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SKY WATCHING

Earth's Atmosphere

Carmel Reilly

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Contents

Glossary words

When a word is printed in **bold**, click on it to find its meaning.

WHAT DOES IT MEAN

Words within a **box** are explained in the 'What does it mean?' panel at the bottom of the page.

Sky watching

When we sky watch, we look at everything above Earth. This includes what is in Earth's **atmosphere** and the objects we can see beyond it, in space.

Why do we sky watch?

Sky watching helps us to understand more about Earth's place in space. Earth is our home. It is also a planet that is part of a space neighbourhood called the **solar system**. When we sky watch we learn about Earth, and our neighbours inside and outside the solar system.

What objects are in the sky?

There are thousands of objects in the sky above Earth. These are Earth's neighbours – the Sun, the Moon, planets, stars and flying space rocks (**comets, asteroids** and **meteoroids**). Some can be seen at night and others can be seen during the day. Although some are visible with the human eye, all objects must be viewed through a telescope to be seen more clearly.

When and how can we see objects in the sky?

Object in the sky	Visible with the human eye	Visible only through a telescope	Visible during the day	Visible at night
Earth's atmosphere	✗	✗	✗	✗
Sun	✓ (Do not view directly)	✗ (View only with a special telescope)	✓	✗
Moon	✓	✗	Sometimes	✓
Planets	Sometimes	Sometimes	Sometimes	✓
Stars	Sometimes	Sometimes	✗	✓
Comets	Sometimes	Sometimes	✗	✓
Asteroids	Sometimes	Sometimes	✗	✓
Meteoroids	Sometimes	Sometimes	✗	✓

WHAT DOES IT MEAN

space the area in which the solar system, stars and galaxies exist, also known as the universe

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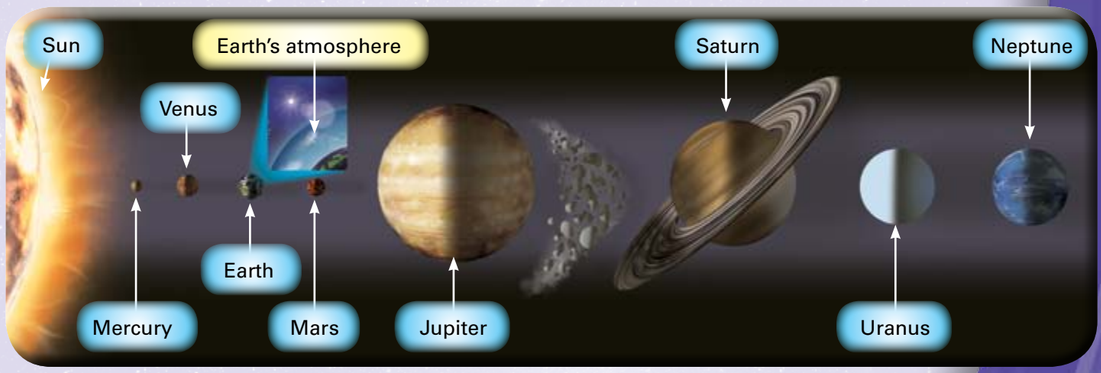
Earth's atmosphere

The atmosphere around Earth is invisible. However, we can see **matter**, such as dust and water, in the atmosphere. We can also feel the temperature and movement of the air.

Watching the atmosphere

Humans have always watched the skies. Only 300 years ago, scientists discovered that the air around them and the skies just above were all part of the atmosphere. Thanks to more discoveries, we now know what the atmosphere is made of, what kind of matter and objects exist in it, and what it does for Earth.

Sky watching can be done during the day or night, with or without a telescope. Just look up!



Earth's atmosphere is the area that lies between Earth and space. This diagram shows the approximate relative sizes of the Sun and the planets. The distances between them are not to scale.

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What is Earth's atmosphere?

The **atmosphere** is made up of layers of **gases** that surround Earth. It formed billions of years ago. The atmosphere acts like a blanket that protects Earth from the dangers of **space**. It helps to create the right conditions for life.

The atmosphere is like a blanket around Earth

The atmosphere is made up of five layers of gases that stretch more than 500 kilometres into space. Theses layers act like a blanket wrapped around Earth. They keep the planet warm and protect it from the Sun's strong rays. Conditions within the atmosphere provide the air and water that allows life to exist on Earth.

Earth's atmosphere acts like a blanket, and protects the planet from the harsh Sun and many collisions with space rocks.

Atmosphere fact

The word 'atmosphere' comes from two ancient words. The Greek *atmos*, which means vapour, or mist, and the Latin *sphaera*, which means sphere, or ball.

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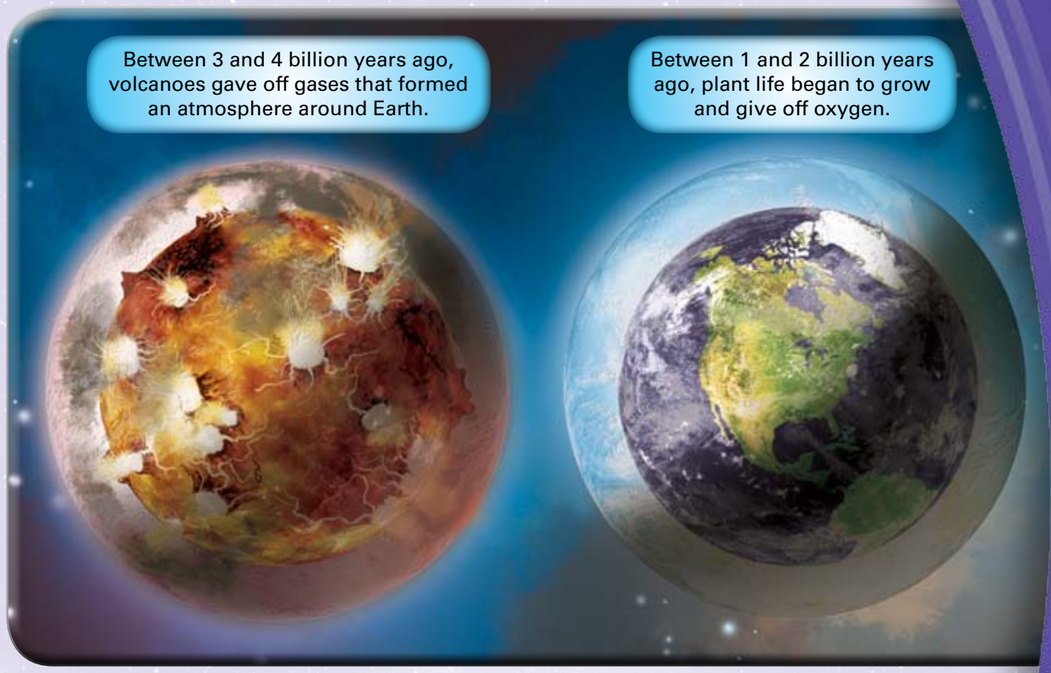
The atmosphere was formed billions of years ago

The atmosphere was first formed about 3.8 billion years ago. It was made by gases that were given off by volcanoes on Earth's surface. About 2.7 billion years ago, the first plants began to grow. They made a gas called **oxygen**. Oxygen mixed with the other gases to make air.



When plants added oxygen to Earth's atmosphere it made the air breathable for animals and humans.

Famous sky watchers

Carl Wilhelm Scheele, a Swedish chemist, became the first to discover the gas oxygen in the air in 1774. He called it 'fire air'. In 1777 Antoine Lavoisier, a French chemist, gave it the name oxygen.

What does it mean

oxygen an invisible gas produced by plants that makes up about 20 per cent of the Earth's atmosphere and makes air breathable

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What does Earth's atmosphere look like?

From Earth, the **atmosphere**, which includes the air around us, is invisible. However, we can see **matter** and objects in the atmosphere, and we see the daytime sky as blue.

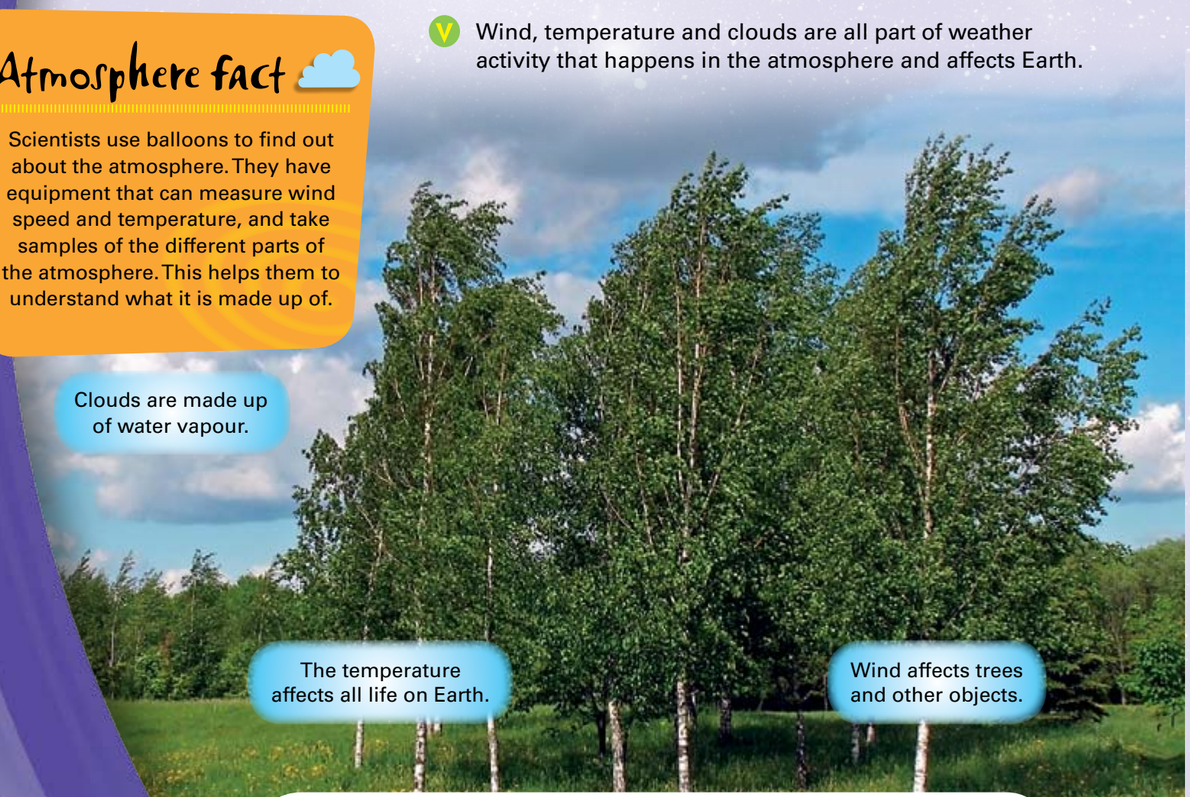
The atmosphere is invisible, but ...

Although the **gases** in the atmosphere are invisible, **water vapour**, smoke and dust carried in the air are not invisible. We can see clouds and weather activity, such as rain, snow and lightning, in the atmosphere. We can also see and feel the effects of wind, and feel the temperature of the air.

Atmosphere fact

Scientists use balloons to find out about the atmosphere. They have equipment that can measure wind speed and temperature, and take samples of the different parts of the atmosphere. This helps them to understand what it is made up of.

V Wind, temperature and clouds are all part of weather activity that happens in the atmosphere and affects Earth.



WHAT DOES IT MEAN

water vapour tiny particles of water that are no longer a liquid and can be carried in the air

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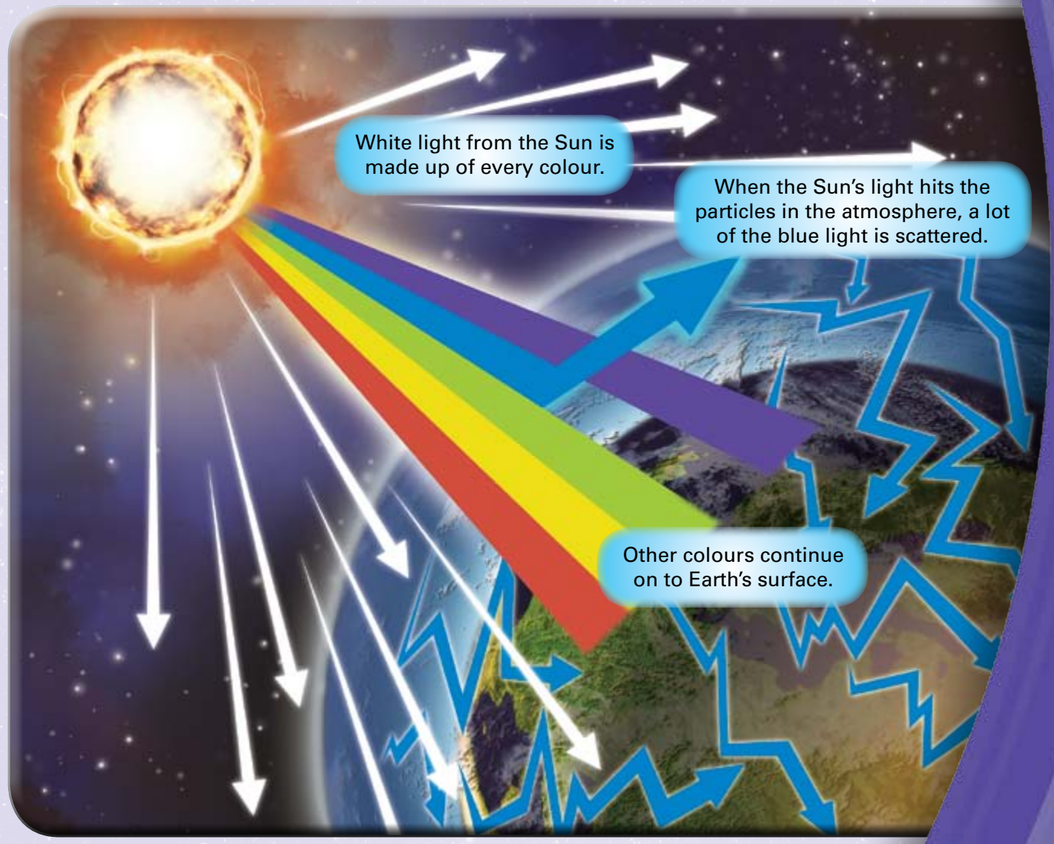
The atmosphere makes the sky look blue

If we were in **space**, the sky would look black during the day. On Earth, the sky looks blue. This is because of Earth's atmosphere.

The atmosphere scatters blue light

The Sun's light seems white, but it is really made up of every colour. When this light shines on Earth, most colours reach the surface without stopping. However, blue light has a short **wavelength** that causes it to bump into **particles** in the atmosphere. When the blue light hits these particles, it scatters in different directions rather than going straight to Earth's surface. The sky looks blue because when we look up, we see all of the blue light that has been scattered.



A The scattering of blue light in Earth's atmosphere is called Rayleigh scattering.

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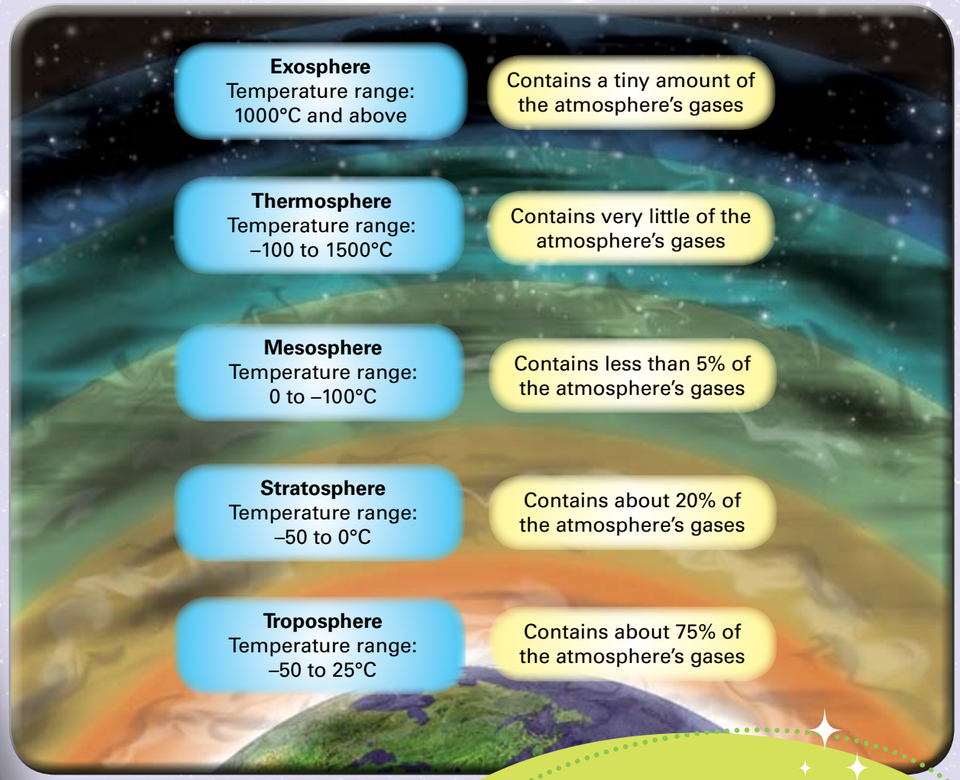
What is Earth's atmosphere made of?

The **atmosphere** is divided into five layers, called the troposphere, the stratosphere, the mesosphere, the thermosphere and the exosphere. The same **gases** are found in all layers of the atmosphere. However, the air becomes thinner in each layer and the temperature in each layer is different. Dust, smoke and **water vapour** are also found in the lower layers of the atmosphere.



As the atmosphere stretches upwards, the gases in the air become thinner until they finally fade away into **space**.

Famous sky watchers

French meteorologist Leon Teisserenc de Bort was the first person to realise there was more than one layer to the atmosphere. In the early 1900s he gave the troposphere and the stratosphere their names.

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The lowest layer is the troposphere

The troposphere starts at Earth's surface and travels upwards for about 12 kilometres. Although it is the narrowest layer of the atmosphere, it contains about 75 per cent of all the atmosphere's gases. It also contains large amounts of water and dust. The troposphere is the only layer of atmosphere in which weather occurs.

Rain, sunshine, wind and cloud all occur in the troposphere.

Atmosphere fact

As the Sun heats Earth's surface it makes the air move, which leads to wind, rain, snow and other weather in the troposphere.

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The second layer is the stratosphere

The stratosphere starts at the top of the troposphere and rises to 50 kilometres above Earth's surface. It contains about 20 per cent of the **gases** in the **atmosphere**. It has less **water vapour** and less air movement than the troposphere.

FAMOUS SKY WATCHERS

In 1913, French scientists Charles Fabry and Henri Buisson discovered an important band of gas within the stratosphere called the **ozone layer**. This layer of gas absorbs many of the Sun's harmful **ultra-violet (UV) rays** and stops them from reaching Earth's surface.

Jets and other aircraft often fly in the stratosphere to avoid the weather conditions of the troposphere below.

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The third layer is the mesosphere

The mesosphere is the next layer of atmosphere above the stratosphere. It lies between 50 and 80 kilometres above Earth. The mesosphere is the coldest layer of the atmosphere, with temperatures dropping as low as –100°C. Icy clouds, called noctilucent clouds, sometimes form in this layer.

Atmosphere fact

The air in the mesosphere is thin compared to the lower layers. However, it is still thick enough to slow down and burn up small **space** objects, such as **meteoroids**, when they enter the atmosphere.

Noctilucent clouds are also called 'night shining' clouds. They can be seen in the sky from some parts of Earth in summer.

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The fourth layer is the thermosphere

The thermosphere is the fourth layer of the **atmosphere**. It reaches about 500 kilometres above Earth. The air in the thermosphere is quite thin. It is also very hot because it absorbs **UV rays** from the Sun. Temperatures in the thermosphere are as high as 1500°C.

The Aurora Borealis is also known as the Northern Lights. It is seen in the thermosphere above the Arctic.

FAMOUS SKY WATCHERS

For centuries, many people have tried to explain auroras, the colourful light shows seen from Earth, near the North and South poles. In the late 1800s, Norwegian scientist Kristian Birkeland discovered that auroras are caused when dust **particles** from **space** and particles in the thermosphere crash together.

The highest layer is the exosphere

The exosphere is the last and highest layer of the atmosphere. The **gases** of the exosphere are thin, and temperatures are quite cool. Scientists believe that the exosphere ends about 1000 kilometres above Earth. This is where the last of the atmosphere's gases escape into space.

Atmosphere fact

Many **satellites** that are made by humans **orbit** Earth in the atmosphere. Some of these satellites check the weather and temperatures. Others send communications from one part of Earth to another.

The Advanced Communications Technology Satellite (ACTS) was sent into space by NASA. It orbits Earth in the exosphere, sending back information about weather conditions.

WHAT DOES IT MEAN

orbit to travel around another, larger space object

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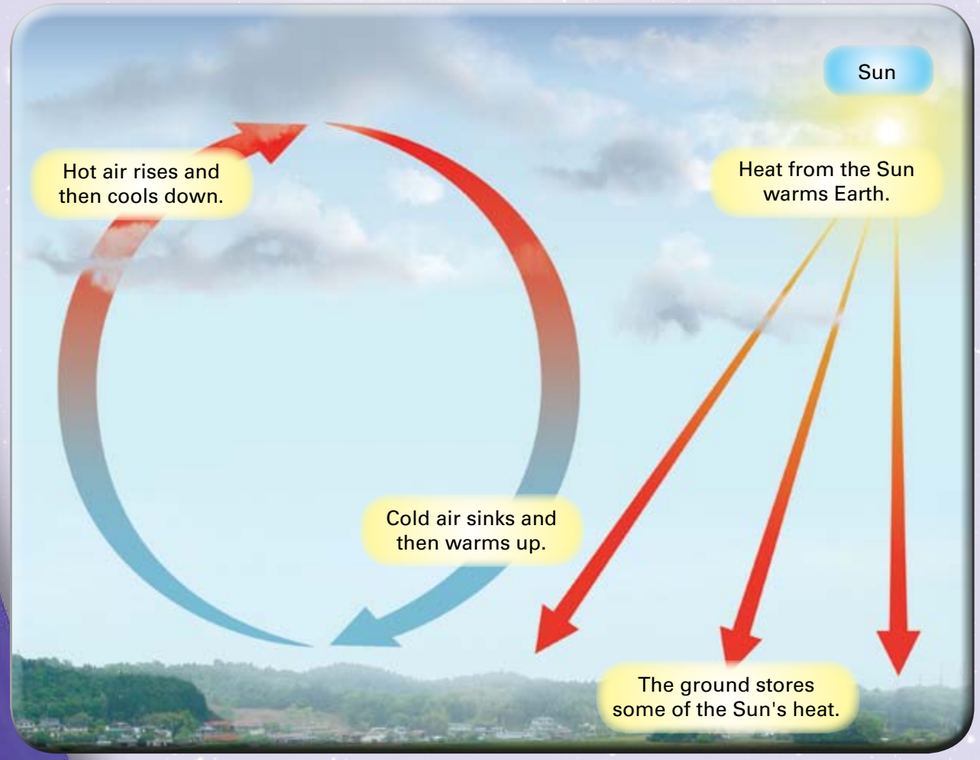
What happens in Earth's atmosphere?

From the ground, we can see that the **atmosphere** is a busy place. The air is always moving and the weather changing. A lot of bird, insect and human activity also takes place in the atmosphere.

Air movement in the atmosphere keeps Earth warm

Air movement is started by the heat of the Sun. The Sun does not heat Earth evenly. When one part is warm, another part is cold. The heat from the warm areas rises into the atmosphere, pushing the cold air downwards. This creates air movement and keeps temperatures even.



The ground stores much of the heat from the Sun and warms the air around it. This contributes to the movement of warm and cool air.

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Weather activity in the atmosphere changes conditions on Earth

Weather is the word we use to talk about changing conditions in the atmosphere. Weather happens in the troposphere. It is caused by sunshine, air and water. When hot and cold masses of air meet in the atmosphere, this can create winds, rain, thunderstorms and lightning.

When the **water vapour** in clouds becomes heavy and cold, it is released as rain, hail or snow.

FAMOUS SKY WATCHERS

Vilhelm Bjerknes was one of the first scientific meteorologists. In 1917 he set up a series of weather stations in Norway. Using information from these stations, he discovered a great deal about how weather was formed in the atmosphere.

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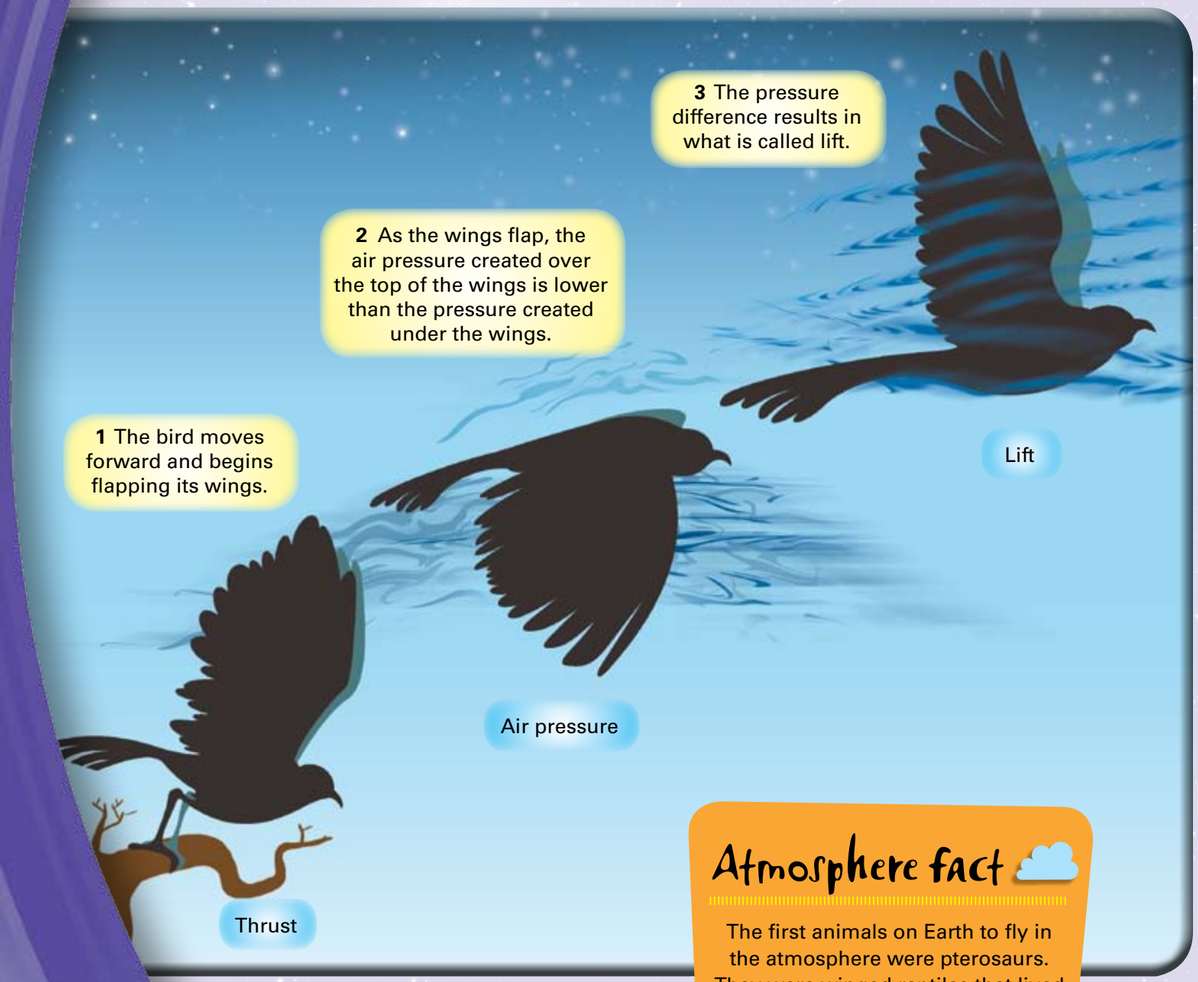
Flying animals move through the atmosphere

Bats, most birds and some insects are animals that have adapted to be able to fly. They use the **atmosphere** as their transport. Flying animals can move around freely to hunt and eat. They are also safer from attack by animals on the ground.

Birds are able to fly because of 'lift'. Lift is the result of thrust and changing air pressure caused by birds flapping their wings.



Atmosphere fact

The first animals on Earth to fly in the atmosphere were pterosaurs. They were winged reptiles that lived between 200 and 65 million years ago, in the time of the dinosaurs.

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Humans move through the atmosphere

The atmosphere is all around us. Everything we do takes place in the atmosphere. However, humans have always been curious about exploring the skies above. The first human journey into the air was in a hot air balloon in 1783. The first aeroplane flight was in 1903. Since then, aeroplanes have become a common form of transport, with thousands in the air every day. Since the 1960s, **space** stations and **satellites** have been launched into **orbit** in the upper layers of the atmosphere.

More than 200 years since the first hot air balloon flight, people still enjoy exploring the skies in hot air balloons.

Famous sky watchers

Aircraft are not the only human-made objects or **matter** in the sky. The atmosphere also carries smoke and pollution caused by human activities. Atmospheric scientists, such as those at an Australian Government organisation called CSIRO, spend their time studying air pollution and looking at ways to reduce it.

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How does Earth's atmosphere stay in place?

The **gases** in our **atmosphere** mostly stay in place because of Earth's **gravity**. Earth's gravity pulls everything that is smaller than Earth towards it. Gravity pulls the atmosphere towards Earth and stops the gases from drifting off into **space**.

Earth's gravity keeps the atmosphere in place

The bigger an object, the stronger its **gravitational pull**. Earth is big and it therefore has a strong gravitational pull. The **particles** that make up gases are small and have very little gravitational pull. This means that the gravity of Earth has a strong pull on all of the gases in its atmosphere. This keeps the gases close to Earth's surface.

FAMOUS SKY WATCHERS

British scientist Sir Isaac Newton was the first person to put forward the theory of gravity. It explains why objects, and even **matter** such as gases, stay close to the surface of Earth.

Compared to Earth, people are very small, which is why gravity pulls this skydiver towards Earth after he jumped from a plane.

Heavier gases are pulled closer to Earth

Some gases are heavier than others. The heaviest gases, such as **oxygen**, are pulled closer to the Earth's surface by gravity. This pushes many of the lighter gases higher into the atmosphere. Over time, a tiny number of these lighter gases escape Earth's gravity and drift off into space.

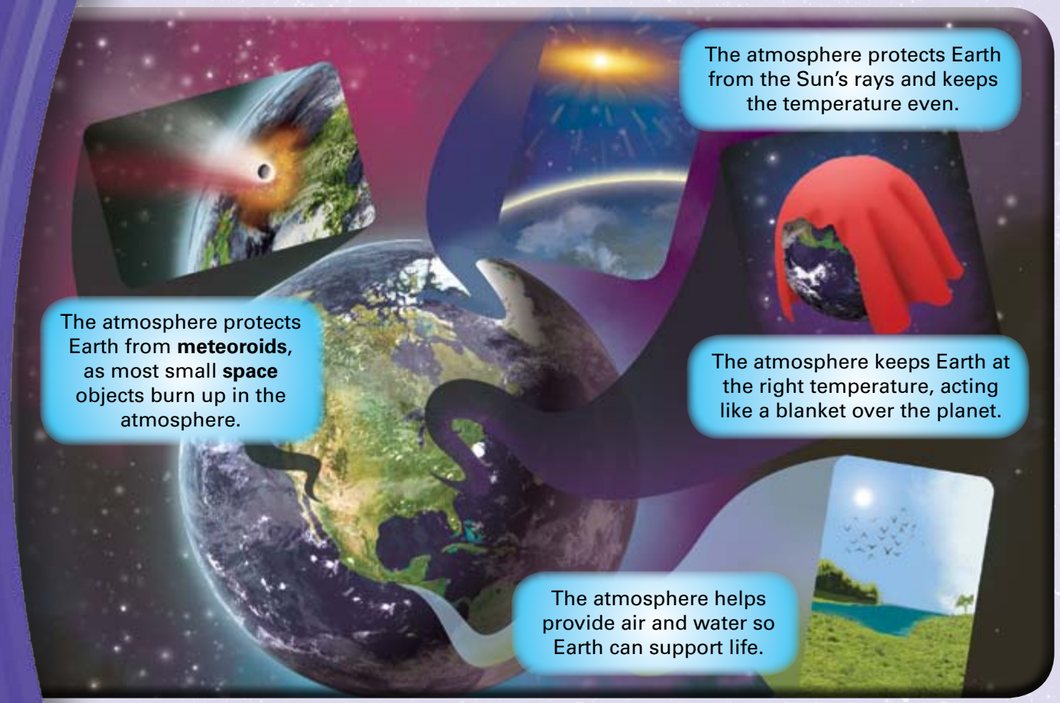
Atmosphere fact

The gases in the atmosphere are pulled towards Earth by gravity. However, they also move due to their own energy. This energy works against gravity and stops air from being pulled flat against Earth.

Most of the gases in the atmosphere are in the troposphere, close to Earth.

Why is the atmosphere important to Earth?

Without the **atmosphere**, we would not have life on Earth. The atmosphere protects Earth from the harmful effects of the Sun. At the same time, it uses the Sun's energy to provide the warmth, water and air needed for life on Earth.



The atmosphere is important to Earth in many ways.

The atmosphere protects Earth from meteoroids

Meteoroids are small space objects that are made of rock and travel through space. If they pass close to Earth, they are pulled towards Earth by its **gravity**. However, rather than crashing to Earth, most of these objects are burned up in the atmosphere.

What if there was no atmosphere?

Thousands of small space objects, such as meteoroids, burn up in or are slowed by Earth's atmosphere every day. These objects travel between 20 and 70 kilometres per second! If there was no atmosphere, many of these objects would crash to Earth with great force.

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The atmosphere protects Earth from the Sun's rays

The Sun gives off **radiation**. Radiation is a form of energy. The Sun's radiation reaches Earth in the forms of heat and light. Although heat and light are good for Earth, some parts of the Sun's radiation can damage life on our planet. Most of the harmful radiation, such as **UV rays**, is filtered out by the **ozone layer** in the stratosphere.

What if there was no atmosphere?

If there was no atmosphere on Earth, more of the Sun's heat and energy would hit Earth. The levels of radiation would be so high that plants, animals and humans would not be able to survive.

Atmosphere fact

Even small amounts of UV rays are harmful to skin and eyes. To be protected against its effects, you should wear sunglasses and sunscreen while out in the Sun.

Most of the Sun's UV rays are stopped by the atmosphere's ozone layer, but some still reach Earth's surface.

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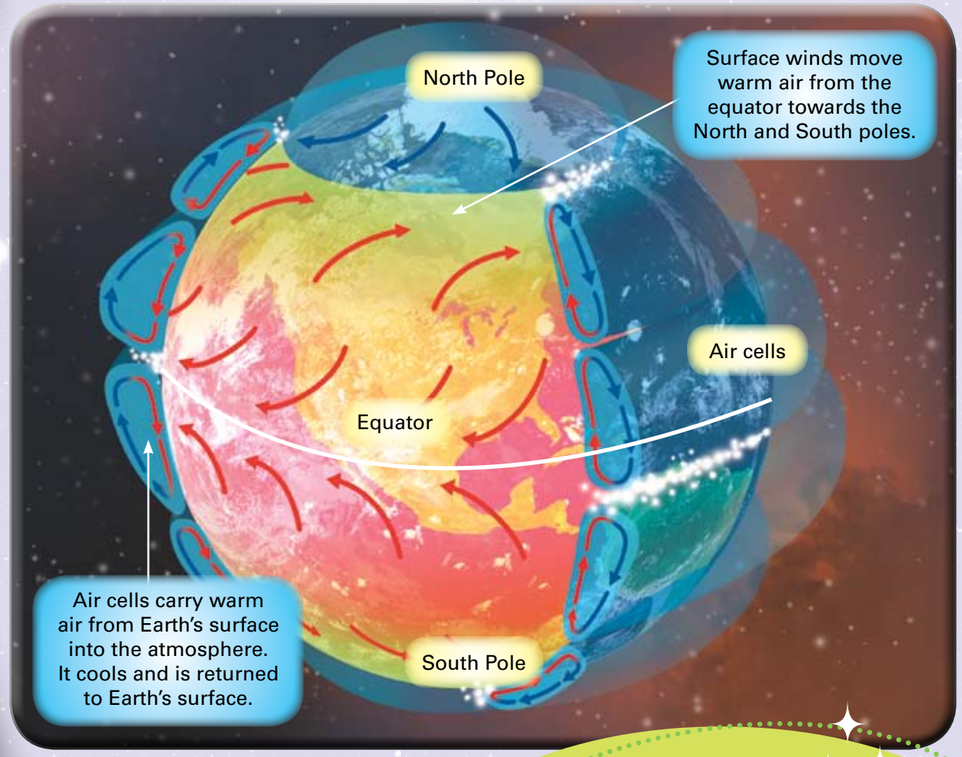
The atmosphere keeps Earth at the right temperature

The **atmosphere** acts like a blanket to keep Earth at the right temperature. The blanket works like a greenhouse, trapping the warmth of the Sun and keeping it from escaping back into **space**. Underneath the blanket, winds move warm and cold air from place to place. This keeps the temperature even around the planet.

Air is always moving around Earth, warming cooler areas and cooling areas that are too hot.



FAMOUS SKY WATCHERS

French mathematician Gustave-Gaspard de Coriolis discovered the worldwide movement of air. Air is pushed north and south from the equator, or centre of Earth. This air movement is called the Coriolis Effect.

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The greenhouse effect warms Earth

The greenhouse effect is a natural process in which the Sun heats up Earth and its atmosphere. The Sun's energy, or **radiation**, flows to Earth. Some energy is reflected from Earth and returns to space. However, most energy is stored in the Earth itself or is trapped by the atmosphere. This keeps the Earth at an even, warm temperature.

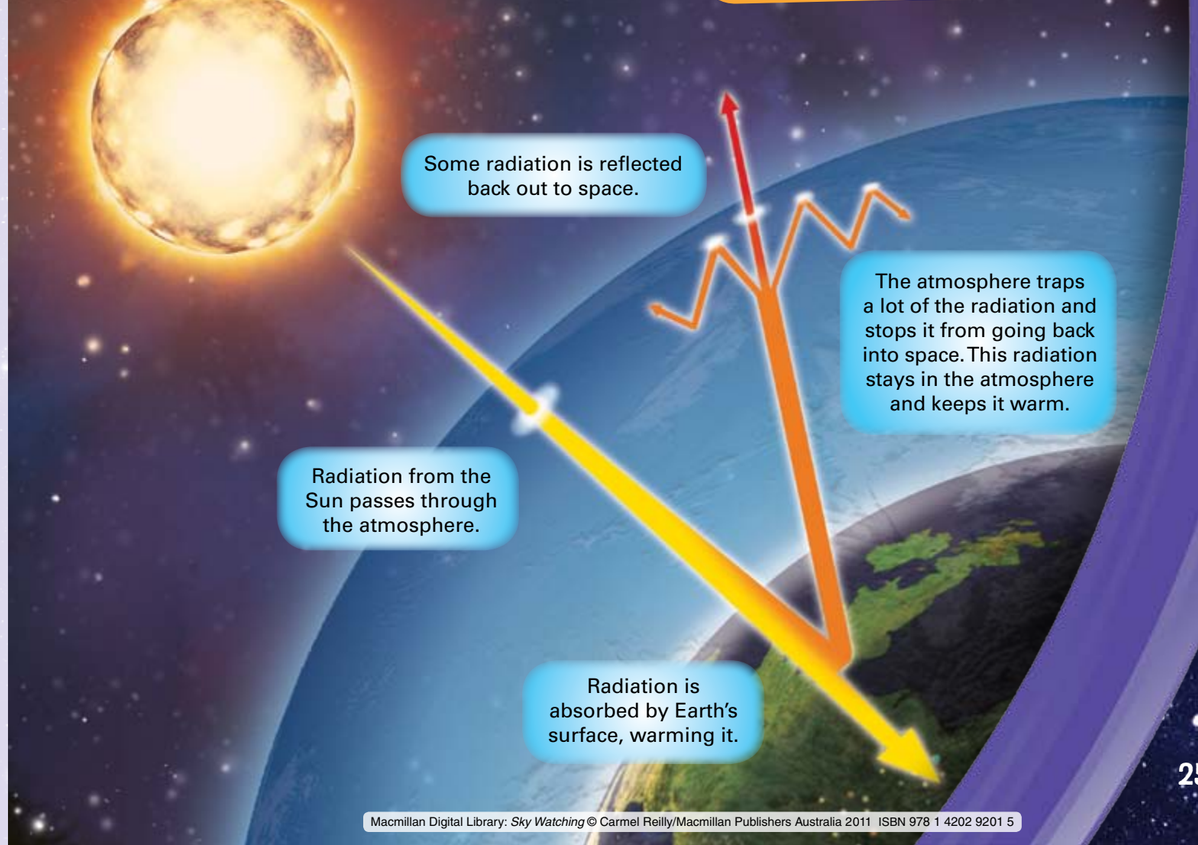
What if there was no atmosphere?

If there was no atmosphere, temperatures on Earth would not be even. It would be very hot during the day and very cold at night. All of the energy from the Sun would escape back into space.

Atmosphere fact

The atmosphere keeps Earth at an average temperature of 15°C. On the Moon, which has very little atmosphere, temperatures only average 1°C.

The atmosphere around Earth acts like the glass in a greenhouse to keep Earth warm.



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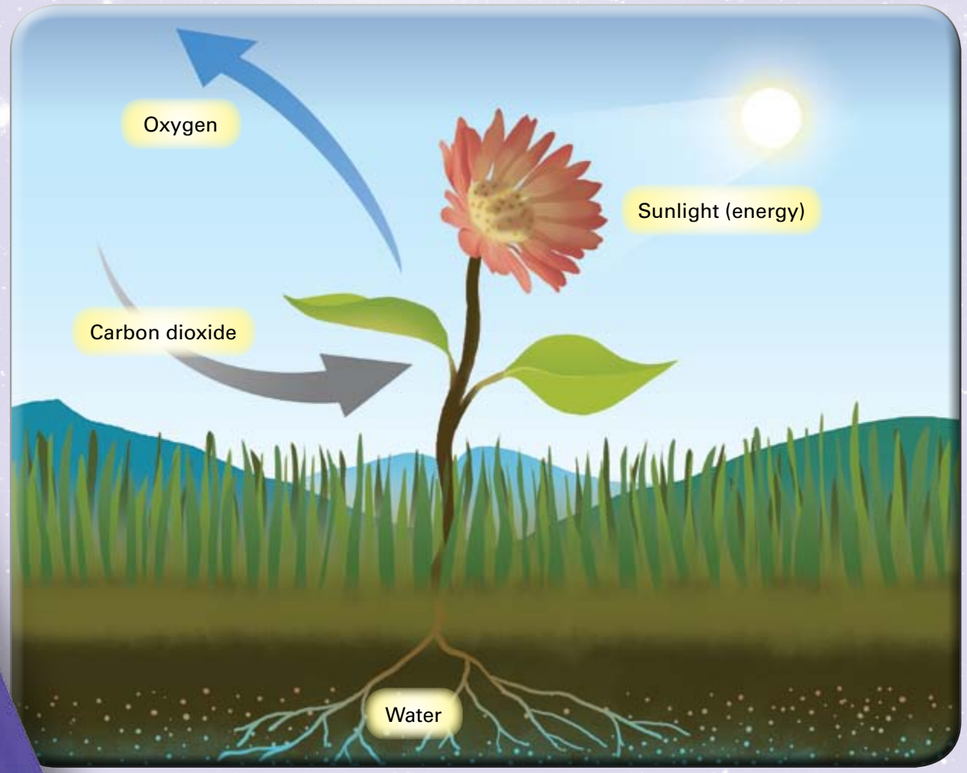
The atmosphere helps provide air and water

The **atmosphere** carries air and water. Air is made up mostly of the **gases nitrogen** and **oxygen**. The oxygen and water in the atmosphere are what allows life on Earth to exist. Oxygen and water are both used and re-created in processes called the oxygen cycle and the water cycle.

Air is provided in the oxygen cycle

Oxygen is vital for life on Earth. Humans and animals need to have oxygen in the air to breathe. Oxygen is used and re-created in a process called the oxygen cycle.

Humans and animals breathe oxygen in and breathe **carbon dioxide** out. Plants use the energy of the Sun, water and carbon dioxide gas (from humans and animals) to grow. As they grow, they give off oxygen into the atmosphere. This process is the oxygen cycle.

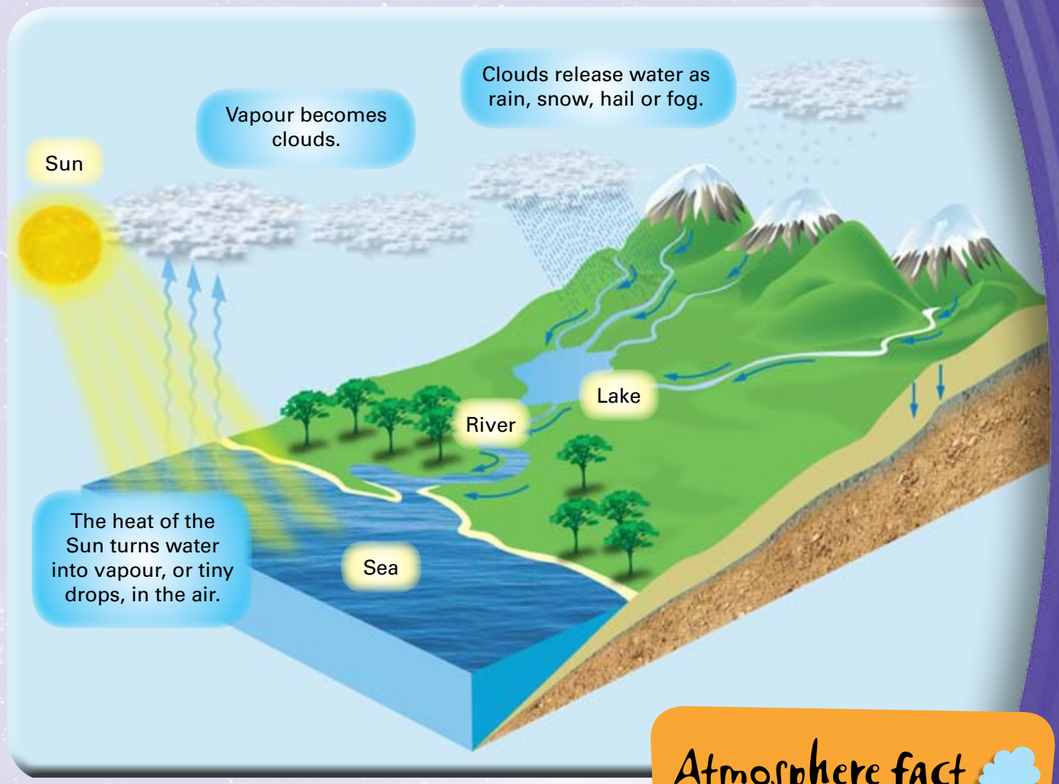


Oxygen needed by humans and animals, and carbon dioxide needed by plants are both carried in the atmosphere.

Water is provided in the water cycle

Living things need water. Water in the atmosphere is used and re-created in the water cycle.

Water stored in oceans, lakes, snow and ice is turned into **water vapour** by the heat of the Sun. This rises into the atmosphere and becomes clouds. When clouds become very heavy and cold they let the water out as rain, snow, hail or fog. This is called the water cycle.



Water is always moving from the Earth's surface, into the atmosphere and back again. This is called the water cycle.

What if there was no atmosphere?

If there was no atmosphere, Earth would have no air or water. Without air and water there would be no life on Earth.

Atmosphere fact

Humans need fresh water to drink. However, only 3 per cent of all water in and around Earth is fresh water. The remaining 97 per cent of water on Earth is found in oceans, which are salt water.

What is the future of Earth's atmosphere?

Scientists have found that Earth's **atmosphere** has warmed by 0.6 degrees Celsius in the last 30 years. Although this may not seem like a lot, if temperatures keep rising like this it will have a huge effect on Earth's life.

The atmosphere is getting hotter

The heating of the atmosphere is called global warming. Most scientists think global warming has been largely caused by human activities. Burning **fossil fuels** and cutting down rainforests contribute to global warming. These activities put extra **carbon dioxide gases** into the atmosphere. This adds to the greenhouse effect and causes Earth to heat up.

Famous sky watchers

Swedish scientist Svante Arrhenius was the first to link growing levels of carbon dioxide in the atmosphere with global warming. He was awarded a Nobel Prize in Chemistry in 1903.

Global warming has melted a lot of sea ice in the Arctic, reducing the habitat that animals such as polar bears need to live.

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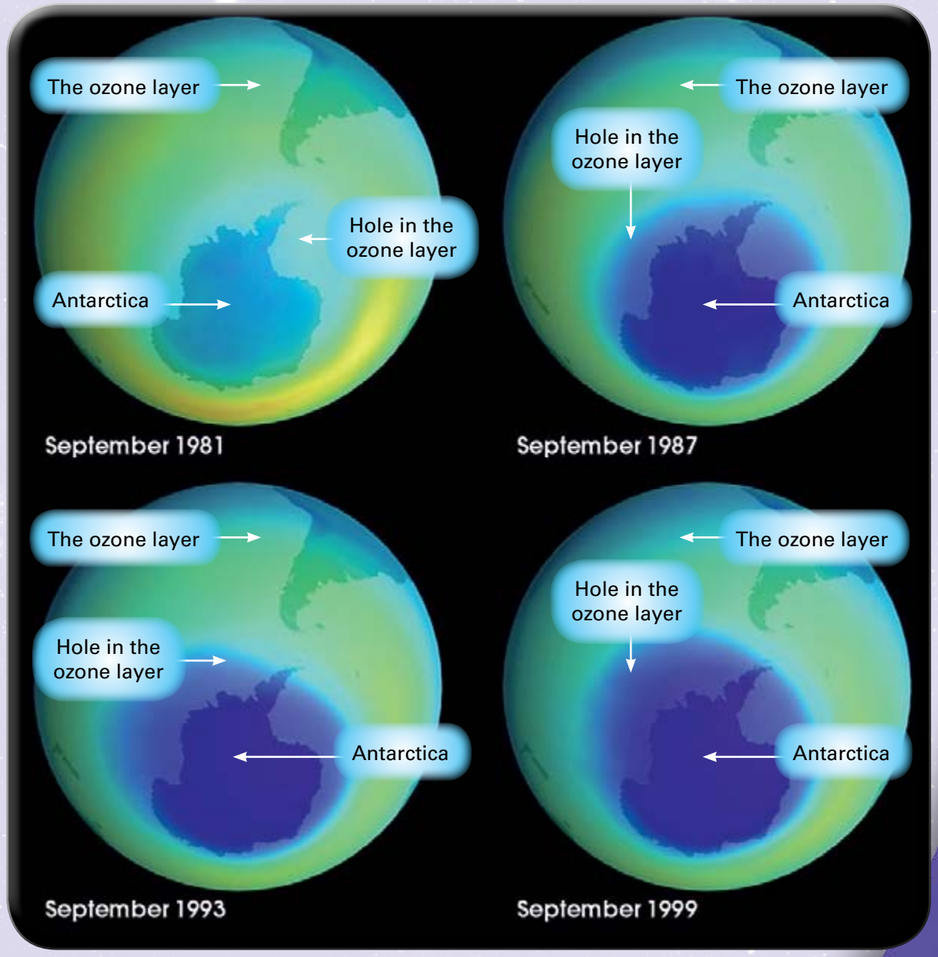
The ozone layer is becoming thin

The **ozone layer** is a band of gas that sits in the stratosphere. It helps protect Earth from the Sun's **UV rays**. In the 1970s, scientists noticed that the ozone layer was becoming thin in places. Scientists believe this was caused by chemicals called CFCs, which escaped into the atmosphere.

Atmosphere fact

In 1996, production of CFCs was stopped. Since then, the ozone has stopped thinning. Holes in the ozone layer are also slowly starting to repair themselves. The ozone might return to normal in another 50 years.

Between 1981 and 1999, a large hole grew in the ozone above the Antarctic.



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What are the best ways to atmosphere watch?

The **atmosphere** is all around you and above you. Every time you look at the sky, you look at the atmosphere. The weather is what you see most often.

Weather watching

Look at the sky and write down the time and what you see. Now look at the same part of the sky using binoculars or a telescope. Write down the time and what you can see now.

Satellite maps are also useful for weather watching. Look up a local weather site or **bureau of meteorology** site on the Internet. Find satellite maps for the time you looked at the weather.

How different are these views of the weather?

Useful equipment for backyard weather watching

Equipment	What it is used for
 **Binoculars or a telescope**	A pair of binoculars or a telescope will help you see objects in the atmosphere in more detail.
 **Satellite map**	A satellite map will help you look at the weather in your area. Visit the website of your local bureau of meteorology for an updated map.
 **Compass**	A compass will help you face the right direction when you are using the satellite maps.

Useful websites

Satellite Images: www.bom.gov.au/satellite

The Nine-Eyed MISR: http://spaceplace.nasa.gov/en/kids/misr_xword/misr_xword2.shtml

Scattering of Light: http://scifiles.larc.nasa.gov/text/kids/Problem_Board/problems/light/sim2.html

Greenhouse Effect: http://www.epa.gov/climatechange/kids/greenhouse.html

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Glossary

asteroids	small, rocky or metal space objects that orbit the Sun
atmosphere	the layer of gases that surrounds a planet, moon or star
bureau of meteorology	a government agency that provides weather information
carbon dioxide	an invisible gas that is produced when humans and animals breathe
comets	small, rocky and icy space objects that have long, shining tails that appear when orbiting near the Sun
fossil fuels	substances that formed in the Earth's crust from the remains of plants and animals that lived millions of years ago, and which produce energy when burned (such as coal, oil and natural gas)
gases	substances that are not solid or liquid, and are usually invisible
gravitational pull	the forces of gravity that attract two objects towards each other
gravity	the force that attracts all objects towards each other
matter	a substance of a particular kind, such as gas and dust
meteoroids	small space objects that are made of rock and metal, ranging from metres wide to the size of a pea
nitrogen	an invisible gas that forms 78 per cent of Earth's atmosphere
orbit	to travel around another, larger space object
oxygen	an invisible gas produced by plants that makes up about 20 per cent of Earth's atmosphere and makes air breathable
ozone layer	a band of gas found within the stratosphere and which absorbs many of the Sun's harmful rays
particles	very small parts of substances or matter
radiation	energy that travels in the form of waves or rays and can be harmful to living things
satellites	natural or human-made objects that orbit, or travel around, a planet
solar system	the Sun and everything that orbits around it, including planets and other space objects
space	the area in which the solar system, stars and galaxies exist, also known as the universe
ultra-violet (UV) rays	invisible rays that are a part of sunlight and which can be harmful to human eyes and skin in large amounts
water vapour	tiny particles of water that are no longer a liquid and can be carried in the air
wavelength	the waves in which light and sound travel; different types of sounds and colours have waves of different lengths

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