barometer

Issue 4 www.metoffice.gov.uk Met Office magazine

INCREASED ENERGY
Helping energy companies plan for the future

SUMMERTIME
Tourism boss keeps an eye on the weather

HATS ON
Royal Ascot hits full-stride in the racing calendar

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Summer's lease hath all too short a date

With the arrival of summer, the Met Office is helping all of its customers respond to changes in the weather and climate, explains Diana Formby, Director of Finance and Corporate Services...

➔ **Diane Formby**
Director of Finance and Corporate Services

The title may be an extract from a well-known Shakespearean sonnet but no doubt the words felt all too true for many this year, as the long awaited summer was preceded by the coldest, spring (March to May 2006) for five years in England and Wales. Spring itself had followed the coldest and driest winter for nine years in England and Wales.

Last winter, for the first time, the Met Office issued a long-range winter forecast warning our customers, from as early as autumn 2005, of the impending colder and drier conditions before winter set in. We also briefed officials and leaders from Government and business on what to expect, helping them to plan well ahead. The winter was indeed colder- and much drier-than-average, with mean temperatures the lowest since 1996/7 for England and Wales and many areas, particularly across south-east and central southern England, experiencing two consecutive dry winters.

Now that summer is here, *Barometer* looks at the effects of the drier-than-average winter, which has resulted in water shortages in some parts of the country. The Met Office is working closely with the Environment Agency and water companies in the South of England in their efforts to beat the drought. Although Drought Orders have been issued only for the worst affected areas of the South so far, many other areas are experiencing lower-than-average water levels so water conservation is something for us all to consider.

If you are holidaying in England this summer, *Barometer* captures just some of the exciting activities on offer in the South West, come rain or shine — whether you're after a relaxing break or something a bit more adventurous. Whatever your preference, be sun safe by checking the solar UV forecast from the Met Office for your area before venturing outdoors. *Barometer* also describes how we are working to integrate atmospheric chemistry into our everyday forecasts to help those sensitive to air quality.

Heat stress can be caused by warm UK summers and increases the risk to health in vulnerable people, particularly the elderly and very young. British troops around the world often operate in extremes of heat and can experience the same physiological symptoms. The Met Office is assisting the military by mapping heat stress for particular locations.

In this issue, we focus on our customers and, importantly, how the Met Office is listening and responding to your particular requirements. Our Top Level Objectives put services for the public and government, as well as those for commercial customers, at the core of Met Office business. For our public and government customers, we are focusing on delivering higher value services. For our commercial customers, the priority is to develop services that help businesses world-wide thrive by managing the risks and making the right business decisions based on the weather and climate.

As we turn on air-conditioning systems in summer and turn up the heating in winter, our world-leading climate researchers are helping the UK energy industry respond to changing energy demands. *Barometer* explores the impact of climate change on energy management and looks at how three leading energy companies are preparing now for a challenging future.

I hope that *Barometer* will give you an insight into the Met Office's capabilities and how we use our skills to turn world-class science into user-friendly, customer-focused solutions. Be prepared, whatever the weather. Contact our 24-hour Customer Centre on 0870 900 0100 or email enquiries@metoffice.gov.uk for more information on Met Office products and services.

The worth of water

With winter relied upon to replenish reservoir stocks, swell rivers and raise groundwater levels, two consecutive dry winters have led to water shortages, Drought Orders and hosepipe bans.

The wet weather in May helped river flows and reservoir levels to increase, and reduced the demand for water. But the Environment Agency is still concerned about public water supplies in Kent, Sussex and London. This is because much of the water for south-east England is derived from groundwater and, following a second dry winter, summer 2006 got underway with already depleted stocks that will not be replenished until the autumn. With the arrival of warmer weather, river flows and reservoir levels can drop quickly and the combined effect may lead to widespread environmental problems — particularly across south-east and central southern England.

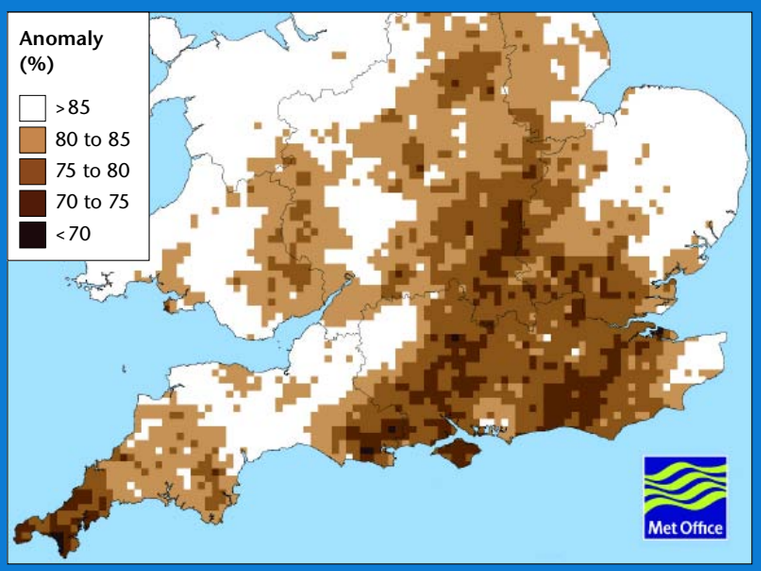
We're all downstream

Figures released by the Met Office show that south-east and central southern England area has now recorded 16 out of 20 months with below average rainfall since November 2004. This dry spell spans two crucial winter recharge periods, with November 2004 to June 2006 having 78% of average rainfall (1001.8 mm compared to an average of 1279.3 mm.) The last equivalent period to be drier than this was November 1942 to June 1944. May's above average rainfall (172% of average) has not been able to remedy the water shortage. People, therefore, should still be careful with the water they use.

The Environment Agency publishes monthly Water Situation Reports for England and Wales to provide essential information on rainfall, soil moisture, river flows, groundwater levels and reservoir shortages — and updates these each week. Met Office rainfall and soil moisture data form a vital part of these reports. Predicting what could be one of the most serious droughts to affect south-east England in the last 100 years, the Environment Agency reports that eight water companies in the region have already imposed a full hosepipe and sprinkler ban which means that nearly 13 million people must not use a hosepipe to wash their cars or water their gardens. Others have in place the first phase of a Drought Order restricting non-essential water use, which prevents people filling ornamental ponds, cleaning buildings and refilling privately owned swimming pools in a bid to conserve water.

You too can help — by saving water at home, in the garden and at work. It takes very little effort, but makes a surprisingly big difference. Turning off the taps when you brush your teeth, for example, can save up to five litres of water a minute. If the entire adult population of England and Wales did this, we could save a total of 180 mega litres a day, enough to supply nearly 500,000 homes.

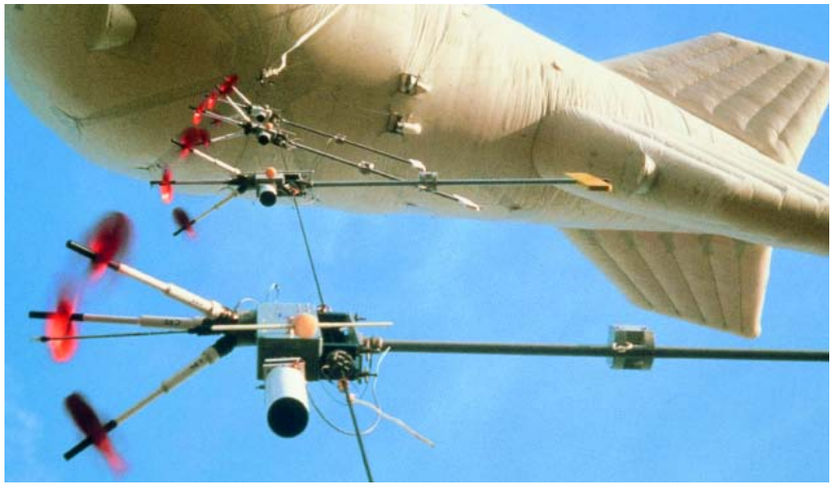
Like water companies in the South of England, join forces with the Environment Agency to help beat the drought.



Nov 2004 to May 2006 rainfall 1961–1990 anomaly (%)

Using Met Office forecasts, the Environment Agency is doing all that it can to minimise the impact of the drought on the environment, while making sure there is enough water for people. The Met Office works in partnership with the Environment Agency to:

- provide a range of weather forecast services, including heavy rainfall warnings, tailored to Environment Agency operational areas;
- operate the storm tide forecasting service on behalf of the Environment Agency, providing the primary warning service for coastal flooding around the shores of England, Wales and Scotland;
- support the Environment Agency in delivering a flood forecasting and warning service for England and Wales;
- install and operate a joint Environment Agency weather radar network in England and Wales, a key tool in detecting and forecasting potential flooding;
- collaborate in air quality monitoring, which includes sharing with the Environment Agency our atmospheric dispersion models;
- provide seasonal forecasts and climate change advice to aid Environment Agency contingency and adaption planning.



Weather images online

A unique collection of 3,500 weather images has been catalogued by the Met Office's National Meteorological Library and Archive and can now be found online at

www.metoffice.gov.uk/corporate/library/index

Illustrating all aspects of meteorology — from weather phenomena to observation instruments — the collection provides a striking pictorial insight into the work of the Met Office.

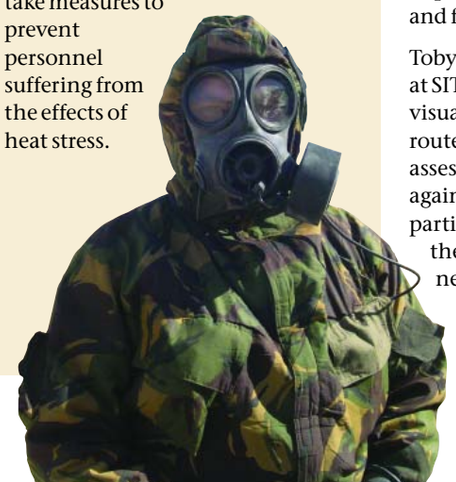
To narrow down your search, images can be viewed in subject categories (e.g. 'clouds', 'weather phenomena', 'observing sites', 'Met Office at work'.) Thumbnail images appear within these categories and you can click on a link to open a larger picture.

It is hoped that the collection will capture people's imagination and encourage them to submit their own weather related images. If you would like to submit a picture for consideration, email metlib@metoffice.gov.uk. Please include a copy of the image, your name and brief details of where and when the picture was taken.

Stressing the dangers of heat

For the first time this summer we issued a level 3 public alert about the health risks of high temperatures during the heatwave. The heat can be extremely dangerous — something which the military has been aware of for a long time. Military deployments around the world often see British personnel operating in extremes of heat. During the Iraq conflict in 2003, British soldiers often went on duty in full body armour and CBRN (Chemical, Biological, Radiological or Nuclear) suits in temperatures reaching 40 °C — under such conditions the body can suffer 'heat stress'. Heat stress is the term used to describe the physiological strain on a human being, caused by a set of environmental conditions.

But heat stress is not simply a function of air temperature — it is dependent on three other factors: humidity, wind and radiation from the sun. These can be incorporated into one simple measure: the wet bulb globe temperature (WBGT). Working closely with the military the Met Office has developed a model that can provide forecasts of WBGT. Output from this model is used to produce maps of heat stress and forecasts for particular locations around the world, helping them to take measures to prevent personnel suffering from the effects of heat stress.



Blue sky thinking

When taking to the skies, we all like to know that we're in safe hands. That is why the Met Office has joined forces with SITA — the largest provider of IT solutions to the aviation industry — to provide real-time, route-specific weather information to pilots and operations staff.

Showing details of current weather and any significant forecast changes in graphical form, the web-based briefings highlight those factors that might affect a flight routeing, such as clear air turbulence or volcanic eruptions. The service helps to improve operational efficiency by avoiding weather-related disruption and ensures that your flight is safe, comfortable and punctual. Critical safety alerts at your destination are also provided when minimum landing requirements are compromised by actual and forecast airport weather conditions.

Toby Tucker, Director Flight Operations at SITA said: "Presenting information visually will make choices on flight routes quicker and easier. For example, assessing projected flight-plan routes against the shifting track of a hurricane, particularly when aircraft are already in the air, and being able to take the necessary action will give aircraft operators a critical advantage." Good to know if you're planning a foreign holiday this year.

Unusual UK weather

In September 2005, the Met Office predicted that parts of the UK, particularly the South, would have a colder, drier winter than normal — in marked contrast to recent years. Following this much-publicised forecast, wintery conditions arrived early in mid-November and saw the mild, wet weather suddenly replaced by calm, cold conditions with widespread night frosts and freezing fog.

Later in November, our forecasters picked up on the possibility of a 'northerly plunge' — a sequence of changes across the North Atlantic, leading to an influx of chilled Arctic air across the UK. Bodmin Moor in Cornwall captured the news headlines at this time, as a continuous feed of heavy snow led to a serious road traffic accident that, in turn, caused more than 100 vehicles to become stranded on the A30 (pictured).

Heavy snow on the A30 on Bodmin Moor

Overall, the Met Office winter period (December 2005 to February 2006) produced temperatures near or slightly below the long-term average in the South, making it the coldest winter since 1996/7. Late December produced one such cold snap, with the eastern side of England bearing the brunt of the snowfall and disruption. Arriving too late for a white Christmas, it brought 10–15 cm of snow in places from Kent to Northumberland. And then there were some very cold days in February 2006, when Leek in Staffordshire remained below – 2 °C all day and parts of the South West experienced their lowest daytime maxima since 1997. Northern Britain had some cold days too but, overall, was milder.

Though March falls outside the Met Office winter season, it produced some of the coldest conditions of the winter which stretched relentlessly until almost the last week of the month. Scotland suffered most, with a lowest temperature of –16.4 °C logged on 2 March at Altnaharra. The south-west and central belt of Scotland also saw major snowfall as late as mid-March 2006, closing airports and leaving up to 3,000 clubbers stranded in Glasgow.

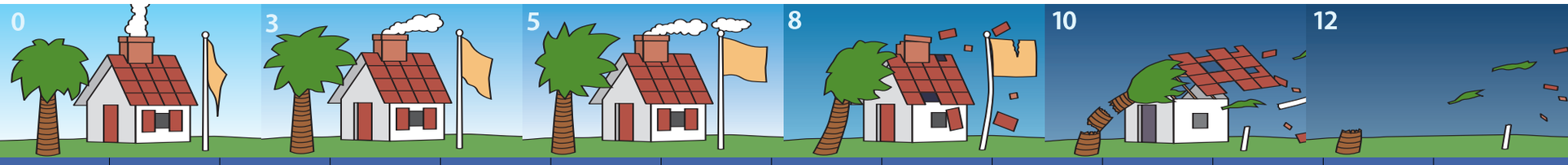
At the end of the third week of March, mean temperatures were running more than three degrees below normal across England and Wales. Had the cold weather lasted, it might have been the coldest March since around 1970. Public perception of the unusually cold weather reached a peak around this time, spurred by the recognition that spring and Nature were running very late. A milder end to the month meant it was the coldest March for ten years across England and Wales and for five years further north.

The final figures also revealed that all regions of the country had a drier-than-average winter, in line with our seasonal forecast. In the event, the winter fortunately had little severe impact for most industry sectors although the combined dry and cold conditions through to March 2006 put water, energy and some other companies and their supplies under heavy pressure.

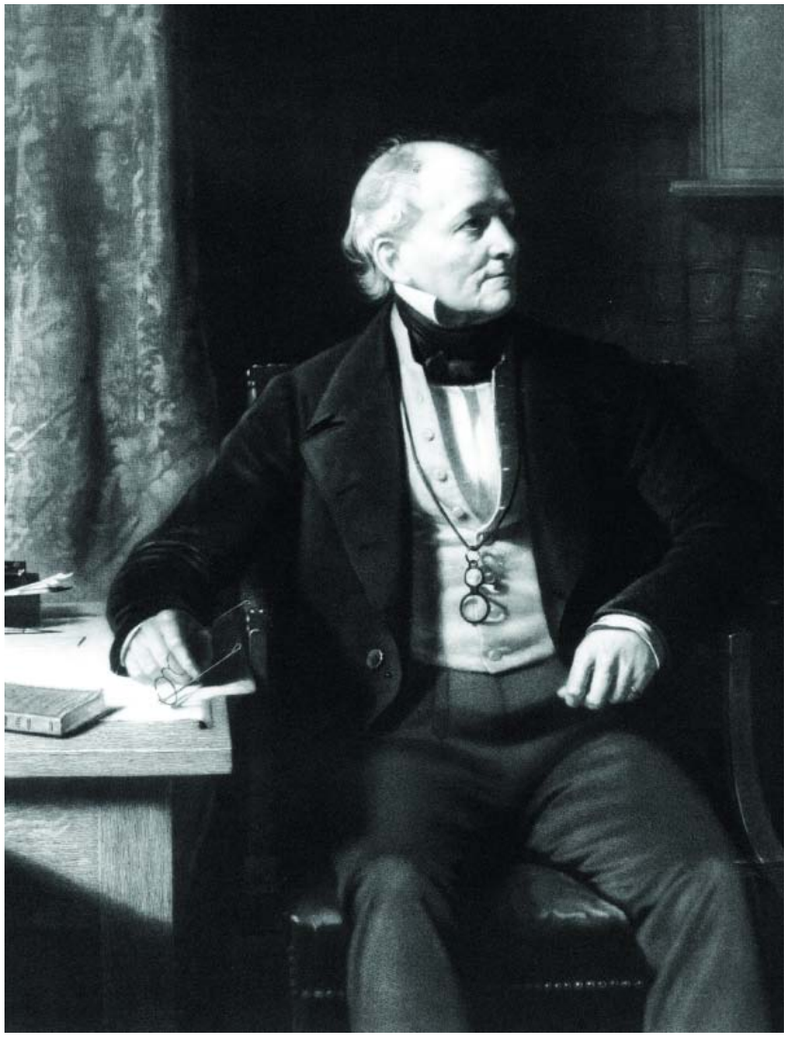
After the winter

April 2006 saw mixed conditions with temperatures averaging near normal in the North and a little above normal in the South, although parts of Kent had a last taste of winter on the 10th. Based on provisional data, it took until 3 May before anywhere in the country (with the exception of the Channel Islands) managed to record 20 °C — the latest date that this has occurred since 1983. However, this value was easily surpassed the very next day, when temperatures peaked at around 27 °C in parts of the London — a relatively rare occurrence for so early in the year.

But the balmy conditions were brought to a sudden end mid-month, as an unsettled and cool spell ensued. This brought strong winds and heavy rain across all areas, and even local frost and hill snow in the North. It also helped boost rainfall totals, such that England and Wales experienced the wettest May for more than quarter of a century. However, even this amount of rainfall fell well short of that needed to replenish groundwater reserves, particularly in the South East, leading to water shortages.



No.	0	1	2	3	extended	4	loose paper raised. ~~Small branches~~ move	5	6	wires. Difficult to use umbrellas	7		8
Knots/mph	0/0	1-3/1-3	4-6/4-7	7-10/8-12		11-16/13-18		17-21/19-24	22-27/25-31		28-33/32-38		34-40/39-46
Description	Calm	Light air	Light breeze	Gentle breeze		Moderate wind		Fresh wind	Strong wind		Very strong wind		Gale
Effects at sea	Sea like a mirror	Ripples, but no foam crests	Small wavelets	Large wavelets crests, not breaking		Numerous whitecaps		Many whitecaps, some spray	Larger waves form. Whitecaps everywhere. More spray		White foam from breaking waves begins to be blown in streaks		Edges of wave crests begin to break into spindrift
Effects on land	Smoke rises vertically	Smoke drifts in the wind	Leaves rustle. Wind felt on face	Small twigs in constant motion. Light flags		Dust, leaves and		Small trees sway	Large branches move. Whistling in phone		Whole trees in motion		Twigs break off trees. Difficult to walk



An all-weather friend

Measuring exact wind speed without sophisticated equipment is not easy but you can get a fair idea just by looking at the objects around you, thanks to the work of Rear-Admiral Sir Francis Beaufort.

Born in 1774 in County Meath, Ireland, Francis Beaufort began his nautical career aged just 13. Quick to recognise the value of being weather-wise, at 16 he began keeping a journal of his own meteorological observations — a practice he would continue until his death in 1857.

In 1805 Commander, later Rear-Admiral, Sir Francis Beaufort published a method of measuring the wind at sea based on the sails a frigate could safely hoist. It was first used officially by Met Office founder Robert FitzRoy in 1831 when, in command of HMS Beagle and with naturalist Charles Darwin on board, he embarked on the five-year voyage that was to become the inspiration for Darwin's epoch-making 'The Origin of Species'. The Beaufort Scale, as it came to be known, was formerly adopted by the Royal Navy in 1838 when it became mandatory for all ship's log entries.

Alongside sea-state descriptions, the Scale categorised wind strength from force 0 calm winds, to force 12 hurricane winds of at least 64 knots (or 75 miles per hour). From this standard, sailors were able to predict how ships would react in certain wind speeds — a major breakthrough at a time when large sailing ships were much more at the mercy of the weather, especially strong winds, than they are today.

Later in the century, the Beaufort Scale was adapted for use of land and, in many respects, the descriptions that went with it are still used today. Beaufort numbers from force 1 to 12 are used, for example, to describe wind strength in the Shipping Forecast that is issued by the Met Office four times a day, on behalf of the Maritime and Coastguard Agency.

Horses for courses

Horse racing is a year-round sport in the UK, but for the majority of enthusiasts spring and summer are the most exciting times when major fixtures in the racing calendar, such as the Cheltenham Races and Royal Ascot, hit full-stride.

There are two types of horse racing: jump racing and flat racing. Each year a massive 1,340 race meetings are held across the UK as far afield as Perth (the most northerly racecourse) and Newton Abbot (the most southerly). In fact, horse racing is so popular it is Britain's second most televised sport after football — and more than six million people turn up to watch the action live each year.

Gallop or stop

The British weather makes horse racing particularly interesting because it impacts on so many areas of the sport. It affects the 'going', or condition of the ground, with some horses preferring the slow going on soft ground and others the fast going on firm ground. This, in turn, can affect the times of the horses by as much as ten seconds; sway the odds on Tote; and, of course, influence what spectators wear. In extreme cases it can even stop a race altogether which means everyone involved in the sport, from racehorse trainers to betting agents, always has one eye on the weather.

Clearing the hurdles

Predominantly a winter sport, jump racing is run on turf over steeplechase fences, or hurdles, and the major weather-related concerns are frost, snow and rain.

On the day of a meeting, the weather is foremost in the mind of the clerk of the course, who is responsible for the arrangements of the meeting and its fixtures — that is, the condition of the course, reports on the going, the race programme and almost everything else in between. Inevitably, he or she will need to plan ahead in case frost or water-logging means abandoning the race.

"Our forecasters have a very personal relationship with the clerks," says Met Office Operations Manager and horse racing enthusiast Robin Thwaytes. "We have to learn their language. They don't want to know if the forecast is for sunny intervals with showers. They want detail. How many showers? How much rain will this give? What is the temperature going to be? Will the course dry out quickly?"

Running on flat

During spring and summer, flat racing on turf occupies the race schedule. Again, the clerk will be worried about water-logging. But, by contrast, if the sun is strong and temperatures are high, firm ground becomes a problem for safety — if, for example, the course is dry and it starts to rain it can make the ground incredibly slippery. Horses will be in danger of losing their footing on a bend and the clerk may have to abandon mid-meeting.

Adds Robin: "The clerk may speak to one of our forecasters four or five times on the morning of a meeting. The last thing he or she will want to do is abandon the race, but if there's no alternative this needs actioning sooner rather than later to avoid disappointing — and annoying — all the trainers, spectators and media who have travelled to the racecourse from miles around."

Defying the weather

The weather has such a varied and, in some cases, overwhelming impact on the sport that some racecourses go to great lengths to stay one step ahead of it. For instance, Newbury racecourse in Berkshire, which celebrated its centenary last year, has invested in a tarpaulin to protect the track from overnight frost and drawn up a multi-million-pound development plan that includes the construction of an all-weather course.

To read how champion racehorse trainer Martin Pipe CBE copes with the British weather, turn to our celebrity feature on page 18.

Putting a face to the weather

After eight years working as a TV weather presenter for the Met Office on BBC 1, BBC 2 and Radio 4, **Sarah Davies** often calls upon her broadcasting experience in her latest public-facing role for the Met Office — that of Public Weather Service Consultant.

Sarah Davies, or Sarah Wilmshurst as she is known to countless BBC viewers and listeners, joined the Met Office on a graduate training course in 1993. "I wanted to be the next Michael Fish," she says.

Having successfully completed the programme, Sarah was posted to the Southampton Weather Centre where she presented the weather on local television and radio. But in her early broadcasting years, she wasn't as confident as she seemed and had to write everything down, thoroughly rehearse her lines and take very deep breaths before going on air. "At the time, I wasn't sure that I dealt with it very well. But, actually, a little bit of nervous energy helps you deliver a good broadcast."

Sarah soon found her stride, both as a meteorologist and as a broadcaster, and learned to think quickly on her feet — a skill that has served her well since taking up the role of Public Weather Service Consultant in August 2005. It's been an exciting challenge right from the word go.

"At the BBC everything was laid out — what I should do and when," she says. "As a Public Weather Service Consultant, I organise my own time and do the things I think need doing when they need doing. This is new and thrilling for me. I'm in a different place, meeting different people every day. And, of course, I still get the thrill of being involved when there is serious weather."

A natural

Born in Newcastle-upon-Tyne, Sarah was first inspired to study the weather by her geography teacher at Cheadle Hulme School in Cheshire where she sat meteorology at GCSE level. From there, she went on to complete a Bachelor of Science degree in Geography at the University of Birmingham, followed swiftly by a Master of Science post-graduate qualification in Applied Meteorology and Climatology.

The weather and the Met Office have always played an important part in Sarah's life. She met her husband, John, at the Met Office College 13 years ago, while her three-year-old son is already very weather-aware. "We ask Sam every morning what sort of day it is. He loves thunder but hates wind" says Sarah.

All go

Now based in London, Sarah is rarely at her desk. She travels across the South of England liaising with government departments and local authorities, helping them plan for and respond to weather-initiated or related emergencies.

As a result, Sarah doesn't have a typical day but has found that her presenting skills equip her for most eventualities such as making speeches to government departments or at press conferences. "You name it," says Sarah, "if it's to do with the Public Weather Service, I'll do it. As a result, I'm out there meeting all sorts of people every day. A large part of my job is media-related — speaking to TV and radio stations or to reporters — so having a background in broadcasting is very helpful."

Recently, Sarah has been advising the Environment Agency and water companies on the drought caused by the driest two consecutive winters since 1920–22; explaining the science behind the cold winter forecast published in autumn 2005, and dispelling some of the myths about the drought circulating in the media.

Being prepared

Sarah has yet to be directly involved in a live disaster, but nonetheless much of her time is occupied by planning for the worst. As she explains: "What many government departments and local authorities have done in the past is to go for absolute Armageddon

> “ Whenever and wherever there is a weather-related emergency, I want the Met Office and our experts to be at the forefront of people’s minds”

when testing their emergency preparedness. They’ve perhaps envisaged a major hurricane, such as Katrina, coming up through Southampton or something similar that isn’t very likely to happen. So we’ve been advising them on more likely scenarios which still have to be tough and out of the ordinary — but not totally extreme.”

In a recent planning exercise, Sarah described the weather conditions that would cause severe coastal flooding and the consequent displacement of thousands of people in the South West of England; producing a series of mock TV broadcasts so that the emergency services could react accordingly on the day of the exercise. As the scenario unfolded, Sarah took off her broadcasting hat and donned her Public Weather Service Consultant moniker, providing additional weather information when it was needed — a vital role in such an emergency.

Her ambitions for the future are as straightforward as they are single-minded. “Whenever and wherever there is a weather-related emergency — either caused directly by the weather, or where it is a prominent feature in the management of a major incident — I want the Met Office and our experts to be at the forefront of people’s minds.”

2006

Climate change is happening. As we turn up the heating in our homes during colder winters and turn on air-conditioning systems in summer, the UK's energy companies are busy preparing for the future.

Climate change and energy management

Although you may not realise it, scientists, engineers and energy companies are working hard behind the scenes to ensure that in 20, 50 and 80 years' time your home will still run as effectively as it does today. In the future, your cup of tea may taste the same, but the electricity you use to boil the kettle will probably have a very different history. As a world-leader in climate prediction and research, the Met Office Hadley Centre is providing the expertise needed by the UK energy industry to respond to the challenges of climate change.

"Global temperatures are rising, which causes regional changes in seasons, rainfall and wind patterns, and more severe and intense weather," says Met Office Science Development Manager, Fiona Hewer. "These will inevitably affect how much central heating people use in winter and the need for air-conditioning in summer. It will also increase the flood risk in some areas, alter the efficiency of electricity generation and affect the way we develop renewable energies."

National Grid, EDF Energy and E.ON-UK, which generate, distribute, transmit and supply much of the UK's energy, have jointly funded an innovative Energy Impacts Project. Met Office climate scientists have worked together with industry experts to identify the impacts of climate change on the industry. While under pressure from the UK Government, the European Union and international directives to reduce CO_2 and other gas emissions, these three major energy companies want to lead the way in energy management.

Generation

Every day billions of units of energy are generated in power stations around the UK. Climate change will affect everything from how much energy existing power stations pump out (as temperatures rise they won't be able to produce as much as they did before) to where power stations are sited (many are currently situated on the coast, so will need to account for sea-level rise in their plans).

Another interesting engineering challenge, that Fiona and her team have identified, is the way climate change will affect the many power stations that use water from rivers to cool their energy production systems. With a changing climate there may be less water in the rivers and the temperature of the water will be higher. Future work from climate scientists will help energy companies plan their water management, in order to keep power flowing and protect the aquatic environment.

Distribution and transmission

Towers, cables, poles, conductors, insulators and transformers are all involved in the process of transporting energy to our homes and businesses — and can be vulnerable to damage from wind, heat, flooding and lightning which might increase as the climate changes.

As our environment warms up, what's called cable 'de-rating' — reducing the energy flow through a cable to lower its temperature to a safe, long-term operating level — will also happen more frequently. Outside the UK's cities, cables hung between poles expand and sag in high temperatures, and so de-rating keeps them a safe distance from the ground. But in built-up urban areas, like London, there isn't enough room to do this so they are buried deep beneath the ground. Here, de-rating is required where potentially drier soils and higher temperatures decrease the natural cooling effect of the soil. In the future, soils in many areas will be warmer and drier, increasing the need for de-rating underground cables.

Once a cable is laid, it is likely to be in operation for 40–60 years, so the three energy companies want to use new climate change impacts information to ensure that the cables they lay today will work as effectively in the climate of tomorrow. Advanced planning now could also save money on future repair costs and bring a welcome reduction to the disruption of road-works that cable-laying can cause — an added bonus.

Demand and supply

Climate change will undoubtedly affect when and why we want to use energy. Traditionally, UK winters have prompted the highest demand — you get cold, so you turn on your heating. With hotter temperatures and more of us using air-conditioning and refrigeration, this long-established pattern of seasonal demand may be reversed. The energy industry can use climate change information to plan for rescheduling their annual summer maintenance work, on top of taking measures to ensure you can continue to put the kettle on any time you want.

Next steps

Informed by climate change advice from the Met Office, National Grid, EDF Energy and E.ON-UK have identified these and many other climate change impacts. They now want to engage with others in the energy industry and government to evaluate the size of the problem and include climate change impacts in their plans for the future of our energy provision.

Energy fact file:

- People are consuming more energy. According to the International Energy Agency global energy demand will rise 50–60% by 2030
- In 1970, 5.6 million homes had central heating, by the millennium this number had risen to 21.7 million
- 80% of the electricity energy in the UK is generated from the 'fossil fuels' coal, oil and gas
- The UK has 23 working nuclear reactors, which generate 20% of our electricity
- Between October and March the average household spends around £400 on energy bills
- 59% of UK households own two or more television sets. Leaving TVs and DVD players on standby uses £163 billion of electricity every year
- EDF Energy has invested £70 million in energy efficiency projects and has helped to save over one billion units of energy, equivalent to switching off the power in London for 140 days
- Renewable energy currently provides around 3% of the UK's energy
- E.ON-UK produces 15% of all renewable power in the UK

2026

Summertime
in the South West

Stunning scenery, compelling sights and more opportunity for adventure than you can imagine, here we take a look at what is on offer in the South West of England in the summertime, come rain or shine.

Chief Executive of South West Tourism, Malcolm Bell, has a professional and personal interest in the weather. In a region that experiences some of the most dramatic variations in weather seen anywhere in the UK, it can make or break businesses in his area; and, as a keen dinghy sailor himself, it can make or break his weekends too.

"For day trips and short breaks, tourism in the South West switches on and off with the weather" says Malcolm. "People generally make decisions about what they're going to do on a particular day based on the weather. So if the Met Office forecast says the weekend is going to be mainly dry, then it will bring people out of their homes."

The changeable weather in the South West is accentuated by numerous micro-climates. From the moors of Devon to the beaches of Cornwall the weather can change from fine to foul in a matter of minutes. But, with over 600 miles of coastline, two National Parks, 14 Areas of Outstanding Natural Beauty, three UNESCO World Heritage Sites and more than 300 tourist attractions covering Gloucestershire, the Cotswolds, Wiltshire, Bristol, Bath, Somerset, Devon, Dorset and Cornwall, it's unlikely you will be stuck for things to do. The conditions might even add to the excitement.

"The weather has various aspects that can appeal to visitors in different ways," says Malcolm. "For instance, wild winds and storms can be awe-inspiring, while many people find misty and foggy days romantic."

Getting back to nature

One of the best ways to explore the South West is on foot where the environment can be both challenging and rewarding. There are three National Trails in the South West: the Cotswold Way, the Ridgeway and the South West Coast Path which runs for 630 miles from Studland in Dorset around Lands End in Cornwall to Minehead in Somerset. Other long distance paths include the Tarka Trail and the White Horse Trail, while Dartmoor and Exmoor have a criss-cross of footpaths that run their length and breadth.

Today's technical clothing, which is lighter and more weatherproof than ever, means most conditions can be enjoyable — even a biting wind or heavy downpour. But it's always important to check the weather forecast before you set out. In fact, the Rambler's Association advises all walkers to "keep an eye on the sky" and make sure someone knows when to expect you back.

Sense of adventure

The South West is also a great playground for anyone that likes a bit of adrenaline. Diving, sailing, surfing, power boating, land yachting, rock climbing, cycling, flying, ballooning, you name it, you'll find them all here. Each sport relies to an extent on a particular set of weather conditions.

Surfers, for example, can find some of the UK's best spots in Devon and Cornwall. Experienced surfers study the Atlantic weather charts to see whether there is a depression forming out in the ocean that will generate the swell that, in turn, creates good surf. They also work out the direction of the wind, as this determines the quality of the waves.

Even sports fanatics that prefer to stick to firm ground are just as affected by the weather. Somerset's Quantock and Mendip Hills are great spots for people beginning mountain biking. But the trails can get slippery when wet so it's always advisable to wear protective clothing — especially a helmet. The rain also affects rock climbers who can find a route that's usually quite easy becomes very challenging in wet weather.

Living heritage

Culture and heritage are also abundant in the South West — and provide the perfect distraction for wet weekends. The Eden Project near St Austell has been a huge success ever since it opened in 2001, while other popular days out include the Roman Baths and Pump Rooms in Bath, the Cornish Cyder Farm, Longleat Estate, Paignton Zoo, Westonbirt Arboretum in Gloucestershire and, who could forget, Stonehenge. As long as you've got an umbrella and a sun hat handy, you can enjoy these sights whatever the weather.

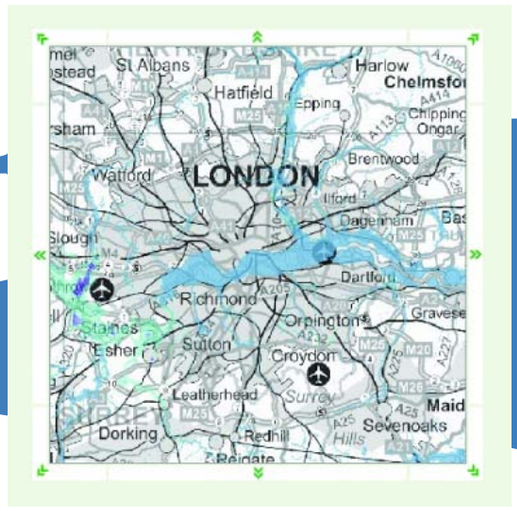
Enjoy the summer safely by turning to page 17 for information on UV radiation and air pollution levels.

South West Tourism fact file:

- Tourism is the largest industry in the South West. Visitors spend around £4,103 million in the region every year
- It is the most popular destination for visitors from the UK, accounting for 15% of England's domestic tourist trips in 2003
- Most visitors live locally in the South West (26%) or cross over from the South East (20%)
- 40% of visitors stay at the seaside, 21% stay in villages and rural areas and 22% stay in the towns and cities
- The South West's two National Parks, Dartmoor and Exmoor, cover 629 square miles
- The Jurassic Coast, which spans Dorset and East Devon, was declared a World Heritage Site in December 2001
- The Lulworth Cove Heritage Centre in Dorset is the most visited free admission tourist attraction in the South West
- The South West has more than 600 miles of coastline
- Torbay is known as the English Riviera for its sunny micro-climate and sheltered beaches, while the Scilly Isles, with their warm sea breezes, are often referred to as the British Caribbean
- The Eden Project is the South West's number one tourist attraction with 1.5 million visitors; the Roman Baths in Bath are in second place with around 840,000 visitors; and, in third place, is Stonehenge with 745,000 visitors

Planning ahead — the Thames Estuary exercise

Coastal floods can be one of the most destructive natural hazards, so with 7,500 miles of coastline how secure is the UK? And what are the chances that a storm surge from the North Sea could break through the flood defences of the Thames Estuary?



Courtesy of the Environment Agency

Earlier this year, the Flood-Risk Management Research Consortium (FRMRC) ran the first of three planned simulations to assess the risk of flooding in the UK. The Consortium is funded by a group of stakeholders (see box) and comprises a large number of organisations of which the Met Office is one.

Flood forecasting

Hosted by the Met Office in Exeter, the first exercise focused on the possible affects of a major surge from the North Sea on the flood defences of the Thames Estuary. Dr Brian Golding, Head of Forecasting Research at the Met Office describes how floods can be divided into three stages: sources, pathways and receptors.

"Sources are the weather elements that contribute to a flood, such as rain over land or a storm over the ocean. Pathways are the processes that turn the weather event into a hazard, such as a storm surge, high waves, breaching of defences and inundation of the land. And receptors are those things damaged by the flood, such as buildings and people" he explains.

The Met Office's role in the FRMRC exercise was to provide its knowledge and data for the first, or 'sources', stage of a possible flood by simulating a severe storm. This, combined with the knowledge of the other organisations taking part, helped the Consortium build a detailed picture of each stage of a major flood event.

Worst case scenario

Creating a scenario that would test the Thames' flood defences involved, as Brian puts it, "...the Met Office playing God in creating the weather.

He continues: "On the first day of the exercise, the group used real forecasts of real weather conditions that happened on 25 November 2005 and transplanted them to 30 September 2015. This particular date was chosen because it will see the highest tide in the Thames Estuary area for 25 years."

The aim was to create a scenario that was extreme enough to cause the flood defences to fail, so that the affects of a flood could be examined. But despite the extremely testing conditions, the defences — which were designed to withstand a 1 in 1000-year weather event — proved too strong to be affected.

So on the second day of the exercise the group upped the stakes. In fact, they increased the storm surge by a factor of four, or in Brian's words: "We took conditions to a ridiculous extreme in order to create the result we needed and cause the flood barriers to fail".

With the defences breeched — at least theoretically — the group was able to study the affects of the water as it ran onto the land, and assess factors that would be key in an emergency such as water depth in certain areas and how far inland the flood would encroach. It also helped them study the velocity of the water, which can be a key element in how dangerous a flood is to people.

Working together

This first successful exercise enabled the FRMRC to test how each organisation's models and information complements the others'. It also gave observers from stakeholder organisations an understanding of the sort of information that could be provided in the event of a real flood. Ultimately, the exercise helped test and refine many of the processes that could be critical for minimising damage should a major flood event occur; and, as an offshoot, helped demonstrate the high level of protection afforded by the current flood defences in the Thames Estuary.

The FRMRC is funded by:

- Engineering and Physical Sciences Research Council
- Department for Environment, Food and Rural Affairs
- Natural Environment Research Council
- Environment Agency
- Department for Agriculture and Rural Development, Northern Ireland
- Scottish Executive
- UK Water Industry Research
- Scottish and Northern Irish Forum for Environmental Research
- Rivers Agency, Northern Ireland

Reaching new heights in global modelling

Increasing the resolution of NWP* models is one way of improving the accuracy of weather forecasts. **Dr Mike Keil**, Assimilation Applications Manager, explores how this is also helping Met Office scientists investigate the stratosphere in greater detail.

* Glossary on opposite page

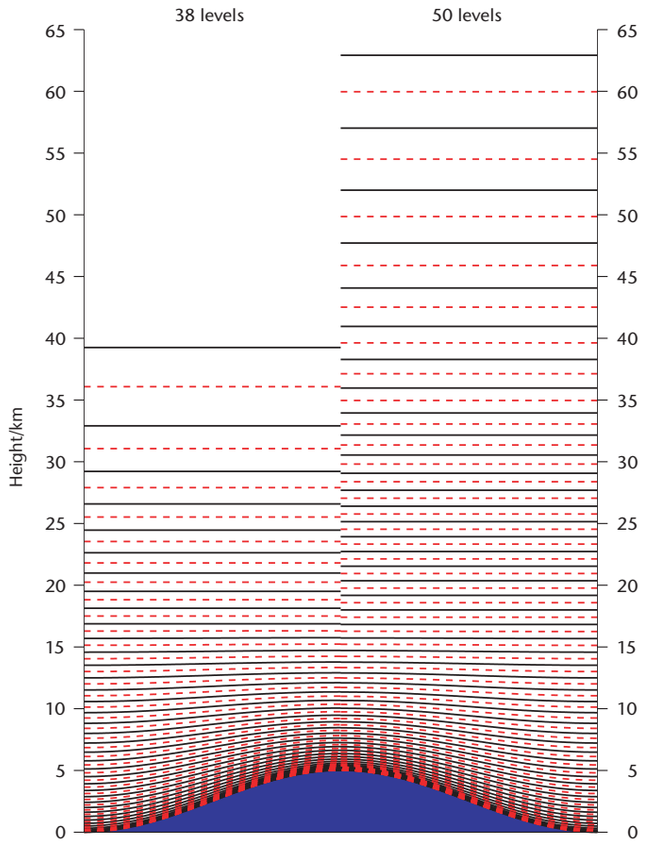


Figure 1. New enhanced global model vertical levels (right) compared to the previous level set (left)

As resolution increases, smaller scale features which play an important part in determining the weather can be reproduced more accurately. Recent NWP model improvements saw the horizontal resolution increase from 60 km to around 40 km over the UK and 50 levels replace 38 in the vertical domain, as illustrated in **Figure 1**. These were added to the top of the model with 12 levels put into the stratosphere and mesosphere producing a new upper boundary at around 63 km. Only a few years ago resolution of this kind was unheard of, but advances in supercomputing power have allowed such high resolution to become a reality.

Ranging in altitude from approximately 10 km to 50 km, the stratosphere is important because it contains the vast majority of the atmosphere's ozone which helps protect life on Earth from the sun's harmful UV radiation. One difference between the stratosphere and the underlying troposphere is that the temperature in the stratosphere increases with height, due to ozone which absorbs solar UV radiation.

Forecasting the weather in the stratosphere has considerable influence on forecasting that in the troposphere, because satellites take measurements through large vertical slices of the atmosphere, including the stratosphere. In order to make best use of the satellite information for the troposphere it is therefore necessary to accurately represent what it going on above this region. The higher NWP model top has led to the use of three additional ATOVS satellite channels, which previously fell outside its upper boundary. Not only has this improved the representation of the stratosphere in the global NWP model, but it also allows the Met Office to fully exploit available satellite observations.

Although the stratosphere is far removed from the Earth's surface and the weather that we experience, it is an area of active scientific research. Discovered more than one hundred years ago, the stratosphere is still producing scientific surprises. The new global NWP model allows the stratosphere to be investigated in more detail than ever before.

One such surprise occurred earlier this year when a record low total ozone column measurement of 177 DU was made over Reading on 19 January 2006. Other monitoring stations in the UK and Western Europe also measured low ozone values around this date. Analyses from the new Met Office global model and back trajectories from our NAME III model were used to investigate this unique event.

Typical total ozone column values over the UK in January are around 320 DU. The measured low is approaching half this value and investigations showed that there were a number of processes at work in the atmosphere which led to this record low measurement.

Analysis showed that stratospheric temperatures during the first three weeks of January were cold enough for PSC formation, providing a suitable environment for chemical destruction of ozone. Usually temperatures low enough for PSC formation are confined to polar regions within the stratospheric polar night jet. However, in this case, a major warming event was occurring in the stratosphere which heated the polar region and displaced the cold polar night jet southwards towards the UK, as highlighted by the hatched region in **Figure 2**.

Simulations using backwards runs from the NAME III model were used to investigate the origin of air that made up the low ozone columns over the UK. These showed that the air was primarily stratospheric polar night jet in origin and thus susceptible to chemical ozone depletion. It also indicated the presence of a raised troposphere due to the passage of tropospheric weather systems. Therefore, two mechanisms for low

Science profile

➔ **Derrick Ryall**
Head of Government
Meteorological Research

The Met Office employs professionals and experts who are constantly expanding the boundaries of weather and climate prediction. Here we meet one of them...

Derrick Ryall is a key adviser to Government. As well as climate change research, his job involves forecasting atmospheric pollution and air quality — three of the biggest challenges facing the world today. "One of the strengths of research within the Met Office is that it relates directly to the UK Government's policy needs, so has a very sharp focus," says Derrick.

An aptitude for geology and physics at Wellington College led Derrick to study for a degree in Physics and Geophysics at the University of Bath. After graduation, he took up a post as a physicist at BP, where he remained for seven years. Initially, Derrick looked at the electrical and acoustic properties of rocks to quantify oil content, before moving on to research gas dispersion around oil rigs. This was a turning point for him. He has had a keen interest in atmospheric pollution ever since.

The air we breathe

Working with others, Derrick has helped develop emergency response services at the Met Office that advise the Government on how to deal with pollutants that are released into the atmosphere, deliberately or by accident. Such events include volcanic eruptions, nuclear incidents, or major fires like the one that occurred at the Buncefield Oil Storage Depot on 11 December 2005. The Government Meteorological Research (GMR) programme also provides information on general air quality — a subject that is investigated further on page 17 — including emissions that come from traffic or industry that may affect people's health. When there is a problem with pollution, Met Office experts investigate the source of it to help the Government respond accordingly.

"Traditionally, we have looked at atmospheric pollution in separate models to weather forecasts," says Derrick. "We are trying to improve this by integrating atmospheric chemistry within the forecast model itself, which will ultimately increase accuracy and hence usefulness. The British public will also benefit. Basic air quality forecasts are already broadcast on some television channels. However, we would like to make more detailed information available, so that people who are sensitive to air quality can take better action."

Model behaviour

As far as climate change is concerned, there is now wide acceptance across the scientific community that it is happening, which requires major policy initiatives from the world's governments and also keeps Derrick and his team busy. Such decisions have to be based on good advice, which, in turn, is based on good science, a sound understanding of the uncertainties involved and a confidence in the predictions — which is where the Met Office helps.

A major role of GMR is to write and develop climate forecast models, and in the past two years the introduction of the Global Environmental Model has pushed this work forward. Over the next couple of years the trend will be to try to represent more processes in these models, to include the carbon cycle (the way that carbon is taken out of the atmosphere and moved around the whole ecosystem) and atmospheric chemistry — to help build a more detailed picture.

"We are trying to get better predictions of climate change through representing more of the processes taking place in the atmosphere, improving the realism," explains Derrick. "Simulating the complexities of the world's climate in this way helps the Met Office provide ever more accurate climate change information to governments."

This is exactly what motivates and excites him. "Climate change is going to affect us all in a big way. The Met Office is a world-leading centre of climate change research and being part of that is a huge privilege — particularly as our research is already influencing the way the world is looking at and responding to this important issue."

ozone columns were occurring which led to the record low values over the UK. Although low ozone events can have a serious impact on human health, it is unlikely that this event presented any real danger because the strength of the sun is low over the UK in January.

The Met Office continually strives to improve its NWP capability, leading to the development of more sophisticated models that allow other aspects of the atmospheric environment to be examined in greater detail, in addition to forecasting the weather. The recent enhancement of the global NWP model to span the whole of the stratosphere is an excellent example of how improvements in weather forecasting can also bring benefits to wider areas of atmospheric science.

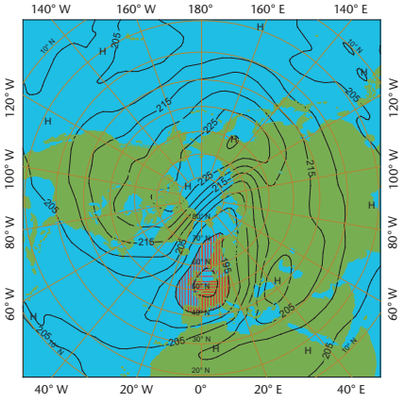


Figure 2. Met Office temperature analysis for 19 January 2006 at approx. 20 km, indicating the possibility of polar stratospheric cloud formation

Glossary

NWP	Numerical Weather Prediction
UV	ultraviolet
ATVOS	Advanced TIROS Operational Vertical Sounder
TIROS	Television Infrared Observation Satellites
DU	Dobson Unit: 100DU is equivalent to 1mm thickness of ozone at STP
STP	Standard Temperature and Pressure
NAME III	Numerical Atmospheric-dispersion Modelling Environment III
PSC	Polar Stratospheric Cloud

Forecasting a healthy summer

More information is now being included in our everyday weather forecasts. Two aspects that will become increasingly visible over the summer months are information about UV radiation and air pollution levels. **Claire Witham** explains.

Index	Fair, burns	Fair, tans	Brown	Black
1 2	Low	Low	Low	Low
3 4	Medium	Low	Low	Low
5	High	Medium	Low	Low
6	Very high	Medium	Medium	Low
7	Very high	High	Medium	Medium
8	Very high	High	Medium	Medium
9	Very high	High	Medium	Medium
10	Very high	High	High	Medium

Table 1. The Solar UV Index, indicating the risk of damage to different skin-types

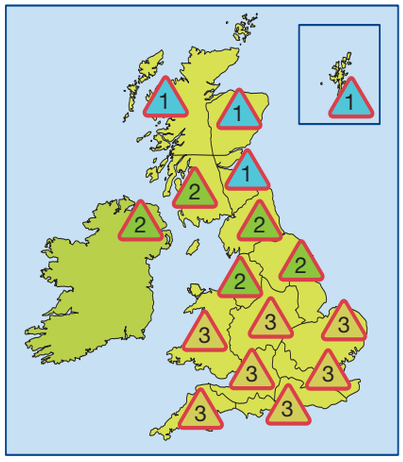


Figure 1. Example of our UK UV forecast. The Index numbers correspond with those in Table 1

Increased levels of UV radiation and pollution can be harmful to health and warning people in advance is the first step to reducing their exposure. UV and pollution forecasts use a simple index system from 1 to 10. Designed to be easy to interpret, 1 indicates a very low risk and 10 a very high risk.

UV radiation

The main source of UV radiation is the sun. This causes sunburn and increases the risk of developing skin cancer. Intense UV can also inflame the eyes and long-term exposure may cause cataracts. The Solar UV Index, developed by the World Health Organization, expresses UV strength and is shown in **Table 1**. Risk is determined by skin-type, with fair-skinned people most at risk from UV damage and dark-skinned people also at risk of burning, but at higher Index levels.

To aid people in making sensible decisions about their behaviour in the sun, we provide, via our website, a 5-day Solar UV Index forecast for UK regions and for a number of locations in Europe. The forecast takes into account sun position, cloud cover and stratospheric ozone. An example forecast is given in **Figure 1** and shows the maximum Solar UV Index value for each region. In the UK, the Index rarely exceeds 7, but Indices of 9 and 10 are common in the Mediterranean area.

Air quality

A variety of air pollutants are known, or suspected, to have harmful effects on human health and the environment. In the UK, these principally come from road traffic, power stations, industry and homes. Ground-level ozone is the main cause of poor air quality in the summer and is formed in sunlight by chemical reactions of other pollutant species. This ozone is different to the stratospheric ozone considered in the Solar UV Index. Poor air quality in winter is most likely due to particulate matter (PM10), which becomes trapped in the surface boundary layer during stable weather conditions.

The Met Office is working with Defra and the BBC to provide daily and 5-day forecasts of air quality in the UK. These are made using our NAME model that is capable of predicting the transport, chemical transformation and deposition of a wide range of airborne materials. Air quality forecasts are made for five pollutants: carbon monoxide, sulphur dioxide, ozone, nitrogen dioxide and PM10. The level of pollution is given either as an index level or as a banding (low, moderate, high or very high), as shown in **Table 2**. These levels are based on the effects on health of each pollutant and are set by Defra and the Department of Health following EU directives on air quality. The pollution level that the Met Office gives in daily weather forecasts is the maximum level, or band, predicted for each location.

Future developments to our air quality forecasting include the incorporation of air pollutants into the global NWP model. This will directly couple forecasting of the dispersion and chemistry of air pollutants with that of meteorological parameters, improving the simulation of both.

Combined effects

On hot sunny days, heat stress from high temperatures increases the risk to health in vulnerable people, particularly the elderly and very young. Additionally on these days, air quality levels may be poor due to increased ground-level ozone, and UV Index levels may be high. The combination of these three factors creates a greater risk to people's health. The summer of 2003, which proved particularly fatal across Europe, was a prime example of this synergy. The Met Office is now providing forecasts of all of these factors so that at-risk groups can take suitable preventative and protective measures in the future.

Index	Banding	Health effect
1–3	LOW	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants
4–6	MODERATE	Mild effects, unlikely to require action, may be noticed amongst sensitive individuals
7–9	HIGH	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their 'reliever' inhaler is likely to reverse the effects on the lung
10	VERY HIGH	The effects on sensitive individuals described for high levels of pollution may worsen

Table 2. The UK air pollution index and banding, with the health effects that they represent

Martin Charles Pipe CBE

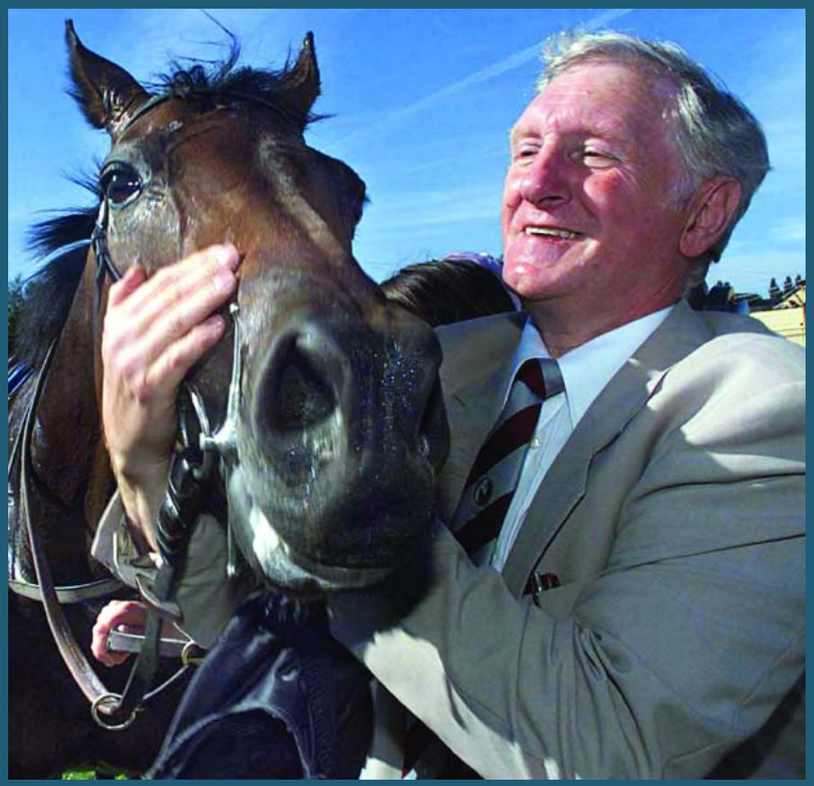
With more than 30 years' experience of working with horses, champion racehorse trainer Martin Pipe has broken all the rules and beaten all the records. One of the most prominent figures in the world of horse racing today, he isn't going to let anything get in the way of his success — and that includes the weather.

Based at Pond House in Nicholashayne on the Devon-Somerset border, Martin currently has 138 horses in training. But, despite the large numbers, he treats every horse as an individual and gives them his personal attention, right down to calculating exactly how much feed each horse needs.

"I love looking after horses every day, watching how they grow and mature. They are just like young children," he says. "At first, they don't know how to run and just saunter along. Then you get them on gallops and see how much they enjoy themselves."

There is no doubt that Martin's horses share the same passion for racing as their trainer. It would be impossible for them not to — Pond House is as impressive as a five-star luxury spa. The mild-mannered mounts, as well as the divas of the equine world, benefit from extensive onsite facilities that include a swimming pool and treadmill, a physiotherapist, professional horse walkers and even solarium lamps in the stables, on top of the most comprehensive training school facilities in the UK.

Martin's interest in all things equine started from a very young age. When David Pipe Senior decided to step down from his position as manager of — by that time — 50 West Country betting shops, the Pipe family bought a small farm. Martin started racing horses and competing in local point-to-point meetings and had his first win on a chestnut-coloured and appropriately named horse Weather



Permitting at Bishop's Leigh. But, after a series of accidents, a broken leg and a car crash, Martin decided there was no place for him in the saddle. "I was useless," he says.

Instead, Martin got his hands on every book about racehorse training that he could find and subsequently discovered his vocation in life. He turned traditional methods upside down and wrote his own rules.

In the early years he learnt the hard way. "I knew nothing about racehorse training. It was a couple of years before we had any winners. Among the first were Bobo Boy and Clock Corner. We bought them for a minimum price in a sale and it wasn't until afterwards that we realised both had injuries. We had to retrain them from scratch."

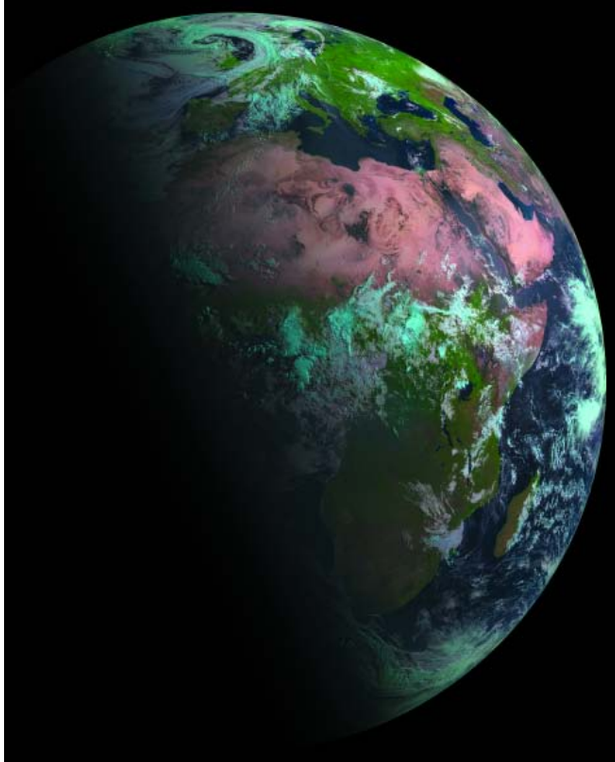
Since then, Martin has never looked back. His first major winning horse was Baron Blakeney, which won the Triumph Hurdle in 1981 at the Cheltenham Races — the odds were 66/1. In 1994, he won the Grand National with Miinnehoma, a horse owned by comedian Freddie Starr. By far his best season was 1999/2000, with 243 of his horses crossing the finishing line in first place. His most promising horse at the moment, eight-year-old Celestial Gold, won the Betfair Bowl at Aintree this April.

As Martin's career goes to show, horse racing can be as unpredictable — and as exciting — as the weather. Every horse must be in peak condition before the start of a season, so he cannot let the wind, rain or sun get in his way. At Pond House the horses run year-round on an all-weather track and are put through their paces at an indoor canter house.

But when it comes to race day even champion trainers like Martin are at the mercy of the weather. "I have to work out which horses I can run and when. Different horses like different grounds so I have horses trained to their peak fitness for both soft and firm conditions. When the ground is too firm, however, I can't run any of my horses. I watch the forecast on television closely and speak to the clerk of the course on race day. With all things ready to go, it's particularly frustrating when a race meeting is abandoned because of the weather."

However, despite the challenges that the weather poses for Martin, you know you're onto something major when your career counts 4,000 winning horses among its achievements.

➔ For more information on Martin Pipe visit www.martinpipe.co.uk



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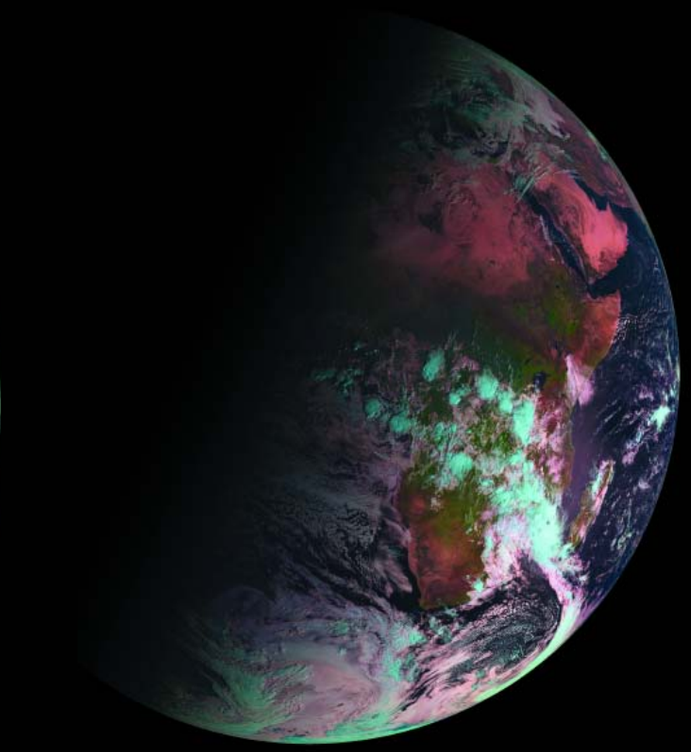
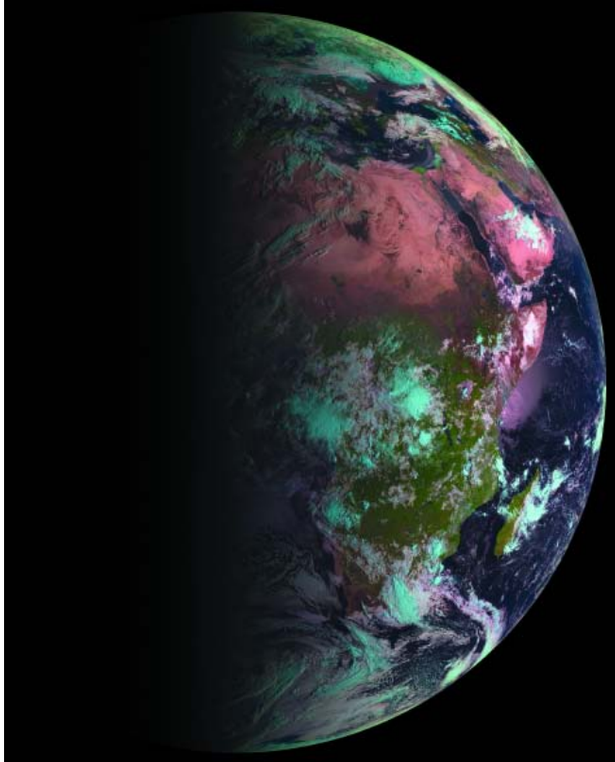
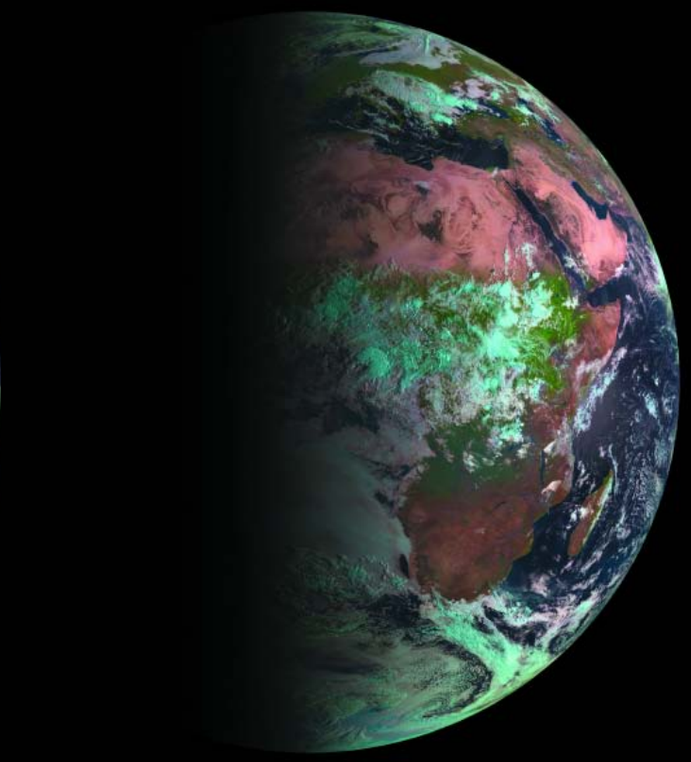


//WINTER SOLSTICE 20//21 DECEMBER

//SPRING EQUINOX 20//21 MARCH



//AUTUMN EQUINOX 22//23 SEPTEMBER



A summer's warmth

Our planet takes just over 365 days to orbit the Sun — the basis of our calendar year.

During the year, different parts of the globe receive varying amounts of sunlight due to the tilt of the Earth's axis (23.5 degrees) — creating the seasons.

The position of the Sun as seen from the Earth moves north to south through the year. When it changes direction it appears to stand still momentarily — this is the Solstice. In the northern hemisphere the Summer Solstice is the longest day of the year, when the Sun is at its most northern point in the sky (around 20/21 June). The Winter Solstice is the shortest day of the year, when the Sun is at its most southern point in the sky (around 21/22 December).

An Equinox occurs when the Sun crosses the celestial equator and the astronomical day and night are equal. At the Spring Equinox, the Sun is at the midpoint of the sky (around 20/21 March) and reaches this point a second time during the year at the Autumn equinox (22/23 September).