Met Office

Helping you understand

Weather and Climate

The word 'climate' is derived from the Ancient Greek 'klima', meaning 'zone' or 'region'. This implies that people were aware of differences in temperature, rainfall and vegetation across the world as far back as 2,500 years ago.

Today, many people from the UK travel south to the Mediterranean for their summer holidays as it's more likely to be hot and sunny there. Day to day variations in weather mean that holidaymakers could still experience damp days. But on average the weather is likely to be better in the Mediterranean during the summer because it's in a different climate zone.

Different climate zones arise because the Sun heats the tropics much more strongly than the poles. This sets up atmospheric circulation and ocean currents which try to reduce the imbalance by moving heat (the energy cycle) and water (the water cycle) around the Earth.

To see these key processes in action, simply look out of your window — the same systems drive your everyday weather.

Defining climate zones

The Earth's climate has changed many times throughout history, responding to natural causes, such as changes in orbit and the slow movement of continents.

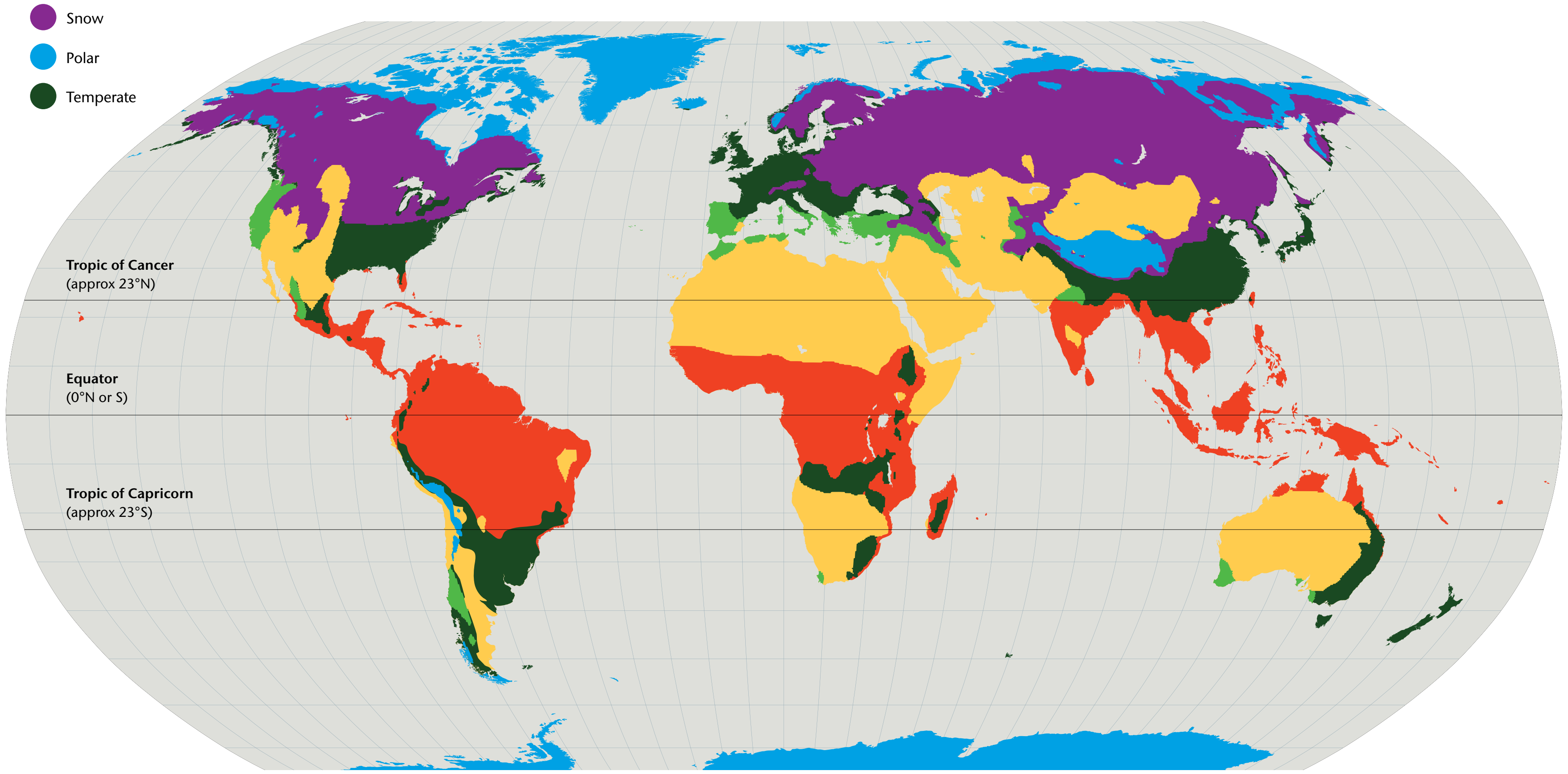
The somewhat simplified classification of today's climate zones that you see here is broadly based on the work of Wladimir Köppen, a climatologist born in St Petersburg, Russia, in 1846.

At the very end of the 19th century, Köppen came up with an idea of classifying the climates around the world according to the different types of vegetation found there. Over the years, he refined his classification — the final version being published in 1936, four years before he died. It is still used today.

The map shows where the broad zones are located throughout the world, but what might it be like to live in these conditions?

The climatologist, Wladimir Köppen

Different climate zones



EQUATORIAL

Lying between the Tropics of Cancer in the Northern Hemisphere and Capricorn in the south, equatorial climates are home to the world's rainforests where rainfall and humidity are high. Surprisingly, temperatures are not that extreme — generally 25 to 35 °C — and vary little. The hottest months are only two or three degrees warmer than the 'cooler' times of the year. Because these regions are so close to the Equator, the length of day and night hardly varies throughout the year.

ARID

Our deserts — the hottest, driest and most inhospitable places on Earth — are found mainly across the subtropical continents. Here, descending air forms large, almost permanent, areas of high pressure leading to cloud-free skies virtually all year round. Annual rainfall is low and, in some deserts, almost non-existent — no rain has fallen in the Atacama Desert in South America for 400 years. Because they're so dry, the temperature range in our deserts is huge, regularly exceeding 45 °C by day in summer and often falling to below freezing overnight in winter.

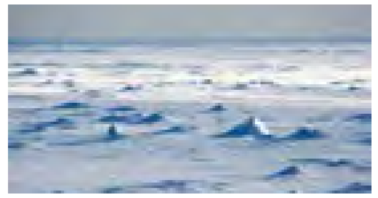
MEDITERRANEAN

The hot, dry summers of the Mediterranean are caused by a seasonal shift of the descending air that also creates our deserts. Low summer rainfall is matched by many months of warm, sunny weather, making it a popular holiday destination. But, at times, dangerously hot spells of weather engulf the region with fiercely high temperatures of up to 45 °C. In winter, there is more rain and cooler temperatures, but little frost. This type of climate is perfect for growing grapes for winemaking and can be seen in other parts of the world too, such as in South Africa and southern Australia.

SNOW

In the higher northern latitudes vast areas of the continental interior endure long, hard winters with short, bountiful summers, separated by rapid climatic changes during spring and autumn. The landscape here

is completely contrasting. On the one hand, there is the world's largest terrestrial ecosystem — the vast forests of fir and spruce of the taiga. But to the north, where summer temperatures are lower, there is only featureless tundra. Here, the land will not thaw even during the brief summer. Typical summer temperatures will be around 15 °C but, by August, frosts could have already returned and there may be ice on the region's lakes by September.



POLAR

The polar regions experience the coldest temperatures on Earth but their climates are different. The Arctic is mostly frozen ocean, while Antarctica is a vast continent of mountains and high plateaux buried under more than 3 km of ice. The Arctic climate is also moderated by the relatively warm waters of the Atlantic Ocean. However, in winter, temperatures still fall below -30 °C. This is nothing compared to the conditions in the south though, where temperatures below -80 °C have been recorded. The Antarctic interior is very dry — drier than many deserts. This is because as the temperature falls so does the atmosphere's capacity to hold water vapour needed to make snow.

TEMPERATE

This classification covers a range of climates from Mediterranean-type climates and humid, subtropical zones to maritime climates influenced by the oceans — like ours in the UK. A Mediterranean-type climate is mostly found on the western side of continents at 30–45° latitude. Summers can be either hot or warm, but they are always markedly drier than other times of the year. Humid, subtropical climates tend to be in the middle, or on the eastern side of continents at 25–45° latitude. Summers here are humid with plentiful rain, but winters are likely to be dry.

The UK has a typical maritime climate, where temperatures are quite moderate although hot summer days and cold winter nights still occur. Summers in maritime climates can be hot, warm or cool. In the UK we have what's considered to be a warm summer, whereas in Iceland the season is classified as cool.

Some temperate climates have wet and dry seasons while others have no marked dry season at all. But all have four distinct seasons. This means they can experience unpredictable weather throughout the year; and, as we in the UK well know, what can seem like all four seasons in one day. This, perhaps, more than anything helps to explain the difference between weather and climate — sometimes what we get (weather) is not what we expect (climate).

Changing climate zones

Climate change will inevitably disturb the balance of Earth's climate zones. All regions will warm but some will warm faster than others. Rainfall patterns will change. The polar and snow zones of the Northern Hemisphere are likely to change the most. This is because the loss of ice and snow in these regions reduces the reflectivity of the Earth, increasing the warming effect of the Sun. Closer to home, Mediterranean zones are likely to spread north even possibly affecting the far south of the UK.

Met Office

What drives the weather and climate?

A number of different processes form a complex mix of energy, water and moving air to produce our everyday weather and long-term climate:

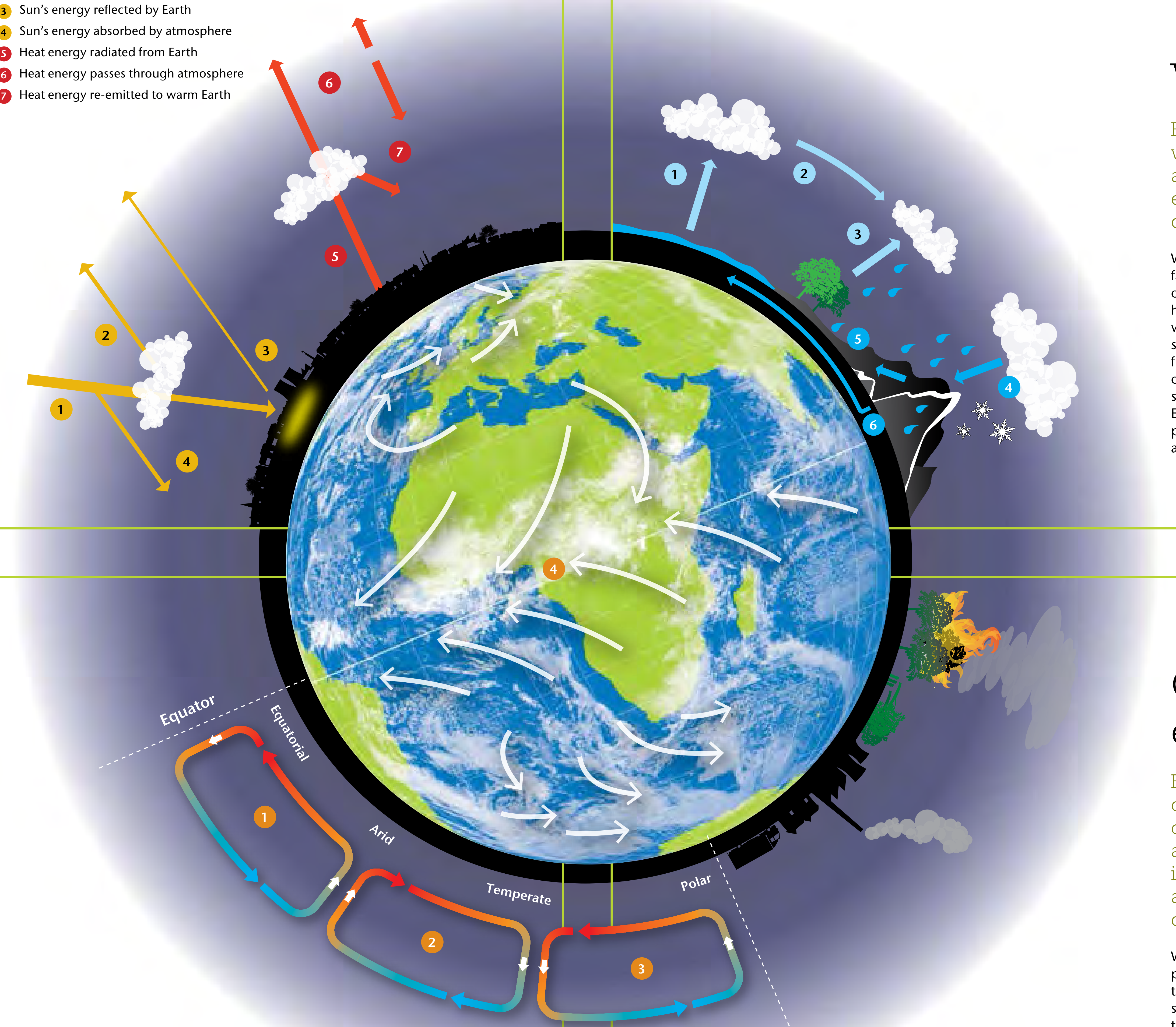
Energy cycle

The Earth receives heat from the Sun. About half of the Sun's energy reaches the Earth's surface, while around a quarter of the energy is absorbed by the atmosphere and a quarter is reflected by clouds back into space.

As the Earth's surface warms, energy is emitted back into the atmosphere in a similar way that the hob of an electric cooker radiates heat. But if that's all that happened, the Earth's surface would be frozen, with an average temperature of around -18 °C — too cold to support life.

Instead, gases in the Earth's atmosphere absorb some of the outgoing energy and return part of it to the Earth's surface. These gases (water vapour, carbon dioxide, methane, nitrous oxide, ozone and some others) act like a blanket by trapping some of the heat. The greater the concentration of these atmospheric gases, the more effectively they return energy back to the Earth's surface, trapping even more heat and warming the Earth rather like a greenhouse. That's why this process is known as the greenhouse effect.

1. Incoming energy from Sun
2. Sun's energy reflected by clouds
3. Sun's energy reflected by Earth
4. Sun's energy absorbed by atmosphere
5. Heat energy radiated from Earth
6. Heat energy passes through atmosphere
7. Heat energy re-emitted to warm Earth



Water cycle

1. Water evaporates from rivers, lakes and the ocean
2. Water condenses to form clouds
3. Loss of water from plants, soil, animals and people
4. Water returns to land as precipitation
5. Water carried downhill by rivers
6. Water seeps into ground and flows to sea

Energy from the Sun drives the water cycle, evaporating water from the Earth's surface which rises into the atmosphere, cools and condenses to form clouds. Water eventually falls back to the Earth from clouds in the form of rain, hail, sleet or snow (precipitation).

When water falls as precipitation, it may fall back in the oceans, lakes or rivers or it may end up on land. The oceans hold about 97% of the Earth's water, while the remaining 3% is the freshwater so essential for life. About 78% of freshwater is frozen in the ice-sheets of Antarctica and Greenland; 21% is stored in sediments and rocks below the Earth's surface; and less than 1% falls as precipitation and is found in rivers, lakes and streams.

Eventually, nearly all of the water that falls on land finds its way back to the ocean affecting the temperature, saltiness and density of different ocean regions. Colder, saltier water sinks in the oceans while warmer, less salty water rises. This overturning of the oceans creates warm and cold currents in different parts of the world and plays a significant part in determining the climate.

Our weather and climate

The Earth is a sphere, which means that the Sun's energy hits the Equator more directly than the poles and heats the Equator more. As the air at the Equator is heated it expands, rises and tends to move towards the poles. This displaces colder air, causing large-scale atmospheric circulation and creating the ever-changing areas of high and low pressure we're familiar with in our everyday weather.

At any one time, the atmosphere contains many travelling weather systems with variable winds. When these winds are averaged over many years a well-defined pattern of large-scale 'cells' of circulation appears. These cells help to explain some of the different climate zones across the world.

The largest cells (named Hadley cells, after English meteorologist George Hadley) extend from the Equator to 30–40° latitude. Here, warm, water-laden air rises, condensing to form a broken line of thunderstorms, sustaining the world's tropical rainforests. From the tops of these storms, air flows towards higher latitudes where it sinks to produce high pressure regions with hot, dry air — the world's deserts.

Out-flowing air from these higher latitudes forms the trade winds that blow towards the Equator over the ocean.

At the opposite extreme, the smallest and weakest cells are the polar cells extending from 60–70° latitude to the poles. Here, the air is very dry and stable — Antarctica is the driest continent on Earth. The cold air sinks and flows away from the poles.

In between, in the mid-latitudes — where the UK is located — warm, moist air from the subtropics meets cold, dry air from high latitudes bringing unsettled wet weather typical of the temperate zones.

1. Hadley cell
2. Ferrel cell
3. Polar cell
4. Trade winds

One thing changes everything

Human activities like burning coal, oil and gas to power our homes, factories and transport have released huge quantities of carbon dioxide into the atmosphere, causing an enhanced greenhouse effect. This causes an imbalance in the energy cycle that, in turn, impacts the water cycle, atmospheric circulation and ocean currents, leading to changes in weather and climate.

Weather is the temperature, wind and precipitation (rain, hail, sleet and snow) that we experience every day. Weather systems are constantly circulating within the Earth's atmosphere so what you see today may be different tomorrow. An approximate 23° tilt in the Earth's axis also causes the atmospheric circulation cells to shift and the seasons to change. Yet weather follows identifiable patterns in different regions and over time. This is known as climate.

Changeable conditions are a feature of the British weather — a topic that is often used to break the ice in conversations. Nowadays, however, we need to consider what may happen around the world over the next century, not just the next few days.

Satellite cloud image: Planetary Visions

Our changing climate

At the Met Office it's our job to build climate models, based on our understanding of how the Earth works, and compare them to what's actually happening.

To do this, we represent the energy and water cycles, atmospheric circulation and ocean currents, as a series of equations in our climate models. These basic processes, along with some other natural influences, summarise our existing knowledge of how the Earth works. To work out how the Earth may change in the future, we add additional man-made greenhouse gases to our climate models to see how they affect temperature.

This makes it possible to see how much of the recent changes in climate have happened in response to natural causes, such as changes in the Sun's energy, or if human activity has played a major role. We use this information to make climate predictions and advise governments and companies, groups and committees on what the Earth's climate might be like in the future.

The Met Office is the UK's national weather service and a world-leading provider of climate science and services. Our weather forecasts help to keep the UK moving every day on land and by sea, and protect anyone taking to the air. Around the world, our knowledge of the weather and climate informs the long-term decisions and policies of businesses and governments. Critically, we contribute to the global understanding of climate change and inform the UK Government's international negotiations on greenhouse gas emissions.

Printed on FSC certified, 80% post-consumer content paper, using fully sustainable, vegetable oil-based inks, power from 100% renewable resources and waterless printing technology. Print production systems registered to ISO 14001: 2004, ISO 9001: 2008 and EMAS standards and a carbon free status by offsetting all site emissions through the DEFRA and DECC recognised charity PURE.

MIX
From responsible sources
FSC® C013343

Met Office
FitzRoy Road, Exeter
Devon, EX1 3PB
United Kingdom

Tel: 0870 900 0100
Fax: 0870 900 5050
enquiries@metoffice.gov.uk
www.metoffice.gov.uk