



HOW THE

WEATHER

WORKS

**Discover**  
our changing  
skies and climate!





# 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?

### Exosphere

Above this top layer is SPACE!



Satellites orbiting Earth

Flashing lights called auroras

### Thermosphere

### Mesosphere

Meteors from outer space

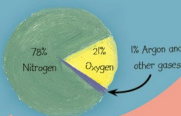
### Stratosphere

Planes often fly in this layer.

### Troposphere

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.

Don't forget the sun cream!



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



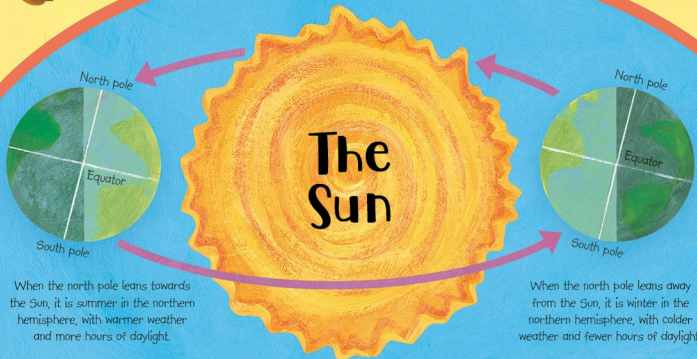
If you live near the equator, the Sun shines directly over your head so it is hot. If you live closer to the poles, the Sun's rays reach the curved surface of the Earth at an angle, so it is colder.

**Short distance + small area = intense rays**  
At the equator, the Sun's rays don't have far to travel through the atmosphere. They shine directly over a small area, so the heat is very intense.

**Long distance + large area = spread-out rays**  
Nearer the poles, the Sun's rays have travelled further through the atmosphere and are spread across a larger area, so their heat is less intense.

# 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.



The weather dictates the clothes we wear...



... and sometimes our mood!

## 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.

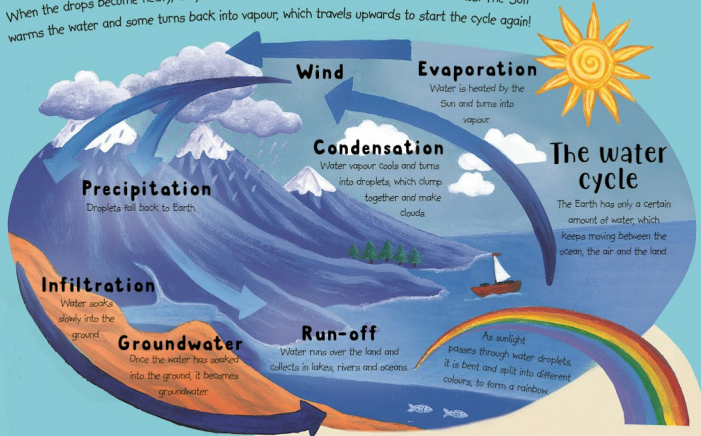
## “Great weather we’re having!”

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.



**Rain**  
Rain is made when water vapour cools and turns into droplets.



**Snow**  
Snowflakes are made when water vapour turns to crystals of ice high in the atmosphere.



**Sleet**  
Sleet is a mixture of snow and rain.



**Hail**  
These balls of ice form when raindrops move up and down inside a cloud and freeze.

## 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.



## 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

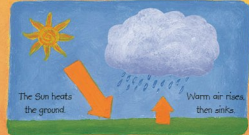
Droughts happen when there is less rain than expected for several months or even longer. Some plants and animals have amazing techniques to cope with these dry conditions. The darkling beetle, for example, collects dew on its body to drink.



## Types of rainfall

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

### Convective 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.



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.

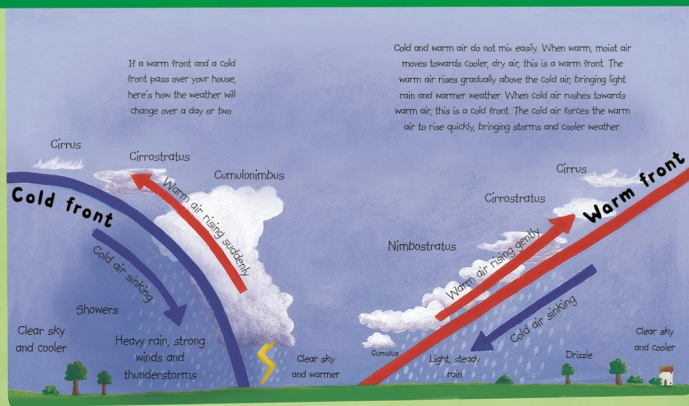
## UP, up and away!

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.



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

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.



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.

# 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.



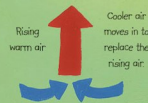
Each square metre of the Earth's surface has about 10,000 kilograms of air above it. That's the weight of two elephants!

## 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

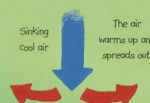
When air warms, it rises, leaving less air pressing down on the Earth's surface. The air pressure goes down.



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.

## 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 'curl of hair', *cumulus* means 'heap', and *stratus* means 'blanket'.

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

**Cirrocumulus:** Layers of tiny rippling cloudlets mean fair weather.

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

### Medium clouds

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

**Altostratus:** Look like bread 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 even taller than Mount Everest!

**Altostratus:** 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, puffy 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.