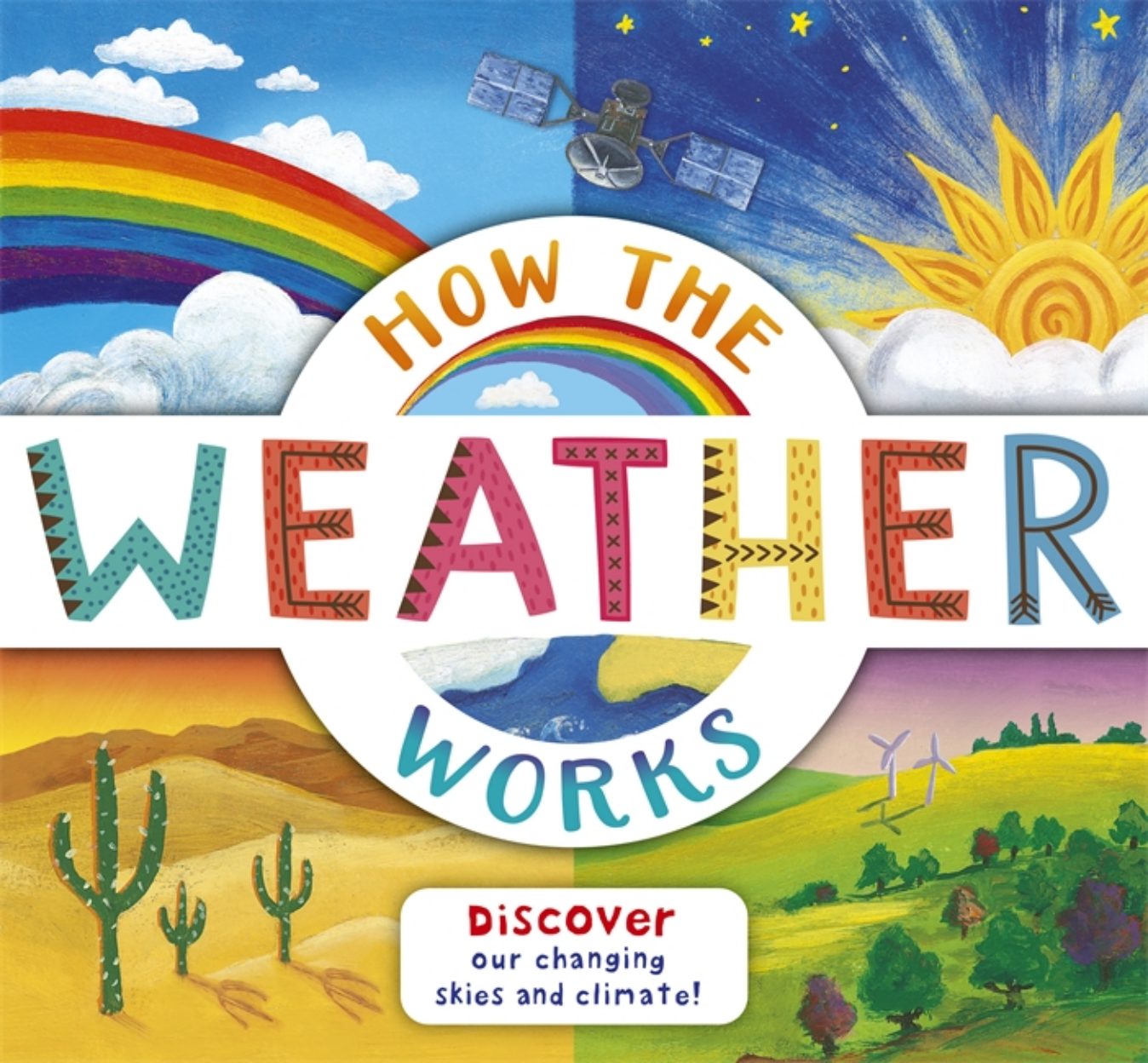
HOW THE
WEATHER
WORKS
Discover
our changing
skies and climate!

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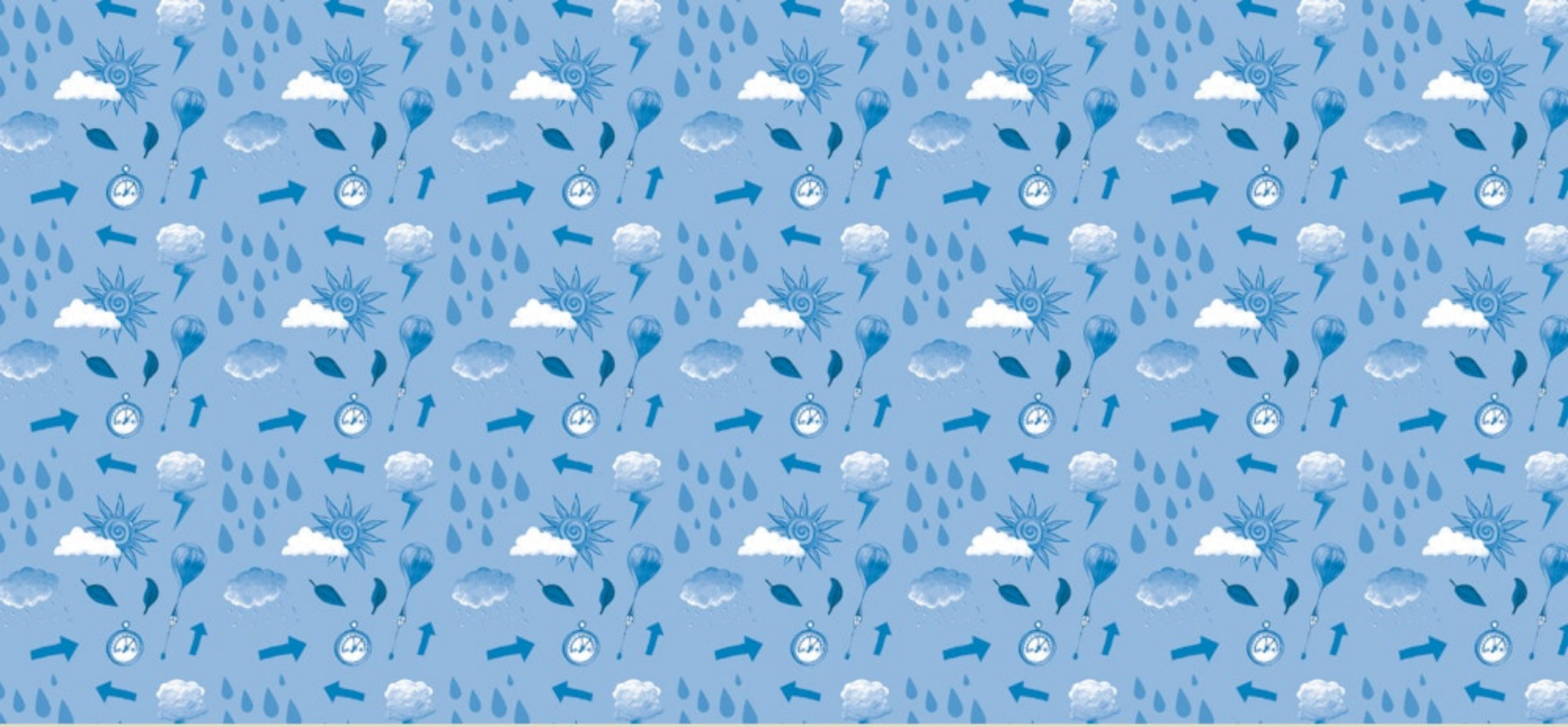

To Phil, Tom and Nico – C.D.

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HOW THE WEATHER WORKS

By Christiane Dorion and Beverley Young

templar

What causes the weather?

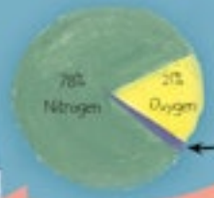
The answer is the Sun, our closest star.

The weather is what is happening in the air above our heads. It may be hot and sunny in one part of the world and cold and snowy in another. In some places, the weather can change from one minute to the next. It's amazing to think that all this weather is caused by the Sun – which is 150 million kilometres away!

What's above our heads?

The Earth is wrapped in a thin layer of gas called the atmosphere, which keeps the planet warm and protects us against the Sun's dangerous rays. It also provides oxygen to breathe. Scientists divide the atmosphere into five different layers according to temperature. The weather we notice every day occurs in the layer closest to the Earth, called the troposphere.

The air above our heads is a mixture of different gases.



The Sun is a giant ball of burning gas. Its warming rays have a huge effect on the Earth's weather. They change the temperature, cause the winds and even make rain happen.

The ozone layer

High up in the stratosphere is a thin layer of gas called ozone, which absorbs harmful ultraviolet rays from the Sun. In the 1980s, scientists discovered that chemicals from aerosols and old fridges were damaging the ozone layer.

Fortunately, these chemicals have been banned in most countries!

The life of a sun ray

What happens to the Sun's heat when it reaches Earth? Some is trapped by the atmosphere, some is reflected back into space by clouds and some is absorbed. Dark surfaces such as oceans, forests and cities soak up the heat, warming the air above. Bright surfaces such as snow and ice reflect the heat, which cools the air.

The north and south poles are the coldest places on Earth. They have no sunshine for 182 days a year!

Why do we get seasons?

In some parts of the world, the weather changes throughout the year. This is because the Earth is like a spinning top that leans to one side. As it makes its annual journey around the Sun, different areas receive different amounts of sunlight and heat. This causes the seasons.

When the north pole leans towards the Sun, it is summer in the northern hemisphere, with warmer weather and more hours of daylight.

It is winter in the southern hemisphere, with colder weather and shorter days.

When the north pole leans away from the Sun, it is winter in the northern hemisphere, with colder weather and fewer hours of daylight.

It is summer in the southern hemisphere, with warmer weather and longer days.

What makes up the weather?

Precipitation is the water that falls from the sky as rain, snow, hail or sleet.

Wind is the movement of air caused by differences in temperature on the Earth's surface.

Temperature is a measure of how hot or cold the air is.

Humidity is the amount of water vapour in the air.

Pressure is the weight of the air pressing down on the Earth's surface.

Day and night

Temperature also varies throughout the day. The Earth rotates once in 24 hours and this creates day and night. When your side of the Earth faces the Sun, it is daytime and warmer. When it turns away from the Sun, it is nighttime and cooler.

The weather dictates the clothes we wear...

... and sometimes our mood!

"Great weather we're having!"

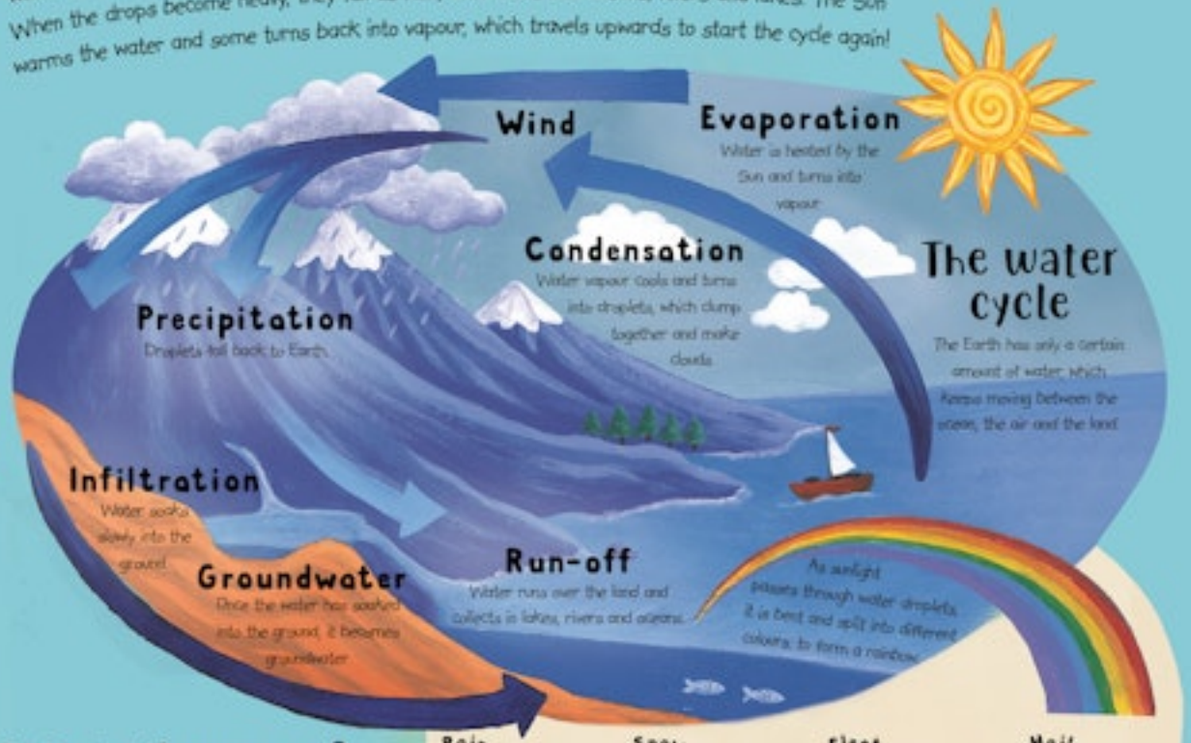
The weather is always a good topic to start a conversation, especially in countries where it changes all the time.

"Raining cats and dogs again today!"

"Yes, nice weather for ducks!"

Where does rain come from?

Even though we can't see it, air contains water in the form of water vapour. As air rises, it cools, which turns the water vapour into droplets. These stick to dust particles and other droplets, growing bigger to make clouds. When the drops become heavy, they fall as rain, which runs into oceans, rivers and lakes. The Sun warms the water and some turns back into vapour, which travels upwards to start the cycle again!



Rain, hail or snow?

Did you know that water can be a gas, a liquid or a solid? When it falls from the sky, it can take many forms depending on how cold it is in the clouds and above the ground. You might end up with soaking rain, lumps of hail or powdery snowflakes.

Types of rainfall

To make clouds and rain, something needs to force air to rise and cool. So what makes this happen?

Frontal rainfall

When warm air meets cold air, the warm air is pushed above the cold air. As it rises, vapour in the air turns to droplets.

Convectional rainfall

When the Sun heats the ground, the air directly above warms up, then rises. As the air cools, water vapour turns into droplets, clouds form and it rains.

Too much, too little

Different places on Earth have different amounts of rain throughout the year. Some countries have too much and others have too little, leading to very difficult conditions.

Flooding

Flooding happens if a river rises and overflows its banks after days of heavy rain or melting snow. In cities, concrete and tarmac make flooding worse because the water can't be absorbed by the ground.

Droughts

Droughts happen when there is less rain than expected for several months or even longer. Some plants and animals have amazing techniques to cope with these dry conditions. The darkling beetle, for example, collects dew on its body to drink.

Relief rainfall

When moving air reaches a large obstacle, such as a mountain, it is forced to rise over the top. This cools the air down, causing rain.

What is lightning?

In a thunderstorm, water and ice particles rub against each other inside the clouds, creating an electric charge that zaps down to Earth as lightning. Lightning heats up the air, causing it to expand and collapse rapidly, which produces a rumble of thunder.

What is a weather front?

The most changeable weather on the planet is halfway between the equator and the poles, where there is a constant battle in the atmosphere between warm and cold air. This was discovered by the Norwegian scientist Vilhelm Bjerknes in 1918. With the First World War fresh in his mind, he used the word 'front' to describe an area where large pockets of air clash, like two armies on a battlefield.

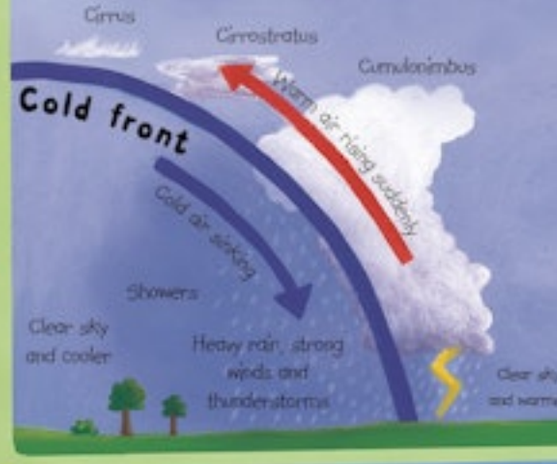
Up, up and away!

Warm air rises. As the Sun heats a patch of the Earth's surface, the air above it warms, expands and becomes lighter. It floats upwards through the surrounding cooler air, a bit like the blobs of wax in a lava lamp.

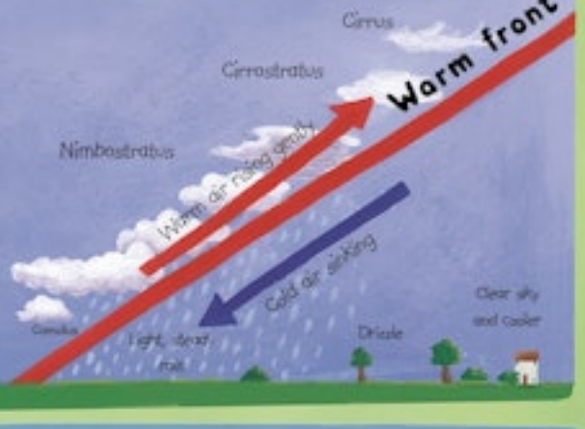
What's the link with hot-air balloons? The air in a hot-air balloon is heated, so it expands and becomes lighter than the surrounding air. This makes the balloon rise.

Vultures and eagles use their long, broad wings to soar effortlessly into the sky, carried by rising warm air currents.

If a warm front and a cold front pass over your house, here's how the weather will change over a day or two.



Cold and warm air do not mix easily. When warm, moist air moves towards cooler, dry air, this is a warm front. The warm air rises gradually above the cold air, bringing light rain and warmer weather. When cold air rushes towards warm air, this is a cold front. The cold air forces the warm air to rise quickly, bringing storms and cooler weather.



Cloud spotting

The way clouds change can tell us what kind of weather may be on the way. Clouds come in all sizes and shapes and can appear near the ground or high up in the sky. Learning a few Latin words will help you to become a good cloud spotter!

High clouds

The Latin word *cirrus* means 'lock of hair', *cumulus* means 'heap', and *stratus* means 'blanket'.

Cirrus: Delicate white streaks made of falling ice crystals mean fair weather.

Cirrostratus: Layers of tiny rippling sheets of cloud mean fair weather.

Cirrocumulus: A thin milky veil that covers most of the sky means rain is on the way.

Medium clouds

In Latin, *alto* means 'high' and *nimbus* means 'rain'.

Altostratus: Look like broad rolls and mean wet weather is on the way.

Cumulonimbus: Bring sudden heavy rain, thunder and lightning. They reach from low to high and can be seen taller than Mount Everest!

Altocirrus: A smooth blanket of grey clouds that bring rain.

Low clouds

Cumulus: Puffy clouds that form on a sunny day.

Stratus: Flat, misty clouds sometimes producing drizzle.

Stratocumulus: Low, patchy layers of clouds covering most of the sky.

Nimbostratus: A thick, grey blanket of clouds that bring lots of rain. Can also be found higher.

How heavy is the air?

While you're reading this book, a huge amount of air is pressing down on your head. Gases in the air are made up of tiny molecules. Although they're invisible, they still have weight and take up space. So why can't we feel this weight? It's because there's also air inside our bodies, which pushes outwards, balancing the pressure from the air above our heads.

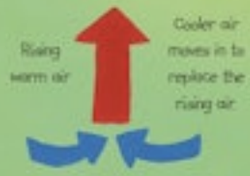
Each square metre of the Earth's surface has about 10,000 kilograms of air above it. That's the weight of two elephants!

Air pressure

Air pressure is the weight of air pressing down on the Earth's surface. When air warms up and rises, there is low pressure. When air cools and sinks, there is high pressure. Air pressure varies across the planet because different areas receive different amounts of the Sun's heat.

Low pressure

When air warms, it rises, leaving less air pressing down on the Earth's surface. The air pressure goes down.



Areas of low pressure, or 'depressions', have rain, storms and changing temperatures.

High pressure

When air cools, it sinks. This means more air pressing down on the Earth's surface. The air pressure rises.

As air sinks, it becomes warmer and drier and clouds disappear. Areas of high pressure usually bring dry, calm weather with clear skies.

Why does the wind blow?

We don't always notice it, but the air above our heads is always rising, sinking and swirling. This is because the Sun heats some parts of the planet more than others. When warm air rises it leaves space for cooler air to move in to replace it. This movement of air creates the wind. Sometimes it's barely noticeable, but at other times the wind causes terrifying gales and hurricanes.

Masses of air

Huge pockets of air with different temperatures and levels of moisture form and move around in the atmosphere. These are called air masses. The weather they bring can be wet or dry and hot or cold depending on whether they form over sea or land, near the equator or near the poles. This map shows where air masses form around the Earth.

Under pressure

When a mass of cool air sinks, it creates an area of high pressure beneath it, and when a mass of warm air rises, it creates an area of low pressure. This leaves space for the high-pressure air to move in. So wind always blows from areas of high pressure to areas of low pressure.

Winds blow from high to low.

The bigger the difference in pressure, the stronger the wind is.

Jet streams

Jet streams are super high-speed winds that weave a wiggly path around the globe. We never feel jet stream winds because they flow miles above our heads, but we often feel their effects as they carry storms and other weather along with them.

Global winds

Air circulates all the time between the chilly poles and the warm equator, keeping temperatures around the world balanced. As air rises and sinks, huge bands of low and high pressure form around the Earth. These produce three main belts of wind in each hemisphere. In places where the winds come together, such as the area near the equator known as the doldrums, the weather is calmer.

Spiralling winds

Cyclones and anticyclones are large areas of circulating air.

Cyclone

A cyclone is an area of low pressure that forms when warm air lifts, allowing cooler air to spiral in to take its place. Clouds form and it rains.

Anticyclone

An anticyclone is an area of high pressure that forms when cool air sinks, causing the winds to spiral away. As the air sinks, it becomes warm and dry. Water droplets turn to vapour, and clouds disappear.

The Coriolis effect

Because the Earth spins like a top, the winds swerve! We call this the Coriolis effect.

Local winds

The winds don't just affect the weather on a global scale, they also have an impact where you are. At the seaside on a summer's day, there is often a gentle breeze. What causes it?

Monsoons

The monsoon winds blow across India and South East Asia. They change direction with the seasons, like an enormous sea breeze.

Meteorologists use information from complex weather charts to make these simple maps for us.

How can we predict the weather?

Every day, measurements about the weather are recorded at thousands of weather stations around the planet. They are set up in all sorts of places, from remote islands to mountain peaks. Ships and buoys collect information at sea, while balloons and aircraft take measurements in the atmosphere. Satellites circle the Earth, beaming back images of clouds and storms. All this information is fed to powerful computers that carry out millions of calculations a second. Scientists called meteorologists use these computers to predict the weather. But the weather is so complicated that sometimes even supercomputers can't predict it!

How we used to predict the weather

Long before the invention of modern weather instruments, farmers and sailors relied on clues in nature to predict the weather. Some of these old sayings can be amazingly reliable!

Animals

"If birds fly low, expect rain and a blow." Before rain, birds fly near the ground where the air is denser.

Feeling closeness in the air, cows often huddle together and lie down if bad weather is on its way.

"If frogs croak louder, rain is on its way." Sound travels better in moist air, so this saying has some wisdom.

Humidity

"Flowers smell best before rain." This is because scents travel better in moist air.

"When chairs squeak, it's of rain they speak." Wood absorbs moisture from the air, expands and squeaks.

"When the dew is on the grass, rain will never come to pass." Dew forms when air cools quickly on clear, cloudless nights.

Observing the sky

"Chimney smoke descends, fair nice weather ends." The moisture in the air can stop smoke from rising.

"If a circle forms around the Moon, it will rain soon." When moonlight passes through clouds, it looks like a halo around the Moon.

Don't forget clouds

"When clouds look like black smoke, a wise man will put on his cloak." Thick, rainy clouds look dark.

How to make a rain gauge

Make your own gauge and find out how much rain falls each day where you live.

1. Ask an adult to help you cut the top off an empty plastic bottle.

2. Place the top upside down in the bottle, making a funnel. With a pen and a ruler, mark a scale in centimetres up the side starting from the bottom.

3. Place your gauge outside and take measurements at the same time every day.

Fact or folklore?

Although some old weather sayings are quite dependable, others, like these, don't have any science to back them up.

"When squirrels gather large stores of nuts, expect a hard winter."

"If a groundhog comes out of its burrow at noon on 2 February, Groundhog Day, and sees its shadow, there will be six more weeks of winter."

Modern tools to measure and predict the weather

Rain gauge

This is a simple instrument that measures the amount of rain over a period of time.

Barometer

This measures whether the air pressure is rising or falling. Rising air pressure means sunny, dry weather is on the way, while falling pressure brings stormy, wet weather.

Thermometer

This measures the air temperature. The tube contains a liquid such as mercury. When air heats the liquid, it expands and moves up the tube.

Anemometer

This measures the wind speed. The wind makes the cups spin around, and the number of turns is recorded every minute.

Weather balloon

These carry instruments that measure humidity, pressure and temperature. The information is transmitted via radio waves to meteorologists.

Satellites

Satellites take detailed images of the atmosphere and the planet and can track storms and hurricanes.

What's the weather like?

Weather maps tell you what the current weather is and what's expected over the hours and days ahead. Maps like this one help to forecast the weather every day. See what happens where cold air is meeting warm air.

Discoveries and inventions that have helped us understand and predict the weather

1643 Evangelista Torricelli, an Italian mathematician, made the first barometer and proved the existence of air pressure.

1714 Gabriel Fahrenheit, a German instrument maker, invented the mercury thermometer.

1960 NASA launched the first weather satellite into orbit around Earth.

What is a hurricane?

A hurricane is a massive swirling storm that forms over the ocean near the equator. When hurricanes hit land, the heavy rain, strong winds and giant waves that they bring cause terrible damage and can be deadly. But these storms also do an important job for the planet, moving heat from the equator to cooler areas.

How to make a hurricane

1. Find a warm sea

Hurricanes form near the equator over warm seas that are 27 degrees Celsius or more. Heat from the water warms the air above it, making it rise.

2. Blow on the surface

As the warm air rises, winds blow from different directions, forcing more air upwards.

3. Spin the planet

The rotation of the planet makes the winds spiral, carrying heat and moisture upwards until it starts to look like a cylinder, twisting faster and faster.

4. Cool down the rising air

The moist warm air cools as it rises, producing large dark clouds and heavy rain.

5. Let the winds escape

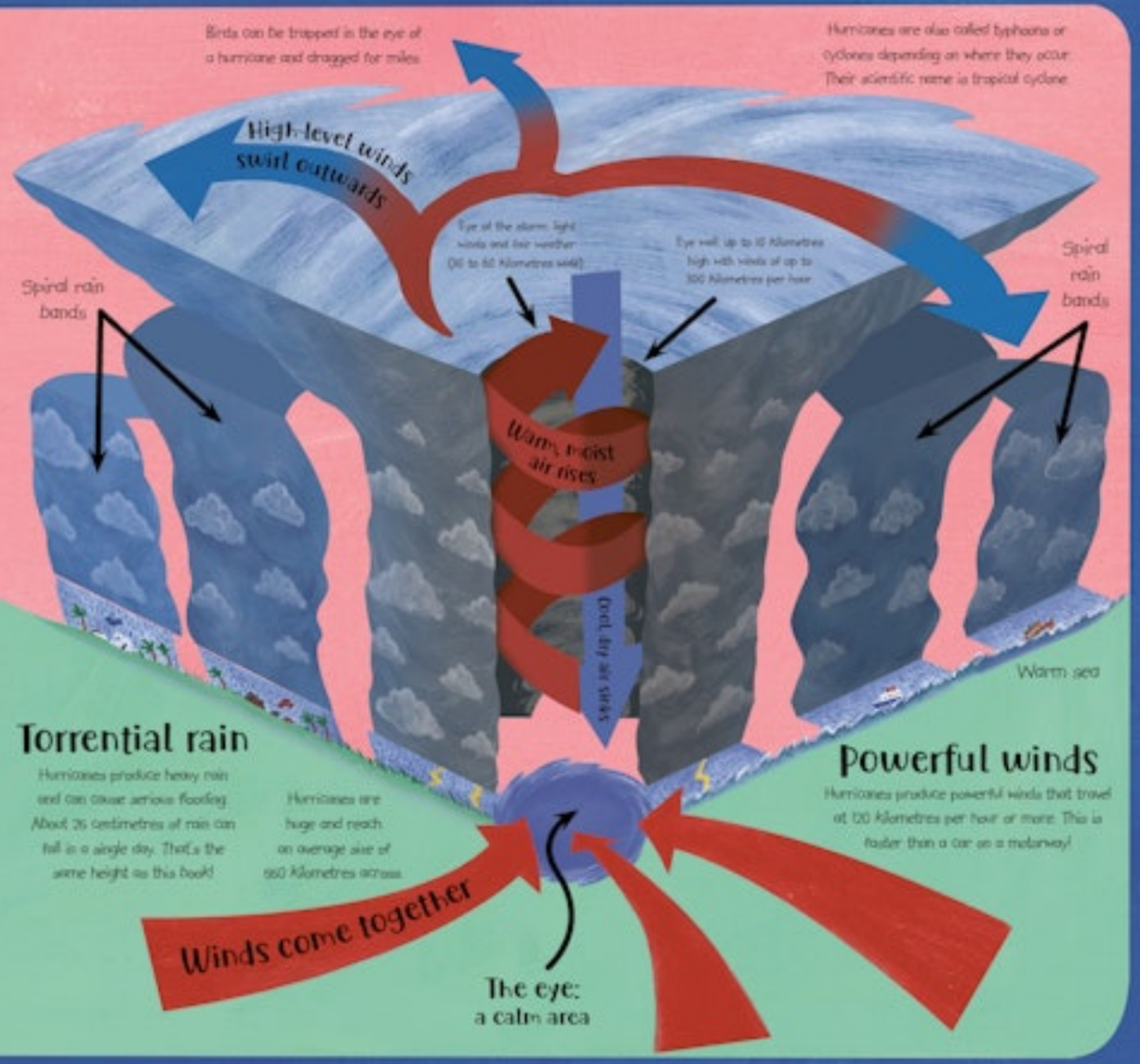
As the winds flow outwards at the top of the hurricane, more air rushes in at the bottom.

Storm surges

A hurricane's strong, spiralling winds push seawater in front of it. This water rises to make a high mound, called a storm surge. It can reach up to 13 metres in height, flooding large areas of coast.

Birds can be trapped in the eye of a hurricane and dragged for miles.

Hurricanes are also called typhoons or cyclones depending on where they occur. Their scientific name is tropical cyclone.



What is extreme weather?

Extreme weather is any weather that falls outside normal patterns. It includes hurricanes but also severe weather such as thunderstorms, tornadoes, droughts, hail and blizzards. These can be dangerous and cause a lot of damage. We can reduce their impact by trying to predict them and be prepared!

The winds of tornadoes can reach speeds of up to 150 kilometres per hour!

Tornadoes

Tornadoes, also called twisters, are violent, twisting storms. They form over land when a warm wind meets a cold wind and these winds start moving around each other. Tornadoes are smaller than hurricanes but produce the fastest winds on Earth. They can suck up everything in their way.

Sandstorms

Sandstorms are caused by strong winds blowing over the desert. Spirals of warm air rise from the hot ground, sweeping up dust, sand and everything else in their path.

Blizzards

Snowstorms with very strong winds are called blizzards. The strong winds drive huge drifts of snow, which may completely cover houses, cars and trains, trapping people inside.

If you live in a hurricane zone, make sure you have a survival kit ready. Keep a battery-powered radio handy to find out how the storm is developing.

Hurricane hunters

Would you fly straight into a hurricane? Well, that's what some pilots do to collect information about wind speeds and rainfall inside the storm. This helps to predict the path and strength of the hurricane before it reaches land.

What is climate?

While weather is what happens each day in the sky above our heads, climate is the average temperature and rainfall in a place over many years. Climates are influenced by the atmosphere, the oceans and the landscape. They are very complicated things – in fact even scientists do not completely understand how climates work and how they change over time.

What affects climate?

Usually, climates cool as you head away from the equator towards the poles because there is less direct heat from the Sun. Climate also depends on the height of the land. If you live on top of a mountain, it will be colder than down in the valleys. The oceans can influence climate by storing and transporting the Sun's heat around the planet.

Have you heard of El Niño?

Every few years in the Pacific Ocean near the equator, the ocean's surface gets warmer than usual, causing more thunderstorms and changing the wind patterns. This causes floods and droughts in different parts of the world.

Microclimates

In small areas, such as a hill, a forest or even a garden, the climate may be a bit different from the surrounding area. We say that this area has its own 'microclimate'. Imagine a forest. It is usually cooler, darker and less windy than the fields around it.

We create microclimates by building cities. Roads, pavements and buildings absorb heat from the Sun during the day and release it at night, so the overall temperature is warmer. Cars and factories also produce heat, which gets trapped by the city's tall buildings and narrow streets.

Smog

Smog (smoke and fog) was common in cities when coal was used for heating. Smoke would mix with cold air. The 'Great Smog' happened in London in 1952. A thick haze choked the city, even finding its way into people's houses. Today, smog mostly comes from car exhausts.

Continental climate

In the northern hemisphere, a long way from the equator and the sea, the temperature changes drastically in spring and autumn, bringing long, harsh winters and short, warm summers.

Polar climate

Near the poles, it is bitterly cold and very windy all year round. The ground is covered in snow and ice, but it is as dry as the desert!

Arid climate

In and around the tropics (the areas on either side of the equator), it is hot all year round with very little rain. Without any clouds, temperatures drop sharply at night. Plants and animals are well adapted to cope with the lack of water and extreme temperatures.

Tropical climate

Near the equator, the climate is hot and wet all through the year. The Sun shines directly overhead, and rising hot air produces heavy rain most days. Rainforests grow in these areas and provide homes for more than half of the world's plant and animal species.

Mountain climate

Mountains are cold and windy in the winter and milder in the summer. High peaks are always covered in snow and ice.

Mediterranean climate

Named after the Mediterranean Sea, this climate is also found in other coastal areas. The winters are mild and wet and the summers are hot, sunny and dry.

Temperate climate

Between the tropics and the poles, cold and warm air meet all the time and the weather is changeable. One day it may be sunny and the next day rainy. Sometimes the weather changes several times in one day!

What was climate like in the past?

Isn't it incredible that 40 million years ago, Antarctica was a warm, balmy land of forests and fruit trees?

Precambrian period: cool

4,600 million years ago

When Earth forms, volcanoes erupt all the time. Tiny bacteria appear and slowly change the climate by absorbing carbon dioxide and releasing oxygen. Earth cools and turns into a giant snowball.

This period is 90 per cent of Earth's history!

542 million years ago

Cambrian period: warm

An explosion of creatures spread across the seas.

Worms

Molluscs

Sponges

The Earth's climate is warm and wet. Most of the land above sea level is clustered around the equator. There is little oxygen in the air, and everything lives in the ocean.

Giant woodlice called trilobites dominate the seas for 300 million years.

488 million years ago

Ordovician period: cool

The first reptilelike animals appear, along with snails and corals.

Creatures like Orthoceras float in the Silurian seas.

The continents drift towards the south pole. The Earth cools dramatically and ice sheets form. The continents are covered in ice and more than half of the world's animals die.

443 million years ago

Silurian period: warm

The Earth enters a long warm phase for millions of years. Melting ice causes a huge rise in sea levels and marine animals of all kinds appear. Plants begin to spread across the land.

416 million years ago

Devonian period: warm

Most of the land above sea level is near the equator and the climate is warm. Some sea creatures grow large and start to walk on land.

359 million years ago

Carboniferous period: cooling down

With warm, damp conditions, large trees grow in swamps and shrink, producing lots of oxygen. Gradually, the Earth cools down.

Forests and swamps are home to giant dragonflies and creepy-crawlies.

Fish dominate the seas. This one is a type of shark.

299 million years ago

Permian period: warming up

All the continents join together to form one huge land mass called Pangaea.

This period starts with an ice age and then warms up. Massive volcanic eruptions spurt carbon dioxide into the air. Most of the land becomes desert, and about 90 per cent of all species die.

Giant reptiles such as Dimetrodon walk the land.

251 million years ago

Triassic period: warm

The hot, dry climate is perfect for reptiles to flourish on land, in the air and in the seas.

Early crocodiles and the first dinosaurs appear.

199 million years ago

Jurassic period: cooling down

The climate is warm and the dinosaurs rule the land. Pangaea begins to break apart, and large areas of land flood. Then, the Earth cools down.

The first birds develop from dinosaurs. They have teeth, claws on their wings and long tails.

145 million years ago

Cretaceous period: warming up

Today's continents start to take shape. About 65 million years ago, a meteorite hits the Earth, throwing up clouds of dust and cooling the climate slightly. Many species die, including the dinosaurs.

This is the time of giant dinosaurs, such as the meat-eating Tyrannosaurus rex and the plant-eating Triceratops.

65 million years ago

Tertiary period: cooling

At first, the climate is warm and humid. But then the amount of carbon dioxide in the air drops and the climate begins to cool. The Earth enters an ice age and huge glaciers form across many continents.

Sheep-size animals like this Phenacodus and other big mammals roam the Earth.

1.8 million years ago

Quaternary period: cool with warmer spells

The continents reach their current positions. The Earth has a cycle of warm and cold periods called ice ages. Scientists think that we are now in a warm period between two ice ages.

Are we changing the climate? Turn the page to find out!

Woolly mammoths die out at the end of the last ice age, about 10,000 years ago.

Here we are: modern humans. Our ancestors, the first Homo sapiens, emerged only about 250,000 years ago.

Moving continents

Over millions of years, the continents have slowly moved around, grinding against one another to create mountains and volcanoes.

Volcanoes

BOOM! Volcanic eruptions spurt vast clouds of dust and gas into the atmosphere. These can block the sunshine, making the Earth colder for months on end. Longer term, lots of massive eruptions add carbon dioxide to the air, warming the planet.

In the 1930s, Milutin Milankovic, a Serbian mathematician, discovered through careful calculations that the tilt of the Earth and the shape of its path around the Sun change slightly in regular cycles of tens of thousands of years. This affects the amount of sunshine reaching the planet, triggering ice ages and warm spells. Recently, scientists have found out that during the warm spells, there is more carbon dioxide in the Earth's atmosphere than during the cold spells.

How do we know all this?

Scientists called paleoclimatologists look for clues to find out what the climate was like millions of years ago. They study layers of mud and sand at the bottom of the oceans, bubbles of air trapped inside old ice and the thickness of tree rings.

The rings of a tree trunk can tell us how much it grew during each year of its life and how warm and wet the climate was.

A cold blip in a warm spell

Between the sixteenth and nineteenth centuries, the Earth was cooler than it is today. We call this period the Little Ice Age. Scientists think that it happened because less of the Sun's heat reached the Earth and there were lots of volcanic eruptions, so ash blocked out the Sun.

In the past, the climate has been both much colder and much warmer than it is now. Millions of years ago, your area could have been a desert, a jungle or an ice cap!

Are we changing the climate?

Yes, according to most scientists around the world. The Earth is warming up and the cause is the way we do things on our planet. The Earth's climate has warmed up and cooled down many times over its long history. But now the average global temperature is rising much faster than expected and scientists agree that humans are making this happen.

Fossil fuels

Most of our energy comes from burning coal, oil and natural gas. These are called fossil fuels because they are made from plant and animal remains buried underground for millions of years. When we burn them, we release the carbon that was inside them into the air.

1. 

Before the age of dinosaurs, trees and plants died and sank into swamps.

2. 

Over time, they were covered by mud and sand and turned into a soggy substance called peat.

3. 

Crushed and heated in the ground, the peat slowly turned into coal.

4. 

Today we extract coal and burn it to produce energy.

The greenhouse effect

In 1859, Irish scientist John Tyndall made an amazing discovery: some gases in the atmosphere trap heat and bounce it towards the Earth, like glass in a greenhouse. These gases include water vapour, carbon dioxide, methane, nitrous oxide and ozone. They make up a tiny part of the atmosphere, but they keep the planet mild and habitable.

The natural greenhouse effect

The enhanced greenhouse effect

We are adding more and more greenhouse gases to the atmosphere because of the way we produce energy and use the Earth's natural resources. This traps more of the Sun's heat, warming up the Earth's surface.

Greenhouse gases

How do we add them to the atmosphere?

Planes (carbon dioxide)

We use planes to travel and carry goods all around the world, polluting the atmosphere.

Trees absorb carbon dioxide from the air and give out oxygen. When we burn or cut down forests, the stored carbon is quickly released into the atmosphere.

We spray fertilisers on crops to make them grow bigger and faster. When these break down in the soil, they release greenhouse gases.

When we grow rice, tiny bugs that thrive in the flooded paddy fields release huge amounts of methane.

Fertilisers (nitrous oxide)

Intensive cattle farming (methane)

Rice growing (methane)

Deforestation (carbon dioxide)

Power plants and factories (carbon dioxide)

Cars (carbon dioxide)

Landfill (methane)

As cows digest food they release a gas called methane. There are about 1.5 billion cows in the world – that's a lot of methane!

Most cars, boats and lorries run on fuels made from oil, adding greenhouse gases to the air.

We produce huge mountains of rubbish, releasing greenhouse gases.

We burn fossil fuels in power stations to make electricity for our factories and homes.

What evidence do we have?

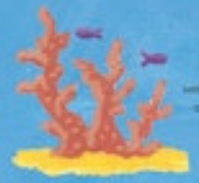
There are lots of things in nature that tell us that the Earth's climate is getting warmer. Instruments on land stations, ships and satellites help us to monitor these changes. Scientists have also come up with ways to measure our human impact and we are finding new solutions to reduce the effect we have on our planet's climate.

So what's changing?

Melting ice caps

The ice in the Arctic Sea and on the frozen continent of Antarctica is melting.

Polar bears are in danger!



Warming waters damage coral reefs.

If all the ice in the Antarctic melted, the oceans would rise by the height of a 20-storey building!

Warming oceans

The oceans are getting warmer. Warm water takes up more space than cold water, so sea levels are rising. This rise is also caused by water flowing into the sea from melting ice caps and glaciers.

Storms and heatwaves

We are seeing more intense weather around the world, with big storms and floods, heatwaves and droughts.

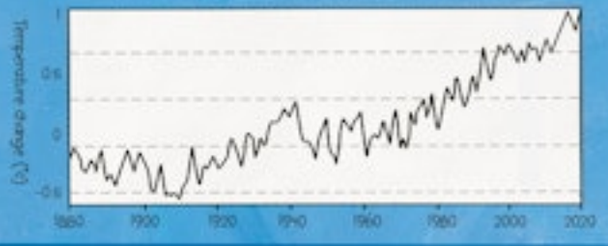
Melting glaciers

Mountain glaciers, which are important water sources for millions of people, are melting. Look below to see how fast the ice cap of Kilimanjaro, the highest mountain in Africa, is shrinking.

In 1896, Svante Arrhenius, a Swedish chemist, made a brilliant link. Could burning coal to power our factories make the Earth warmer by releasing carbon dioxide? In 1968, American scientist Charles David Keeling found a way to measure the amount of carbon dioxide in the air over time. His findings confirmed Arrhenius's idea.

We also know by studying past climates that when there is more carbon dioxide in the atmosphere, the climate is warmer. And we have been adding more and more carbon dioxide to the air since the industrial revolution in the eighteenth century.

Since we started measuring temperatures around the world, we have learned that the planet is warming up. Based on the average temperature over the last hundred years, here's how much the temperature has risen:



What the future holds

In the next hundred years, the Earth will be warmer but no one knows exactly how this will affect the climate. Scientists use computer models to make their predictions, but the climate is so complex that we can't be sure what will happen.

1. Under water

Scientists predict that, as the Earth gets warmer, there will be more storms and extreme weather. Sea levels will rise, flooding coastal areas.

2. False alarm

Some think that it's all a big scare and nothing will change. This is very unlikely, considering the evidence.

3. Find a new planet

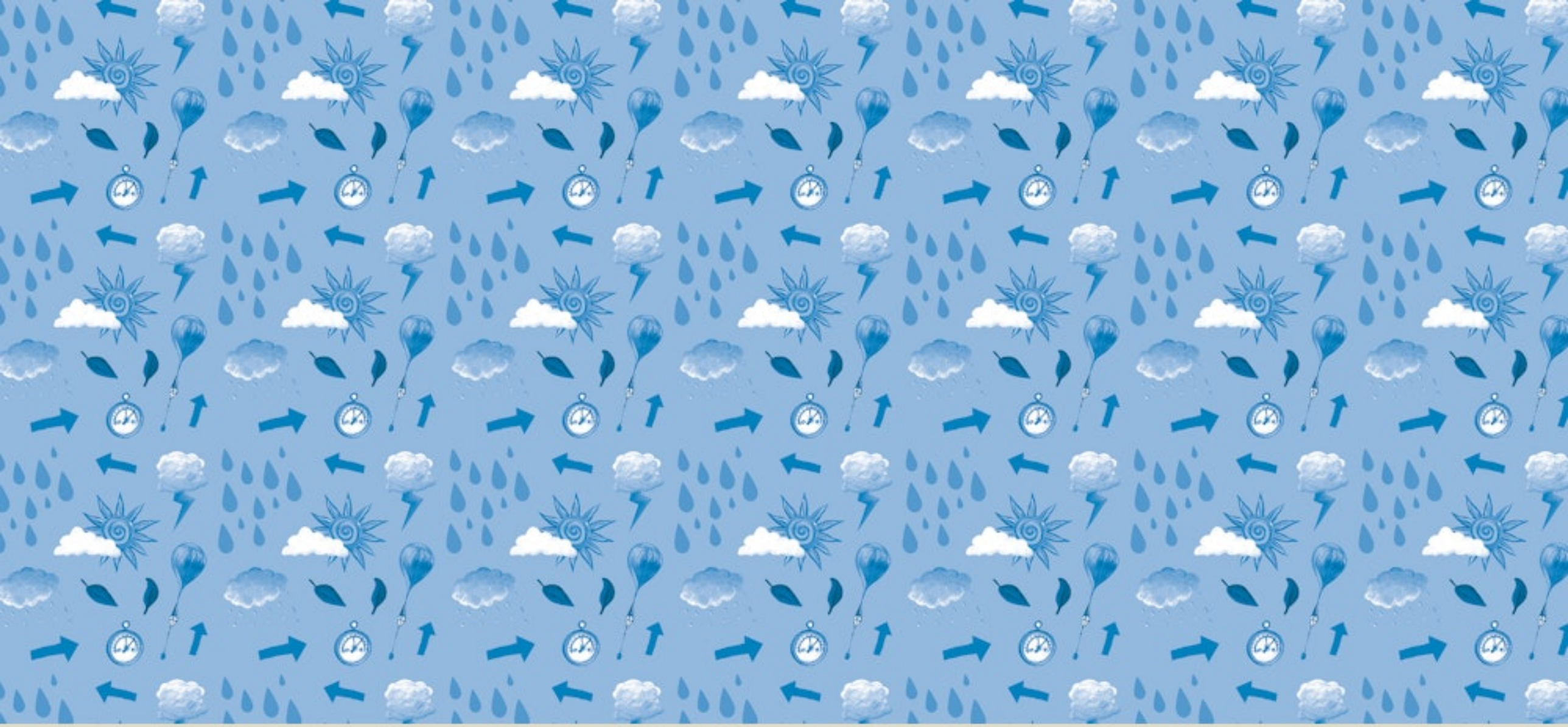
As the Earth gets more and more polluted, we may have to move to another planet. That's not really an option in our Solar System!

4. A different way

We'll change the way we do things and find more sustainable ways of producing energy and using the Earth's resources.

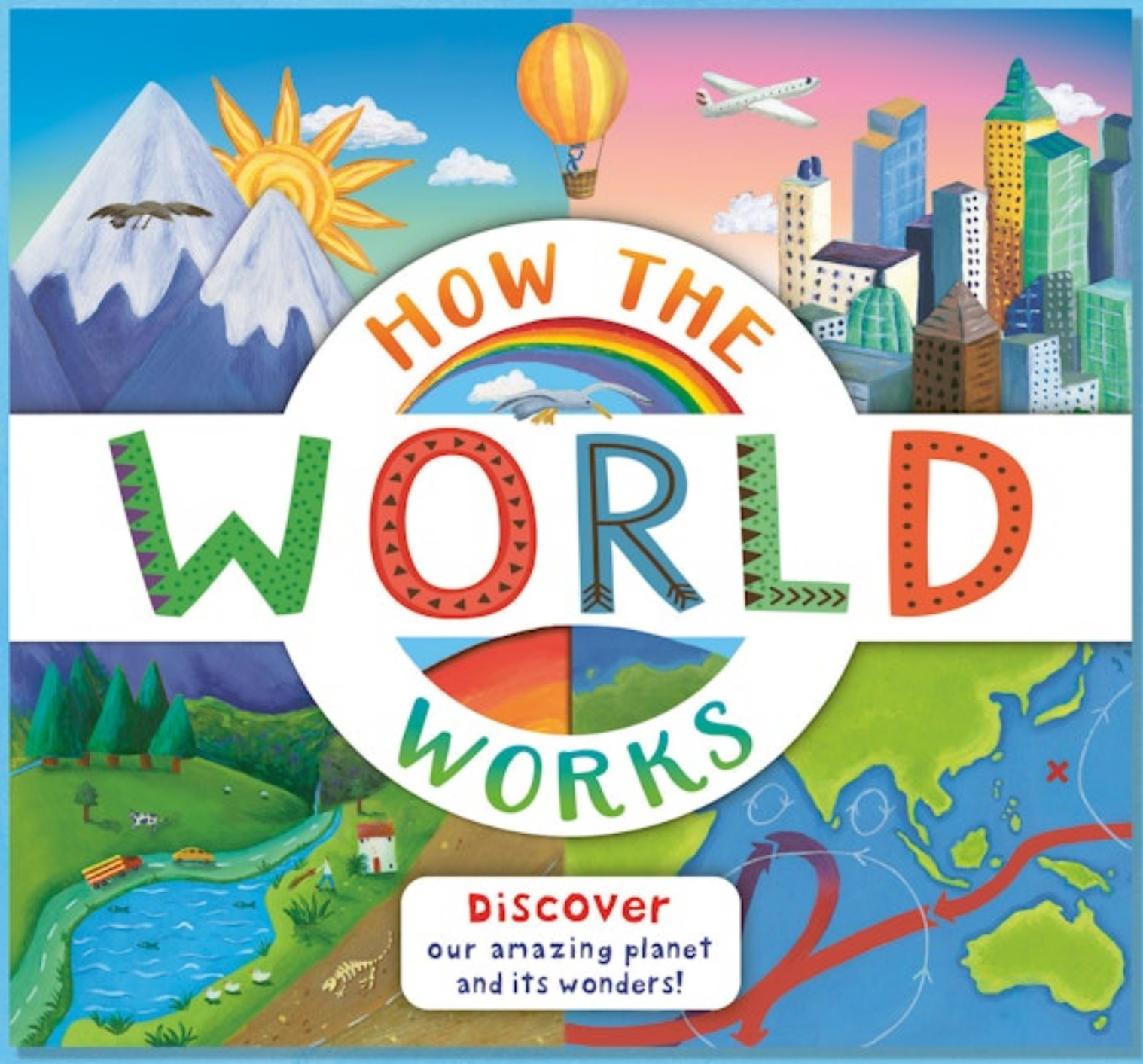
What do you think?

We don't understand fully how the climate works as everything is connected – air, land and water. It's hard to imagine that tiny changes in the atmosphere can disrupt the entire climate of our planet, but it's already changing. Should we wait and see what happens? Or should we take action now?



Now you know how the weather works, discover...

How the World Works!



How is the Earth moving beneath our feet?

What can rubber ducks tell us about ocean currents?