Conservation Education

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The Weather:

Sun, Snow and Storms

Contents

Britain is famous for its changeable weather. We are always talking about it and there is a saying "if you don't like the weather, wait five minutes and it'll change"! Every plant, animal and person on the planet is affected by the weather every day, especially when it is extreme or unusual. Farming and food production can be devastated by unusual or extreme weather events, which in turn can affect you and me. It's not just about what clothes to wear today or whether to head to the beach for a barbeque or stay indoors. Whole crops can fail if there is a drought and farm animals can die in extremely cold weather or floods. If spring is late in arriving it can have a knock-on effect on big scale food production. This can affect food prices in the supermarkets so we become affected too. So you see the weather plays a crucial part in everyone's lives.

Hands up who enjoyed the snow this winter? Wooah – that's a lot of hands! The freezing cold and snowy weather that Britain experienced in December 2009/ January 2010 was the longest and coldest snowy spell for more than 50 years, and didn't it get everyone talking? And sledging! The landscape looked beautiful and was a lot of fun to play in but it also caused many people a lot of difficulty in getting around and keeping warm.

It's important that we understand why and when weather like this happens so that we can prepare for it and not get caught out. We also need to understand the weather in order to understand climate change so we can at the very least prepare for it if we can't delay it.

Scientists that study the weather are called *meteorologists*. You too can become a young meteorologist! In this issue we'll look at all different kinds of weather, so grab your coat, scarf, woolly hat, gloves, wellies, umbrella, sun hat, flip flops, shorts and sunglasses and read on.

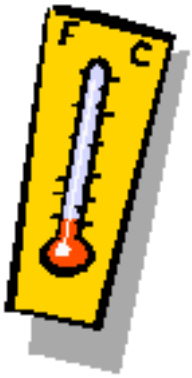
What Is Weather?

Let's start by clearing up the difference between the *weather* and the *climate*.

Weather is what is happening around us at any one moment every day. 'What's the weather like today?' 'It's dry and sunny now but it might rain later'.

Climate is a pattern of weather that repeats itself over a long period of time. For example, Greenland is generally a very cold country throughout the year compared to Ethiopia which is a very hot country. But both places experience daily weather like wind and sun.

Weather happens in the air around us. The Earth has several layers of gases surrounding it and the lowest one, or the one closest to the ground is the *atmosphere*. The atmosphere reaches 1000km above our heads and it protects us from the heat of the sun. The lowest 10km layer of the atmosphere is called the *troposphere* and this is a constantly swirling, moving, stirring layer of moist air.



The air in the troposphere moves because as the sun warms it up, it rises. Cooler, heavier air then moves in underneath the rising warm air. This movement of air is the wind – from the breezes we feel on our faces to the raging gales too. Wind often carries rain and snow with it so actually, in a round about way the sun is responsible for causing our warmest, driest and calmest days as well as the wettest, windiest and coldest!
So without the sun moving the air around there would be no weather: no wind, rain, clouds, fog, snow, hail or thunder.

- How many different types of weather can you think of? Write a list – you might surprise yourself at how many you come up with.

The Sun Has Got His Hat On!

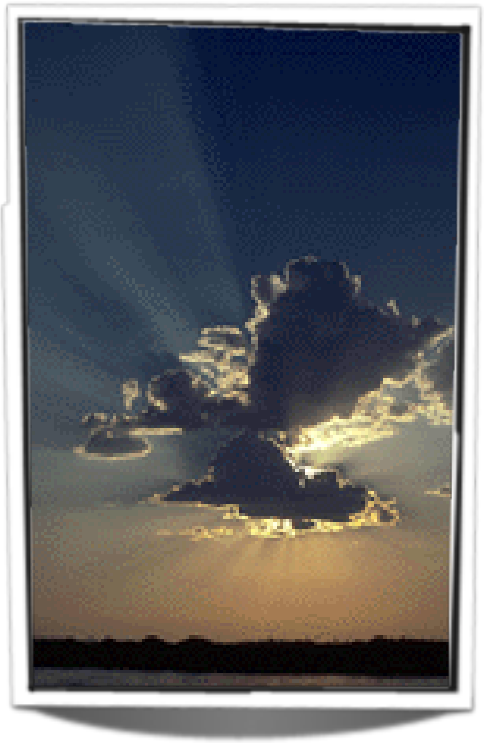
Seeing as the sun is such a vital part of our weather, let's start by looking at why it gets hotter in some places than others and at different times of the year.

The power of the sun is affected by how high it is above Earth. The Earth is tilted on an *axis* which means as it moves around the sun, many countries on Earth face nearer the sun at certain times of the year (summer) and further away at others (winter). The Equator isn't affected by this tilt much and the sun beats directly downwards there nearly all year round in the daytime with no significant seasons. At places further away from the Equator (e.g. the UK) the Earth's tilt means that the sun's rays beat down at an angle so they are more thinly spread onto the Earth's surface, making them weaker and cooler. These places have a cooler overall climate than those at the Equator but more variety during the year, with noticeably warmer and cooler times of year (seasons).

To find out how much sunshine there has been in a day, an instrument called a 'Sunshine Recorder' is used. This was invented by a man called Campbell-Stokes and looks like a crystal ball with a strip of card behind it. The sun shines through the glass ball and burns the card behind. As the Earth moves round the sun during the day, it leaves a burnt line along the card, with gaps where there is no burning if it was cloudy. Hours are pre-marked out on the card so weather recorders can add up how many hours of sunshine there were that day.

Clouds

Clouds form when air warmed by the sun rises up high and gradually cools, causing the invisible moisture in the air to *condense* (change from a gas to a liquid) and form visible water droplets. These droplets stick to tiny dust particles in the atmosphere and gather together to form the clouds we see in the sky. If the air is very dry, clouds can't form. But even in the hottest parts of the world the air is full of moisture, because of the warming of the air by the hot sun, which causes *evaporation* (soaking up) of water from the rivers, lakes and oceans into the air.



Clouds can absorb 80% of the sun's heat which is why we feel cool when clouds pass in front of the sun. However, at night time clouds help to keep the Earth warm by preventing warm air from Earth escaping into the atmosphere.

•In the Sahara Desert the sun is covered by clouds for less than 100 hours a year.

Have you ever looked up at the clouds and noticed all the different shapes, sizes, colours and heights of them all? There are three main categories of cloud types:

Cumulus – these are large and fluffy and look like cauliflowers! They tend to be low in the sky.
Stratus – these form in layers like white sheets of cloud in mid-height zones.
Cirrus – these are feathery and wispy and high up in the atmosphere.

Within each category there are many more different varieties with great names like altostratus, cumulonimbus, Mare's Tails and Mackerel Sky.

Fog and Mist

Fog often happens when there is not much wind, the air is damp and the sky is clear. Water vapour (gas) *condenses* near to the ground and turns to visible liquid droplets – fog.

Fog can also occur where warm, moist air blows over a cooler surface, perhaps off a warm sea onto cool land. Fog can occur a lot in cities where the air is full of dust particles such as car exhaust fumes or smoke. These particles make great sticking points for condensation! This kind of 'dirty fog' is known as smog. London used to be famous for its smog but since a big clean up (banning of smoky fires etc) in 1950 it has been far less common.

Frost and Ice

When the air temperature gets below freezing (0° C) the moisture in the air can freeze on surfaces like leaves, cars and roads. This is frost and individual needles of frost can often be seen if you look closely enough at it.

Ice occurs when water lying on the ground gets so cold it freezes, such as in a puddle, river or lake.

•Did you know? The River Thames in London used to freeze so much that 'Frost Fairs' were held on it. These were like markets on ice but the last one was held in 1814. Sadly our winters are not cold enough any more for these to occur.

•The temperature of the air is measured using *Thermometers* and there are several different types, such as ones which record the hottest (*maximum*) and coldest (*minimum)* temperatures reached in a day. The first thermometer was invented by a scientist called *Gallileo.*

Rain, Rain, Go Away!

We know that rain falls from clouds, but why and when?

Rain forms when the tiny water droplets in a cloud join together, freeze and get too heavy to stay there, so they start falling. All rain in places like the UK begins falling from the clouds as snow but melts on the way down and lands on us as rain. This is because it is a lot colder in a cloud than it is at ground level.
The larger the droplets, the faster they fall, and the darker the cloud, the heavier the rainfall. Cumulonimbus clouds are the most common form of rain cloud and some in the Tropics can reach 15km into the sky and release 0.9m of rain in one afternoon!

Rain gauge

- Rainfall is measured in a '*rain gauge*' which is a container at ground level with a funnel feeding into it down which the rain falls. After 24 hours the rain is emptied from the container and measured to see how much rain fell in that place.

Hail!

Hail is similar to rain but colder and harder. Ice crystals in a cumulonimbus cloud move around a lot, absorbing more and more water as they move. This water freezes in layers (cumulonimbus clouds are very cold) and some hailstones have as many as 25 layers!

Red Sky at Night

Sunsets are usually a shade of red because as the sun sets it shines lower and lower in the sky, the rays have to travel an increasingly long way through the dense air of the lower atmosphere. Gradually all the other colours are absorbed into the atmosphere, leaving just the reds. This is because red colours can travel further than the others.

Somewhere over the Rainbow

We all love to see a rainbow; they are beautiful. But have you ever wondered what a rainbow is?
Pure sunlight is white, but is actually made up of seven different colours. When sunlight shines through raindrops the light bends; all the colours bend in a different way and split to create the full *spectrum* (range of colours) of the rainbow. That is why rainbows nearly always occur when there is rain on a sunny day (or sun on a rainy day!).

- Do you know the seven colours and the correct order?
- And is there really a pot of gold at the end of every rainbow?

Snow

A snowflake photographed by microscope

Snow flakes are one of nature's wonders. Next time it snows have a close look at a snow flake. Each flake is a flat ice crystal with 6 'sides' or 'arms', and no two snowflakes are the same. Every single flake is stunning and unique!

We have already learned that rain starts life in the clouds as snow, but melts on the way down. It only reaches the ground as snow if the air temperature at ground level is at or below 0° C so it doesn't melt. If the ground is also cold then the snow will settle and build up. This is when roads and paths get slippery and everything turns into a white winter wonderland!

So why did we have so much snow for so long this winter? It was partly because the air temperature remained at or well below 0° C for weeks on end, plus the fact that there was a partial thaw (melting) which then re-froze, forming very compact ice and snow that took a long time to melt. And much of the sun's warmth was reflected off the dense snow cover during all the crisp, clear, sunny days.

- The world's biggest snowman was built in 1988 in Alaska. 'Mr Frosty' was 19.37m high!

Snow can actually be helpful to plants and animals as it forms a kind of blanket which protects plants and hibernating animals from the cold frosty air.

Wind

Wind is moving air. Slow moving wind is called a *breeze* and fast moving wind is called a *gale* or *hurricane*. Wind always begins in the same way:

The sun heats up some areas of land or sea more than others. This depends on the time of day, year and location on Earth. The warmed air begins to rise and heavier, cooler air is sucked into the area below the rising air. So winds blow wherever there is a difference in air temperature – always from areas of cooler, sinking air (known as areas of *high pressure*) to areas of rising warmer air (areas of *low pressure*).

Wind sock, used to see wind direction

There are two main ways that wind speed is measured:

1. An *anemometer* is an instrument that has 'cups' that catch the wind and spin round and round, measuring how fast it is blowing. It can also record where the wind is blowing from (this directly affects the weather so is more important than where it is blowing to).

Weather vane

2. The *Beaufort Scale* (ranging from 0-12) can be used along with an anemometer or on its own, using observations on surrounding features like leaves and branches and how much they are moving.

0 on the Beaufort Scale is 'calm' (smoke from a chimney rises vertically)
6 is a 'strong breeze' (leaves moving, branches swaying)
12 is a 'hurricane' (whole trees being ripped up)

A *weather vane* is an old, traditional way of telling wind direction. They often have a cockerel on them which points to where the wind is coming from. They were first put on churches in the 9th Century as a reminder of the story in the bible where the cockerel crowed when Peter denied Christ.

Thunderbolts and Lightning!

You can't beat a good thunderstorm; all that 'bang, crash, wallop'! But what causes all that noise and those flashes?

Thunderstorms occur in huge, dark cumulonimbus clouds up to 16km high. These often form after a spell of intense warm weather which has caused the rapid rising of warm air. Strong updrafts like this create the clouds, where rapid rising and cooling has created ice crystals. The ice crystals are crashing around in the swirling cloud and become charged with static electricity as they hit each other. The positive charged particles float to the top of the cloud and the negative ones sink to the bottom of the cloud. As they separate, the difference in charged areas becomes so great that they are neutralised (joined) by a lightning flash. If this flash occurs within the cloud we see it as 'sheet' lightning. But if the lightning travels from the cloud to the ground it is 'forked' lightning.

The air around this flash gets very, very hot (33,000°C, which is 5 times hotter than the surface of the sun!) and the air expands at supersonic speed as a result of this heating. This rapid expansion causes the big bang we call thunder.

The noise of thunder always follows the lightning as it takes longer for noise to reach us than light. You can tell how far away a thunder storm is by counting the number of seconds between the flash of lightning and the thunder. Divide the number of seconds by 3 for the distance in kilometres.

- Each year, approximately 100 people are killed by lightning.
- At any one time there are 1,800 thunderstorms rumbling somewhere in the world.
- Earth is hit by lightning 100 times every second!
- A bolt of lightning can contain one billion volts of electricity.
- Someone who studies lightning is called a *fulminologist.*
- A very unlucky (or lucky?) park ranger called Roy Sullivan was struck by lightning 7 times during his life – and survived! He had his eyebrows scorched; his hair set on fire twice, twisted his ankle and suffered serious burns.
- 9/10 people struck by lightning survive.
- Lightning rods on high roofs guide lightning safely to the ground. Lots of churches have them.
- Sailors have reported seeing balls of light on top of their ship's mast during thundery weather. These are known as 'St Elmo's Fire' and are an electrical discharge similar to lightning that occurs between the tip of the mast and the air around it.

A survival guide to thunderstorms:

Don't:
Stand under a tall tree, pole or on top of a hill
Lie on wet ground (water and electricity are a lethal mix)
Don't go swimming or fishing, especially with metal rods.
Don't use the landline phone or computer as electrical charge can come down wires.

Do:
Stay in the car with windows closed but don't touch anything (except the seats and rubber mats on the floor)
Find decent shelter that isn't vulnerable to being struck or...
Stay close to the ground with your feet together and head tucked in if you are caught outside. Don't lie down – the less of your body touching the ground the better.

Extreme Weather

Weather can happen on different scales, and can cause untold chaos and damage when it gets extreme. Let's have a look at some of the worst scenarios.

A **heat wave** is a long spell of unusually hot weather without rain. It is often *humid* (the air is full of moisture) too which can be very uncomfortable. Fumes and smog get much worse in a heat wave, crops are ruined and wildfires are common.

- The hottest, longest heat wave in the world occurred in Marble Bar, Australia in 1923/24 when temperatures reached 38°C or above for 160 days in a row.
- Britain experienced their hottest summer on record in 1976. The temperature remained around 27°C for several weeks and reached a maximum of 36°C on 23rd July.

Heavy rain and **flooding** kills more people than any other type of weather. When unusual amounts of rain fall in a short space of time, rivers fill up very quickly and become raging torrents that can overflow into surrounding fields and settlements ('burst their banks'), washing away bridges, roads, crops, animals and people. Flooding can also occur when *storm surges* (huge waves) sweep ashore from the sea and flood coastal towns and villages.

- People who study and try to predict floods are called *hydrologists*.
- The worst flood ever recorded was in 1931 in China when the Huang He (Yellow River) burst its banks from July until November. 4 million people died either as a direct result of the flooding or from starvation. 80 million were left homeless and 88,400 square km of land was flooded. The cause of this flood was silt, which had been washed into the river by heavy rainfall, blocking the flow.
- In the UK on August 15th and 16th 1952 at Lynmouth, record rainfall caused the river Lyn to rush through the town. 34 people were killed and 100 homes destroyed.

Monsoons are the annual, long periods of rainfall that occur in the Tropical and Sub-Tropical areas of the World (countries around the Tropics of Cancer and Capricorn), for example, India. The land warms up throughout the hot summer and as the air rises, it draws in cooler, wet air from the oceans in large cumulonimbus clouds. This causes 6 months of torrential rain.

A **blizzard** is a winter storm where there is heavy snowfall and strong winds together. The snow gets blown around in the sky to form a swirling white mist ('a white out') and very deep piles of snow.

- In Antarctica the winter winds regularly blow at 160kph in temperatures at an average of -60°C in winter.

Tornadoes

Also known as a Whirlwind or Twister, a tornado is a narrow spinning tunnel of wind which comes down from big, dark, thunder clouds like an elephant's trunk! The funnel acts like a giant vacuum cleaner, sucking up anything in its path. No-one really knows exactly what it's like inside the tornado as meteorological instruments rarely survive to tell the tale, but we do know the following:

- Wind speeds can reach 400kph in a tornado – the strongest winds on Earth.
- They form when rapidly rising warm air begins to spin like a corkscrew.
- This forms a funnel, or vortex, of immensely low pressure which can be anything from a few metres to 1km across and can move across the land at up to 55kph.
- Tornadoes follow a very narrow path and often destroy everything in their way, leaving items untouched either side of it.
- They have been known to lift cars, roofs, animals and people into the air.
- Sometimes items are set down again very gently, often hundreds of metres away, with hardly any harm done.
- They can last anything from one minute to several hours. The longest recorded was 7.5 hours.
- If a tornado occurs over the sea it becomes a giant water spout.
- Tornadoes have occurred on every continent except Antarctica.
- In the Northern Hemisphere they twist anticlockwise, in the Southern Hemisphere, clockwise.
- There is an area in the USA known as 'Tornado Alley' because there are approximately 700 tornadoes there every year. The area stretches through Texas, Oklahoma, Kansas, Nebraska and N & S Dakota.
- There was once a pink tornado in USA 1991 because it was full of pink geranium flower petals from a greenhouse that it had sucked up!
- Over the years alligators, frogs, mice and crabs have all fallen from the sky after a tornado.

The scale to measure the strength of Tornadoes is called the 'Enhanced Fujita Scale' (EF Scale):

EF0 = 105-137kph – Roof tiles are lifted, tree branches are broken
EF2 = 179-218kph – Roofs are ripped off, cars are lifted.
EF5 = over 322kph – Houses get swept away, cars hurled hundreds of metres and malls flattened. Yikes!

That all sounds pretty scary, doesn't it? But the deadliest storms on the planet are *hurricanes*. Read on to learn what a REAL storm is like!

Hurricanes, Typhoons, Cyclones, Willy-Willies:

Hurricanes are called by different names in different parts of the world but they are all a Tropical Revolving Storm. They mainly occur over the mid-Atlantic and Pacific oceans.

Hurricanes are a combination of torrential rain and very strong winds (118kph and upwards). They begin out at sea as small thunderstorms over warm water; if several storms cluster together they begin to whirl as one big storm and a hurricane is born. They are basically a 'wall of air' that sweeps over the sea towards land, with winds blowing in a spiral from areas of high pressure to areas of rising air (low pressure).
They can grow up to 960km wide with an 'eye' of calm weather at their centre measuring 30-65km across. As the swirling continues, the calm eye shrinks, the pressure drops further and wind speeds increase to hurricane force. As a hurricane reaches land, it brings torrential rain, hurricane force winds and *storm surges*. These are mounds of sea water, up to 8m high, which have been sucked up by the eye. They can crash onto the coast causing massive devastation – buildings are destroyed and areas seriously flooded.

- Hurricanes claim more lives than any other kind of storm.
- A hurricane can be 12,000 times more powerful than a 'normal' storm.
- A hurricane can absorb up to 2 billion gallons of moisture from the sea by evaporation *every day* as it begins to drift towards land, gaining more and more energy as it goes.
- More rain is released in a day in one hurricane than falls in a year in London.
- A hurricane can pump out 2 million tonnes of wind every second!
- The energy in one hurricane could power the whole of the USA for three years.
- One of the deadliest hurricanes was Hurricane Mitch which struck Guatemala in 1998. Wind speeds of 290kph were recorded and 11,000 people killed.
- Each hurricane is given a name to avoid confusion when forecasting and giving evacuation warnings.
- Satellites in space mean hurricanes can be tracked and accurate warnings given to people who may be in their path.

Street scene after Hurricane Katrina, New Orleans, USA - 2005

The scale for measuring Hurricane strengths is called the 'Saffir-Simpson Scale' (SSS):

SSS1 = 119-153kph – Trees are damaged, some coastal flooding occurs.
SSS3 = 178-209kph – Buildings are damaged, there is serious flooding 10km inland.
SSS5 = Over 249kph – Catastrophic damage occurs – Buildings get swept away by flood waters, trees blown down, roofs blown off and serious flooding 16km inland.

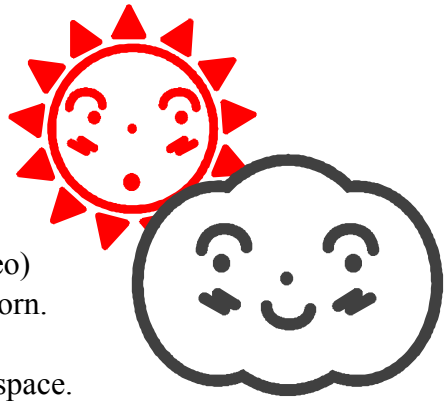
Hurricanes and wildlife:

Animals have an uncanny ability to predict when a hurricane is approaching and to protect themselves during the storm or to make the most of the strong winds. Here are some examples:

- Flocks of ocean-living frigate birds fly to safety inland ahead of a hurricane.
- Quelea birds weave tight, round, protected nests to shelter in and swing, unharmed, from the branches.
- Locusts lay their eggs in the wet soil during the rains ahead of a hurricane. The eggs hatch in the warm air before the storm arrives and the larvae are then blown in the strong winds to their far-off feeding grounds.
- Coral reef animals lay their eggs (spawn) just before a hurricane arrives. The eggs float around until the storm surges distribute them far and wide to new breeding areas.
- Animals which live near the coast are known to run inland to safe, higher ground long before the arrival of a storm surge or tsunami. They can sense the waves coming long before humans can see them.

Perhaps if we were more 'in tune' with nature we'd be able to predict bad weather without the use of expensive equipment!

Forecasting the weather

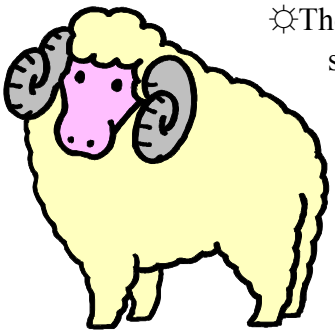


Working out what the weather is going to do in the future has been a problem since the Ancient Greeks began measuring the weather centuries ago. But 'proper' scientific studies really began in Italy in the 17th Century when air was discovered to have 'weight' (low and high pressure). The first barometer was built and then the first air temperature thermometer (by Gallileo) and the science of *meteorology* (recording and forecasting the weather) was born.

There are now meteorologists and weather stations all over the world, and in space. They use high-tech computers and communication techniques to make calculations and predict how the weather is going to change over the next few hours (short-range forecasting), days, weeks and even years (long-range forecasting). All the information is gathered together every hour, every day, all year round and analysed to form predictions for you and me to see and use.

Wildlife and Weather.

But you don't always need sophisticated instruments and gadgets to tell what the weather is going to do. Mother Nature has many subtle ways of warning us of changes in the weather – there are clues all around us. Tiny changes in the air can be felt by plants and animals but not us so if you know what you're looking for you can be a weather forecaster without the need for expensive instruments! Some are 'old wives' tales'; others are more reliable:



☼There is a saying: 'Red sky at night, shepherd's delight' (good weather ahead); 'red sky in the morning, shepherd's warning' (bad weather is on the way).

☼Kelp (seaweed) shrivels up in dry weather. When moisture is in the air and rain is on the way it swells again.

☼Sheep's wool goes straight when rain is on the way

☼Pine cones close when air is moist and rain is on the way and open when the air is dry.

☼Scarlet Pimpernel flowers close up when the air is moist.

Weather and Climate - The Future:

It is now accepted that the world's climate is slowly but surely getting warmer. By how much and why is still under fierce debate (see Con Ed issue 16 'Climate Change'), but whatever the reasons and timescales involved, the outcome is still going to be the same – our weather is going to become more extreme. This is thought to be because as the air temperature warms up, more warm air rises causing more variation in air pressure and therefore more wind. More evaporation is also occurring, which in turn leads to more rainfall, more floods and so on. So we can expect more storms, flooding, heat waves, a rise in sea levels and more disease and crop failures around the world.

Let's look at some alarming facts and figures:

- In 2004 there were 21 hurricanes in the Atlantic. In 2005 there were 27.
- In 2004 there were a record 1,722 tornadoes in the USA. That was 500 more than in a normal year.
- In S America in 2005 some rivers dried up for the first time ever and fish 'fried' in the heat in their millions.

Did you know?

Fears of different weather conditions are known as the following:

Brontophobia – Thunder
Keraunophobia – Lightening
Anemophobia – Wind
Chionophobia - Snow

Ombrophobia - Rain
Psychrohobia - Cold
Nephelophobia - Clouds

The record breakers of the weather!

Here are the hottest, coldest, windiest, snowiest, driest and wettest places on Earth:

The **hottest** place on Earth is Dallol, Ethiopia (Africa) where the average annual temperature is 34.4° C
But Al' Aziziyah in Libya reached a scorching 58° C *in the shade* in September 1992!

The **coldest** place is Vostok, Antarctica where it is regularly -57.8° C. In 1983 it got as low as -89.2° C!

The **wettest** place is Mawsynram, India. It receives 12,000mm rain every year.
At Mount Wai-'ale-'ale in Hawaii it pours with rain every day for up to 350 days per year!

Valle de la Luna, Atacama Desert, Chile.

Mount Rainier, Washington State, USA.

The **driest** place is the Atacama Desert, Chile. Between 1570 and 1971 (i.e. for 400 years!) no rain fell at all.

The **windiest** is Commonwealth Bay, in Antarctica again. Gales there gust up to 320kph. The fastest ever recorded wind was 371kph.

The **snowiest** place where the most snow fell in a single year was at Mt Rainier, USA. Between 1971 and 1972 31,000mm of snow fell.

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