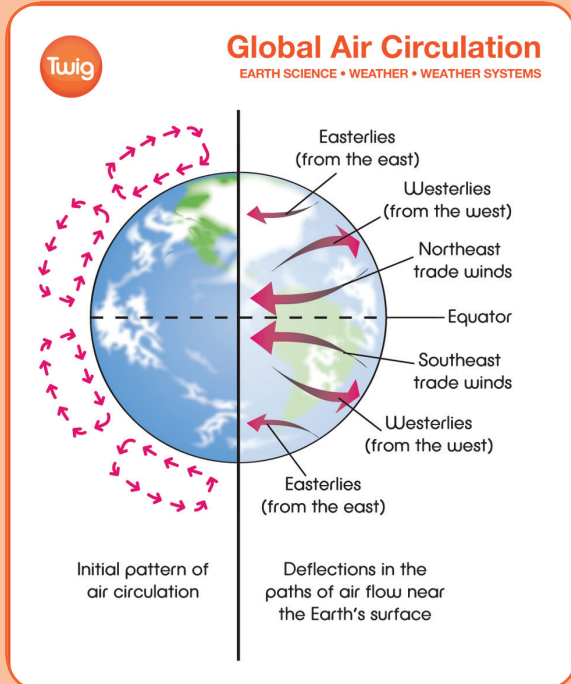
#### Q8. What is a front?

The place where warm air meets cold air is called a front.

## Section 2: Pressure Systems

- What is a low-pressure system or a 'depression'?

### DIAGRAM 02:



When air at the Earth's surface is rising, in this case over a wedge of cooler air, it causes low atmospheric pressure (the weight of air above you is being lifted up). As this warm air rises, the water vapour in it cools, condenses and then forms rain. The space created by the rising air is quickly filled by air moving in from either side. We experience this as wind. A low-pressure system, or depression of pressure, is usually characterised by wet and windy weather. These systems always swirl anticlockwise in the northern hemisphere and clockwise in the southern hemisphere. Low pressure is generally categorised as anything below a 1000mb. The lower the pressure, the worse the weather will be.

#### • Suggested Films

- Weather Systems
- El Niño

### Extension Questions

Q9. Why is a low-pressure system called a depression?

Because the isobars on the synoptic weather chart appear to form a hollow, representing a centre of lower pressure.

Q10. Why does wind direction change as a depression passes?

Winds are trying to reach the centre of a low-pressure system from where they'll be sucked up into the upper atmosphere. However, as they move they are deflected by the Earth's spin. The wind tends to blow parallel to the isobars, rather than across them. So, in the northern hemisphere, the depression circulates anticlockwise around a central low-pressure point (and clockwise in the southern hemisphere). For example, as the depression passes a particular place, the direction from where the winds are coming from will 'veer' from south west, to west, to north west.

Q11. Why do people use the saying "rain before seven, fine by eleven"?

This proverb relies on a typical weather pattern in the British Isles. Dominated by low-pressure systems, or depressions, it causes a belt of rain to travel across the country. A rain shower that fell at 7am will have usually passed in three to four hours, therefore the weather will be fine by 11am.

### • What is high pressure or an 'anticyclone'?

When air descends to Earth, the pressure felt on Earth increases. You wouldn't actually feel this change in pressure, but you could see the numbers rise on a barometer. High pressure would read as anything above 1010mb. The weather system associated with high pressure is called an anticyclone. This is because the air doesn't fall straight down to Earth, it twists around a centre point. In the southern hemisphere, the air twists anticlockwise, while in the northern hemisphere the air twists clockwise. However, winds in an anticyclone are very gentle or even non-existent.



### • Suggested Films

- Types of Weather: Introduction
- Killer Heat Wave

### Extension Question

#### Q12. What extreme weather can be associated with an anticyclone?

Atmospheric pressure systems normally move freely around the globe. However, in some cases they can become stationary. These blocks can remain in place for several days, or even weeks, causing the areas affected by them to have the same kind of weather for an extended period of time. If the blocking system is particularly high pressure, the result can be a heatwave. High pressure can cause the temperature to rise well beyond a summer average for one place. Two recent heatwaves include Chicago's 1995 heatwave, which killed 485 people in seven days, and the 2003 European heatwave, which killed 15,000 people in France and 20,000 people in Italy.

### • What are the conditions associated with high pressure?



High pressure often leads to clear, cloudless skies

In summer, high pressure means there are no clouds to protect people or the land from the Sun's rays. No clouds mean no rain, so there may be drought in some places. But as the ground heats up more and more, especially inland far from the cooling effect of the sea, the air on the Earth's surface may rise rapidly in convection currents. It will then cool, the water vapour will condense, and tall dark clouds will quickly form. The strong currents inside these turbulent forming clouds will quickly result in a thunderstorm. So, while high pressure is related to periods of clear skies and settled weather, you may occasionally experience a thunderstorm.

In the winter, without the blanket of cloud, the ground cools fast at night and quickly cools the air above it. The water vapour condenses and freezes in the sub zero temperatures, giving us frost (this is dew in the summer). The temperatures continue to drop over a period of time, resulting in wide spread ice and frost.

### • Suggested Film

- Weather Systems

Section 3: Clouds

• What is a cloud?

A cloud is a swirling mass of condensed water vapour or tiny ice crystals. They form because moist air has risen up into the atmosphere. As it does, the air cools and the water vapour in it condenses to form cloud droplets. At high altitudes water vapour is frozen in ice crystals and therefore produces little or no precipitation, whereas lower clouds, composed of water dense water droplets, are more active and produce precipitation. The turbulence within the cloud keeps them aloft. Only when the cloud droplets have joined together are they heavy enough to fall as rain.

• Suggested Films

- Thunder and lightning
- Low-Level Clouds
- High and Medium-Level Clouds
- FactPack: Superstorms

Extension Question

Q13. What is a thunderstorm?

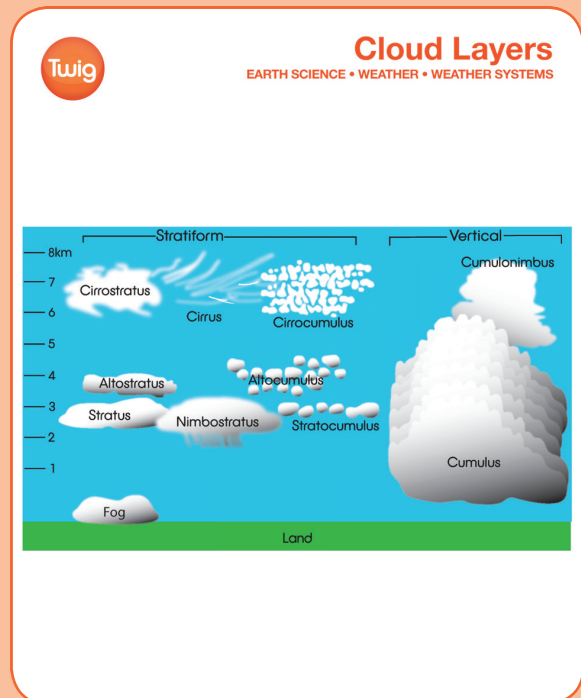
A thunderstorm is a violent weather system, usually comprised of heavy rainfall, tall dark cumulonimbus clouds, thunder and lightning.

In the southern hemisphere, a thunderstorm is more likely to occur in December, during the summer, because this is when the Sun is strongest and more effective at heating the ground. As it heats, the surface air rises in convection currents. As it cools, and the water vapour in it condenses and then rains as convective rainfall. Because of the strength of the air's uplift, the cloud is taller resulting in more violent conditions. The rapid movement of air results in static electricity being generated, which is discharged as thunder and lightning.

Q14. To measure the distance of the storm from you, you should count the seconds between seeing lightening and hearing the clap of thunder; why is this?

Sound travels more slowly than light. You see the lightning the instant it occurs, but the sound takes about 3 seconds for every kilometre to reach you. Therefore, if you count the seconds between the lightning and thunderclap, and then divide this number by 3, you can work out, approximately, how many kilometres away the storm is.

DIAGRAM 03:





### • What are high and medium-level clouds?



Here we can see both altocumulus and cirrostratus clouds

High-level clouds are those that stretch from the upper regions of the troposphere into the stratosphere; some are at altitudes as high as 12km above sea level. At this height, the freezing temperatures mean that any moisture in the cloud is locked as frozen ice crystals; these clouds therefore do not produce any precipitation. There are three types of high-level clouds: cirrocumulus, cirrostratus and cirrus; they all give a hazy effect to the sky. Moving lower to medium-level clouds, between 3 and 5km, water vapour is composed of ice crystals or water droplets. The main types of cloud are altostratus and altocumulus.

### • Suggested Film

- FactPack: Weird Weather

### Extension Questions

#### Q15. What are the layers of altitude?

Moving from the earth upwards, the layers of altitude are: troposphere (all 'weather' exists in this zone), stratosphere, mesosphere, and thermosphere.

#### Q16. What does 'cumulus' mean?

Any of the clouds with vertical development have 'cumulo' at the start of their name. For example, cumulus or cumulonimbus.

#### Q17. What does 'stratus' mean?

Stratus means layer. An stratonimbus would therefore be a layer of rain cloud.

### • What are low-level clouds?

Warmer temperatures closer to the Earth's surface mean that the cloud is usually composed of liquid water droplets, rather than just ice crystals. They often produce precipitation, but not always. These clouds have 'nimbus' in the name if they produce rain, 'stratus' in the name if they form a complete layer and 'cumulus' clouds have vertical development so look 'fluffy'. If the cloud touches the ground we call it fog.

### Extension Questions

#### Q18. What does 'nimbus' mean?

Nimbus means rain. A cumulonimbus cloud would therefore be a tall rain cloud.

#### Q19. What is a cumulonimbus cloud?

A very tall cloud that produces heavy rainfall. Often thunder, lightning and hail are also associated with these clouds. These clouds are typical of rapidly rising air in the tropics. They sometimes occur in summertime in mid latitudes.

#### Q20. Why is it wetter in San Francisco than Sacramento, California?

Westerly winds moving eastwards across the Pacific Ocean are forced upwards when they meet The Coast Ranges of California. The air cools and condenses, then falls heavily on cities such as San Francisco. Once that same air travels further eastwards, it then warms as it descends giving a drier climate, as in the city Sacramento in California's Central Valley.

### • Suggested Film

- FactPack: Superstorms

## • Quizzes

## Weather Systems

## Basic

• Which of the following are true of a description of climate, rather than weather?

- A – it was very windy yesterday, and the trees were bent right over
- B – snowfall in April is very unusual
- C – it is forecast to rain all day tomorrow

• If you want to find out the weather forecast where should you look?

- A – to the sky
- B – in a guidebook of the area
- C – on the internet

• Which of the following BEST describes the cause of rain?

- A – when moist air rises, it cools, and the water vapour in the air condenses to form clouds; the droplets become too heavy and fall back down to Earth as rain
- B – when a warm front catches up with a cold front it forces the warm air to form water droplets
- C – if air sinks lower down in the atmosphere it will eventually turn into a cloud and then rain

• What are the three types of rainfall?

- A – condensational, relief, backwards
- B – convective, relief, frontal
- C – condensational, relief, forwards

## Advanced

• When cloud droplets group together it is called...

- A – concentration
- B – coalescence
- C – congregation

• Normally, about how many millibars of pressure are there at sea level?

- A – 100mb
- B – 1000mb
- C – 10,000mb

• Which of the following is a cause of air rising (uplift)?

- A – convection
- B – infiltration
- C – urbanisation

• Which types of clouds are associated with thunderstorms?

- A – cumulus
- B – cirrus
- C – cumulonimbus

## Weather Systems

### Basic

• Low atmospheric pressure is also referred to as what type of system?

- A – storm
- B – anticyclone
- C – depression

• High atmospheric pressure is also referred to as what type of system?

- A – depression
- B – anticyclone
- C – summer

• How do you measure wind speed?

- A – an anemometer
- B – a wind vane
- C – a barometer

• Why does lightning arrive before thunder?

- A – thunder has to travel further
- B – light does not echo
- C – light travels more quickly than sound

### Advanced

• When air moves from high to low pressure it will...

- A – travel directly there in a straight line
- B – bend to the right in the northern hemisphere
- C – bend to the left in the northern hemisphere

• Which of these weather systems is normally associated with an anticyclone?

- A – high pressure
- B – cloudy skies
- C – strong winds

• If you are experiencing prolonged light drizzle, it is likely that...

- A – you are experiencing convective rainfall
- B – you are in the path of a depression
- C – you are in an anticyclone

• If isobars are close together on a synoptic weather chart, you will experience what?

- A – strong winds
- B – very light winds
- C – no rain



• Answers

**Weather Systems**

**Basic**

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**Weather Systems**

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