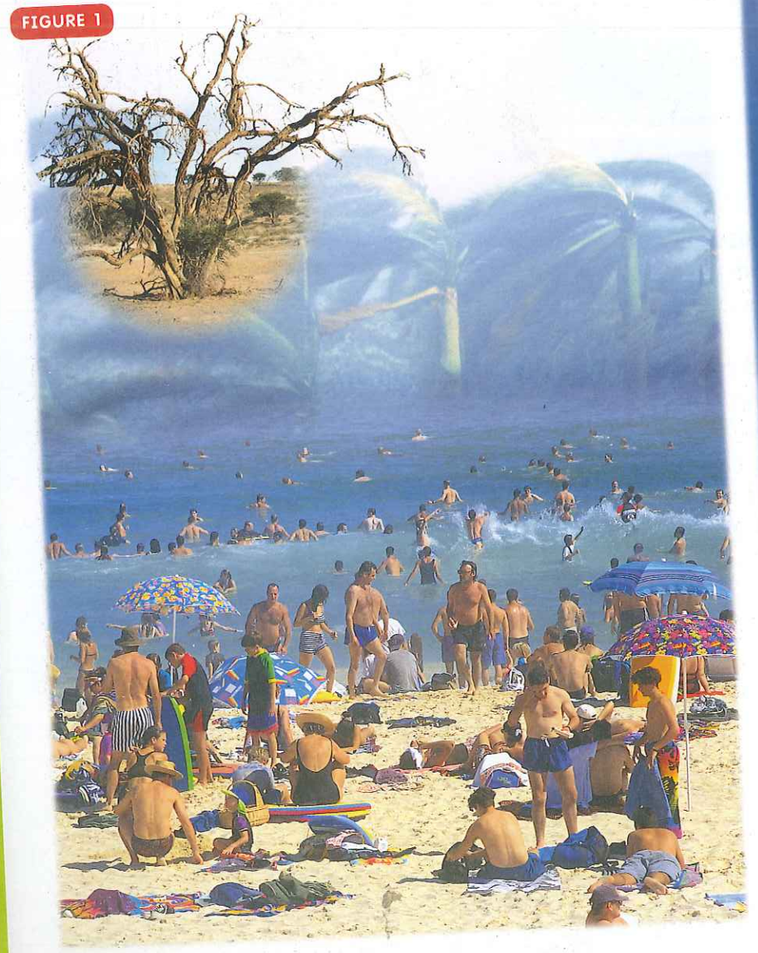
7.1 Weather — what is it?

Our Earth is surrounded by a band of gases called the atmosphere. It protects the Earth from the extremes of the sun's heat and the chill of space, making conditions just right to support life. The atmosphere has five different layers. The layer that starts at ground level, and ends about 16 kilometres above Earth, is called the **troposphere**. Our weather results from constant changes in the air in the troposphere.

Heatwaves, snowfalls, cyclones, tornadoes, floods, droughts, hailstorms — even cloudless days with gentle breezes — all begin with changes in the air in the troposphere.

The five main layers in the Earth's atmosphere are all a bit different from one another. For example, the troposphere contains most of the **water vapour** in the atmosphere.

FIGURE 1



Weather has a major impact on the way we live.

FIGURE 2

Structure of the Earth's atmosphere (not to scale)

How does weather change?

All weather conditions result from different combinations of three factors: air temperature, air movement and the amount of water in the air. The sun influences all three.

Firstly, the sun heats the air. It also heats the Earth's surface, which, in turn, heats the air even further. How hot the Earth's surface becomes depends on the season and the amount of cloud cover.

Secondly, the sun causes air to move. This is because land surfaces are heated more by the sun than oceans are. As the warmer air over land gets even warmer it expands, and as it expands it rises. When hot air rises, colder air moves in to take its place.

Thirdly, the sun creates moisture in the air. The heat of the sun causes water on the Earth's surface to **evaporate**, forming water vapour. As this water vapour cools, it forms clouds. It may return to Earth as rain, dew, fog, snow or hail.

The difference between weather and climate

Weather is the day-to-day, short-term change in the atmosphere at a location. Climate is the average of weather conditions that are measured over a long time. Places that share the same type of climate are said to lie in the same climatic zone.

Because of Australia's size, the continent's climate varies considerably from one part to another.

FIGURE 3 Climatic zones of Australia

Activities

Student workbook 7.1

REMEMBER

1 What is the name of the layer of the atmosphere where all Earth's weather happens?
2 What role does the sun play in influencing weather patterns?
3 What is the difference between weather and climate?
4 In which levels of the atmosphere are the following features found?
(a) Most passenger planes
(b) Orbiting satellites
(c) Burning meteors

THINK

5 Look carefully at the three photographs in figure 1.
(a) Describe the weather event in each photograph.
(b) How would each weather event affect people's lives?
6 Describe how the weather affected you yesterday.

COMMUNICATE

7 Look carefully at the map of Australia's climatic zones (figure 3).
(a) Describe the climate in each of these places: Darwin, Brisbane, Kalgoorlie, Alice Springs, Adelaide, Hobart.
(b) Find the description for the climate zone in which you live. Does it describe the weather there today? Explain.
8 From a magazine or newspaper, cut out a photograph that shows an example of one type of weather. Glue the picture in the centre of a page and add labels pointing to the impact of that weather on the environment and on what we do (such as puddles or the clothes people are wearing).

evaporate change liquid (e.g. water) into a vapour (a gas) through heat
troposphere the layer of the Earth's atmosphere closest to the Earth. It extends to about 16 kilometres above the Earth's surface and is where Earth's weather occurs.
water vapour water in its gas form, formed as a result of evaporation

7.2 The sun — the source of all our energy

The sun influences our weather by sending out **solar radiation** that reaches the surface of the Earth. This energy affects the atmosphere by heating the air and water contained in it. Sometimes a sun halo can form as a result of the interaction of light and moisture. This phenomenon was often used in early weather forecasting.

Reason for the seasons

Why is Melbourne having a heatwave while people in the United States are having blizzards? Melbourne is in the southern **hemisphere** and the United States is in the northern hemisphere. When a hemisphere tilts towards the sun, the sun's rays 'hit' it more directly. This means that a larger area is in more intense sunlight for longer. So days are longer and warmer. This hemisphere experiences summer.

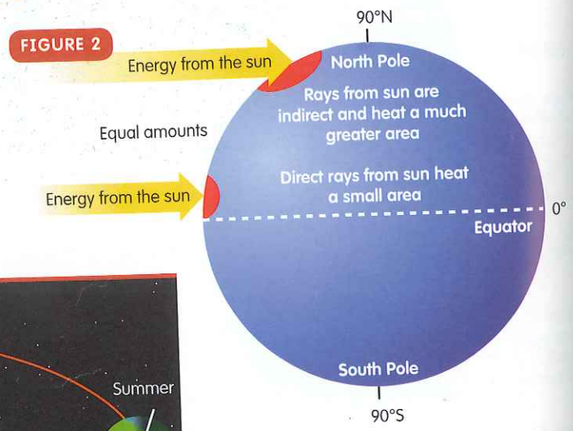
When a hemisphere tilts away from the sun, the sun's rays 'hit' it at more of an angle. So heat energy from the sun's rays is spread out more and is not as intense. Days are shorter and colder. This hemisphere experiences winter. When neither hemisphere tilts towards the sun, which happens during autumn and spring, each hemisphere receives the same amount of the sun's rays. So there is not much difference between, say, a northern hemisphere spring and a southern hemisphere autumn.

The four seasons that are typical of places such as Melbourne occur because of the tilt of the Earth's axis. Note in the diagram below how the sun's rays cover more of the southern hemisphere than the northern hemisphere during an Australian summer.

FIGURE 1

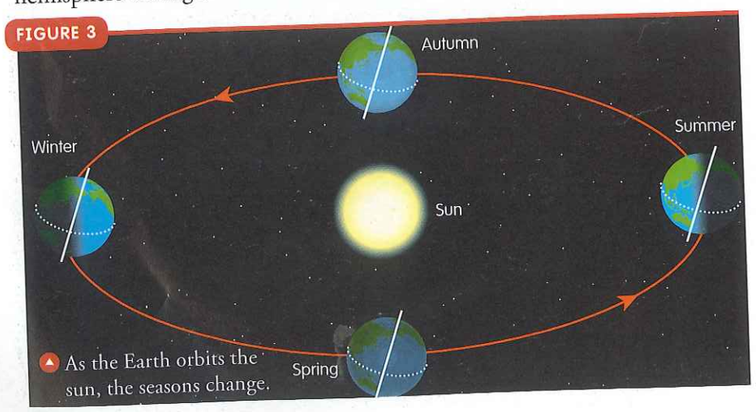
A sun halo formed by clouds and moisture

FIGURE 2



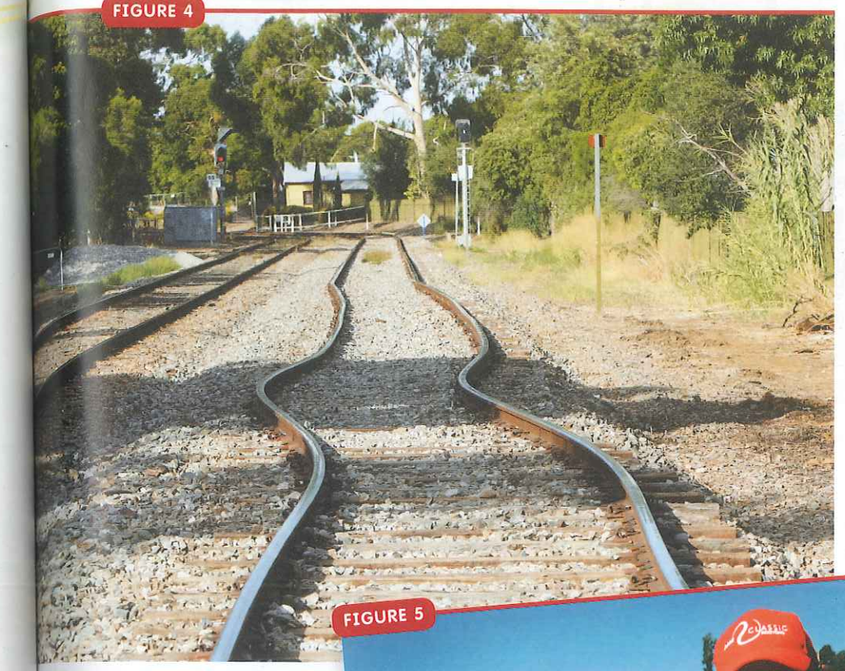
The sun's rays are more direct at the equator. With more energy focused on that region, it heats up quickly. At the poles, the sun's rays are spread over a larger area and therefore cannot heat up as effectively. Thus, areas at the poles are much cooler than areas at the equator.

FIGURE 3



As the Earth orbits the sun, the seasons change.

FIGURE 4

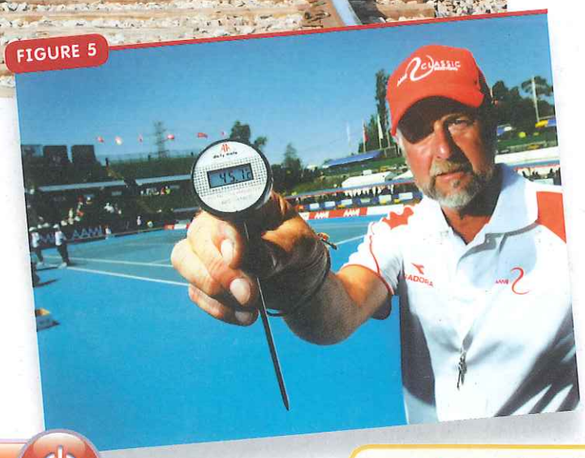


A prolonged heatwave buckled these railway lines near Melbourne.

Heatwaves

Heatwaves are weather hazards caused by extremely hot and humid days with very little air movement to help cool things down. These events are expected to become more frequent in Melbourne in the future. Heatwaves may not be as spectacular as floods or cyclones but they can cause deaths, especially among the elderly. They can also disrupt sporting events and public transport and increase water and power consumption. Planners are looking at ways to cope with these events, including building rooftop gardens to cool high-rise buildings and provide shade.

FIGURE 5



When the temperature reading on a tennis court reaches a certain value in an important tournament, such as the Kooyong Classic in Melbourne, tournament directors can invoke hot weather policies that ensure players will not have to play matches in excessive conditions.

Activities

hemisphere one half of the Earth, as divided by the equator
solar radiation energy from the sun that heats the Earth

REMEMBER

1 What is the major influence on our weather?
2 What is a heatwave?
3 In what season do heatwaves usually occur?
4 Identify four possible effects that heatwaves may have.

THINK

5 Describe the weather conditions that can occur in the United States at the same time as our heatwaves occur.
6 Explain why areas near the equator are warmer than areas near the poles.
7 What season was the northern hemisphere experiencing in January?

TEAMWORK

8 Working with a partner, use two balls (a soccer ball to represent the sun and a tennis ball to represent the Earth) to simulate the Earth's orbit around the sun. Remember to keep the 'Earth' tilted on its 'axis', as shown in figure 3. Use this science simulation to explain why temperatures at the equator change very little throughout the year.

COMMUNICATE

9 Find a current weather event article in the newspaper or on the internet. Prepare a short report on the article, and answer the following:
(a) In what season did the event occur?
(b) Describe the nature of the weather event.
(c) What was the impact of the event?

7.3 Hot and cold places

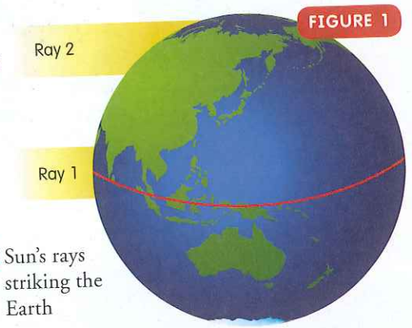
The world's warmest places are in the tropics (near the equator) and the coldest places are nearer the poles. There are several other factors besides **latitude** that determine the temperature of a particular place, including **altitude** and distance from the sea.

What determines temperature?

The hottest place in the world is Dallol in Ethiopia (which is 12 degrees north of the equator), where the average annual temperature is 34°C. The coldest place is Russia's Vostok Base in Antarctica (which is 78 degrees south of the equator), where a temperature of –89.6°C has been recorded.

The general differences in world temperatures are determined by the angle at which the sun's rays hit the Earth's surface. Figure 1 shows that the area heated by Ray 1 is much smaller than the area heated by Ray 2, because of the angle of the Earth's surface. At the equator, the sun's rays have a smaller area of the Earth's surface to heat, so these areas will be hotter.

FIGURE 1



Sun's rays striking the Earth

FIGURE 2 Climatic zones of the world

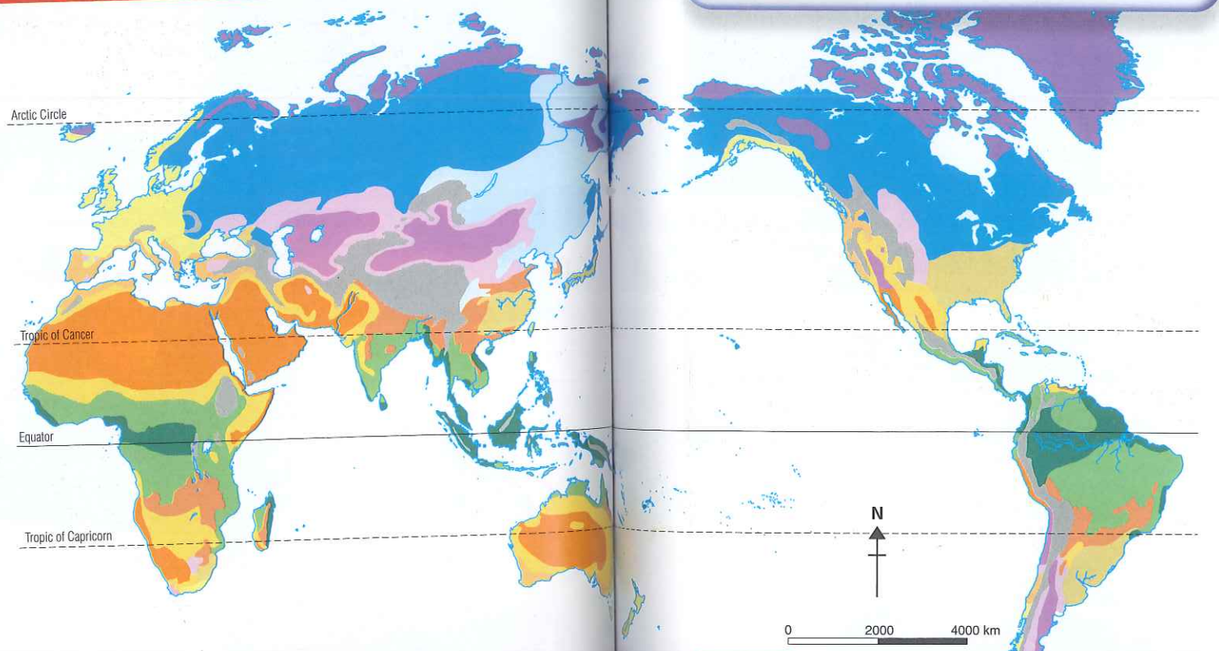
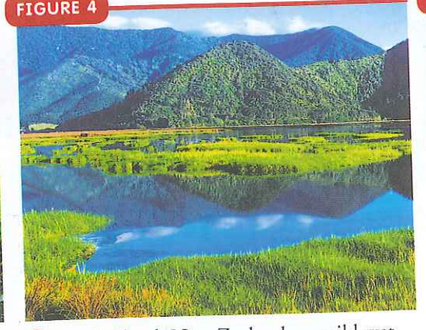


FIGURE 3

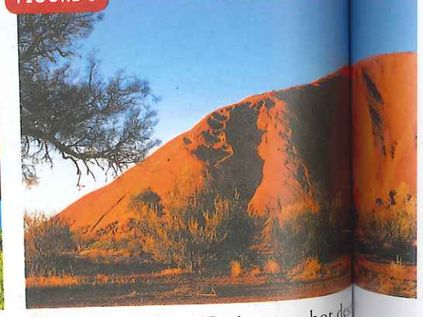
The Daintree, Queensland — tropical wet

FIGURE 4



South Island, New Zealand — mild wet

FIGURE 5



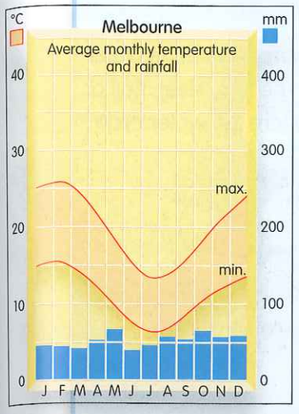
Uluru, Northern Territory — hot de

FIGURE 6

Alberta, Canada — cold, wet

SkillBooster

Drawing a climograph



Climographs are a combination of a bar graph and a line graph, and are used to show the climate of a place over a 12-month period. The line graph section always shows average monthly temperature and the bar graph represents average monthly rainfall. Be careful to read from the correct axis when studying climographs.

Activities

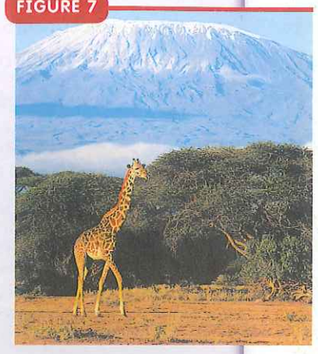
Student workbook 7.2

REMEMBER

1 Name the world's hottest and coldest places.
2 Why are temperatures higher at the equator than at the poles?

THINK

FIGURE 7



3 Look at figure 7, an image of snow-capped Mt Kilimanjaro. This African mountain is located three degrees south of the equator.
   (a) What type of climate do you expect near the equator?
   (b) How can snow fall so close to the equator?
4 What is the difference between a tropical wet and a tropical wet and dry climatic zone?
5 Which climatic zone is extremely cold all year round? Explain.
6 Based on the information provided in figure 2, what sort of climatic zone do you live in? If you could change it, what sort of climatic zone would you most like to live in, and why?
7 Head up a page with the names of climatic zones listed in the map key. Then use an atlas to sort the following place names according to the climatic zone in which they lie:

Helsinki	Cairo	Hobart	Calgary
Edmonton	Oodnadatta	Santiago	Paris
Denver	Manaus	Cooktown	Brisbane

COMMUNICATE

Drawing a climograph

8 Draw a climograph using the statistics below. This could also be created using Excel.
   (a) In which climatic zone does this city lie?
   (b) Using an atlas to help you, decide if the mystery city is New York, Sydney or Singapore. Give reasons to support your choice.

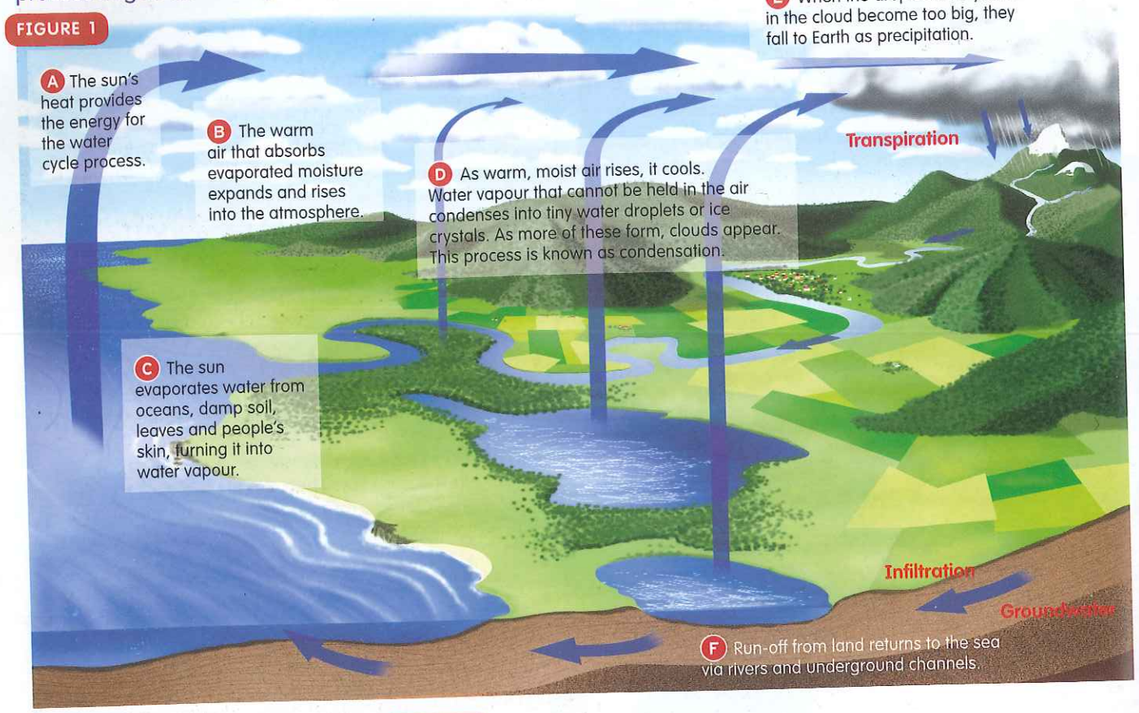
Month	J	F	M	A	M	J	J	A	S	O	N	D
Av. rainfall (mm)	250	180	195	190	175	175	173	200	180	210	252	255
Av. max. temp (°)	29	31	31	31	31	31	30	30	30	30	30	29
Av. min. temp (°)	23	24	25	25	25	25	25	25	24	25	24	23

altitude height above sea level
latitude distance north or south of the equator, measured in degrees, minutes and seconds

7.4 The water cycle

What causes rainfall? Where does the water come from and where does it go? The answers lie with the water cycle. Water **evaporates** from oceans, lakes and vegetation and **condenses** into clouds. The rain, sleet, hail or snow that falls from clouds flows back into rivers, lakes and oceans and underground, where the water cycle process begins all over again.

FIGURE 1



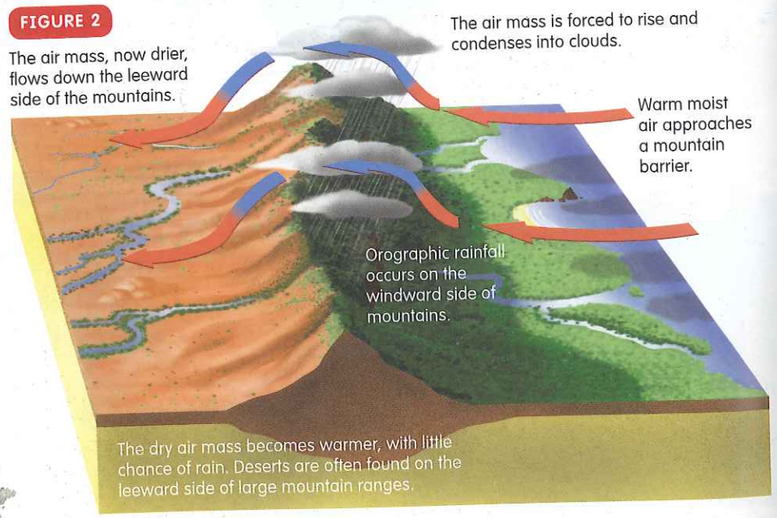
▲ The water cycle

Rising air

Under normal conditions, the temperature of the air gradually decreases with increasing height. So as warm, moist air rises, it becomes cooler. Cool air cannot hold as much moisture as warm air. Therefore any water vapour that the air cannot hold condenses into water droplets (or ice crystals) and forms clouds. Eventually precipitation occurs.

Warm moist air is pushed up into the atmosphere in three ways. Figures 2, 3, and 4 show how each of these actions (and associated rainfall) occurs.

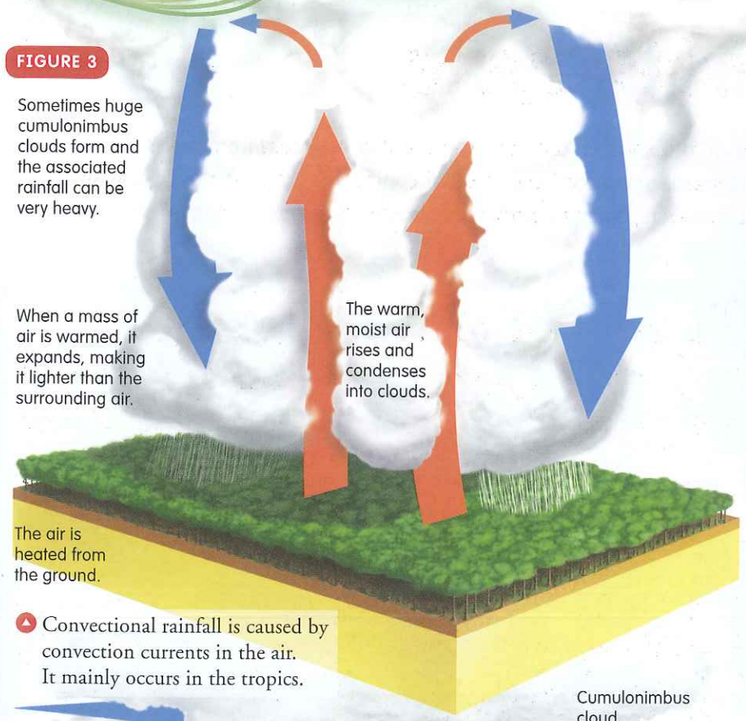
FIGURE 2



▲ Orographic rainfall is caused by the shape of the land.

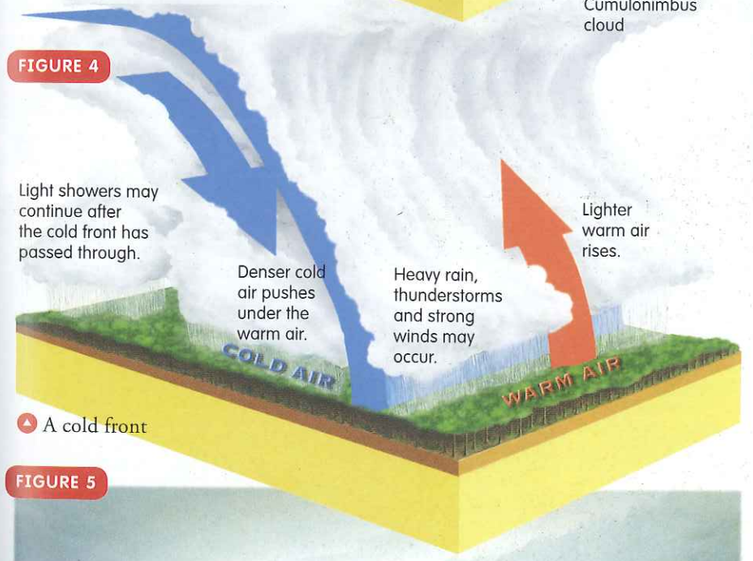
FIGURE 3

Sometimes huge cumulonimbus clouds form and the associated rainfall can be very heavy.



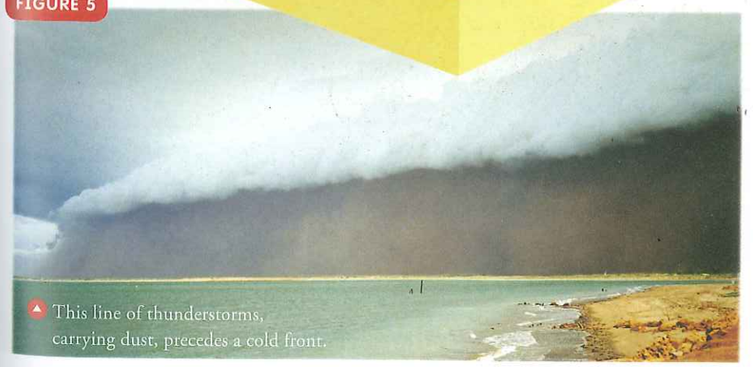
▲ Convectional rainfall is caused by convection currents in the air. It mainly occurs in the tropics.

FIGURE 4



▲ A cold front

FIGURE 5



▲ This line of thunderstorms, carrying dust, precedes a cold front.

Activities

Student workbook 7.3

REMEMBER

1 What form of energy powers the water cycle?
2 Choose terms to explain each of the following changes:
(a) water to water vapour
(b) water vapour to cloud
(c) cloud to rain.

THINK

3 Explain how clouds form.
4 Refer to figure 5.
(a) Does it show convectional, orographic or frontal uplift of air?
(b) Make a sketch of the photograph and add labels to show what is happening.
5 The wettest place in Australia is Babinda in Queensland, with 4537 millimetres (average) of rainfall annually. The driest place is Troudaninna in South Australia with 105 millimetres (average) of rainfall annually. Use the map of Australia on page 181 and your knowledge of rainfall to explain why this difference occurs.

COMMUNICATE

6 Using an outline map of the world and an atlas, mark in:
(a) the world's major mountain ranges
(b) the world's major deserts
(c) arrows showing the direction that you think rain-bearing winds might travel
(d) a title, key, north arrow, scale and source.
7 Using examples from your map, show how many deserts are found on the leeward side of mountain ranges.

condensation the process by which water vapour in the air cools and turns into droplets of water
evaporation the process by which water turns into water vapour (a gas) when heated
transpiration the process by which water is lost from the pores of leaves into the atmosphere

7.5 Signs in the sky

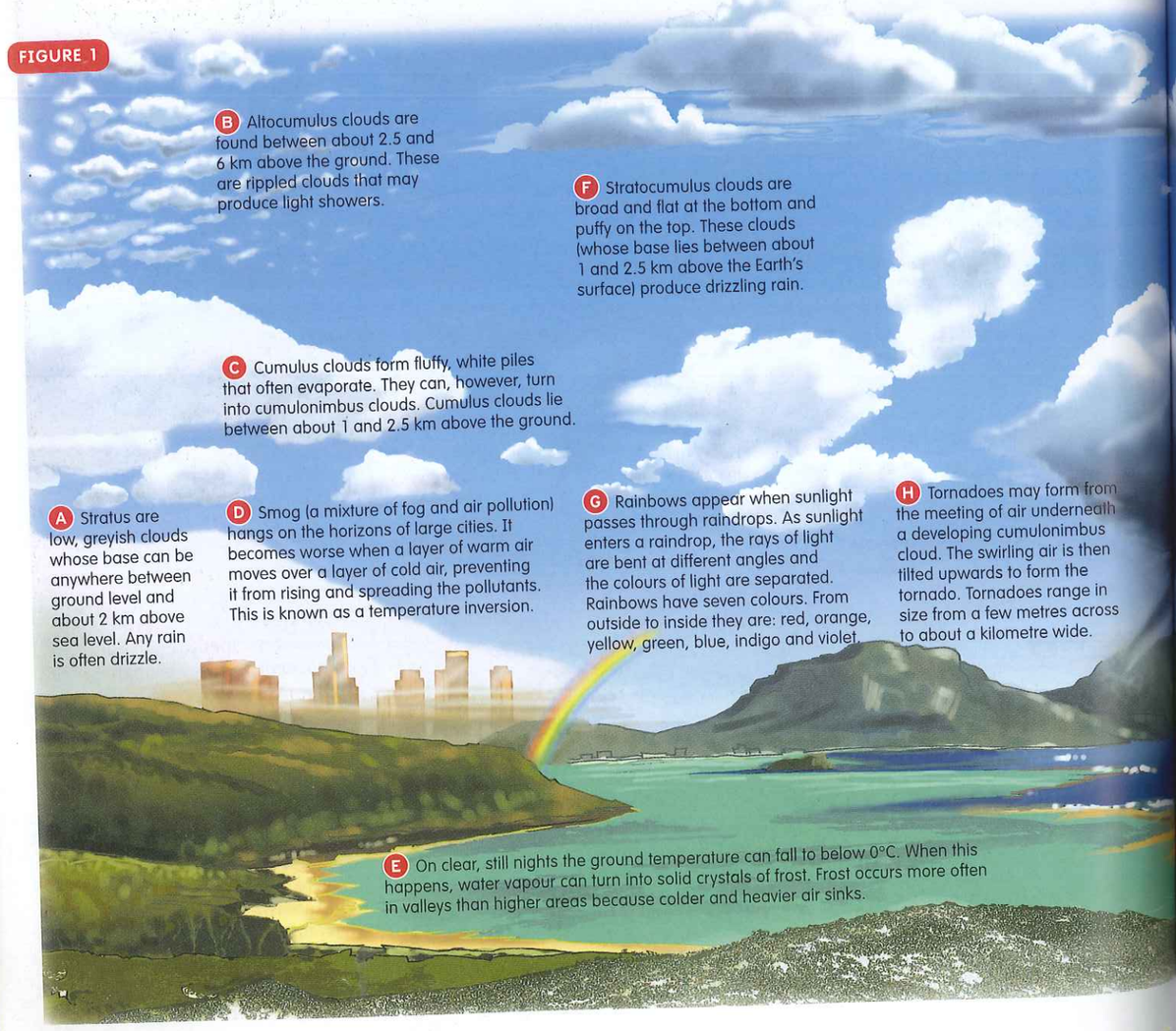
White, wispy shapes skip across the sky. Clouds put on a daily show in our skies. Apart from their interesting shapes and colours, clouds can provide a useful indication of weather conditions. Weather observers around Australia send regular reports to Bureau of Meteorology forecasters on cloud types and height and the amount of sky covered.

Cloud types

Clouds come in a range of textures, shapes and sizes. Some form only at certain altitudes. Cumulonimbus clouds grow vertically and may be up to 16 kilometres tall, extending right up through the troposphere. Clouds can generally be described as belonging to one of three main types. The meanings of their Latin names give us some idea of their appearance:

- *strato* means smooth, flat layer
- *cumulo* means pile or heap
- *cirro* means curl
- *nimbus* means rain.

FIGURE 1



static electricity electricity produced by friction (when things rub together)

wavelength Light waves, like sound waves, are movements of energy, usually up or down. Wavelength is the distance between the same point at either the top or the bottom of two waves that are side by side.

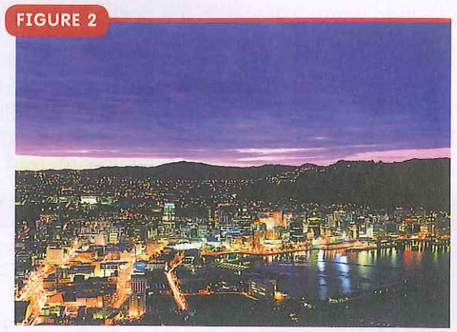
Activities

Teacher guide T7.1

REMEMBER

1 Identify the type of cloud shown in figure 2.
(a) Where is it usually found in the sky?
(b) What type of rain do these clouds bring?

FIGURE 2



THINK

2 Look carefully at the illustration opposite.
(a) Describe what cumulus clouds look like.
(b) Clouds are categorised as low (from the Earth's surface to about 2 km), middle (about 2 to 6 km), or high (above 6 km). Give one example for each.
(c) Which clouds are made of ice crystals, and why?
(d) What are the similarities and differences between fog and clouds?
(e) What types of clouds can you see today? Will they produce rain? Explain.

FIELDWORK

3 Work in small groups for this activity, sharing tasks and planning the exercise. Observe the clouds you can see in the sky above your schoolyard over a two-week period. *Do not look directly at the sun.*
- Use a rain gauge to measure the rainfall.
- On each day, measure the temperature using a thermometer. The thermometer should be placed in a shady location about a metre above the ground and well away from buildings.
- Estimate the percentage of the sky covered by cloud.
- Identify the type(s) of cloud.
- Draw up a table like the following one, and record your results in it.

Date	Time	Temp.	Cloud type	Cloud cover	Rain

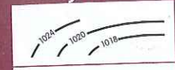
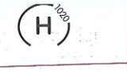
(a) Is there a relationship between the percentage of cloud cover and temperature?
(b) Is there a relationship between the type of cloud and temperature?
(c) Did any rain fall during your trial? If so, which clouds produced rain?
(d) Produce a summary of your report findings.

7.6 Reading a weather map

Everyone's life is affected by the weather. It has been watched, predicted, even worshipped, for thousands of years. People who study and predict it today, called meteorologists, have much more accurate ways of doing so than were available in the past. These include satellite images, **radar-tracking weather balloons**, automatic weather stations, ships and aircraft.

Weather maps appear every day on the weather segment of television news and in the weather section of newspapers. They may look complex. However, just as you learned to read words — and as musicians learn to read music — it is only a matter of knowing how to 'read' the symbols.

Weather maps code

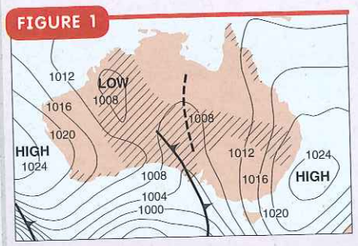
Symbol	Name	What does it mean?	Comment
	Isobars	Join places of same air pressure.	The closer together these lines, the stronger the wind.
	High pressure area	Sinking air	Generally fine weather. Winds rotate around these areas anticlockwise.
	Low pressure area	Rising air	Generally cooler weather, rain. Winds rotate around these areas clockwise.
	Tropical cyclone	Rapidly rising air	Strong winds, torrential rain
	Cold front	The 'line' along which an approaching mass of cold air meets warmer air	Fall in temperature, rain. Front moves in direction of arrowheads.
	Warm front	The 'line' along which an approaching mass of warm air meets colder air	Temperature rise, sometimes light rain. Uncommon in Australia.
	Rain	Rain in the last 24 hours	Usually associated with low pressure areas and fronts

Activities

THINK

1. What is a weather map, and why is it useful?
2. Explain what isobars, cold fronts and low and high pressure systems are.
3. Trace and then enlarge the following weather map.

FIGURE 1

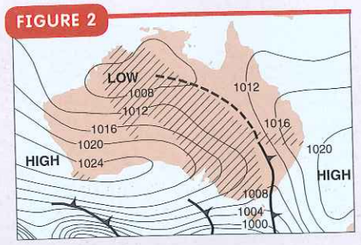


Colour the high pressure systems (pressure above 1013 millibars) dark blue and low pressure systems (pressure below 1013 millibars) red. Shade with light blue any areas that have had rain in the past 24 hours.

Use your map to help you explain what the weather was like.

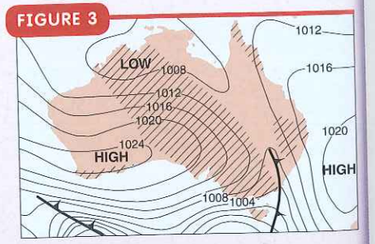
4. The map below, produced on 11 November, predicts the weather for 12 November. List what is different from the previous day's weather map (figure 1).

FIGURE 2



5. The map below shows what the weather was actually like on 12 November.

FIGURE 3



(a) Compare the actual weather conditions with those predicted 24 hours earlier. How accurate was the predicted weather map? Where was it different?

(b) Use the SkillBooster opposite to help you describe Melbourne's weather on 12 November.

SkillBooster

Student workbook 7.4

Reading a weather map

Weather maps use lines and symbols to show regions of low and high pressure and weather events such as warm and cold fronts.

The lines are called isobars. They join places with the same **atmospheric pressure**. Atmospheric pressure is the weight of air. It varies from place to place, depending on the temperature of the air. Meteorologists use very sensitive instruments called barometers to measure atmospheric pressure.

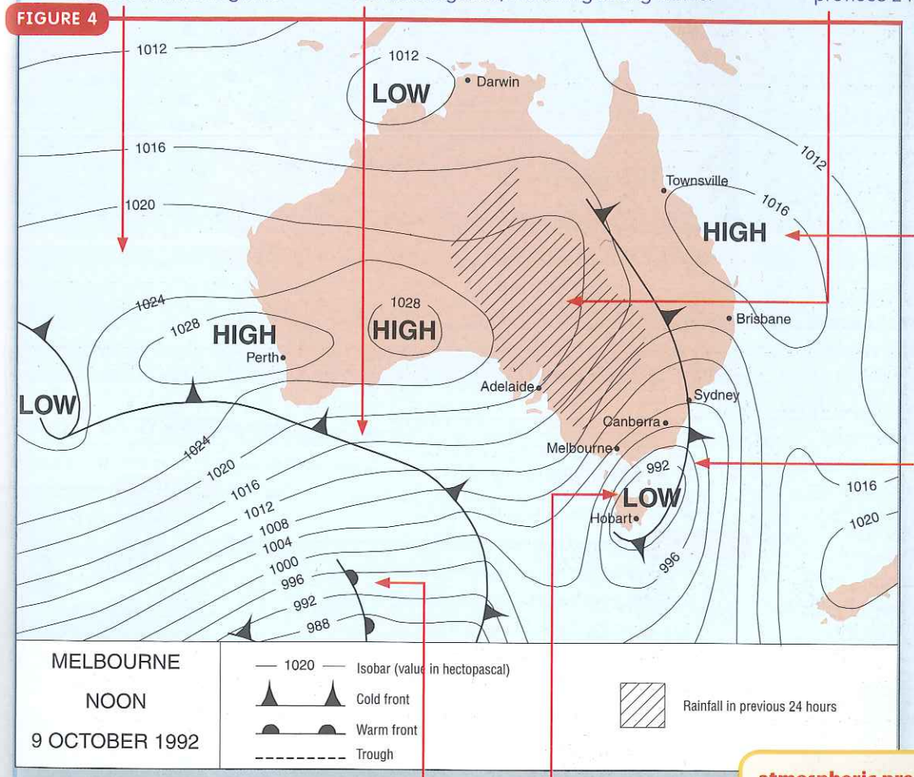
The average weight of air is 1013 millibars (or kilopascals). Measurements higher than this average (e.g. 1020 millibars) indicate regions of high atmospheric pressure, where air is sinking. Measurements lower than this (e.g. 985 millibars) indicate regions of low atmospheric pressure, where air is rising. Let's use this code to read the weather map below.

Greater distance between isobars indicates wind is weaker in these regions.

Cold front advancing from west to east — towards southern Australia. Note how the isobars behind it are close together, indicating strong winds.

Shading indicates rain fell in the previous 24 hours.

FIGURE 4



Typical weather map

High pressure system. Note how the isobar is joining points with an atmospheric pressure of 1016 (higher than 1013 average).

The cold front that has just passed over Melbourne has brought unsettled, rainy weather behind it. More rainy weather is likely for Melbourne when the cold front coming towards it from the west gets closer.

The main influences on Melbourne's weather are the low pressure system south of it, the high pressure system to the north-west, and the cold fronts to the west and east.

Warm front advancing from west to east behind the cold front. Note the lower atmospheric readings on the isobars.

Low pressure system. Note how the isobar is joining points with an atmospheric pressure of 992 (lower than the 1013 average).

atmospheric pressure the pressure that the weight of the air in the atmosphere exerts on the Earth's surface. Rising air reduces this pressure; falling air increases it.

radar tracking weather balloon an airborne balloon that uses radar technology to gather information on winds in the upper atmosphere, as well as on cloud and precipitation patterns

7.7 Too much rain — floods

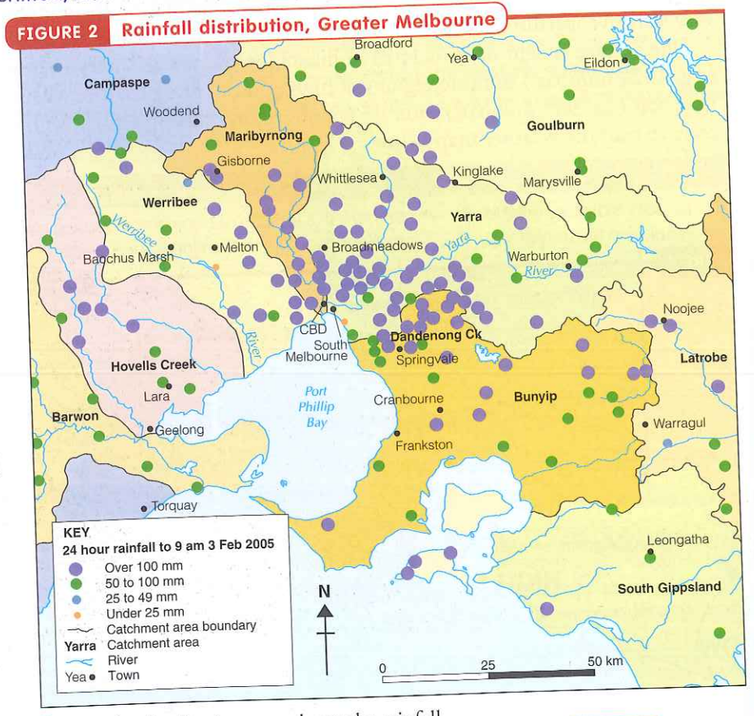
Flood disasters in Australia are responsible for damage to property and the loss of livestock. Since 1788 more than 2000 people have been killed by floods, equalling the number of deaths from cyclones. In some cases, entire sections of a town have been shifted, as in 1852 when one-third of the town of Gundagai disappeared.

A flood occurs when water spills over a river channel onto land that is normally dry. People who live on flat land near a river may experience floods regularly. Some of these floods cause little damage. However, when a lot of water enters a river channel after very heavy rainfall, major flooding can occur.

Melbourne flood, 2005

On 3 February 2005, Melbourne was brought to a standstill by the biggest downpour since records began in 1856. Melbourne recorded 23 per cent of its annual rainfall in just one day. An intense low pressure system had dumped a record 120.2 millimetres of rain in just 24 hours, closing roads, railways and airports. Winds of more than 100 kilometres per hour added to the chaos by bringing down trees and power lines, cutting off power to 120 000 homes. The storm put great pressure on the State Emergency Service, police, ambulance and fire services, who received a record number of calls for help.

FIGURE 2 Rainfall distribution, Greater Melbourne



This dot distribution map shows the rainfall in the 24 hours leading up to the flooding.

FIGURE 3

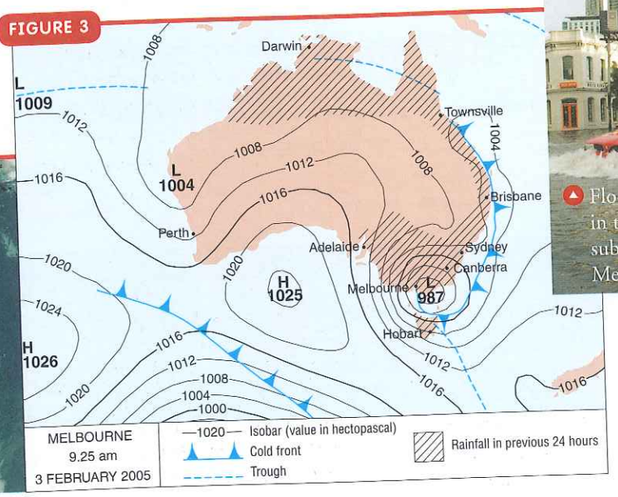
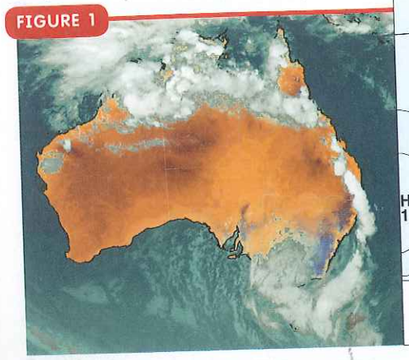


FIGURE 1



Satellite image and matching **synoptic chart** of the weather at 9.25 am, 3 February 2005

FIGURE 4

Floodwaters in the inner suburb of South Melbourne

FIGURE 5

Flood warnings

Floods can be classified as minor, moderate or major. These are defined as follows:

- *Minor flooding:* Causes some inconvenience, as low-lying areas next to rivers and streams become inundated. Minor roads may close as some bridges are covered by water.
- *Moderate flooding:* In addition to the above, some houses may require evacuation and main roads become covered in water. Rural areas are likely to be worse off.
- *Major flooding:* In addition to the above, large areas of rural and urban land become covered, cutting off many residential properties. Major transport routes are likely to be closed, with many evacuations being necessary — as, for example, during the floods in north Queensland in January 2009.

Official advice about flooding following severe weather events (often called a flood watch), or warnings of floods that are happening or about to happen, can be obtained from the website of the Bureau of Meteorology at www.bom.gov.au.

catchment area an area of land drained by a river and its tributaries
flood water inundation, usually when a river overflows its banks and covers the surrounding land
synoptic chart commonly called a weather map, containing current weather details of the specific area covered

Activities

Student workbook 7.5

REMEMBER

1 What is a flood?
2 When do floods occur?
3 What problems occurred in the floods and high winds that hit the Melbourne area on 3 February 2005?

COMMUNICATE

4 Look carefully at the dot distribution map of Melbourne's rainfall (figure 2). Each dot represents the rainfall measured at a recording station.
(a) How many millimetres of rainfall were recorded at the station to the south-east of Warragul?
(b) Describe the location of the two recording stations that were faulty during the downpour. Explain your answer.
(c) Which **catchment area** received the greatest rainfall?
(d) Which catchment area received the least rainfall?
5 Examine the satellite image and synoptic chart shown opposite (figures 1 and 3).
(a) Was the air over Melbourne rising or sinking?
(b) Describe the areas of Australia where rain had fallen in the past 24 hours.
6 Compare the satellite image and weather map.
(a) How is the line of clouds that runs from Melbourne to Brisbane shown on the weather map?
(b) In which direction was the cold front heading?
(c) Look at figure 3. Why does the arrival of a cold front often cause rainfall?

SELF-DISCOVERY

7 (a) What level of flood warning would the Melbourne flood of 2005 have reached?
(b) Use the Bureau of Meteorology weblink in your eBookPLUS to find out more about flood warnings. Prepare an information sheet that could be released to a rural community about to be affected by a major flood event.

7.8 SkillBuilder

Understanding aerial photographs

What are aerial photographs?

These are photographs of an area of the Earth's surface, usually taken from an aircraft. They show more detail of a specific area than a photograph taken at ground level could.

Why are they useful?

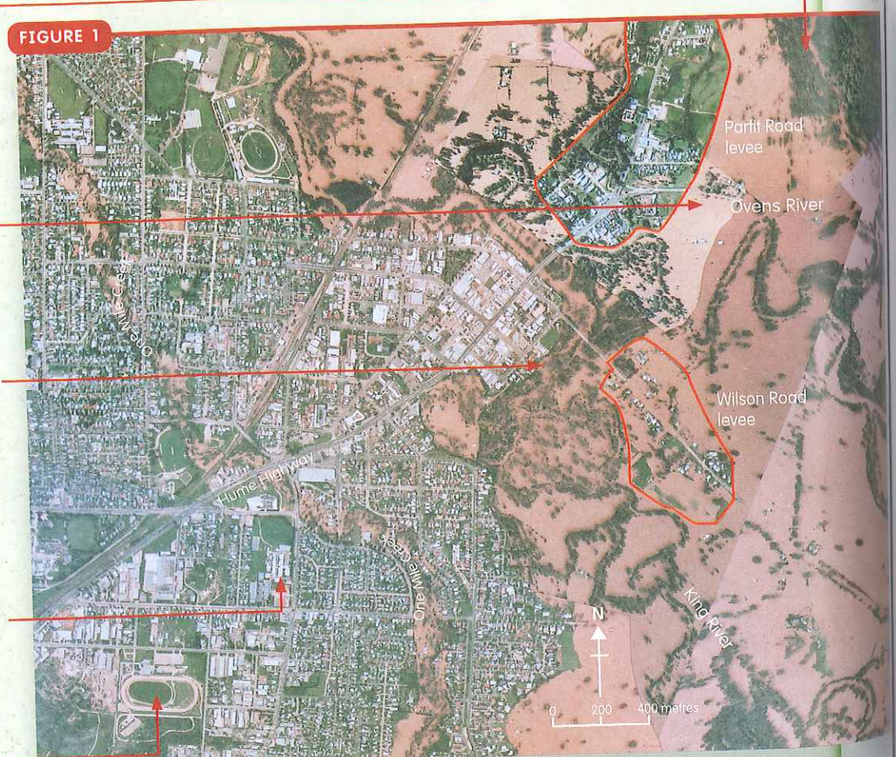
Vertical aerial photographs have a view of the landscape similar to a plan view and are usually the basis for drawing accurate topographic maps. They provide a unique and fascinating view of an area, enabling us to identify landmarks with their distinctive shapes, land uses, geographical patterns and changes over time. These patterns cannot always be as easily identified on the ground. One disadvantage of aerial photographs is that heights cannot be accurately measured. However, an understanding of aerial photographs can help people when they are planning where to build or live in a flood-prone area.

How to interpret an aerial photograph

The aerial photograph below shows the floodwaters that hit the town of Wangaratta in October 1993. These elements of aerial photographs can help us identify specific features:

- ***Texture:*** Objects possess a degree of coarseness or smoothness — for example, forests appear coarse compared with smoother grass.
- ***Tone:*** Objects reflect light, and the colour of the landscape can help identify the features and land uses — for example, floodwaters can be recognised by their distinctive muddy colour.
- ***Pattern:*** Rivers can be identified by their winding path and the trees lining their banks, while towns can be identified by the rectangular pattern of their streets.
- ***Size:*** Objects vary in size — for example, factory buildings, schools, hospitals and shopping centres are larger than houses.
- ***Shape:*** Objects have a distinctive shape — for example, horse-racing tracks and sporting ovals.

FIGURE 1



How to draw a map from an aerial photograph

Drawing a map fro m an aerial photograph helps you to simplify the information and interpret it more easily. It also shows you the relationships between the features and enables you to make predictions for future planning.

YOU WILL NEED:

- an aerial photograph
- tracing paper, paperclips or clear adhesive tape
- pencils or fine liners (ballpoint pens are not a good idea on tracing paper).

STEP 1

Use the paperclips or tape to secure your tracing paper to the aerial photograph (figure 2).

STEP 2

Decide on the detail and specific features that are to be included. Using the Wangaratta map, mark in the following features: the major transport routes (Hume Highway and Melbourne–Sydney rail line), the usual course of the Ovens and King rivers and One Mile Creek, the Wangaratta township, the extent of the floods and the two levee banks (figure 3).

STEP 3

(a) Use colours or symbols to identify features on your map (figure 4).
(b) Complete the map by including BOLTSS (border, orientation, legend, title, scale and source).
(c) Attach your completed overlay map to a sheet of plain paper so the features stand out clearly.

FIGURE 2

FIGURE 3

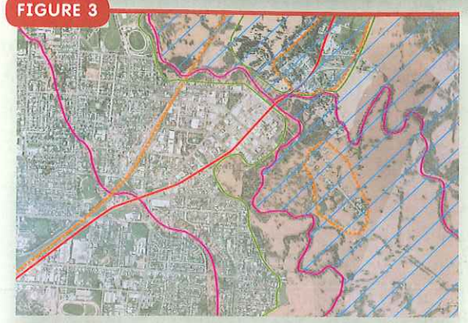
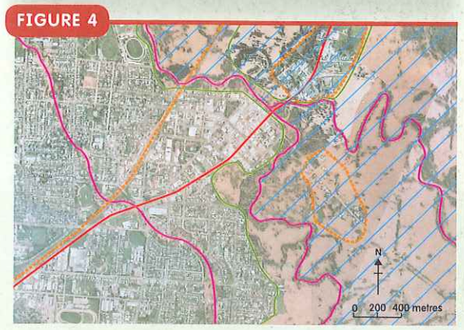


FIGURE 4



Developing my skills

Examine this aerial photograph of an Australian country town. Identify the main roads, the main street, the shopping centre, residential areas, dry areas on the outskirts of town and an area where the town may be expanding. Then create a map using the steps outlined above.

FIGURE 5

7.9 Thunderstorms

Thunderstorms form in unstable, moist atmospheres when powerful **updrafts** occur, such as when a cold front approaches. Over the past 12 years, an average of around 100 severe thunderstorms were reported in Australia each year.

FIGURE 1

Some 1000 or so years ago, the Vikings thought thunder was the rumble of Thor's chariot. (He was their god of thunder and lightning.) Lightning marked the path of his mighty hammer Mjollnir when he threw it across the sky at his enemies.

What really causes thunderstorms?

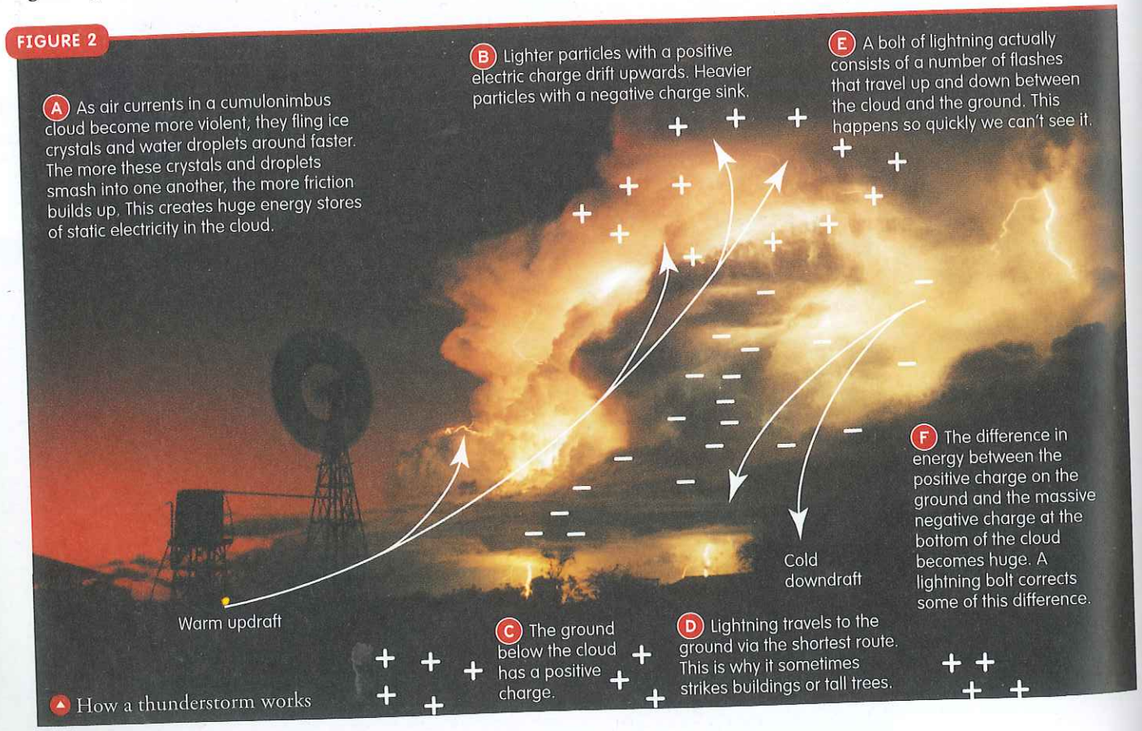
Today we know that thunderstorms occur when large cumulonimbus clouds build up enough static electricity to produce lightning. Lightning instantly heats the air through which it travels to about 20 000°C — more than three times as hot as the surface of the sun. This causes the air to expand so quickly that it produces an explosion (thunder). The time between a lightning flash and the crash of thunder tells you how far away the lightning is (5 seconds = 1.6 kilometres).

Severe thunderstorms

According to the the Bureau of Meteorology, a thunderstorm can be classified as severe if it has one or more of the following features:

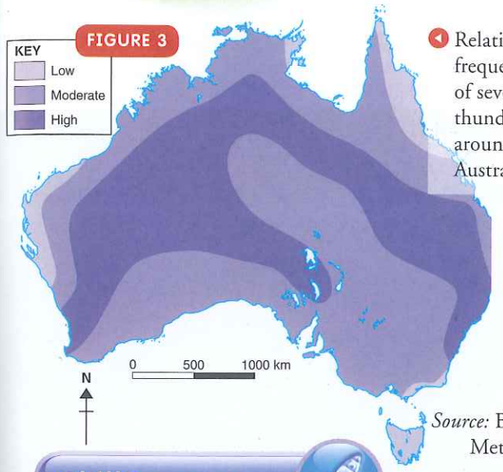
- hailstones that are two centimetres or more in diameter
- wind gusts of 90 kilometres per hour or more. Cold blasts of wind hurtle out of thunderclouds, dragged down by falling rain or hail. When the drafts hit the ground, they gust outwards in all directions.
- flash flooding. A thunderstorm often moves slowly, dropping a lot of **precipitation** in one area. The rain or hail may thus be too heavy and prolonged for the ground to absorb the moisture. The water runs off, quickly flooding local areas.
- tornadoes. These are rapidly spinning updrafts of air. Although severe tornadoes are not common in Australia, around 400 tornadoes have been recorded.

FIGURE 2



How a thunderstorm works

FIGURE 3



Relative frequency of severe thunderstorms around Australia

Source: Bureau of Meteorology

SkillBooster

Analysing bar graphs

Bar graphs help us to see trends quickly. They also help us to compare two different sets of data easily.

Monthly distribution of reported severe thunderstorms in New South Wales and the Australian Capital Territory

Source: Bureau of Meteorology

- Can you identify any trends? Do some months show higher numbers than others? Which months are these?
- Is the average data for 2002–2003 more or less the same as the average data for 1989–2003? Explain.
- To work out how many severe thunderstorms were reported in January 2003, place a ruler along the top of the January 2002–2003 bar and estimate the point at which it cuts the axis on the left. Now estimate by how many this figure exceeded the January average (using the 1989–2003 bar).
- During which months do severe thunderstorms most often occur? What season of the year is this? What is the weather generally like then?
- Are any data differences for any particular month significant? Can you see any trends? What might this suggest about the weather in 2002–2003 when compared with the 15-year average?

Activities

Student workbook 7.5
Teacher guide T7.2

THINK

1 Why do you think weather events such as thunderstorms were often assumed by people in former civilisations to be caused by the gods?
2 Complete the following table to show how far the storm is from you in each case.

Time between lightning and thunder	Distance
15 seconds	
10 seconds	
	1 kilometre

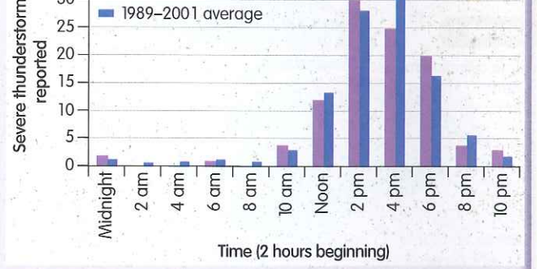
COMMUNICATE

3 Prepare an illustrated book for children starting school, explaining as simply as possible, with accompanying pictures and diagrams, how lightning and thunder occur.
4 Study the map of Australia (figure 3).
(a) Use your atlas to work out which capital cities are more likely to have severe thunderstorms.
(b) Which parts of Australia are least likely to have severe thunderstorms?

Analysing bar graphs

5 Study the bar graph below and answer the questions that follow.

Hourly distribution of severe thunderstorms in New South Wales and the Australian Capital Territory



Source: Bureau of Meteorology

(a) Between what hours of the day do most severe thunderstorms occur? Why do you think this is so? Think about the temperatures at those times.
(b) Between what hours of the day do severe thunderstorms hardly ever occur? Why do you think this is?
(c) Is the average data for 2000–2001 roughly the same as the average data for 1989–2001? What does this indicate?
(d) How many severe thunderstorms occurred between 2 pm and 6 pm in 2000–2001?

precipitation rain, hail, sleet or snow that falls from clouds
updraft strong upward air current

7.10 Wild winds

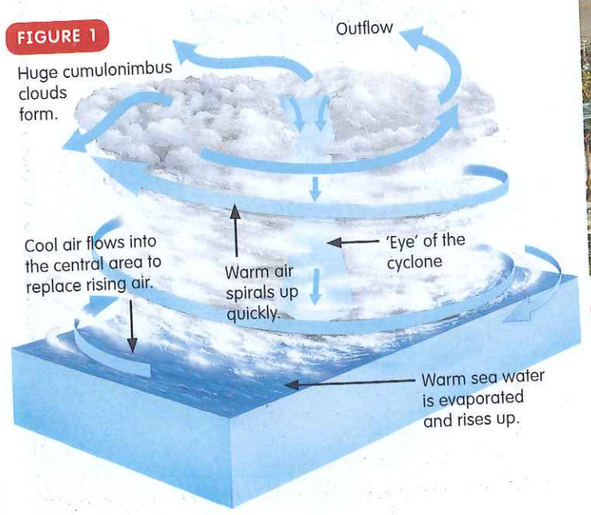
The wild winds caused by both tornadoes and the much larger tropical cyclones (called hurricanes in the Americas and typhoons in Asia and the Pacific) are constant weather hazards. They can cause great damage to property and significant loss of life.

Tropical cyclones

Some 80 to 100 tropical cyclones occur around the world every year. Cyclones form when a cold air mass meets a warm, moist air mass lying over tropical seas with a surface temperature greater than 26°C. Cold air currents race in to replace rapidly rising, warm, moist air currents, creating an intense low pressure system.

At first the winds spin around an area about 200 to 300 kilometres wide. As the winds gather energy by sucking in more warm moist air, they get faster. In severe cyclones, winds may reach speeds of 360 kilometres per hour. The faster the winds blow, the smaller becomes the area around which they spin — called the 'eye'. It might end up being only about 30 kilometres wide. Around the edges of the eye, rain and winds are at their fiercest. However, in the eye itself, the air is still, and the sky above may be cloudless.

FIGURE 1



Cyclones in the southern hemisphere rotate in a clockwise direction. In the northern hemisphere they rotate in an anticlockwise direction.

Cyclone damage

Tropical cyclones can cause extensive damage if they cross land. Gale-force winds can blow buildings to bits and uproot massive trees. Torrential rain can cause flooding, as can **storm surges**. If a storm surge hits a coastline during high tide, it causes serious flooding.

FIGURE 2

The path of Hurricane Katrina as it moved from the Atlantic Ocean through the Caribbean to New Orleans, August 2005

FIGURE 3

Cyclone Tracy, which devastated Darwin on Christmas Eve in 1974, killed 65 people (16 at sea) and injured 650. Nearly 70 per cent of homes were destroyed. Some 35 000 people had to be evacuated. The damage bill was $800 million (1974 dollars).

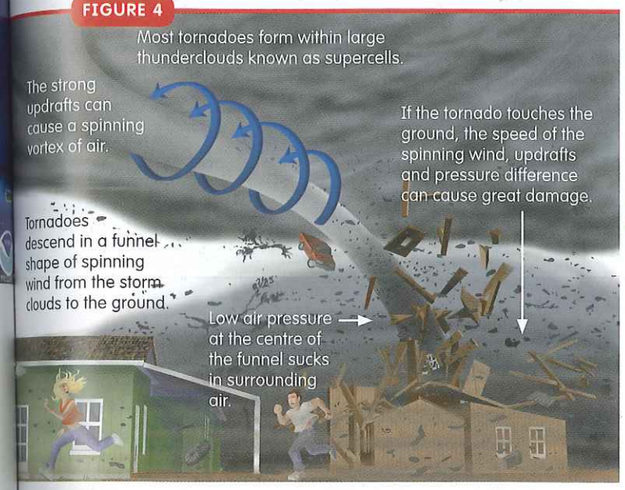
Tornadoes

A tornado (or twister) is a wildly spinning column of air that drops down from under a cumulonimbus cloud and moves across the ground or the water.

Over water, tornadoes create waterspouts, which sailors once thought were the heads of sea monsters. Some tornadoes can suck up objects as heavy as 300 tonnes and create winds of 320 kilometres per hour.

The funnel of a tornado is called the vortex. When it drops down, it hisses. This sound becomes a roar when the funnel hits the ground, especially if the tornado is large. Some very big cumulonimbus clouds may produce many funnels at once.

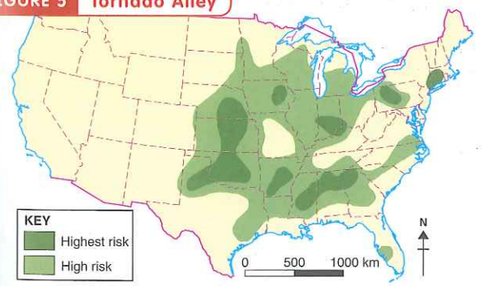
FIGURE 4



Where do they occur?

Tornadoes can occur anywhere, but most occur during spring and summer in a part of the United States known as **Tornado Alley**. Between 1950 and 1998, 39 011 tornadoes were recorded in the United States, causing 4354 deaths. The worst on record occurred in Missouri in March 1925. It destroyed four towns and killed 689 people.

FIGURE 5 Tornado Alley



Areas in the United States at risk of being hit by a tornado. Every single point in places of highest risk can expect to be hit by a fairly large tornado at least once every 2000 years.

Activities

Student workbook 7.5
Teacher guide T7.3

REMEMBER

1 What is (a) a tornado and (b) a tropical cyclone? What conditions do they need to develop?

THINK

2 What do you think you might see, hear and feel if you were watching a severe tornado move through both built-up and open environments?
3 Look at the photograph of Darwin (figure 3). Suggest what sort of injuries people could have suffered.
4 If the satellite image opposite (figure 2) had no caption, how would you know it was taken in the northern hemisphere?

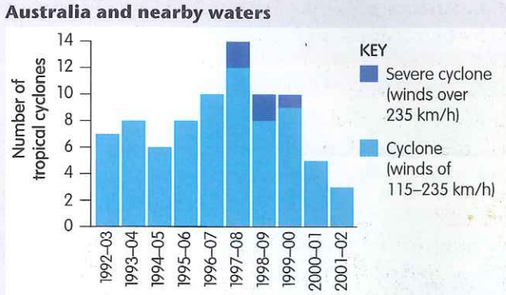
COMMUNICATE

5 Use figure 5 and an atlas to work out which American states are most at risk of being hit by a tornado. List 10 American cities or towns that lie in the highest risk zone.

Analysing bar graphs (p.197)

6 Study the bar graph below and answer the questions that follow.

Tropical cyclones affecting Australia and nearby waters



(a) How many tropical cyclones (including severe cyclones) affected Australia and nearby waters between 1992–3 and 2001–2?
(b) In which years did cyclones occur with wind speeds over 235 kilometres an hour?

7 Write a poem or a song to describe what it would be like to be in the 'eye of a cyclone'.

ICT

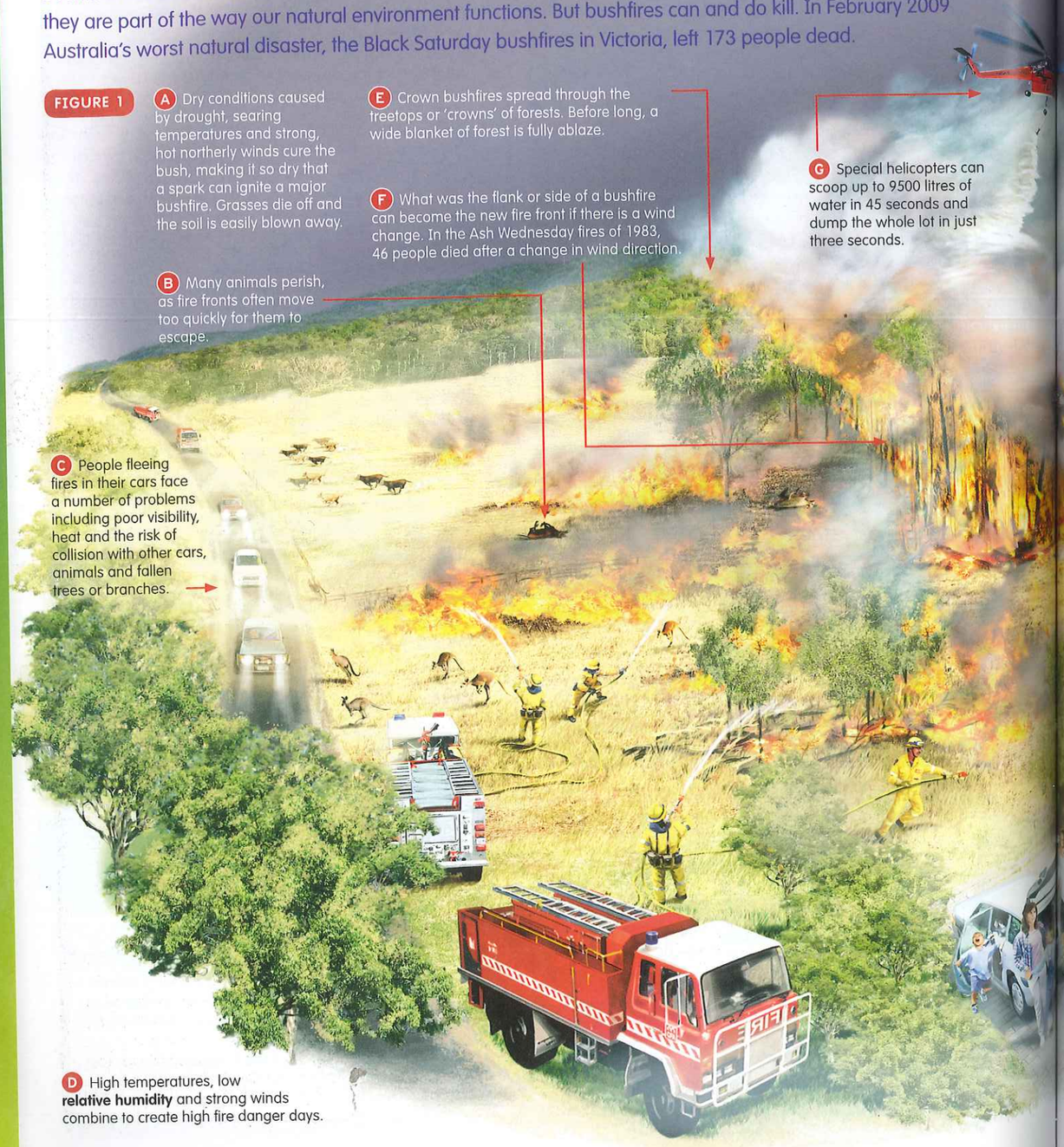
8 Use an internet search engine to find information advising local residents how to protect themselves and their property in the event of a cyclone. Use ICT skills and programs to create a series of slides or a brochure that could be presented or sent to residents living in hazardous areas.

storm surge raised sea levels, churned up by storms or tropical cyclones, which push extra water onto adjoining coastlines
Tornado Alley a region of the eastern United States across which tornadoes are most likely to form. It extends from Texas to North Dakota.

7.11 Bushfire: Australian hazards

Bushfires are one of the most common weather hazards faced by Australians. Along with floods and droughts, they are part of the way our natural environment functions. But bushfires can and do kill. In February 2009 Australia's worst natural disaster, the Black Saturday bushfires in Victoria, left 173 people dead.

FIGURE 1



combustible capable of burning
eucalypt commonly known as a 'gum tree'; any tree of the genus eucalyptus
flammable easily burnt and quick to catch fire
relative humidity a measure of the amount of water vapour in the air. It is expressed as a percentage, which is a ratio of the amount of water vapour in the air compared with the maximum amount the air can hold.

H Australia's **eucalypt** forests not only tolerate fire but also need it in order to survive! The seeds of some eucalypts need the heat of a bushfire to be able to open and grow. The low moisture content of eucalypts means they ignite and burn easily. Their fibrous bark is highly **combustible**.

Activities

Student workbook 7.5, 7.6

REMEMBER

1 What is a crown bushfire?
2 List the fire-fighting techniques shown opposite.
3 Why do many animals die in bushfires?

THINK

4 Why do bushfires often occur in times of drought?
5 How do eucalypt trees help bushfires spread?
6 Imagine a small fire front with a long flank. The fire is being pushed by winds from the north. Suddenly the wind changes and starts blowing from the west. Will the people on the west or on the east of the original fire now be in danger? Explain your answer using a clearly labelled diagram.
7 Look carefully at the following table.

Fire danger	Temp. °C	Relative humidity %	Wind speed km/h
Low	21	70	10
Moderate	30	20	20
Very high	35	10	50
Explosive	41	5	80

(a) What is relative humidity? Explain how relative humidity might contribute to creating bushfire conditions.
(b) What combination of weather conditions is most likely to produce bushfires?
(c) Explain the reasons for your selection.
(d) If the weather bureau was predicting a top temperature of 40°C, wind speeds of 75 km/h and a humidity of 7 per cent, what would the fire danger classification be?

8 Describe how people who live in bushfire-prone areas might plan to protect their houses from the fires.

COMMUNICATE

9 Write a news report of the scene shown on these pages. Outline the effects on people and wildlife. Include interviews and describe the fire using key terms explained in this chapter.

7.12 Victoria's Black Saturday

Australia's greatest natural disaster occurred in Victoria on Saturday, 7 February 2009. Australia watched images of the bushfire in disbelief as the scale of the impact became known. One hundred and seventy-three people were killed and many more were badly injured; 2029 properties were destroyed, 7000 people were made homeless and over 400 000 hectares burned. An estimated 1 million native animals were also killed. The worst-hit communities were Marysville, Kinglake and Strathewen near Melbourne, but 78 Victorian townships were affected. More than $15 million was raised to aid the victims.

Many parts of the world experience threats from earthquakes, cyclones and tsunamis. Victoria is located in one of the world's most hazardous bushfire zones. The state has experienced a number of disastrous 'mega-fires'. On Black Thursday, 6 February 1851, one-quarter of the new colony of Victoria burned. On 14 February 1926, 60 lives were lost, and another 71 people died on Black Friday, 13 January 1939. The fires on Ash Wednesday, 16 February 1983, killed 47 Victorians. These are not the only days when Victoria experienced deadly fires — they're just the worst. Two characteristics mark these historic fire days: a long period of drought; and weather conditions on the day that combined high temperatures, low humidity and very strong winds.

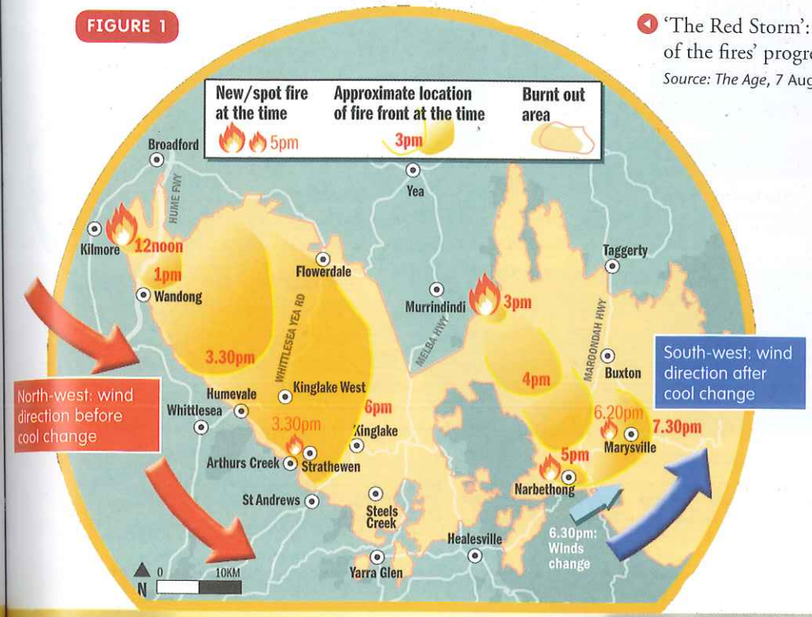
Following the 1939 fires, the MacArthur Forest Fire Danger Index (FFDI) was developed. The index uses maximum temperature, relative humidity, wind speed and dryness of fuel (measured using a drought factor) to rate days of fire danger. The ratings are:

Fire danger rating	FFDI range
High	12–25
Very high	25–50
Extreme	>50

The Black Friday fires scored an FFDI of 100. On Black Saturday, the FFDI for a number of sites in Victoria reached unprecedented levels, ranging from 120 to 190.

Fires are a natural part of the Australian environment, but steps need to be taken to ensure that fires like these never have a similar impact in the future. Governments, planning bodies and individuals need to make decisions about: allowing people to build in fire-prone areas; clearing native vegetation and dead trees around homes and along roadsides; controlled burning during the cooler months; provision of private and public bushfire shelters; early warning systems; stronger building codes; and the issue of people deciding whether to leave their property and fight the fire or to evacuate.

FIGURE 1

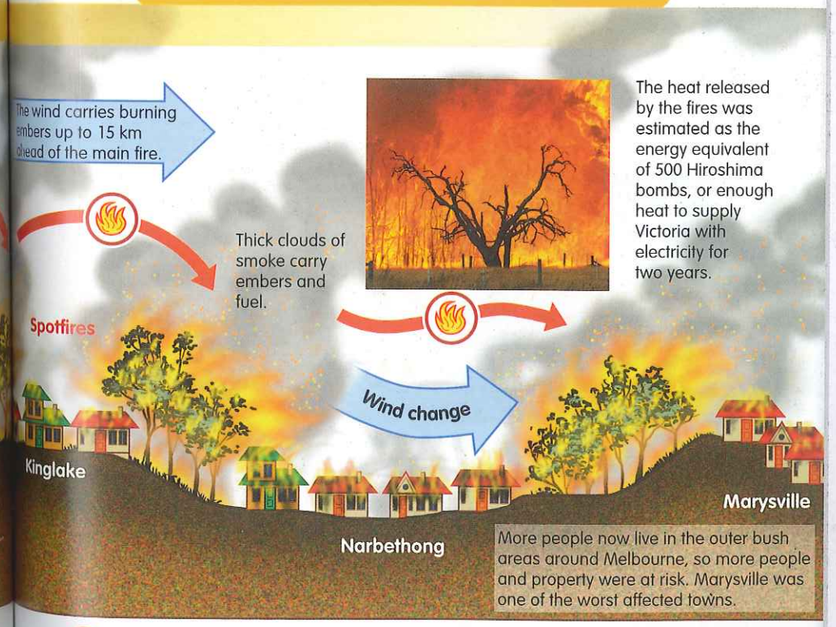


'The Red Storm': a snapshot of the fires' progress through 7 February
Source: The Age, 7 August 2009.

VICTORIA BURNS: ANATOMY OF AUSTRALIA'S MOST DEVASTATING BUSHFIRE

Ideal fire conditions
- Temperature 46.4°C
- Humidity 5 per cent
- Melbourne's driest start to a year on record
- Three consecutive days over 40°C
- Plenty of dry fuel
- Strong northerly winds

1. Fire broke out at East Kilmore at 11.40 am, burning across the Hume Highway eastwards towards Kinglake.
2. A second blaze began at a sawmill at Murrundindi at 3.00 pm; 120 km/h winds moved the fire from Kinglake West to Kinglake, a distance of 12.8 km, in five and a half minutes.
3. Northerly winds fanned the blaze south towards Narbethong and Buxton. These towns are situated in heavily timbered mountains.



4. A cold front brought relief from the extreme temperatures late in the afternoon, but this wind changed direction and swept north-east to Marysville. The Murrundindi and Kilmore fires combined.

Note: This illustration is not to scale.

Activities

Student workbook 7.7

REMEMBER

1. What started the Black Saturday fires?
2. Identify the conditions in Victoria on 7 February 2009 that contributed to the severity of these fires.
3. Describe the changes that occurred in the direction of the wind on Black Saturday.
4. Outline the impacts of this wind change on the fire and the areas affected.
5. What is the FFDI and why is it an important tool for planners and emergency services?

THINK

6. Outline the role of spot fires in spreading bushfires.
7. How much land was burned in the fires?

COMMUNICATE

8. A number of issues have been identified that might contribute to better preparation for future fires. In groups, prepare and present a report on one of these issues to the class based on your research, outlining the arguments for and against this proposal.
9. The fires devastated a large area of Victoria. Imagine you are a news reporter. Select a specific location affected by the fires and prepare a three-minute report on some aspect of the fire.

SELF-DISCOVERY

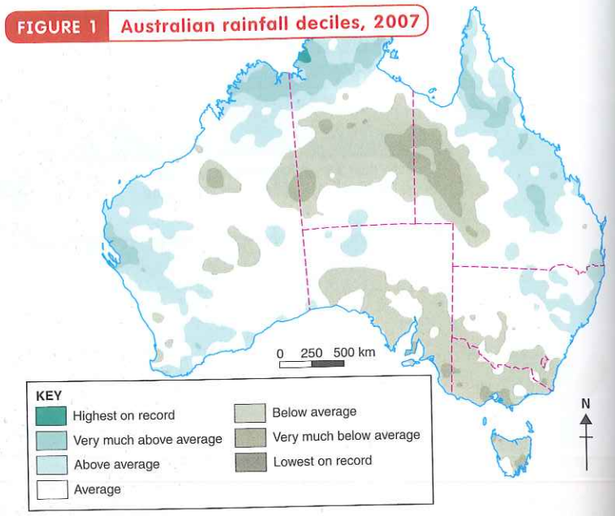
10. Write a diary entry describing how you felt when these fires struck Victoria or how you imagine you would have felt if you had witnessed the event.

7.13 Drought in Australia

As the world's driest inhabited continent, Australia has had many **droughts**. Of all the climatic hazards to affect Australia, drought is probably the most costly. Crop failures and stock losses hurt our national economy, and dust storms remove valuable topsoil from the land.

Low average rainfall and extended dry spells are a normal part of life throughout most of Australia. The continent is located in a zone of high pressure, where sinking, dry air creates conditions of clear skies and low rainfall. Drought conditions occur when the high pressure systems are more extensive than usual, creating long or severe rainfall shortages. A drought is a long period of below-average rainfall, when there is not enough water to supply our normal needs.

FIGURE 1 Australian rainfall deciles, 2007



This drought may never break

Richard Macey, 4 January 2008, *Sydney Morning Herald*

It may be time to stop describing south-eastern Australia as gripped by drought and instead accept the dry as permanent, one of the nation's most senior weather experts warned yesterday.

'Perhaps we should call it our new climate,' said the Bureau of Meteorology's head of climate analysis, David Jones.

He was speaking after the release of statistics showing that last year was the hottest on record in NSW, Victoria, South Australia and the ACT.

For the eleventh year in a row NSW and the Murray–Darling Basin experienced above-normal temperatures, and for the past seven years rainfall has been below average.

'There is absolutely no debate that Australia is warming,' said Dr Jones. 'It is very easy to see, it is happening before our eyes…

'There is a debate in the climate community, after…close to 12 years of drought, whether this is permanent. Certainly in terms of temperature, that seems to be our reality and there is no turning back…

'Sydney's nights were its warmest since records were first kept 149 years ago, and some areas were getting closer to 1.5 to 2 degrees above what we were seeing during the early parts of the twentieth century,' said Dr Jones.

FIGURE 2

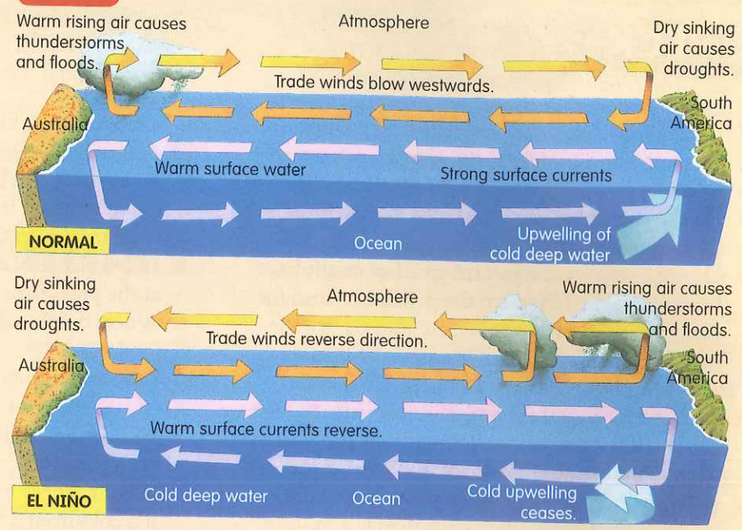
A farmer stands on drought-cracked ground in a wetland area in Moorook, South Australia, near the Murray River, in 2008.

The causes of drought in Australia

Australia's drought of 2002 and beyond, like many before, was caused by what meteorologists call an **El Niño** event.

In a normal year, warm surface water is blown west across the Pacific towards Australia. This brings heavy rain to northern Australia, Papua New Guinea and Indonesia. On the other side of the Pacific, South America experiences drought. When there is an El Niño event, these winds and surface ocean currents reverse their direction. The warm, moist air is pushed towards South America. This produces rain in South America and drought in Australia.

FIGURE 3



How an El Niño event influences weather patterns

The impact of drought

In times of drought, the greatest impact is felt by farmers. Reduced rainfall can lead to poor pasture and crop growth, and the death of stock from lack of food. Drought can also bring long-term environmental damage through dust storms that blow away valuable topsoil.

Eventually, all Australians feel the impact of a severe drought as profits from exports decline and food prices rise.

Droughts can last for many years. They may be widespread or confined to smaller areas. The drought since 2002 has affected large areas of Australia.

drought a long period of time when rainfall received is below average

El Niño the reversal (every few years) of the more usual direction of winds and surface currents across the Pacific Ocean. This change causes drought in Australia and heavy rain in South America.

Activities

REMEMBER

1 What type of pressure system affects most of Australia?
2 What effect does this system have on Australia's climate?
3 What is a drought?
4 List some of the effects that drought can have on Australia.

THINK

5 Why does a senior weather expert suggest that we should stop using the word drought to describe what is happening in south-eastern Australia?
6 What evidence does he use to support his suggestion?
7 Look at the information about El Niño events and complete the following:
(a) Describe the climate for eastern Australia during a normal year.
(b) Explain what causes an El Niño event.
(c) Describe the effects of an El Niño event on Australia.
(d) Which continent to the east of Australia is affected during an El Niño event? Describe these effects.
8 Examine figure 2.
(a) Describe the landscape shown in this image.
(b) Suggest how the farmer might be feeling and why.
(c) What plans might need to be made for the long-term future of this land?

Check and challenge

CHECK

1 What is the difference between weather and climate? Write a jingle or rap song to help you remember the difference. (p. 181)
2 Describe in broad terms the type of climate enjoyed by each of Australia's capital cities.
3 Describe what you think the weather might have been like at the following times. Give reasons for your answer in each case.
   (a) Melbourne in the late afternoon of the day shown in figure 4, p. 183.
   (b) Melbourne at 2.00 pm on 7 February 2009 (p. 202)
   (c) Melbourne on 3 February 2005 (p. 192)
   (d) Darwin in the late evening of 24 December 1974 (p. 198)
4 Refer to the map of Australia's climatic zones on page 181. Decide, for each of your answers for activity 3, whether what you have written is typical of the climate of each of these places. Justify your decision in each case.
5 Explain why Darwin is hotter than Hobart. (p. 184)
6 Use the following climographs for Mount Hotham and Tennant Creek to describe the broad differences in climate between these places. Use an atlas to help explain why they are so different. (p. 185)
7 Use an atlas to help you find one other city outside Australia that is situated in the same climatic zone as the place you live. In broad terms, what sort of weather would it enjoy in June each year? Justify your answer. (pp. 182–5)
8 Draw a labelled diagram to explain why it is colder at the poles than at the equator. (p. 184)
9 Where do most of the world's tornadoes occur? (p. 199)
10 What are tropical cyclones? Where do they form? (p. 198)
11 Which combination of weather conditions is responsible for large bushfires? (pp. 200–3)
12 What changes in weather can be expected if a cold front arrives? Why? (pp. 190–2)
13 Prepare a poster to illustrate (with words, diagrams, maps and other illustrations) in what ways one of the following weather events damages or changes natural and human environments: a prolonged drought, a widespread flood, a severe tropical cyclone, a very heavy hailstorm.
14 The cars in the photograph below ended up in the front seats of a cinema after a string of tornadoes swept through Ohio in North America on 12 November 2002. Explain why tornadoes can produce this outcome.

FIGURE 1

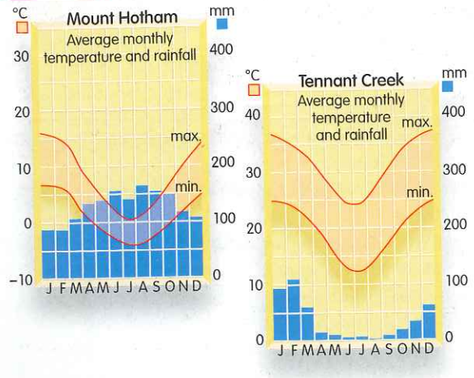


FIGURE 2

CHALLENGE

15 The following extract, from the British newspaper *The Guardian* of 4 February 2009, reports on a severe drought in northern China's wheat belt.

Drought threatens China's wheat crop

The most severe drought since 1951 has hit northern China and affected almost 43 per cent of the country's wheat crop. No rain has been recorded for 105 days, leaving almost 4 million people and 1.85 million livestock without access to drinking water. Farmers have lost 1.6 billion yuan [$353 million] in income.

This naturally dry region, with only 20 per cent of China's water, supports over 40 per cent of China's population, more than 50 per cent of its arable land and much industry due to its coal reserves. All of these activities place great demands on limited water supplies.

The Chinese government has provided 100 million yuan [$22 million] to help farmers and sent specialist teams to the worst affected areas. Local governments are planning to seed clouds to encourage rainfall.

China will spend 21.3 billion yuan [$463 million] on a long-term solution to watering the dry northern region. This involves diverting 44.8 billion cubic metres of water annually through a series of channels from the Yangtze, Huaihe, Yellow and Haihe rivers. The scheme will take up to half a century to complete.

FIGURE 3

More than 1000 soldiers were used to help irrigate crops in Henan Province, China, after the Chinese government declared a top-level emergency.

(a) What natural weather event affected northern China in early 2009?
(b) Which human activities may have put pressure on water resources in this region?
(c) What impacts might this drought have on people and the environment?
(d) Identify one short-term and one long-term measure the Chinese government is taking to try to improve this situation.
(e) Select one of these measures and explain what it is trying to achieve and what some of the positive and negative effects might be.
(f) Do you think that governments should help farmers struggling with the harsh effects of drought? Look at both sides of the case and debate this topic as a class.

16 The atmosphere around the Earth is a type of greenhouse. It helps to shield out extremes of the sun's heat. Its so-called greenhouse gases also trap some of the heat reflected back by the Earth's surface, keeping its temperature about 3 to 5°C warmer than it would otherwise be.

Most scientists today are concerned that we are producing too much greenhouse gas. They say the extra heat these gases trap will cause the surface temperature of the Earth to rise. If there is too much global warming, they predict:

- more severe droughts, floods and cyclones
- new diseases
- adverse impacts on one-third of forests
- rising sea levels
- damage to coral reefs
- soaring heatwaves.

Some interesting facts

- Since the late 1800s, the average temperature of air at the surface of the Earth has increased by between 0.3 and 0.6°C.
- Ten of the hottest years on record occurred in the past 15 years.
- Sea levels have risen 10–25 centimetres since the late 1800s.
- The volume of ice in European glaciers has almost halved since 1850.
- The largest source of carbon dioxide emissions globally is the burning of coal, oil and gas in power plants, transport, industry and homes.
- The World Health Organization reports that 30 new infections have emerged in the past two decades, many due to warmer conditions.
- Carbon dioxide emissions have reached record levels. Developed countries such as the US, Australia, Canada, Germany and the UK produce much more carbon dioxide per person than developing countries.

Discuss as a class:
(a) what might happen on Earth if the predictions of many scientists are correct
(b) why you think developed countries produce the most carbon dioxide emissions
(c) what you could do personally to help cut back on carbon dioxide emissions
(d) what governments and businesses could do to cut back on carbon dioxide emissions.

Thinking about . . .

. . . what I have learnt

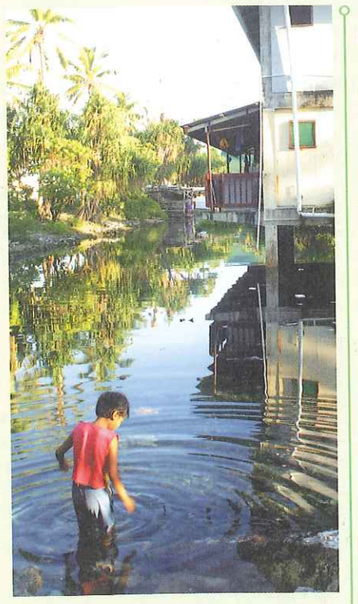
1 'Just add water'

Our weather changes constantly and significantly affects the way in which we live. Some weather changes can be very rapid and have an immediate impact, while others are more gradual. Floods are a result of a rapid change in the weather.

1 Identify some positive and some negative impacts this flood might have had on the people who own the farmland.
2 Should people be allowed to build on land they know is likely to experience floods?
3 How might people who live in flood-prone areas protect their property from the effects of flooding?

Floodwaters west of Brisbane, 2009

2 Long-term effects of changes in weather patterns



Tuvalu's rising sea levels

Tuvalu is a small Pacific nation made up of nine tiny islands. It has an area of only 26 square kilometres and a population of 11 000. The highest point on the islands is no more than four metres above sea level. Several times each year the tides move the Pacific waters onshore to flood roads, fields and houses.

If predictions of rising sea levels caused by climate change are correct, and these tidal events become more frequent and more severe, the people of Tuvalu could be forced to move from their islands.

1 What might the impacts of these floods be on the people, roads, buildings and gardens?
2 Explain how these floods might be different from the one shown near Brisbane.
3 What choices might the people of Tuvalu have regarding this situation?
4 If these tidal floods were to become more severe in the future, how might this affect other countries including Australia?

3 Australia's changing climate

Our weather changes daily. However, many scientists believe that the world's climate is undergoing a long-term change and is warming. This increase in the Earth's temperature is expected to raise sea levels and alter the rainfall patterns of many regions.

1 List ways in which you think your life might change if the weather became warmer in your area.
2 List the effects that an increase in the amount of rainfall in your area might have.
3 List the effects that a decrease in the amount of rainfall in your area might have.

'I expect climate change to affect all Australians. It is the Bureau's responsibility to provide decision makers and the general public with accurate observations and information about our changing climate.'

Dr Geoff Love, Director of Meteorology

4 People controlling the weather

We can control many aspects of people's lives, but it is difficult for humans to control the weather. One effort at influencing the weather is through cloud-seeding, which is directed towards increasing rainfall or snowfall. Pellets containing silver iodide, which is thought to concentrate moisture and cause rain, are fired into clouds. This practice is widely used in China to combat drought conditions. Other countries, including Australia, have also used the technique. Not everyone is convinced that this method is effective.

1 Why do you think that people might wish to control the weather?
2 Why is it difficult for humans to control the weather?
3 Suggest what the advantages and disadvantages of cloud-seeding might be.

Student workbook 7.10

Chinese gun used to launch silver iodide pellets into the clouds

BACK TO THE ESSENTIAL QUESTION

How can people plan and prepare for an extreme weather event and protect themselves against its effects? 'Natural events are too powerful and unpredictable. There is nothing we can do about them.' Based on what you have learnt in this chapter, how accurate is this statement?

. . . how I learn

Now you have worked through the chapter and used a number of skills to learn about weather and its hazards, it is time to consider a few questions:

1 What tools did you use to collect information?
2 What methods worked best for you?
3 What skills could you use to improve your knowledge next time?

Self-evaluation

Now you have learnt how powerful and complicated the weather can be, and have considered *how* you grasped these ideas, it is time to check your level of understanding of what you have learnt. Complete the following table as best you can by ticking the relevant box related to your level of understanding.

Checklist of main ideas or knowledge	Could improve	Not bad	Good	Excellent
I know . . .				
how to explain what conditions occur in the atmosphere to create certain weather events.				
how cloud type influences what precipitation falls from the sky.				
what role the sun's rays have on different climates around the world.				
how some dangerous weather phenomena occur and what damage they can do.				
about serious Australian extreme weather conditions and how they are changing.				

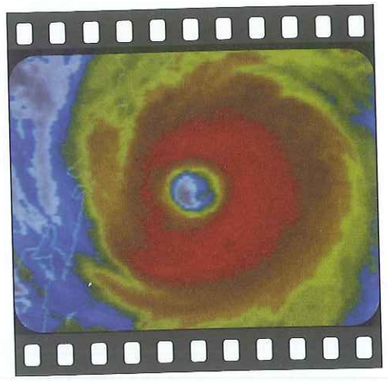
eBookplus ICT activities

eLesson

UNDERSTANDING A WEATHER FORECAST

You might watch the weather report every day on the evening news, but do you really understand what all the information means? Just what is a high or low pressure system, and what are all those swirly lines and colours all over Australia? This eLesson will help you interpret weather maps for yourself and provide you with an insight into how the experts predict future weather conditions.

SEARCHLIGHT ID: ELES-0161

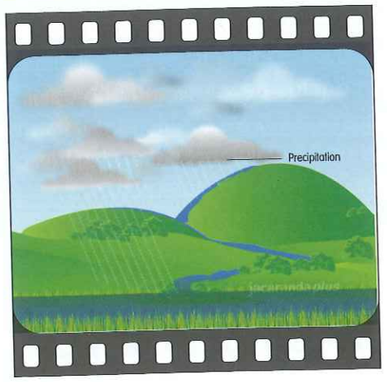


eLesson

THE WATER CYCLE

This video lesson will show you the amazing continuous cycle of water in the Earth's hydrosphere. Through the processes of evaporation, condensation, run-off and rain, water moves constantly between the oceans and the sky. A worksheet is attached to further your understanding.

SEARCHLIGHT ID: ELES-0062

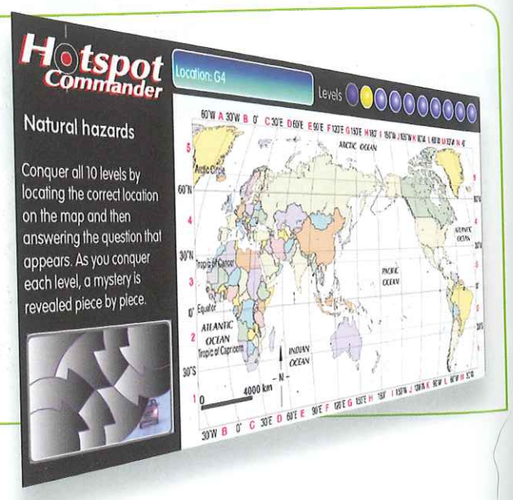


Interactivity

HOTSPOT COMMANDER: NATURAL HAZARDS

Hotspot Commander challenges your geographical skills and knowledge in a fun question-and-answer format. You will receive the coordinates of a location. When you hit your target accurately, you will be given some secret information and a question to answer. Get it right and part of the mystery image is revealed. Can you conquer all 10 locations and become a Hotspot Commander?

SEARCHLIGHT ID: INT-1204



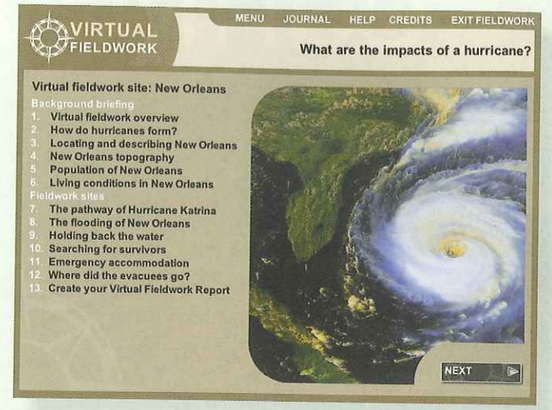
These ICT activities are available in this chapter's Student Resources tab inside your eBookPLUS. Visit www.jacplus.com.au to locate your digital resources.

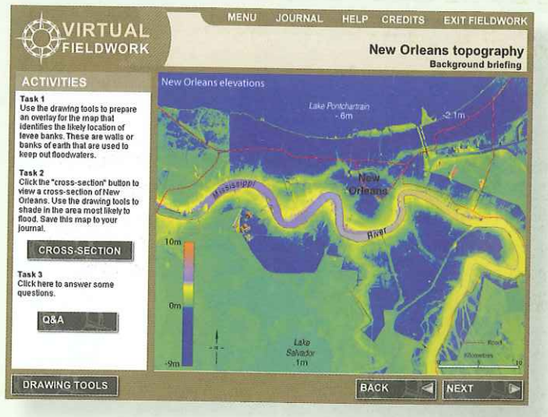
Learning object

VIRTUAL FIELDWORK

The purpose of undertaking virtual fieldwork is to investigate the characteristics of a region, and the physical processes and human activities that form and transform the region. Because of its virtual nature, fieldwork can take place on a local, regional or global scale.

Virtual fieldwork is intended to be as real as possible, with the added advantage of interactive design. You are encouraged to participate in virtual activities to enhance your understanding and appreciation of a region and improve your geographical skills. The interactive fieldwork journal in this learning object will help you organise your fieldwork notes and prepare a final report.





HURRICANE KATRINA

Through an inquiry-based approach, you will discover answers to the following questions:

1 What are the physical and human characteristics of New Orleans?
2 How did Hurricane Katrina form and what path did it take?
3 What damage did Hurricane Katrina cause in New Orleans?
4 What impact did Hurricane Katrina have on the population of New Orleans?

Download this interactive learning object and install it on your computer to investigate the issues surrounding Hurricane Katrina by:

- exploring the plethora of data, photos, maps and drawings
- completing interactive activities
- taking virtual tours.

SEARCHLIGHT ID: LO-0336