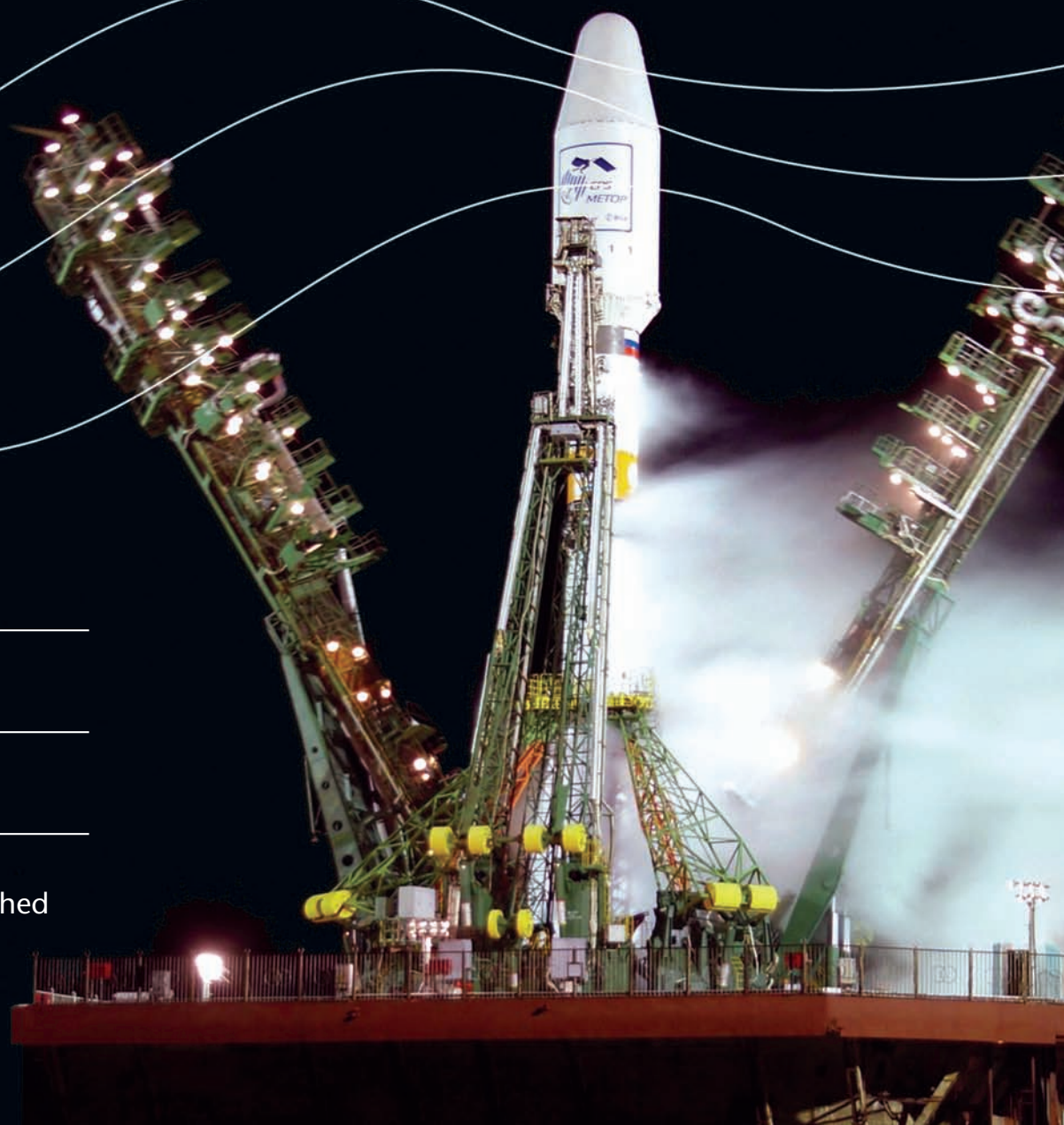


barometer



Issue 5 www.metoffice.gov.uk Met Office magazine



WEATHER HEALTH

Staying healthy, come rain or shine

BIG BUSINESS

Cashing in on the weather

COUNT DOWN

Revolutionary weather satellite launched



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Counting down to winter



With the season of mists and mellow fruitfulness replaced by an extended summer, the Met Office is helping all of its customers adapt to a changing climate, explains **Dr David Griggs**, Director of Government Business...

The nights may have drawn in but there is no denying that the season described in John Keats' 1820 poem 'To Autumn' was very late this year. Instead of experiencing chilly nights and foggy mornings, we were basking in summer warmth deep into autumn. In fact, September was the warmest on record with an average temperature of 15.4 °C, which is 3.1 °C above the long-term average. October was also well above average but not record-breaking.

This adds to the growing evidence that climate change is having a considerable impact on the UK weather and climate. Another startling case in point is that olive trees, native to the coastal areas of the eastern Mediterranean, have now come to Britain. The first olive grove has been planted in Devon with the help of Met Office experts; and, as *Barometer* reports, the first press of home-grown olive oil is expected within seven years. Meanwhile, the Handbook of Climate Trends across Scotland (page 5) is proving a hit with Scottish government departments and agencies developing strategies to adapt to the impacts of climate change north of the border.

If your garden continues to sprout luxurious new growths of grass in the unseasonable warm weather, spare a thought for the gardeners at London's Royal Botanic Gardens, Kew. With Met Office help, they are preparing for the winter ahead while responding to plant behaviour at odds with the time of year. Some plants have flowered for a second time in the mild weather and Kew's own climate studies show that winters have become later over the past 30 years. As Chris Beardshaw, known to countless BBC viewers and listeners as the Flying Gardener, explains in *Celebrity Weather* (page 18) the upside of our changing climate is that gardeners can begin experimenting with more exotic plants.

As the UK's National Met. Service (NMS), the Met Office can tell you what the weather has in store for the next hour, day, five days or ten and predicts the months and seasons ahead. Looking towards winter (page 4), our long-range forecast suggests warmer-than-average or near average temperatures, with signals for lower-than-average temperatures towards the end of season and an increased frequency of cold snaps. Rainfall totals across the UK are expected to be near or above average; but, as always, there are uncertainties with this type of seasonal forecast, particularly this year as weak El Niño conditions are developing in the Pacific Ocean. Look out for further details due to be published by the Met Office in early December and January and posted on the website at www.metoffice.gov.uk

Barometer also looks at the Met Office pricing policy and explores how, through data wholesaling, it is possible to exchange information with other NMSs and use satellite data in our weather and climate forecasts (pages 9 & 10). Part of the Met Office's public task, and one of the main objectives of its data policy, is to make weather information freely available via the Public Weather Service (an integral part of our role as an NMS). This covers a wide range of products and services such as our everyday and long-range forecasts, and includes some weather teaching tools for schools (pages 11 & 12). While it receives funding from government, the Met Office is able to use the revenue generated from its commercial activities to offset the cost of services provided through the PWS. In the business world, many companies turn to the Met Office for up-to-the-minute data and accurate forecast services (pages 13 & 14). Whatever your weather needs, contact our 24-hour Customer Centre on 0870 900 0100 or email enquiries@metoffice.gov.uk for help and guidance.

Britain's first olive grove

Rising temperatures mean that Britain's first home-grown olives and olive oil are expected within seven years.

A familiar sight in the warmer countries of the Mediterranean has now come to Britain. Having successfully nurtured orchards of apricots and almonds, Mark Diacono, a smallholder and environmental consultant, has planted 120 olive trees on his 'climate change farm' in Devon on the banks of the River Otter near Honiton.

Olive trees are native to coastal areas of the eastern Mediterranean and traditionally represent peace and happiness, but this olive grove also represents adaptation to our changing climate. It has potential commercial

benefits as well as the health benefits of eating olives and olive oil and could even help combat climate change by reducing the amount of air miles olives and olive oil have to travel to reach British consumers.

Olive trees grow slowly, but Mark intends to harvest the olives and produce olive oil in five to seven years. He says, "Planting the olive grove is a way of taking advantage of the changing conditions to produce otherwise 'foreign' food, while paying



Photograph by Tom Pilston © The Independent

climate change back through the reduction in associated food miles. We don't need Britain to turn into Portugal, we just need it to be slightly warmer for longer and we are making that shift."

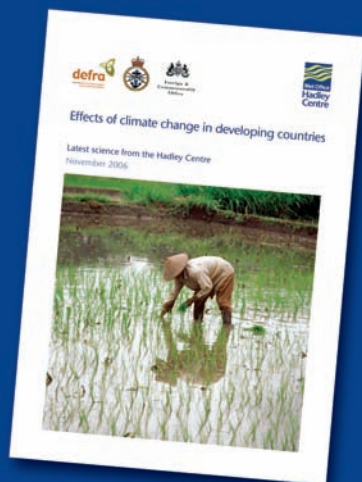
But there are potential problems. Although olives need a period of cold during the winter, they suffer if the roots start to freeze. Gales and long, continual rain can also cause damage. To combat this, Mark is working in cooperation with Emilio Ciacci, an Italian living in England, who provided the olive trees from Maremma, Tuscany.

The species chosen survive frost, snow and heat stress. To aid drainage and avoid the soil becoming waterlogged, the soil has been deeply ploughed to access the river gravels underneath. Red clover planted below the trees will be used as mulch to protect the roots from cold in winter.

Pete Falloon, a Climate Impacts Modeller at the Met Office says, "It's encouraging to see people adapting to climate change. There are some potential difficulties with climate extremes, for example, heavy rainfall and flooding could cause soil erosion and waterlogged roots, and warmer winters could mean an increase in fungal and bacterial diseases and pests, but the potential benefits are clear to see and, with careful planning, problems can be avoided."

As temperatures continue to rise, perhaps olive groves will soon appear all over Britain. Mark already has plans to experiment with peaches, pineapple and the exotic guava and pawpaw fruit.





Nairobi 2006

Climate scientists at the Met Office Hadley Centre have estimated the proportion of land that will experience drought in the 21st century if significant action is not taken to combat climate change.

As our climate warms the global rainfall total is anticipated to increase but, at the same time, some areas will experience less rainfall and more evaporation, widening the amount of land in drought. By 2100, it is estimated that around half of the Earth's land surface will be liable to water shortages, with Africa, South America and parts of South East Asia most at risk.

In November 2006, a group of Met Office Hadley Centre scientists attended the twelfth Conference of the Parties (COP 12) session hosted by the United Nations in Nairobi to discuss the continuing evidence for climate change and, in particular, its effects in developing countries. The latest findings from the Met Office were published at the conference and are available on our website at www.metoffice.gov.uk

Take a chair

Last October, Robert Napier replaced Clay Brendish as Chairman of the Met Office Board. Clay stepped down after three influential years in the post, in which he made an enormous contribution to the direction and success of the Met Office.

Robert is currently Chief Executive of the World Wide Fund for Nature in the UK (WWF-UK) and is a non-Executive Director of Anglian Water Services and English Partnerships. He brings both considerable experience and a different perspective to Met Office matters.

As Chairman of the Met Office Board, he will lead the other members in scrutinising Met Office business performance and supporting and challenging the Chief Executive, Mark Hutchinson, and his team of Directors. Robert will also act as agent for the Met Office's Minister, Under-Secretary of State for Defence, Derek Twigg MP.

Robert said, "It is a great privilege to take up this position at such a key institution which does excellent work forecasting the weather and, through the Hadley Centre, modelling the increasingly concerning impacts of climate change."



A towering tribute

Located in the Patagonian Andes on the Argentina-Chile border in the Los Glaciares National Park stand the towering, jagged peaks of Cerro Chaltén, also known as Cerro FitzRoy, or Mount FitzRoy.

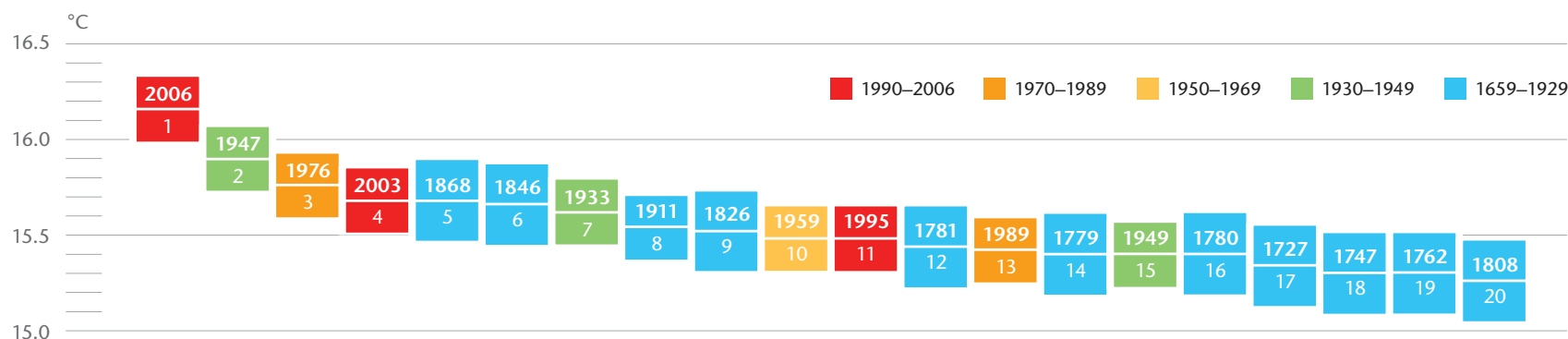
The mountain is considered sacred by locals and the name Chaltén means 'Smoking Mountain' because of the cloud that often forms on its summit. It was Argentine explorer, Francisco Moreno, who named it FitzRoy in 1877 in tribute to Met Office founder Robert FitzRoy who, almost half a century earlier, had captained HMS Beagle on Charles Darwin's epoch-making voyage of discovery.

At 3,440 metres high, Mount FitzRoy is not the highest mountain in Argentina but is reputed to be one of the most difficult to climb because of its sheer granite faces and inhospitable and treacherous



weather. It was first conquered in 1952 by two French climbers.

Most people, however, find the hiking trails the best way to explore the region. Visitors are met with breathtaking vistas of immense glaciers and wind-warped beaches in contrast to the colourful vegetation and snow-capped mountains.



Mean Central England temperature: Top 20 warmest extended summers (May–September) 1659–2006 Source: Met Office Hadley Centre

How autumn lost its cool

This summer, the UK experienced its longest continuous period of hot weather ever. The five months from May to September were warmer than any equivalent period since 1659 with an average temperature of 16.2 °C; two degrees warmer than the average for 1961–1990. The previous record of 15.9 °C was set in 1947.

Summer 2006 also included the warmest month ever, July, and provided the UK with a record temperature for September. It is one thing to get a month with very high temperatures, but to get a record-breaking unbroken stretch for five months adds to the growing evidence that climate change is having a considerable impact on the UK weather and climate.

The warmer weather this summer was particularly intense over central England, where temperatures were more than 2.4 °C higher than average. Elsewhere, in regions nearer the coast, temperatures were mostly between 1.6 °C and 2.4 °C hotter.

The atmospheric circulation pattern over the UK and Northern Europe featured a sustained high pressure system remaining for much of July. It was these anti-cyclonic conditions which led to the clear skies and record-breaking temperatures. The coastal waters around Europe were at least 1 °C warmer than normal due to the increased sunshine, light winds and warm overlaying air at this time.

It was not just waters near the UK that experienced high temperatures this summer. The image opposite shows the sea surface temperature (SST) during

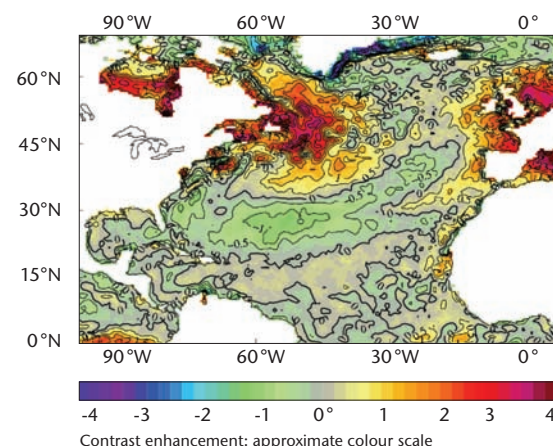
20–27 July 2006 and compares these to the average SST for the same time of year from 1981–2001. This summer, the western Atlantic was much warmer than normal with 4 °C anomalies in the SST off the coast of Newfoundland. Although these warm SST anomalies coincided with the hot July in the UK, any links between the two events are currently not well understood.

The hot weather that gripped the UK over summer also continued deep into autumn. September was the warmest on record with an average temperature of 15.4 °C, which is 3.1 °C above the long-term average. October was also well above average but not record-breaking (both 2001 and 2005 produced warmer Octobers). However, taken together, September and October 2006 constitute the warmest ever early autumn based on the Mean Central England Temperature series going back to 1772. So, instead of experiencing chilly nights and foggy mornings as was once usual for this time of year, the nation was sweltering in summer warmth.

Hurricane Gordon crossed the Atlantic during the third week of September and Met Office forecasters kept a close eye on its expected track, informing relevant parties of the possible impacts. The storm had lost its hurricane status by the time it reached our shores, but still brought trees down across Ireland and led to loss of power supplies. Ironically, most of the UK benefited from ex-Hurricane Gordon as tropical air brought maximum temperatures of 28 °C in places.

However, storms crossing Northern Britain at the end of October and into November caused wind damage, flooding and high seas which tragically resulted in the loss of a trawler in the North Sea, 160 miles off Aberdeen.

The latest outlook for winter 2006/7 suggests warmer-than-average or near average temperatures are most likely for winter as a whole. However, there are signals for lower-than-average temperatures towards the end of winter with an increased frequency of cold snaps. Rainfall totals across the UK are expected to be near or above average. As always, there are uncertainties with this type of seasonal forecast, particularly this year as weak El Niño conditions are developing in the Pacific Ocean. Look out for further details on our website.





Sniff of the past

Published in June 2006, the 'Handbook of Climate Trends across Scotland' is proving a hit with Scottish Executive departments, agencies and public bodies in Scotland.

Using the Met Office and ADAS as research contractors, the Handbook presents the trends in key climate parameters across Scotland in the last century. It was commissioned by the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) on behalf of the Scottish Executive, Scottish Environment Protection Agency, Scottish Natural Heritage and Forestry Commission Scotland.

The Handbook has proved successful both in presenting climate change highlights in an accessible format, and

in helping to inform the development of strategies and future policies to adapt to the impacts of climate change.

A companion technical report provides more detailed analyses and references where readers can obtain further information and guidance.

The analyses for Scotland form part of a more extensive study of climate trends across the whole UK which the Met Office plans to publish in 2007.



SNIFFER is a charity that manages the exchange of research and knowledge on a wide range of topics within the guiding principles of sustainable development. Climate change is just one of the far-reaching environmental concerns the charity is working in, on behalf of partnerships of public bodies in Scotland and Northern Ireland.

→ Copies of the 'Handbook of Climate Trends across Scotland' and the accompanying publication are available from www.sniffer.org.uk



Autumn at Kew Gardens

As autumn comes to an end, many of us will be busy preparing our gardens for the onset of colder weather. At London's Royal Botanic Gardens, Kew, work is already well underway.

Head of the Arboretum, Tony Kirkham, is in charge of looking after Kew's staggering collection of 14,000 trees. His team of 50 experts always has plenty to do, much of it entirely dependent on the weather.

"Tree planting and pruning are best carried out in winter, along with general improvements to the arboretum. I rely on short- and long-range forecasts from the Met Office to plan what we do and when we do it," says Tony. "Before starting any job at this time of year, I want to know that we will be able to finish it ahead of any inclement weather."

"For instance," he adds, "if it is dry this winter we can do groundwork without causing damage to the soil. On the other hand, it will mean that we have to plant the trees a lot later than usual."

Recording the weather

The Royal Botanic Gardens, founded nearly 250 years ago, border the banks of the River Thames. Spanning 132 hectares, over a million visitors flock to Kew each year to enjoy the arboretum, water features, herbaceous borders and bedding, famous botanical glasshouses and historic buildings.

Many visitors might not realise there is also a long history of observing the weather at Kew, which took over responsibility for recording it from the Royal Observatory during the 1870s. Meteorology is still very much a part of the Gardens today.

"Our weather records are of immense value for horticulture, estate management and visitor planning, and can be used to support other scientific observations," says John Lonsdale, Head of Public Programmes and Curatorial Support. "Kew is increasingly concerned with environmental issues like climate change, so while using historical data we also plan ahead with future climate predictions from the Met Office."

Changing seasons

A crucial way in which weather records and climate forecasts assist horticulture at Kew is with the Gardens' phenology study, which looks at the way plants and wildlife respond to changes in climate. Phenology can show how the different collections at Kew are responding to short-term weather conditions and long-term trends, helping the gardeners plan their calendars accordingly.

"There is no doubt we are experiencing some changes in weather patterns at Kew," says Head of Phenology, Sandra Bell. "Over the past 30 years, winters have become later and springs have become earlier and milder. In addition, summers have generally been drier. Our studies show, for example, that oak trees at Kew are now flowering ten days earlier than in the 1980s, a figure mirrored by many other species."

Autumn gardening tips

Owing to a succession of dry summers and winters, efforts have been concentrated at Kew on protecting the plants and trees from drought. All green waste is recycled, composted and used for mulching, as this helps retain valuable moisture. This process has proved extremely successful with more trees surviving last summer than had been anticipated, despite the searing temperatures and water shortages experienced in south-east England.

"Autumn is a great time to introduce new species that will survive dry summers," advises Sandra. "Mulching beds with compost or leaf mould should also help conserve moisture and ensure that newly-planted trees and shrubs benefit from the best of the year's rain over the winter."

The same gardening tips apply to our green-fingered readers. To help you plan ahead, we can tell you what the weather has in store for the next hour, day, five days or ten, delivered by Weathercall to your telephone, fax, or mobile phone. You can also buy our forecasts online. So don't guess. Weathercall.



Images courtesy of Royal Botanic Gardens, Kew



Sensitive to the weather

Could knowledge gained by investigating the effects of the weather enable improved modelling, planning and targeting of public health services? Clinical Director at the Met Office, **Tish Laing-Morton**, thinks it can.



There's more to 'feeling under the weather' than most people realise. Over 2000 years ago Hippocrates, one of the founders of modern medicine, advised doctors to firstly "consider the seasons of the year, and what effects each of them produces for they are not all alike," and secondly to "study the warm and the cold winds, both those which are common to every country and those peculiar to a particular locality."

In the 21st century, health forecasting by the Met Office is helping healthcare professionals in the UK understand Hippocrates' assertion. At its helm is Clinical Director, Tish Laing-Morton. A qualified GP and public health consultant, she joined the Met Office in April 2006 after spotting an advert in the British Medical Journal.

"The weather is something I have always been aware of in my medical work, but it wasn't until I saw the Met Office vacancy that I did anything about it," she says. "I looked at the ad and thought 'Oh, they seem to have written this one for me!'"

Storm chaser

Tish spent her early childhood in Canada, where she frequently witnessed extreme weather. She became aware of a link between weather and health from a young age as her mother would regularly get asthma attacks in summer, particularly during thunderstorms.

After finishing school, Tish joined the Army and eventually trained as a doctor. She travelled extensively throughout her service, experiencing typhoons in Hong Kong and living with rapidly changing weather while stationed on the remote South Atlantic island of South Georgia.

"The sheer power of weather is truly awe-inspiring," she enthuses. "I am very excited to be in a position where it is my job to help people understand the potential links between the weather, the environment and health."

Champion of public health

As well as a successful career in the Army, Tish carved a name for herself in public health. Following the completion of a Master of Science qualification at the London School of Hygiene and Tropical Medicine in the early 1990s, she spent five years training to be a consultant in London and the South East. In 2002, she was appointed Head of Health Inspection at Her Majesty's Inspectorate of Prisons for England and Wales.

Thanks to a strong conviction and unabated passion for public health, Tish has settled quickly into her new role at the Met Office. "Mine is very much a 'people' job and I believe in the principles of public health — using the organised efforts of society to improve the health of everyone. I also love the challenge of developing something new and working in areas that require learning."

Weather concerns

Building on the foundations laid by former Clinical Director Dr William Bird, Tish has been assisting the Department of Health with its preparations for extreme weather. For instance, the Met Office provides heatwave forecasts to the National Health Service (NHS) from June to September each year.

"The effects of the extreme heat this summer are currently being evaluated," says Tish. "But by alerting at-risk groups and NHS organisations when the heat posed a threat to patients' health, preventative measures were taken to protect the most vulnerable."

Not surprisingly, the biggest concern this winter will be the effects of the cold. "England has the highest excess winter mortality of all European countries, largely because people don't take proper precautions such as wearing hats and scarves when they go outside," highlights Tish.

"Chronic Obstructive Pulmonary Disease (COPD) is a serious respiratory disease with over 900,000 people diagnosed with the condition in the UK. COPD patients become more vulnerable from the autumn as temperatures begin to drop, and are particularly susceptible around the Christmas and New Year period. Our twice-weekly COPD forecasts in England and Wales were developed from a model that not only takes into account the weather, but

other local factors such as the level of circulating influenza-like viruses. They help patients take action to prevent an exacerbation which improves their health and quality of life."

Way of the future

While Tish is focused on the current challenge of health forecasting, she has a clear vision for the years ahead.

"Our health forecasting service is world-leading and we are getting very positive feedback on its benefits, especially from patients who feel they can look after themselves better with our forecasts. Health care providers are also seeing benefits in terms of reduced costs and more targeted care. We will be seeking partners in the near future to support the development and expansion of this innovative service for other conditions such as asthma, stroke and heart failure."

" Mine is very much a 'people' job and I believe in the principles of public health — using the organised efforts of society to improve the health of everyone."



Making forecasts possible

The Met Office is a 24-hour, 365-day operation. It receives data from hundreds of meteorological observation systems and a network of satellites around the world. Yet predicting the weather and climate would not be possible without data wholesaling.

As Data Manager, Colin Cuthbert, explains, data wholesaling essentially provides raw information to organisations like the Met Office, while specific licensing conditions help them recover part of the infrastructure cost of obtaining it.

“It also determines licence fees for Met Office data, advises internal and external users on data fees and licensing, and maintains a catalogue of UK data available to the private sector,” says Colin.

Information for all

Data wholesaling is important for a number of reasons. Firstly, the Met Office is a National Meteorological Service (NMS) and exchanges data with other countries. This is coordinated by

the World Meteorological Organization which encourages the wider exploitation of basic meteorological information by its members.

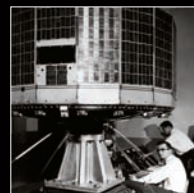
Secondly, it ensures compliance with UK and EU legislation on the re-use of public sector information and competition law, by providing access to meteorological information under equal terms and conditions. Lastly, it applies the rules of operation to organisations that generate data in accordance with these conditions. Full details of the Met Office data policy can be found on our website at www.metoffice.gov.uk

Prices for data vary considerably and apply to users within the Met Office itself, as well as the public and

Satellite timeline

1959 NASA launches Vanguard II, which returns the first photograph from space of Earth's cloud cover.

1960 Launch of NASA's Television Infrared Observation Satellite (TIROS) I improves hurricane-tracking and severe storm warnings.



TIROS

1964 Satellite cloud pictures are first used by the Met Office.

1977 The European Space Agency (ESA) launches Meteosat 1. Subsequent launches of Meteosats 2 and 3 take place in 1981 and 1988.

1978 Nimbus 7 provides data on Earth's ozone layer, which is used as part of the scientific basis for banning the use of ozone-depleting chemicals.

1984 The Earth Radiation Budget Satellite begins its study of how Earth absorbs and reflects the Sun's energy.

1989 Meteosat 4 is launched by EUMETSAT, followed by Meteosats 5 and 6 in 1991 and 1993.



commercial sectors. Much of it costs nothing at the point of use, since part of the Met Office's public task, and one of the main objectives of its data policy, is to make weather information freely available to the public.

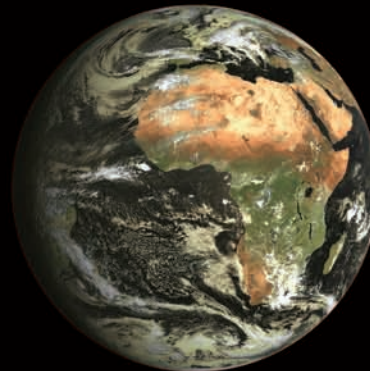
"There are three types of fees associated with the data," says John Ponting, Head of Legal and Procurement. "One is the licence fee, the basic fee to be allowed to use the data — although we make a lot of our data available at zero charge. The second is the data handling and delivery charge, which pays for the infrastructure to provide the data to users. The third charge is a licence for redistributing or broadcasting data."

Eye to the sky

As far as NMSs are concerned, satellites are one of the most important sources of data for which a data wholesaling licence is required.

A number of organisations around the world operate meteorological satellites which contribute to the Global Observing System. These include polar-orbiting satellites that obtain vital data for numerical weather prediction models and geostationary satellites that provide imagery for use by forecasters.

A revolutionary satellite, MetOp A, was launched from Baikonur, Kazakhstan in October 2006 (**main picture**) and is the first ever European polar-orbiting meteorological satellite. Controlled by EUMETSAT — a European meteorological network in



which the Met Office represents the UK — MetOp A will enable more accurate readings of wind speed and direction, temperature and humidity, and the greenhouse gases responsible for climate change.

The MetOp series of satellites is expected to provide critical weather and climate data until at least 2020. Two further polar-orbiting satellites, MetOp B and MetOp C, are planned. Like MetOp A, these will orbit at between 800 and 850 km, passing over the Poles 14 times every 24 hours.

Data from European satellites and those operated by other international partners flows into EUMETSAT headquarters in Darmstadt, Germany, before being shared with other NMSs across Europe by means of data wholesaling.

"Satellite data is fundamentally important for meteorology. Over the years it has proved to have the strongest impact of any form of data

on the quality of our forecasts. The launch of MetOp A was therefore a very big occasion and an important first for Europe — in terms of the polar-orbit it takes and the new technology onboard," says Space Programme Coordinator, Stewart Turner.

The Meteosat geostationary satellites, also run by EUMETSAT, orbit at almost 36,000 km above the equator at 0° longitude and, although they appear to be static, loop the earth once every 24 hours. The most recent in the series is the second of the Meteosat Second Generation satellites launched in December 2005 and renamed Meteosat 9 when it became fully operational in October 2006.

"The second generation satellites bring much more functionality," says Stewart. "They have 12 spectral channels, as opposed to three, each of which takes a different snapshot of the Earth. The higher resolution images they produce show weather systems developing in much more detail. From these, we can get information about wind speed and direction, or dust particles in the atmosphere."

Data from these two complementary satellite systems are fed into complex computer models along with observations and other environmental information to help Met Office forecasters make their predictions. So next time you check the weather forecast for your local area, bear in mind how much goes on behind the scenes, with data wholesaling at the heart of the process.



1992 Data from the US-French TOPEX/Poseidon satellite begins to detail the links between Earth's oceans and climate. In 1994, data indicates that the global sea level has risen in the two previous years.



TOPEX/Poseidon

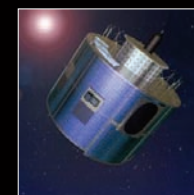
1997 Meteosat 7 launched to maintain operations until the first Meteosat Second Generation satellite (MSG2) is launched.

1999 QuikSCAT, a satellite mission to monitor ocean winds, is launched.

2001 Jason-1 satellite launched to monitor ocean surface topography.

2002 Meteosat 8, the first of the second generation MSG satellites is launched. ESA's Envisat polar-orbiting Earth observation satellite is also launched. It measures the atmosphere, ocean,

land, and ice over a five-year period and enables scientists to monitor environmental and climatic changes.



Meteosat 8

2005 MSG2/Meteosat 9 is launched.

2006 MetOp, the first ever European polar-orbiting meteorological satellite, is launched from Baikonur, Kazakhstan in October.



Weather lessons

Rainbows, tornadoes, hurricanes, thunderstorms: it's all in a day's work when you're teaching schoolchildren about the weather. From online quizzes and factsheets to DVDs and live video-conferencing, the Met Office Education Services funded by the Department for Education and Skills help make weather learning fun.



The Met Office Learning Centre at www.metoffice.gov.uk is designed to help teachers and pupils extend their knowledge of the weather and climate in the UK and around the world. Here, you will find a wide range of downloadable teaching material based on the National Curriculum. The website is constantly being updated with animated diagrams, colour photographs and satellite imagery to bring the weather to life.

"The most topical subject on the website at the moment is climate change," explains Adele Beswick, Education Services Manager. "Our resources explore evidence of how climates have changed in the past and how they are predicted to change in the future. They also look at why climate change is happening and the impacts it is having on the environment, people and world economies."

All in the planning

Met Office Education Services support schools and colleges from Primary through to A Level and Higher Education. Teachers can find lesson plans for every age group on the website, with exercises that range from poems and hands-on activities to test-yourself quizzes, GCSE projects and essay questions.

One of the most popular topics for early Primary children is rainbows. The website explains in basic terms how rainbows are formed and then suggests different experiments to try, such as passing beams of light through water or prisms, to create your own rainbow.

By early Secondary, children are usually fascinated by weather extremes. "Anything that causes havoc, such as thunderstorms, hurricanes and tornadoes, gets their attention," says Adele. "The Met Office College is currently helping the Education Services

write case studies of dramatic weather. We've included some really vivid images — trees blowing down or cars stuck in snow — and then focused on a little bit of theory about how these things come about."

Future forecasters

The weather is an exciting part of the curriculum and enthral children. Adele believes it is important to teach people how and why weather occurs, and how it impacts on our everyday lives.

"The case studies being prepared describe the science behind certain weather events and the impacts on people. For example, intense storms bring damaging and dangerous wind, while prolonged heatwaves exacerbate health problems," she says.

"The intention is to enthuse schoolchildren with the science and the geography of weather in the hope they will show an interest in later life — and potentially become future Met Office employees."

Teaching tools

In addition to the website, the Met Office produces a range of weather resources for use in the classroom. The 'Weather Presenting Kit' for Key Stage 1–3 includes poster-sized maps of the British Isles with reusable weather symbols and activity sheets. And a set of four satellite posters is designed to help secondary school teachers and pupils identify common weather events using satellite imagery.

There are two free CDs, too. Using the 'Interactive Weather Presenting Kit', pupils can create their own weather forecast presentations complete with digital photographs, weather charts and five-day forecasts. The 'Life in a Changing Climate' is designed to support GCSE and A Level studies of climate change by providing access to the latest information and encouraging pupils to consider its wider implications.



Meanwhile, the new 'Weatherbytes' DVD for GCSE and A Level studies of weather and climate is a series of five short films presented by television weather forecaster Martyn Davies, which can be used to introduce a lesson, or as refresher material for teachers who want to build their confidence in the subject.

Face to face

If your students are keen to meet meteorologists in person, there are a couple of ways in which you can make this happen. The first is to arrange a two-hour tour that takes you behind the scenes at the Met Office headquarters in Exeter, gives you the opportunity to meet the people who work there, and to use the weather-recording tools in the Observing Enclosure.

The second is video-conferencing, which is currently being trialled at schools across the UK. These live sessions give students and teachers a chance to put their questions to meteorologists. So far it has proved to be a great success. "The response has been brilliant," says Adele. "The children have all found the sessions very helpful. They've got engaged with the subjects and really enjoyed having an expert to quiz."

Did you know?

- > The coldest place in the world is Plateau Station Antarctica with an annual mean temperature of minus 56.6 °C.
- > 12% of the Earth's land surface is permanently covered by ice and snow.
- > The greatest snowfall recorded in one day is 1.93 metres. This occurred at Silver Lake, Colorado on 14 April 1921.
- > Kericho, Kenya has more hail than anywhere else on Earth, with hail falling 132 days per year on average.
- > The hottest place in the world is Dallol, Ethiopia with an annual mean temperature of 34.4 °C.
- > In terms of annual average sunshine, the sunniest recorded place is Yuma, Arizona with 4,300 hours per year.
- > The South Pole has no sun for 182 days of the year.
- > On 17 July 1841, a shower of heavy rain and hail in Derby, England was accompanied by a fall of hundreds of small fish and frogs, many of them still alive.
- > In the northern hemisphere the winds blow anti-clockwise round a depression. They blow clockwise in the southern hemisphere.
- > The Doldrums is the name given to the part of the Earth between 10 degrees North and South, and on the equator, that has very little or no wind.

In the business world, the weather can boost sales, influence the planning of major projects and make or break deals, which is why many companies turn to the Met Office for up-to-the-minute data and accurate forecasting services.

Big business





From architects to zoologists, there are countless professionals that have more than just a personal interest in the weather. “The Met Office produces both value-added products as well as standard data products to over 1,000 companies in industries such as building, farming, environmental consultancy, water, energy and insurance — you name a sector and we probably provide data to it,” says Head of Business Management, Karen Dutton.

As well as being an essential aid to industry, the commercial activities of the Met Office help reduce the cost of services funded by the taxpayer such as the National Severe Weather Warning Service which provides weather alerts to the public and emergency services 24 hours a day, 7 days a week, 365 days a year. Our commercial activities also offset the cost of sharing data internationally with other National Meteorological Services — a key Government requirement.

“To establish a level playing field, data generated by the Met Office is supplied to its commercial business units via a data wholesaling licence, under the same terms and conditions as any other private sector company. Maintaining a clear accounting separation of its core and commercial activities shows that the Met Office is not subsidising the commercial work from its public task and trading from an advantageous position,” explains Data Manager, Colin Cuthbert.

Always on call

One company that has a strong commercial alliance with the Met Office is iTouch UK, which offers a portfolio of specialist weather forecasting services to the public and business clients such as GMTV, Daily Telegraph, The Times, Farmers Guardian, the Royal Yachting Association and the Royal National Lifeboat Institution. Since 1986, the Met Office has supplied weather data to iTouch UK, which it then packages and makes available via telephone, fax, mobile and online channels. Its two key products are Weathercall and Marinecall.



“The relationship with the Met Office has always been of utmost importance,” says iTouch UK Brand Manager, Hayley Turnbull. “The close support and best-in-brand quality that the Met Office offers is of tremendous value. The use of the Met Office logo in the Weathercall and Marinecall adverts gives the customer the reassurance of quality and reliability. This is part of the reason why they use the service and continue to do so.”

Data at your fingertips

The weather data arrives at iTouch UK in a variety of different formats from graphics and maps to hourly and three-hourly data extracted from the Global Atmospheric Model. This data begins its journey to iTouch UK at 2:00 a.m. every morning, where it is prepared for transmission to customers from 6:00 a.m. Weathercall and Marinecall are updated several times a day and the process begins again as soon as it is complete.

“The services attract around 1.5 million calls a year, but one of the biggest drivers is the weather itself,” says Hayley. “The more unsettled the conditions, the more customers use the service. Gardeners, sailors and the general public alike seek the reassurance of good or suitable weather. Making the wrong decision could cost money, ruin plans or spoil that special occasion.”

Met Office products and services

- > Tailored consultancy and data services, as well as general monthly summaries and one-to-one forecasts are among the many ways in which the Met Office helps the agriculture industry boost the production of crops and livestock.
- > Building and construction professionals, such as architects, construction companies and contractors use services such as MetBuild Direct, NEC Planning Averages and tower-crane forecasts for securing site safety, planning, monitoring energy-saving measures and settling contractual disputes.
- > The insurance industry needs to be aware of weather events so that it can handle claims accurately. Postcoded past weather information, weather sensitivity analyses and risk assessments have all been developed to assist insurers.
- > Independent research by Datamonitor shows that the UK retail industry is potentially missing out on sales of £4.5 billion per year by ignoring the weather. The Met Office provides consultancy and forecasts designed to enable retailers to make the most of weather-driven sales.
- > The Met Office provides accurate forecasts and expert presenters for UK television companies, plus radio services and page-ready forecasts for other global media.
- > Many companies enhance their websites with live weather datafeeds from the Met Office, while others use an internet-based system that delivers numerical weather predictions, modelling and observations information via e-mail, file transfer protocol or download.

➡ For more information on Met Office products and services for business, contact the Customer Centre on 0870 900 0100, or visit www.metoffice.gov.uk



The world's forests play several vital roles in the climate system. They store huge amounts of carbon (as much as is present in the atmosphere), and can help buffer climate change by soaking up some of our carbon dioxide (CO₂) emissions. They also affect climate through their influence on the character of the Earth's surface — a forested landscape absorbs more of the sun's energy but also evaporates more than one that is not forested, so returns rainwater back to the atmosphere.

Forestry, agriculture and other human actions are changing the world's forest cover. Europe and North America were largely deforested over the last millennium, but now some areas of forest are regrowing. In contrast, deforestation is occurring rapidly in the tropics and outweighing the

reforestation elsewhere. As the forests are cleared and burnt, the carbon stored within them is released to the atmosphere and contributes to the rise in CO₂ and climate change. About one-quarter of the human-made increase in CO₂ has come from deforestation, with the rest coming from fossil fuel emissions and cement production.

The tropical forests such as the Amazon rainforest also affect their own climate by recycling rainwater. Rainforest trees suck up huge amounts of water from the soil and effectively pump it into the atmosphere, providing more water to the clouds to be rained back on the forest. Evaporation from the world's oceans provides the ultimate source of water, but the continental interiors are kept



moist by the recycling of rainfall across the land which is enhanced by forests. Rainwater in central Amazonia has gone through several cycles of rainfall and evaporation from the forest on its way from the ocean. Loss of the forest therefore means a weakening of this water re-cycling service and drier climates inland.

Evaporation also helps keep the forested landscape cool. Tropical deforestation therefore warms the world twice, once through CO₂ emissions and again through reduced evaporation.

Some forests themselves are under threat from climate change. Last year saw a major drought in Amazonia, with the mighty Amazon River at record low levels and large numbers of forest fires. Computer model projections from the Met Office Hadley Centre indicate that drought

could become a more frequent visitor to Amazonia, with long-term rainfall levels in some areas dropping below the threshold needed to support rainforest.

The reduction in rainfall in the models arises from shifts in the wind circulation caused by changes in ocean surface temperatures. It is then exacerbated by reduced evaporation due to the loss of the forest, further drying the climate and accelerating the forest loss and making any future recovery of the forest more difficult. There are still large uncertainties in this kind of result from computer models, and it is still too early to say whether the 2005 drought was due to climate change or not. However, comparison with research from other climate modelling centres suggests that a drier future climate for Amazonia cannot be ruled out.

Trees of life

How does deforestation contribute to climate change?
How might climate change itself affect the world's forests?
Dr Richard Betts of the Met Office Hadley Centre examines these key questions.





A significantly drier climate would have major implications for the forest, its huge richness of biodiversity, and the large human population who depend on the forest and its resources. Loss of the forest would also have implications for global climate change — instead of helping to remove CO₂ from the atmosphere, the dying forest would release its stores of carbon to the atmosphere and accelerate global warming.

A key issue is whether direct human-made deforestation and the effects of climate change will exacerbate each other. Fragmentation of forests, for example through the introduction of roads or small patches of deforestation, transforms the forest from a continuous swathe to a broken landscape with lots of forest edges. Forest fires are more frequent near the edges of forests, due to drier conditions and easier access by people. Therefore, the forest may become more vulnerable to a drying climate if it is fragmented. Similarly, the risk of runaway fires initiated by the deforestation processes is likely to be greater under a drier climate.

There are signs that deforestation is beginning to slow down in some parts of South America, but it is still ongoing. Deforestation continues to accelerate in Africa and tropical Asia.



Science profile

→ Dr John Nash, Team Manager for Upper Air Observation

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

Dr John Nash specialises in the development of technology that monitors the air high above our heads. His work includes developing wind profilers, microwave radiometers and lightning detectors, collectively known as 'ground-based upper air systems'. A leading figure in the Met Office and the World Meteorological Organization (WMO), his work is vital for improving the accuracy of data and how different organisations around the world collaborate to create a more accurate picture of the weather.

"There are nearly seven hundred places around the world where they launch weather balloons and it is important that they keep to certain standards. My team tries to ensure that calibration is good and measurements are the same, so that data is comparable. This hasn't always been the case and has previously been a problem for the climate scientists. Our aim is for it to become more harmonised," says John.

High flyer

John's career began at the University of Oxford, where his tutor John Houghton, who later became Chief Executive of the Met Office, persuaded him to study a branch of physics that could be of benefit to the world as a whole. So, John chose Atmospheric Physics and quickly became involved in researching satellite remote sensing systems and the development of early prototype instruments to measure temperature in the stratosphere.

Fresh from university, John joined the Met Office radar research unit in Malvern in 1973 and later moved to Bracknell, where he worked on the satellite radiometers that had been pioneered at Oxford. This job frequently took him to the United States to help NASA with the launch of stratospheric sounding units, travelling between the New Jersey spacecraft factory, NASA's Goddard Space Flight Center near Washington, and the Vandenberg Air Force Base in California.



Fine-tuning

For over 15 years now, John has been responsible for the Met Office radiosonde operations. Used on weather balloons, radiosonde measure different atmospheric parameters and transmit the data collected to a receiver. It is an important tool for research into climate change.

As Team Manager for Upper Air Observation, John oversees a staff of

11 highly qualified practical and research scientists. While much of his time is spent in the UK checking and analysing the development of the new observing systems, part of his remit as the Vice President of the WMO's Commission for Instruments and Methods of Observations is to conduct radiosonde systems tests overseas and train staff in other meteorological organisations around the world.

Of working with his counterparts from Mauritius, the USA, Argentina, Russia, Japan, Brazil and China, John says, "I really enjoy working with people from other countries. There is usually a small team from the UK working to a tight deadline. It can be quite challenging."

Cause celebre

It is obvious that John thrives on such challenges. He was recently presented with a WMO Vaisala Award for his contribution to the work of the WMO in countries in transition.

"One of the problems with the climate observing network was that there weren't enough radiosonde stations in Africa," he says. "The WMO wanted to install new systems in Tanzania. We were working under quite difficult conditions at Dar es Salaam airport."

John and three colleagues produced a report that identified the simple changes that needed to be made to radiosonde systems to make them suitable for climate work. It has subsequently improved radiosonde in other developing countries such as Namibia and Zimbabwe and the WMO hopes to get better data from these systems from now on.

"I am delighted we have won the award because it recognises that the Met Office is doing things to help other countries," says John.



Roaring into action



The Met Office has the capability to rapidly relocate weather, ocean and wave models to any area of interest worldwide. So when over seven thousand NATO sailors, soldiers and airmen took part in Exercise Steadfast Jaguar, the Met Office roared into action to support them.

Accurately depicting the environment in and around the Cape Verde Islands using dedicated weather and ocean forecast models was an essential part of Steadfast Jaguar. Model output was interpreted by Met Office and Royal Navy forecasters based at the Fleet Weather and Oceanographic Centre (FWOC) in Northwood, Portsmouth, from where the forecasts were sent to the NATO Response Force (NRF) in theatre.

Met Office Crisis Area Mesoscale Models (CAMMs) are routinely run in support of allied military operations, for example, in the Middle East and Afghanistan. For detailed weather guidance, a Saharan CAMM with a resolution of 20 km was introduced for Steadfast Jaguar which provided regional Numerical Weather Prediction (NWP) data out to two days.

Saharan dust storms are regularly seen to drift towards the Cape Verde Islands, as shown in **Figure 1**. Such storms can have a significant impact on visibility, hindering both surface and air operations. A dust forecasting scheme, run within CAMMs, is currently under development at the Met Office so experimental dust

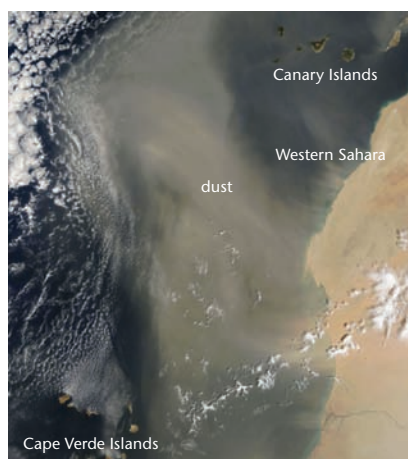


Figure 1. MODIS imagery, NASA, 8 March 2006 shows a Saharan dust storm approaching the Cape Verde Islands.

forecast products were supplied to the FWOC. However, no major dust events occurred during Steadfast Jaguar.

The Cape Verde Islands can yield interesting local weather phenomena such as Von Karman wake vortices which develop to the lee of the Islands, as revealed by the complex cloud structures in **Figure 2**. To adequately capture these local effects, a trial high resolution 4 km Cape Verde Island

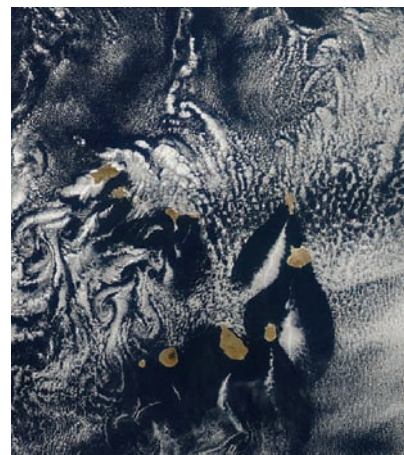


Figure 2. MODIS imagery, NASA, 9 May 2006 showing the effect of the Islands' wakes on the cloud field (the flow is from the north).

CAMM was nested within the Saharan CAMM and run twice daily, providing further detailed local NWP guidance. Marked wind shadows to the lee of the Islands were noted in many of the 4 km CAMM forecasts.

Maritime military units are obviously as interested in the sea state as they are in the atmospheric state. For this Exercise, the Royal Navy requested ocean wave forecasts, surf zone forecasts for target beaches, and a demonstration of our tidal current forecasts for the Cape Verde region.

In order to represent the sheltering effect of the Islands on the waves, a grid resolution of one nautical mile was used in the ocean wave forecast model — the first time the wave model had been run at this high a resolution. Since the Islands are exposed to long period swell from both South and North Atlantic storms, the model was

nested into the global wave model and run once a day to provide information on the incoming swell.

Lieutenant Commander Colin Manson of the FWOC reported at the time: "Feedback from theatre is that the model has been performing very well. There has been a great deal of correlation between the model fields and observed data — from both the ships directly and from the aircraft flying over the sea. Especially useful was the sheltering effect of the Islands on the forecast wave height and direction. This enabled us to identify the long low swells coming from the south Atlantic storms as they passed northwards through the Islands."

Output from the wave forecast model was also used in a nearshore wave transformation model to give forecasts of surf conditions for amphibious beach landings. Although tidal currents are generally weak around the Islands, a coastal tidal forecast model was set up which identified regions where tidal currents of up to 2 knots could be expected.

Steadfast Jaguar was the first opportunity for the Met Office to fully demonstrate its flexible environmental forecasting capability. The Met Office will continue to take the lead in providing forecasts for the NRF until at least the end of 2007. The suite of forecast models will be tailored to meet the needs of each subsequent NRF exercise, such as Brilliant Midas which took place in the Mediterranean during September / October 2006.





Chris Beardshaw

A natural obsession

From landscape architect to college lecturer, TV presenter to published author, Chris Beardshaw has made his living from understanding what makes plants thrive. Here he talks about gold medals, the garden as theatre and snow-covered glasshouses.



Courtesy of Michael Walter, Troika

From as far back as he can remember, Chris has loved plants. One of his earliest memories is of growing cress on a windowsill at the family home, when he was just four years old. Like the plants he tended, his fascination with the natural world has grown over the years, leading him to take a degree in horticulture and a Master of Arts in

Landscape Architecture. Then came the step into television with shows including *The Flying Gardener*, *Gardeners' World* and *Hidden Gardens*.

Despite the huge popularity of his TV appearances, Chris' proudest career moment was winning gold at this year's Chelsea Flower Show. For someone who has built his life around gardening, achieving the recognition of his peers, including a panel of Royal Horticultural Society experts, was a special moment. Chris explains, "At any garden show, you bear your soul to the world, and it can all go horribly wrong. Luckily, the response to our entry was phenomenal, far exceeding our expectations."

Changing scenes

Perhaps Chris' win at Chelsea was less of a surprise to the rest of the gardening community, given his unique approach to design. He has quite a psychological view of gardening, believing it's crucial to get into the mind of the person that's going to use a garden, in order to make design 'flow'. "A garden is a bit like theatre. It can tempt and tease and test a person's emotional robustness. It can create a story, like music or literature."

He continues, "If you want somewhere that makes you feel calm, think about what sounds, shapes, colours and textures make you feel that way. So when it comes to details, such as a water feature, ask whether the water should be moving or still."

Foreign encounters

One of the biggest challenges facing gardeners today comes not from how people interact with the spaces they create, but how the environment and weather is changing. Chris remembers as a teenager working in the nursery and beating snow off the polytunnels and glasshouses. It could often be over a foot deep — something that is far less frequent now. And he's noticed other changes too.

"There's less predictability in the garden and some plants now have two flowering seasons. Some flowers rely on increased day length and increased temperatures that used to only occur in spring but happen in autumn too. It may not be detrimental, but it does confuse even the most robust and hardy plants. The upside is it increases the gardening palate — gardeners can begin to experiment with plants from Africa, Southern America and Asia."

On the horizon

It seems there are few challenges that can hold Chris back at the moment and he has a very busy year planned. He's working on a series of show gardens including one for the Malvern Spring Show that is a 'celebration of the rural environment'. And with his success at this year's Chelsea Flower Show, he's already preparing for 2007 and hoping to team up with the National Trust.

If that wasn't enough, Chris is also working on his second book, 'How Does Your Garden Grow?' Due for launch in April, the main theme of the book is to encourage the gardener to become more sensitive to plants — something, it seems, that's come naturally to Chris all his life.



'Sunset and storm clouds in autumn'
by Sarah Dalrymple, 12 years old
is one of the winners of a worldwide
weather art competition for children
organised by the World Meteorological
Organization (WMO) last autumn.

The competition was open to three
age groups: 4–7 years, 8–10 years
and 11–16 years. The Met Office
encouraged children from the UK to
take part and contribute paintings
and drawings inspired by the weather
under various themed headings.

To present different perspectives of
weather and showcase the talents of
youngsters from around the world,
the WMO has set up an online art
gallery of 'Weather by Children'
at www.wmo.ch/web/mediacntr/artgal/kids

