Met Office

BUILDING RELATIONSHIPS
A matter of trust

SCIENCE TO SERVICES
International capacity building

HURRICANE SANDY
Complex forecasting challenge

Barometer

Issue 23 www.metoffice.gov.uk Met Office magazine

Kay Eldergill, Met Office HR Director, looks at why people can rely on the Met Office.

The importance of integrity

Working on behalf of the British public, high standards are expected. Delivering on those expectations is fundamental to people's trust in the Met Office and to ensuring that we deliver services that are valued by society and our customers. For instance, if we say it is going to snow, it is important that people believe us, as lives could depend on it.

Trust is something that happens on a personal, human level. From individuals to multinational companies, people rely on the Met Office. They believe in our ability, integrity and reliability. To me it is clear that people trust not only the Met Office as an organisation, but our staff as individuals.

People underpin all the stories in *Barometer*. For many of us, working at the Met Office is not just a job. People here love what they do; it is a passion and a way of life. It's that kind of dedication that leads to Professor Brian Golding being awarded an OBE in the New Year's Honours and the Met Office winning the UK IT industry awards (see page 3).

Despite recognition that we're at the top of our game, nobody here just rests on their laurels; instead they are constantly striving to deliver more and to continually improve. By committing to our new corporate charity, WaterAid, we are demonstrating our desire to improve people's lives — not just with our day to day forecasting, but internationally (page 3).

The article on page 9 examines why people trust us. One important reason is our integrity which is visible in our eagerness to do the best for other people. We know that it is our actions — the honesty and reliability of our people — that make the difference. The way we work, how we treat people externally, is a manifestation of how we treat each other internally.

The worth of our warnings was clear during the wet weather of 2012 and snow in January (page 4). None of this can be achieved without functioning as a team. This applies both within the Met Office and externally, working in collaboration, for example, through our partnership with the Environment Agency in the Flood Forecasting Centre, and with others through the Natural Hazards Partnership (NHP). This is also true in the case of meteorological research flights for which we work closely with the Natural Environment Research Council (NERC).

Successful teamwork depends on building relationships, as typified by Alex Hill, the Met Office Chief Government Advisor for Scotland and Northern Ireland (page 11). Through our collective experience and expertise we add value to help people make wiser decisions.

We also develop specific knowledge for others. Often, the advice we provide is for complex and particular environments, such as our offshore consultancy work (page 21). Our quality of service is something others are interested to learn from. For instance, we're passing on our knowledge to others through the new Masters courses for international students (page 13). In that way we support career development, not only for our own staff, but for others all around the world.

Much of our work has a strong international flavour. Hurricane Sandy involved working with others all over the globe (page 16). Such a powerful storm brings weather to the forefront of people's minds and emphasises the important role of a national weather service. The variety of our work reflects the diverse skills of our staff. We fulfil a variety of international requirements, including helping developing counties plan for the possible impacts of a more volatile climate (see page 19).

All our relationships are based on mutual respect. In that way, we are trusted partners, often guiding but also learning from others. People put their faith in us, confident that we will deliver, time and time again. We will continue to strive to ensure we maintain that trust.

***Barometer* is also available online at www.metoffice.gov.uk/barometer**

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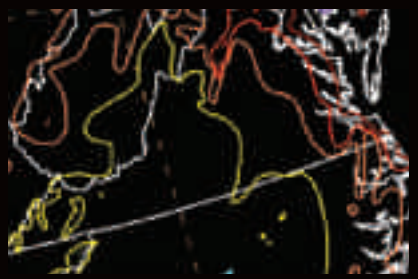

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OBE for Professor Brian Golding

Met Office Deputy Director of Weather Science, Professor Brian Golding, was awarded an OBE in the New Year's Honours.

After four decades of working in meteorology, Professor Golding is a world-recognised expert in hydro-meteorology and numerical weather prediction.

For the last decade he has led the research and development of our operational forecasting capabilities. He has directed significant scientific and technological progress, including the development of a weather forecast model that covers the UK at a very high resolution, predicting small-scale weather such as thunderstorms, heavy rain and snow, in great detail.

Professor Golding said: "I think this honour recognises the work that has been done in the field of numerical weather prediction over the last few decades, which has been one of the great success stories in science. Improved forecasting accuracy has made a huge difference to lives around the world, helping to safeguard life and property, as well as make infrastructure more resilient to the weather. I'm proud to have played a small part in that."

UK IT Industry Awards

Up against the best of both the public and private sector, the Met Office won two awards at the UK IT Industry Awards last year.

Our work on the Met Office Weather Observation Website (WOW) was shortlisted for two of the twenty awards available. Being the only organisation to win two awards was an outstanding achievement.

The Rt Hon Michael Fallon MP, Minister of State for Business and Enterprise, said:

"The Met Office is held in high regard and these two awards are recognition of the great work the Met Office does. Putting accurate, timely and useful data and information in the hands of the public, government and business is now an incredibly important area of focus for the Government and it is great to see the Met Office leading in this field and showing the ability to innovate and collaborate with private sector organisations."

Find out more about WOW at: http://wow.metoffice.gov.uk/

WaterAid

Our new corporate charity is WaterAid, an international organisation that helps provide safe water, sanitation and hygiene education to the world's poorest communities.

Met Office staff are set to raise money for WaterAid over the coming years after the non-governmental organisation was chosen to be our corporate charity until 2015.

We received over 30 applications from a variety of organisations to be considered as our corporate charity. Three shortlisted charities, Computer Aid International, ShelterBox and WaterAid, visited the Met Office in Exeter to present their case to Met Office employees. WaterAid was eventually chosen after an online vote by Met Office staff.

Laura Middleton-Padgham from WaterAid said: "We are absolutely delighted to have been chosen by Met Office employees as their corporate charity. People working for our corporate partners play a huge role in raising funds for our vital work and helping to raise awareness of the shocking fact that around 2,000 children die every day as a result of diseases caused by dirty water and poor sanitation. I want to say thank you to Met Office employees for sharing our vision of a world where everyone has access to safe water to drink and decent sanitation. Together we can make a real difference."

Soaked to the skin

50%

more rain during December 2012 than the long-term average

20th

to 26th of November 2012 was one of the wettest weeks in the last 50 years

3rd

wettest year for Wales in 2012

Overall, 2012 was the second wettest year in the UK national record, and just a few millimetres short of the record set in 2000.

The annual rainfall record for England was broken a few days before the end of 2012. At that stage, a further 46 mm of rain was needed to break the UK annual record and the media waited with bated breath for the Met Office statistics to be published early in the New Year.

In the end, 2012 was just a few millimetres short of the record set in 2000 and so became the second wettest year in the UK national record dating back to 1910. It is interesting to note that 2012 was the third wettest for Wales, 17th wettest for Scotland and 40th wettest for Northern Ireland.

Throughout the wet weather, our forecasts and warnings helped everyone across the UK plan and prepare for the worst impacts.

While November started showery and cool with frosts in some areas, milder air covered the country between the 6th and 14th. For England and Wales, the 20th to 26th November was one of the wettest weeks in the last 50 years. Some areas had up to twice the whole month's normal rainfall within a week. There was widespread flooding of transport routes and property with further damage caused by landslips. The floods and storms sadly led to several fatalities.

Together with the Environment Agency and Scottish Environment Protection Agency, we warned of travel disruption and flooding. Things would have been much worse if it was not for our warnings and close team-working with the emergency response community.

Assistant Chief Constable Paul Netherton, Chair of the Local Resilience Forum for Devon, Cornwall and Isles of Scilly, thanked and recognised our work, saying: "The information you provided was invaluable and enabled the responders in Devon, Cornwall and the Isles of Scilly to prepare and respond effectively to assist our communities."

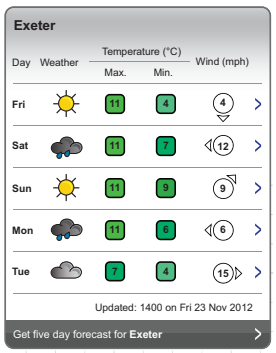
Thankfully, the last few days of November brought some relief, with colder, drier and brighter weather. A generally unsettled December began with wintry showers bringing some snow to the north and east of the UK, particularly over higher ground. A brief change to conditions then brought some colder, frostier weather. ➔

Trusted, listened to, acted up on

A timeline of a severe weather event

NEWS RELEASE

2,568
pieces of media coverage



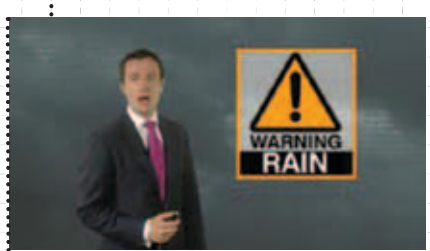
HOME PAGE WEATHER FORECAST

14,511,875
web page views

TWEETS

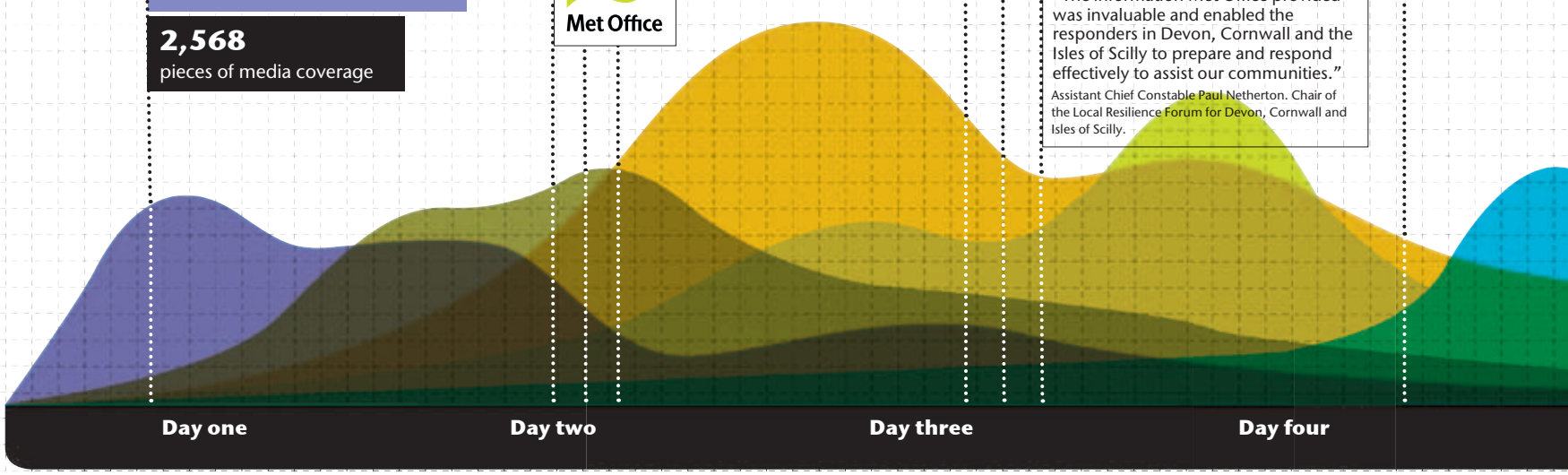
WEATHERAWARE TWIBBON

TV COVERAGE



WEATHER BROADCAST

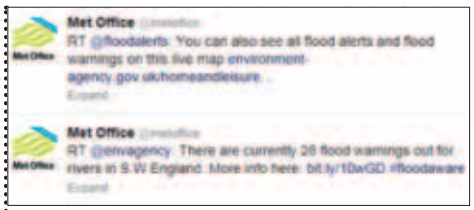
"The information Met Office provided was invaluable and enabled the responders in Devon, Cornwall and the Isles of Scilly to prepare and respond effectively to assist our communities."
Assistant Chief Constable Paul Netherton. Chair of the Local Resilience Forum for Devon, Cornwall and Isles of Scilly.



ITV

Mirrorpix.com

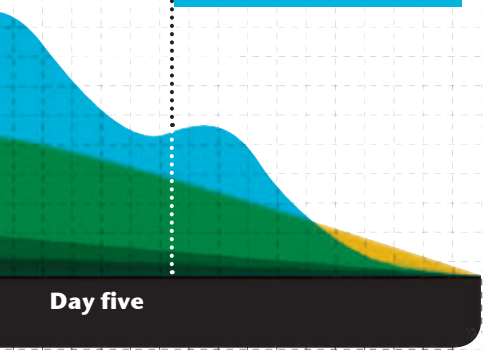
NATIONAL PRESS



RETWEETS

1.2 million
people reached through retweets

Twitter moved from 19th best referrer to the
9th



The second half of the month was mild but very unsettled again as Atlantic fronts brought heavy rain. Rain and high winds caused disruption in some coastal areas of southern England and eastern Scotland. There was more to come with further heavy rain and widespread flooding in the run-up to Christmas.

Working closely with the Environment Agency in the Flood Forecasting Centre (FFC), we advised the public to stay aware of the latest forecasts and warnings, and to be prepared for further travel disruption and flooding as the rain fell on already saturated ground. December rainfall totals for the UK overall were 150% of the long-term average, making it the wettest December since 1999 and the eighth wettest since 1910. For many people this was not good news, especially for those areas already suffering from flooding in November.

As people made their way to visit friends and family for Christmas, we issued severe weather warnings so that the public could plan ahead to take account of possible travel delays. After a thoroughly wet festive period, the soggiest parts of England and Wales had a chance to dry out early in the New Year, before colder temperatures and substantial snowfall arrived to affect many areas of the UK. Throughout the cold weather we continued to work closely with agencies across the UK to help keep the country safe, well and on the move.

Rainy days – is it getting wetter?

Rainfall in the UK has always varied because of constantly changing weather patterns. We are studying how rainfall may change over the next decade and beyond so we can advise on the frequency of extreme weather and potential flooding.

Preliminary evidence based on observations suggests that we are getting slightly more rain in total and it may be falling in more intense bursts. Annual rainfall figures show that the UK as a whole is getting wetter in recent decades. Our research also suggests that extreme days of rainfall may have become more frequent over time.

Changes in sea-surface temperatures due to natural cycles and reducing Arctic sea-ice could be influencing increases in rainfall, but more research is needed to establish the role they play. Increasing global temperatures may be another factor, as a warmer atmosphere can hold more moisture and we have seen an increase of about 0.7 °C in global temperatures since pre-industrial times. This equates to about a 4% increase in moisture in the atmosphere which means there is a greater potential for heavy rain.

Professor Julia Slingo, Chief Scientist at the Met Office, said: “The trend towards more extreme rainfall events is one we are seeing around the world, in countries such as India and China, and now potentially here in the UK. Much more research is needed to understand more about the causes and potential implications.”

Flying the skies

Last year marked the 70th anniversary of 'atmospheric research flying' — a discipline that, over the years, has helped the Met Office gain a greater understanding of weather systems. But what initially prompted the study of weather from up high?

1942

1950

1968

1973

The story of atmospheric research flights begins in World War II and, specifically, the Battle of Britain. In those relatively early days of flight, much less was known about how a plane interacted with the atmosphere when in flight. The RAF was troubled by aircraft condensation (or vapour) trails as they provided clear indicators of their planes' positions in the sky — making them easier targets for enemy fighters and ground artillery. Discovering the science behind these tell-tale trails became a priority for the RAF — and atmospheric research flying came into being.

Their early airborne investigations found that vapour trails, also known as contrails, were caused by changes in the air pressure as the wing passes though the sky — and were generally more persistent on humid days. Armed with this knowledge, the RAF was able to plan certain flights around weather conditions and therefore minimise the chance of pilots revealing their locations.

The practice of conducting research in the sky has continued to this day — as Kirsty McBeath, resident Cloud Physics Research Scientist at the Met Office explains:

"Planes can make unique measurements that can't be made any other way; their research has become one of the most important areas of data collection for the Met Office." Such breakthroughs — and the resulting increase in knowledge — made the Met Office realise the value of airborne research. The 'Meteorological Research Flight' (MRF) was formed in 1946, as a follow on to the earlier research done on contrails.

Progress of science

Of course, the measurements made today onboard atmospheric research planes have increased in sophistication — building on many of the breakthroughs made in the early years. The invention of the 'frost-point hygrometer' in 1943 for example, made it possible for scientists to reliably measure humidity in the stratosphere for the first time. This greatly added to scientific knowledge of the lower stratosphere — and enabled researchers to build up a data set on humidity and other elements such as ozone that is still widely used today.

In the early days, data collection from the air was a highly challenging pursuit. With fairly rudimentary equipment, scientists faced a range of conundrums — such as how to measure air temperature while travelling at 300 mph and at an altitude of up to 40,000 ft. But with every challenge comes the potential for new knowledge and this particular problem was eventually solved by the development of 'thermodynamic theory'. This, in turn, brought about a whole new understanding of the difference between a standard atmosphere and the ones in which pilots fly at various altitudes. And this is still an absolutely essential part of aircraft safety even to this day.

A growing need

Initially, research was conducted on aircraft such as the Mosquito and Flying Fortress. But in the 1950s, the need for data increased — and the size and number of aircraft used followed suit. By the Cold War, specially adapted Canberra aircraft helped the MRF to understand the causes of turbulence. This, in turn, made flying safer and more comfortable for pilots and — as commercial flights became more commonplace — for passengers too. Later on, the MRF was also involved in backing up and validating data from satellites by providing information about temperature, humidity and clouds. This was yet another undertaking that led to significant improvements in forecasting. Such crucial measurements have only been possible through the development of specially adapted aircraft — a process that was not without challenges, as Kirsty explains: "Developing instruments for a moving aircraft was not easy. Power supplies were not smooth. Temperatures varied. Flights were often bumpy. Only through experience — alongside a lot of trial and error — did we make any significant headway."

Working together

During the 1970s, international collaboration helped MRF develop further. For example, the MRF team worked with both American and Russian aircraft on the GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment (GATE) — which involved studying convective clouds near the west coast of Africa. This was the largest international meteorological field campaign ever, bringing together 72 different nations including both the USA and Russia — and the results influenced the development of computer models for tropical meteorology.

Another example is a project that ran in collaboration with the Central Electricity Research Laboratory. The project's research on acid rain across Scandinavia led to the implementation of clean air restrictions across Europe — helping to limit the amount of sulphur dioxide and nitrogen oxides above the continent.

In 2001, the MRF, the Natural Environment Research Council (NERC) and the university community joined forces to establish the Facility for Airborne Atmospheric Measurements (FAAM). The remit of this organisation is to provide an aircraft measurement platform to assist the UK's atmospheric research community on campaigns throughout the world. Most recently they were at the frontline, making in-situ measurements of volcanic ash in the skies over Britain in the days after the 2010 Icelandic volcanic eruption.

Looking back on the historical development of certain scientific disciplines shows how they may be born out of immediate necessity — but also how they can grow and adapt to tackle much more widespread challenges. While atmospheric research flying was prompted by the very acute need to protect the lives of young WWII pilots, today it helps us gain a better understanding of global weather systems and even climate change — a phenomenon that affects us all.

1987

1997

2004

2011

A matter of trust

Trust is the bedrock of every long-term relationship. As Dee Cotgrove, Met Office Executive Head of Communications says, "For us at the Met Office it is vital that people trust, listen, and act on our warnings and advice."

Taking a poll

One way we measure trust among the public is by sampling views with a quarterly YouGov poll which recently generated its fifth set of tracking data. Alongside questions relating to the way people access weather information, the poll measures trust levels in Met Office services in general.

YouGov figures for the Met Office make impressive reading. In fact, they show around 80% of respondents say they trust the organisation, ranging from 'a little' to 'a lot'.

So what is keeping the trust index so consistently high? Dee explains, "We asked those who trust us a lot about the reasons for their level of trust. Accuracy is top of an unprompted list for many people. This can be seen as a consequence of our increasingly accessible forecasts and the benefits of investing in technology so we can perform more calculations, more precisely."

Dee continues, "90% of our next day maximum temperature forecasts are right to within 2 °C and our iPhone app is regularly in the top free weather apps list, with more than 2.9 million downloads since 2010. This combination of accuracy and ease of access contributes to our high trust scores."

Engaging the nation

Accuracy is just part of the picture as trust is also driven by strong public perception of the Met Office's professionalism and expertise. Dee says, "The public know that ultimately it is our people — their forecasting, science and technological expertise — which make Met Office forecasts the trusted source of advice."

> With personal safety or business output at stake somewhere in the UK virtually every day of the year due to weather, ensuring trust in Met Office services is a priority right across the organisation.

The way we operate is also important and, following on from this, the third most important driver of trust is that we are seen as part of government and impartial. Dee describes, "The Met Office's number one priority is to provide trusted advice and we work with other trusted agencies from the Environment Agency in England and Wales to Traffic Scotland further north, to provide valuable and impartial information when it matters most."

As well as forecasts via our BBC and ITV partners, the public access Met Office forecasts via our website — over 4.5 million website visits on a peak day.

Social media is another powerful way of reaching out and engaging with the public. Dee says, "As a nation we love talking about the weather. With 100, 000 followers on social media, our Weather Desk is busy answering queries 24/7. Combined with engaging content on YouTube, this puts the Met Office in the Top 10 most 'social' brands in the UK."

Time to listen

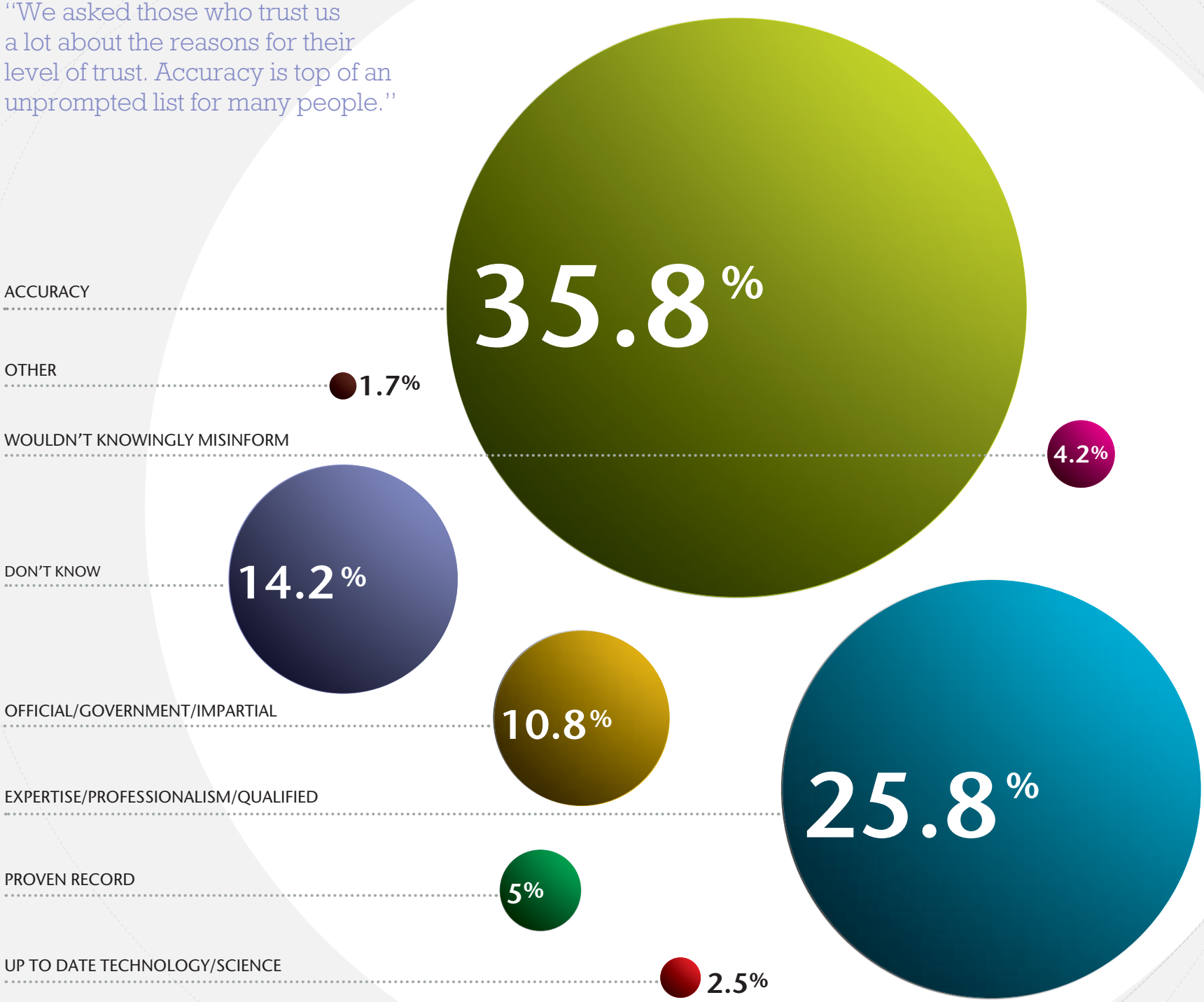
Capturing and responding to customer feedback on Met Office services are also essential for any commercially-minded organisation aiming to be recognised as the best weather and climate service in the world.

We achieve this through a team of account managers who have day to day contact with customers, as well as in-house public feedback response team and independent surveys.

The information this generates enables us to drive immediate improvements, as well as longer term action plans for delivery throughout the year. We are determined to work to maintain the high levels of trust placed in us by public and private partners.

As Dee puts it, "In the end, trust is not only about doing what you say you'll do and doing it well. It's also about being a good listener and responding to what you hear."

"We asked those who trust us a lot about the reasons for their level of trust. Accuracy is top of an unprompted list for many people."



Alex Hill's nearly four decade career at the Met Office has seen him in diverse roles including airport observer and aviation forecaster, TV weatherman, London Weather Centre supremo, and Regional Manager for South of England and Europe. Today, he is located in Edinburgh as Chief Government Adviser, Scotland and Northern Ireland.

Weather in the blood

Since 2008 Alex has been responsible for ensuring that Scotland and Northern Ireland benefit as fully as possible from the Met Office's developing capability in weather and climate.

"The Met Office is a household name and we are in peoples' living rooms on a daily basis, but there is less understanding and visibility of the full range of things we do and the scale of the Met Office in terms of science, supercomputing and communication. It is really important that we are able to share all this in the right way — with Governments, Parliaments and other stakeholders. At the end of the day, it's all about making sure the people of Scotland and Northern Ireland get full value from what we do."

Building bridges

Alex's vast experience makes him uniquely qualified for a complex role.

The nature of what the Met Office does means that we have to communicate with a wide range of people on a wide range of issues — something that can be a real challenge. Over the nearly five years Alex has been in post those challenges have included everything from Icelandic volcanoes to UK climate change projections and the introducing the new National Severe Weather Warning Service (NSWWS), not to mention several episodes of severe weather.

"We work closely to support the Scottish Government, in particular to keep Scotland moving in severe weather," says Alex, "but we've also provided support on the Climate Change Act and Flood Risk Management Act (Scotland). Working in partnership with the Scottish Environmental Protection Agency (SEPA) to set up the Scottish Flood Forecasting Service in 2009 was really important. And our team of weather advisors in Scotland is an integral part of resilience operations and planning, regularly briefing ministers and senior civil servants."

Northern Ireland is another area where we increasingly work to help others take advantage of our forecasts and advice across a range of environmental hazards. Here, as across the nation, the work of people like Alex in the Met Office has led to a better understanding of how the Met Office can help open up new opportunities to keep the public safe, businesses prosper, and to enable wise choices.

A people person for a people job

Alex combines in-depth scientific knowledge with excellent communications skills that have shaped his career and led him into so many 'people-focused' roles.

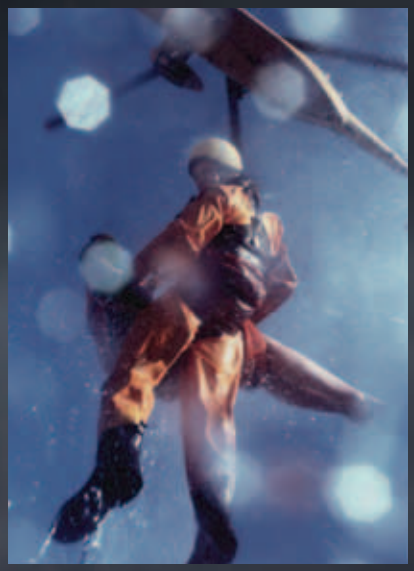
His interest in presenting goes back to forecasting stints at both ITN National Weather and the London Weather Centre — a time during which he developed a successful series of courses for forecasters. His warm, easy confidence again came in useful when performing a TV song and dance routine with Fawlty Towers' Andrew Sachs for Comic Relief in 1993.

But comedy turns aside, what does a 'typical day' for Alex involve?

"Well, there's no such thing as a typical day in my job," laughs Alex, "but there are some routine things such as answering queries or preparing presentations and monitoring who's been saying what about the weather."

Weather and climate have a big impact on energy demand and supply and the Met Office supports the energy industry across the UK. "Here in Scotland, through the Met Office in Aberdeen we deliver forecasts that support the safety of offshore operations and we also advise on renewable opportunities — so I might be talking to stakeholders or putting them in touch with the right expert at the Met Office."

Or Alex might find himself preparing presentations for a forthcoming conference. This could be for organisations such as Scottish Renewables or Sniffer (Scotland and Northern Ireland Forum for Environmental Research), exploring what's happening around buildings and infrastructure as part of the Scottish Climate Change Adaptation Programme, for example.



Richard Cooke / Alamy

Alternatively, Alex might be called on to support BBC Scotland as they prepare a documentary marking the anniversary of the big storms that lashed the north in January 2011.

Whatever the project, the objective is always to ensure the Met Office knowledge, science and capability is available — and the right information gets put in front of the right people.

"Here in Scotland, through the Met Office in Aberdeen we deliver forecasts that support the safety of offshore operations."

Education in its broadest sense

The Met Office is committed to increasing the public's understanding of science, particularly, Met Office science. The science of meteorology is something that affects everyone, and is something of a national obsession. Educating audiences of all kinds is central to Alex's advisory role — especially in his role as a STEM Ambassador, which involves inspiring people in Science, Technology, Engineering and Maths through lectures and other events.

"Education is a very big thing for me," says Alex, "so I also visit schools, colleges and universities all over Scotland. And along with things like being invited to be a judge at 'The Big Bang' fair for UK young scientists and engineers to be held in March 2013, I also make regular trips to organisations such as the Scottish Traditional Skills Training Centre (STSTC)."

A recent joint presentation to the STSTC with a colleague from Historic Scotland focused on the impact of climate change for stonemasons, roofers and other craftsmen who repair World Heritage buildings like those found in Edinburgh.

'Fun' is a word that Alex frequently returns to as he talks about his long and varied career working in a field that's clearly a lifelong passion. Both the Met Office and the numerous bodies Alex supports throughout Scotland and Northern Ireland are stronger thanks to the energy, ideas and commitment he brings to a vital and constantly evolving role.

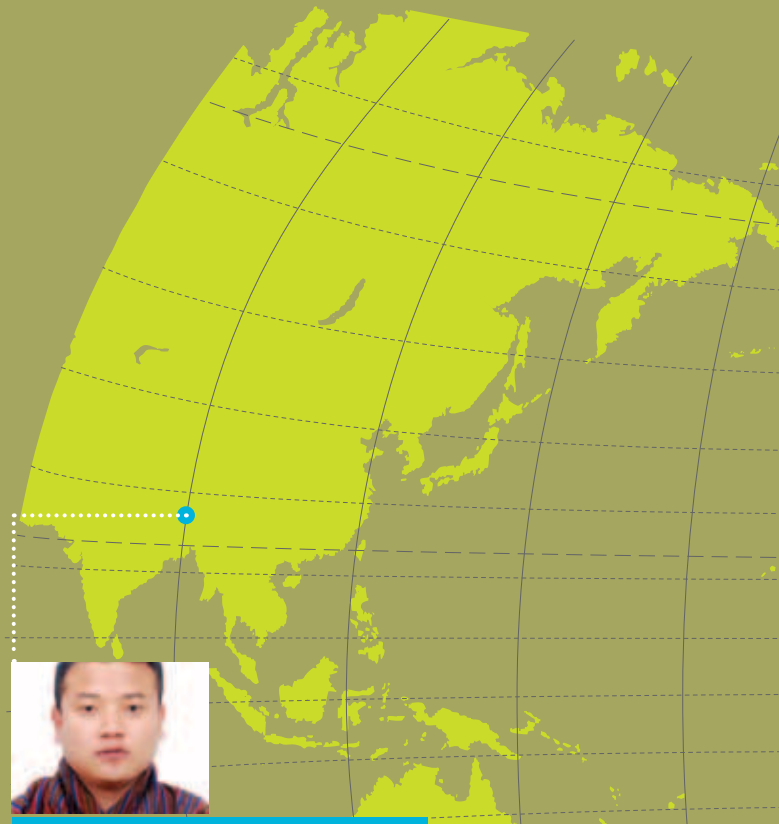
Applying knowledge

Working in partnership with the World Meteorological Organization (WMO) and University of Reading we have developed a new bespoke one-year course specially for students from national weather services in developing countries — an MSc in Applied Meteorology and Climate with Management.

Over the years, the Met Office has worked with the WMO through the UK Voluntary Cooperation Programme (VCP) to sponsor students from national weather services in developing countries. Students can study at universities, both in the UK and abroad, across different subjects from meteorology to business.

Increasingly, people around the world are recognising the need to integrate relevant climate information into planning, policy and practice. Recognising this, and incorporating positive feedback from previous graduates, we were able to develop a new bespoke course in partnership with the Department of Meteorology at the University of Reading. The new course combines scientific studies with management, helping students to develop their skill sets so they can provide better weather and climate services.

The first of these new courses ran from October 2011 to September 2012 with six sponsored students from national weather agencies in developing countries, including Bhutan, Cameroon, Lesotho, Trinidad and Tobago, Uganda and Zimbabwe.



TAYBA BUDDHA TAMANG

BHUTAN

Tayba Buddha Tamang joined the Bhutan Department of Hydro-Met Services as an Engineer. After the MSc he's now working as a Senior Meteorologist.

Tayba explains how things have changed after completing the course:

"I now have the full responsibility of the daily Weather Forecasting Unit. Now the forecasting is in my hands, I am satisfied that what I learned during the course is very helpful in dealing with weather and climate. Overall I gained knowledge on how to deal with staff in an organisation. The Department benefited by getting a meteorologist who will be the key person for developing weather services in Bhutan."

YONTCHANG GERVAIS

CAMEROON

Yontchang Gervais works for the Cameroon National Department of Meteorology as the National Head of Service for Forecasting and the National Head of Service for Met. assistance for Transport's safety.

"The course increased my skills in managing services and projects, communicating scientific information to an audience or various media, and producing research papers in meteorology or in climate related fields," says Yontchang. "These skills enabled me to deal more efficiently with tasks within my national department as well as in African meteorological organisations."

The course also benefitted the National Department of Meteorology in Cameroon. As Yontchang puts it: "They can count on my ability to take further responsibilities as a leader and, at the same time, I can transfer skills to other members of staff through team work discussions, seminars and workshops. They can also rely on my wide network of partners' expertise within the University of Reading, Met Office, Royal Meteorological Society, WMO and so on. Together we can overcome many challenges that we face throughout our diverse assignments."

KENNETH KERR

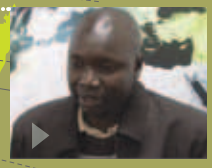
TRINIDAD AND TOBAGO

Since the MSc, Kenneth Kerr, a senior meteorologist in the Department of Meteorology Trinidad and Tobago, has enhanced his climate and management skillset:

"For me, the programme has assisted in closing the knowledge and technological gaps in specific areas. My understanding of the relationships between natural and social sciences was enhanced through several approaches to climate change and the related socio-economic implications. The programme also covered how to respond to climate change impacts; how to influence and promote policy decision and planning for climate change in the long term."

The MSc was also relevant to the development needs of Trinidad and Tobago meteorological service. "The exposure provided the skills for development as a consulting meteorologist which better enable the department to participate in sustainable development with specifically designed programmes such as climate change impact assessment on agriculture, tourism industry, water resources, and coastal zones," says Kenneth.

"Ultimately, the course improved capacity to enhance science by applying the theoretical and analytical concepts and techniques of meteorology and climatology gained to that of sustainable development policies and socio-economic applications both nationally and regionally."



KHALID MUWEMBE

UGANDA

Watch Khalid Muwembe from Uganda Department of Meteorology talk about his experience of the Masters Programme at: www.metoffice.gov.uk/about-us/what/international/development/vcp

MOKOENA FRANCE

LESOTHO

Mokoena France, a meteorologist from Lesotho, outlines what he considers to be the key benefits of the course: "The course improved my scientific and managerial critical thinking. My research and professional skills are strengthened and I can now confidently undertake scientific studies. It increased my network of people in the field by exposing me to a community of world renowned climate scientists."

Reflecting on how the course has helped his organisation, Mokoena says: "The programme has introduced me to a number of advanced tools and methods for analysing, manipulating and visualising climate data which will improve service delivery and quality products by the department. Knowledge gained on scientific research and report writing will be very useful as the department is a research institution and produces a lot of reports on the prevailing climate and climate change. These studies will not only reflect understanding of atmospheric science and its application but also a high level of professionalism."

One of the students, Elisha N. Moyo from Zimbabwe, works as a Senior Meteorologist at the Meteorological Services Department of Zimbabwe (MSD). Specialising in climate applications Elisha is the Officer in Charge of Climate Change at MSD, and is clear about how the course has helped him develop:

"The course increased my understanding of meteorological science as well as my confidence when presenting on weather and climate-related issues. It provided me with links to renowned scientists in leading institutions such as the Met Office, University of Reading, and improved my understanding of the WMO network and its role in strengthening budding scientists in developing countries."

The MSc provides the necessary foundation and principles required for weather and climatological studies and related operations. Diverse areas of study are offered through optional modules such as climate change, tropical meteorology, statistics, hazardous weather, environmental data exploration and visualisation.

Students choose modules according to their personal research interests and national meteorological and climatological needs, often addressing issues relevant to specific geographical locations and national circumstances. The new course also sets out a framework for research or further studies after the course, including PhDs.

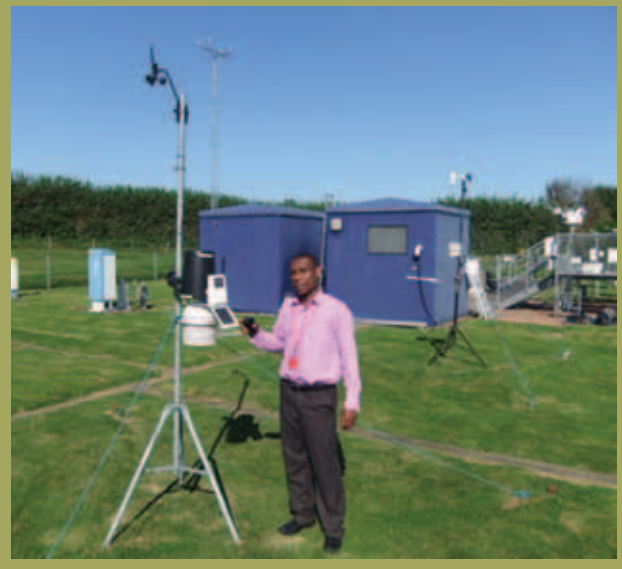
"The course increased my understanding of meteorological science as well as my confidence when presenting on weather and climate-related issues."

It is not just individual students that benefit — entire national weather services gain by enabling students to contribute to projects, as Elisha describes:

"Through enhanced capacity within the department, we are now involved in climate adaptation projects. Our operational sections are already being positively impacted as we are now employing the latest technologies and cutting edge science in product development and service delivery."

By getting involved with climate modelling on the course, Elisha is now involved in the Third National Communications process of the United Nations Framework Convention on Climate Change (UNFCCC), the Climate Change Hub and other initiatives such as working with the National Climate Change Coordinator and office. The course also increased the Department's research capacity, helping it to study the tornado-like storms affecting northern parts of Zimbabwe.

Although he is already reaping the benefits, Elisha sees the course going from strength to strength. "If in future the course includes more leadership courses, and application options such as agro-meteorology, hydrology as well as those which increase the meteorologist's influence on climate policy and decision-making, it will be even more beneficial as there is a tendency to multi-task in our developing national weather services, hence we need diverse skills."

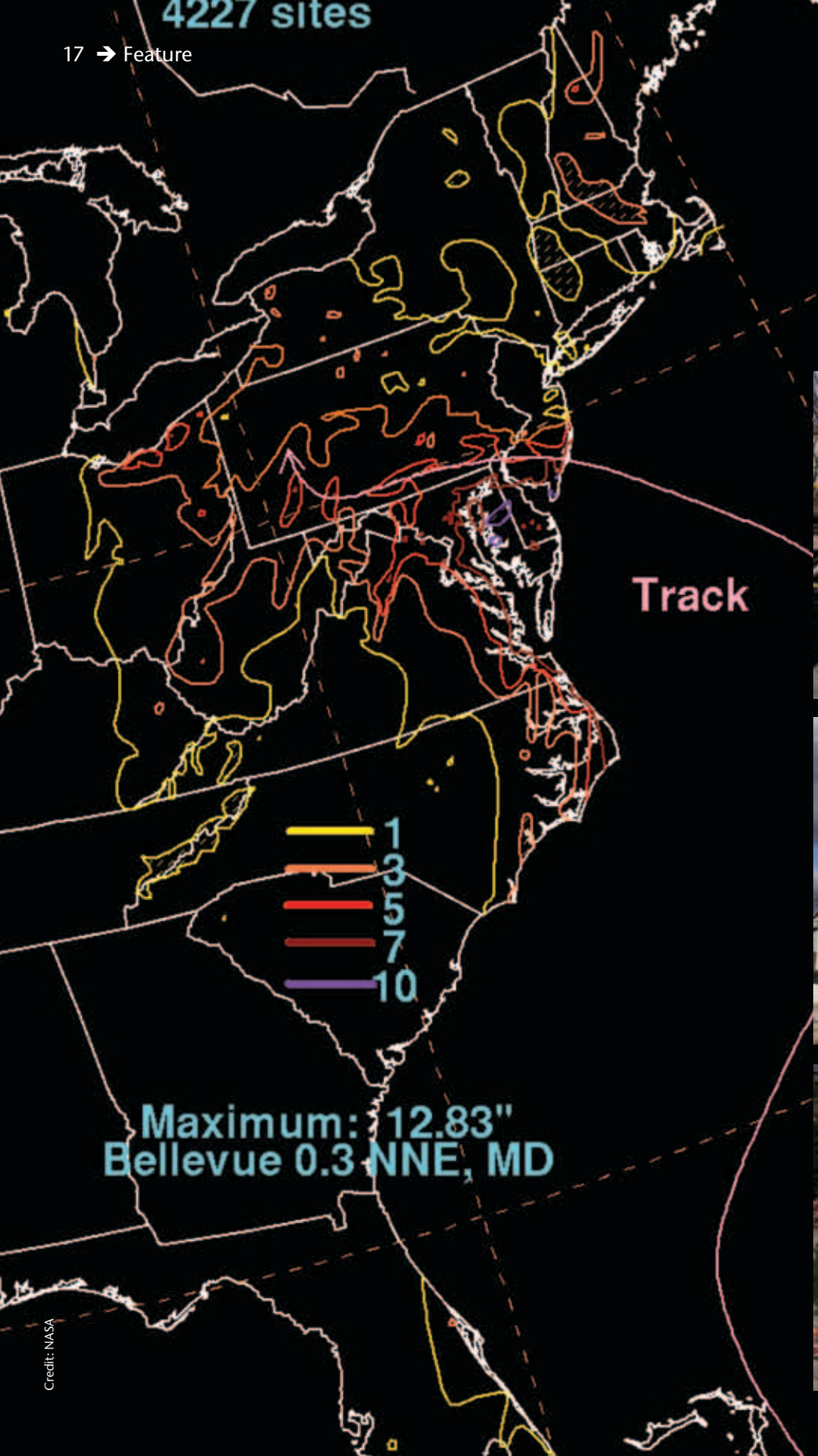


Elisha N. Moyo from Zimbabwe, Senior Meteorologist at the Meteorological Services Department of Zimbabwe, visiting the Met Office headquarters in Exeter.

Forecasting hurricane Sandy

Advance weather warnings made all the difference in reducing the impacts of hurricane Sandy that raged across the Atlantic late last year. Here, James Franklin, Chief of the Hurricane Specialist Unit at the National Hurricane Center (NHC), part of the US National Weather Service, recounts the challenges of forecasting for such a large, complex weather event — and how with the help of the Met Office and other agencies they were able to effectively track it.

Credit: NASA



Credit: NASA

US Air Force Photo / Alamy

Hurricane Sandy will be remembered as one of the largest and most destructive storms in history. Between 22 and 29 October the world watched on as it swept through Jamaica, Cuba, Haiti, the Bahamas and all the way up the Eastern US and even into Canada. Dramatic scenes of flooded New York subways, destroyed homes and enormous queues of people waiting to stock up on petrol filled TV screens across the globe.

There were an estimated 147 direct fatalities due to Sandy, and property damage in the United States alone was estimated at $50 billion. But without the effective forecasting efforts of the NHC it could have been a lot worse. As James explains:

"This storm had huge media coverage yet there were still people who didn't heed the warnings and evacuate. But you can only imagine how much worse it would have been if the warnings were not in place."

Alongside media briefings, NHC liaises directly with decision makers like President Obama, the Governor of New Jersey, and senior executives at the Federal Emergency Management Agency to help them understand the potential threat and how it's developing. "After all, they're the ones making the decisions to evacuate places, not us", says James. But forecasting Sandy, and everything it would bring with it, wasn't as straightforward as with most hurricanes.

"Sandy was very large, with a broad spectrum of weather hazards, from storm surge, to rainfall, to blizzard conditions. In fact, it's the first time ever that we had a snowfall hazard statement in a National Hurricane Center advisory."

This complexity was produced by the fact that the storm changed over time. As it moved from the Caribbean towards the United States, it made the transition from a hurricane to an extra-tropical cyclone.

"The practical importance of this," says James, "is to expand the scope of the impacts. Hurricanes generally are smaller, with the strongest winds and the worst impacts relatively close to the centre. Extratropical cyclones, on the other hand, tend to be very large with, as we've seen, a wide array of hazards."

To forecast the storm's path and strength the NHC used weather models from the Met Office alongside those of other domestic and international agencies. Combining different models in this way is known as 'ensemble forecasting' and taking an average forecast from several reliable models usually produces more accurate readings than using a single model alone.

Improvements in these models over the past decade enabled James and his teams to give emergency managers and the general public a couple of days extra lead-time that they wouldn't otherwise have had — which, given the destructive force of Sandy, made a world of difference. It allowed the NHC to brief President Obama, the emergency services and other decision makers on the regions to be affected and the magnitude of the threat — giving people on the ground the best possible chance to prepare and get out of harm's way.

But for James and his teams, the storm's transformation from a hurricane to an extra-tropical cyclone also presented one of the greatest real-time challenges. In addition to the National Hurricane Center, the US has agencies that specialise in forecasting non-tropical weather events. When the storm changed and became an extra-tropical cyclone, issuing warnings came under another centre's jurisdiction. As James explains:

"Every storm is a learning experience for us and I think we did very well given the constraints. Sandy's transition from a hurricane to an extra-tropical cyclone was a wrinkle that we don't often come across. But we've already come up with plans to improve our services as a result."

"This storm had huge media coverage yet there were still people who didn't heed the warnings and evacuate. But you can only imagine how much worse it would have been if the warnings were not in place."

Met Office and Sandy

An enormous weather event like hurricane Sandy always has widespread impacts and is of great scientific importance — which is why Met Office's forecasters closely tracked its progress. The data we collected was passed on to various bodies who used it to manage their responses and study the storm and its wider significance.

Met Office forecasters provided regular updates to the Foreign Office's Crisis Centre, which helps consular offices around the world deal with large-scale events that affect British nationals abroad.

After Sandy, the Met Office prepared reports to help the insurance industry deal with the numerous claims it was receiving. With the storm being technically reclassified from a hurricane to an extra-tropical cyclone just before it made landfall in New Jersey, forecaster's reports were essential to help insurers understand how claims met policy rules. But despite this transition, the combination of high tide, unprecedented amounts of rainfall, high winds and the sheer size of the Sandy meant it still wreaked havoc across the US.

Finally, the Met Office worked with the UK's Department of Energy and Climate Change (DECC) during and after hurricane Sandy, providing official guidance on hurricanes and studying the significance of Sandy in the context of climate change.

The natural world and human population are affected by natural variations in climate — particularly extreme events. This vulnerability is increasing in some areas as the climate changes. The people that are likely to be hardest hit by climate change live in the least developed countries. That's why we are providing climate services in developing countries so they can plan and adapt for the future.

Helping those hardest hit

Few developing countries can conduct all the necessary climate change research on their own, as it requires significant computing capacity and human resources. Met Office expertise means that we can support the international community in ways beyond the weather forecasts that make us a household name.

Our skill in turning weather and climate science into services is recognised around the world. As the World Meteorological Organization (WMO) embarks on a Global Framework for Climate Services, we will share our knowledge and expertise with others.

The Met Office Hadley Centre already works with many countries — from helping build capacity to predict weather and climate change, to high-resolution regional modelling and developing adaptation strategies.

Building capacity

With a population that relies heavily on subsistence agriculture, Bangladesh is particularly vulnerable to the impacts of climate change. The effects of climate change are already being experienced in the country, so it is essential for Bangladesh to develop adaptation strategies to cope.

The Capacity Building in Climate Modelling in Bangladesh project was a collaboration between the Department for International Development, the Met Office Hadley Centre and the Bangladesh University of Engineering and Technology (BUET).

The Bangladesh climate research community can now produce regional climate projections using regional climate models developed by the Met Office. It also provides a template for other developing countries to build technical capacity with the help of funding from international development organisations.

Assessing vulnerability

Another similar project involved working with The Energy and Resources Institute (TERI) of India and the Government of Maharashtra, on a project called 'Assessing climate change vulnerabilities and adaptation strategies for Maharashtra'. It established how climate change may affect the state of Maharashtra and helped to develop ways of alleviating the impact on economy, society and people's lives.

Rising carbon dioxide concentrations mean that globally averaged temperatures are continuing to increase. For Maharashtra, studies consistently projected a temperature increase over the entire region for the monsoon season between 1.5 °C and 3 °C. Such temperatures could lead to severe drought, water scarcity, and reduced crop yield.

In addition to increasing temperatures, climate change is expected to alter global and regional precipitation patterns. Maharashtra's monsoon season from June to September is very important for agricultural productivity, water resources, and the health of Maharashtra's citizens. Any changes in the duration or intensity of this season could have strong impacts on Maharashtra's vulnerability to future climate change and is a key factor affecting future adaptation strategies.

Adaptation strategies

Although we expect the monsoon season to remain relatively unchanged, all model projections suggest an increase in the intensity of monsoon rainfall, particularly along coastlines, with only slight decreases in rainfall seen further inland. Strong rainfall increases could result in extreme flooding — drastically reducing the state's agricultural productivity and promoting waterborne diseases such as cholera.

Intense rainfall events are likely to extend further into the final months of the season. While the present day monsoon period produces maximum rainfall during July, our projections widen this maximum rainfall period to both July and August. With the heaviest monsoon rainfall lasting longer into the monsoon season, the threat of localised and severe flooding events is further intensified in a warmer future climate.

In both cases, before they could develop adaptation strategies, both Bangladesh and the Government of Maharashtra needed to have a more informed understanding of the climatic factors that influence human and natural systems in their respective regions; what controls these factors; how they could they be affected by climate change; and how those changes will affect food production or infrastructure.

There is an urgent need to improve resilience to climate-related hazards and better manage the risks and opportunities arising from climate variability and climate change. More research is now desperately needed for all developing countries vulnerable to climate change.

Science profile

Dr Bhaski Bhaskaran
Climate Services Manager

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

How can a small group of villages in India — where very little rain has fallen year after year for almost 40 years — adapt and plan for the future without knowing exactly how climate change will affect them? This is the kind of on-the-ground challenge that Dr Bhaski Bhaskaran and his team at the Met Office Hadley Centre are helping to tackle.

Planning for development

Recognised as a world authority on climate change research, the Met Office is often approached by representatives from developing countries looking to plan for the possible impacts of climate change. Using increasingly fine-resolution climate models, the Met Office is able to provide high quality climate projection information, but this is often only the beginning.

In collaboration with governments, local research institutions and donor agencies, Bhaski and his team use climate data to deliver services that help decision making in developing countries in Asia, South East Asia, Africa and South America. "We run workshops to discover the most important requirements for an area's climate change adaptation plan," says Bhaski, "We discuss what information is available, how we can help and why the Met Office is the right organisation to work with."

Once Bhaski and his team have established the local needs and capabilities, they develop and submit proposals to donor agencies, to start the process of making the projects a reality. They work with a range of donor agencies from around the world such as UKaid from the Department for International Development, DANIDA (Denmark), German Development Bank and Asian Development Bank.

Global expertise

Bhaski joined the Met Office as a Climate Prediction Scientist in 2005. He also worked at the Hadley Centre as a student ten years previously when he completed his research for his PhD in Regional Climate Modelling from the Indian Institute of Technology, Delhi. In the intervening years Bhaski worked at the National Institute of Water and Atmospheric Research in Wellington, New Zealand. There, he was the founding member of a team that used the Met Office model as the basis to develop the country's climate modelling research.

Throughout his career, Bhaski has been motivated by using climate science to help improve people's quality of life. "I did my PhD because the climate was changing and people were being affected, but there wasn't credible climate prediction information available to help them." Since then, he has been involved in many advancements in computer science, climate science and climate models which have increased the quantity and quality of information available for decision making.

Visible benefits

For Bhaski the most rewarding part of the job is also the most challenging — the need to ensure that the information he and his team provide is effectively applied so that the benefits can be fully realised. In recent years he has worked on several climate modelling and capacity building projects in Bangladesh, visiting the areas affected by flooding and witnessing the issues and solutions first-hand. In other countries, projects might focus on adapting to climate changes in 50 or 100 years' time but, in some regions of Bangladesh, communities have to adapt every year — especially where it's common to live on boats or to be reliant on fishing in summer and farming in winter. "It's a good place to learn," Bhaski says. "You make suggestions based on predictions — a plan is put in place and the following year you can go back and see it in action. It's very satisfying."

"We discuss what information is available, how we can help and why the Met Office is the right organisation to work with."

Forecasting in the big blue

It's no surprise that offshore projects are particularly sensitive to weather and marine conditions. High winds, treacherous waves and poor visibility make working at sea a risky business. When people's lives, and livelihoods, are at stake, the industry needs sound guidance to make the right decisions. That's where the Met Office's specialist Offshore Marine Consultants come in.

On a day-to-day basis, oil, gas and renewable companies working offshore rely on the Met Office's marine forecasts. But when a special project comes up, such as manoeuvring or fitting kit worth millions of pounds, they need intensive on-site consultancy.

Jim Pearson is the Operational Manager at the Met Office in Aberdeen and the Marine Offshore Consultant Team Manager. He manages a team of forecasters who deliver on-site weather-related services to offshore oil, gas and renewable customers — and their supply companies.

"When we're called in to support an off-shore venture, our consultants live and work with the project team to help complete a specific task. Our job is to identify safe weather windows by evaluating the wave height, wind speed or visibility — or a combination of all three," says Jim.

Working side by side

The Met Office's marine consultants work on a one-to-one basis from onshore bases near the site whenever possible — or offshore on rigs and support vessels. Depending on the project, their expertise could be required for anything from a few hours, right up to several weeks.

"Some of the most challenging projects involve lifting heavy, multi-million pound equipment on to new rigs. Imagine trying to keep a floating crane stable enough on rough seas to safely lift equipment weighing several thousand tonnes," says Jim.

These are challenging, marginal situations and for some organisations, knowing moment to moment what the weather is going to do can be critical to operations.

Building relationships

Much of a consultant's role is to build trust within the project team. In fact, this is as important as the forecasting itself. A consultant will meet with the team face to face, at least twice a day, and it's this regular interaction that builds confidence.

"No one has a crystal ball and sometimes the weather doesn't turn out as predicted. It's times like these when the relationship you've built up is put to the test. But it's how you manage these situations that really counts," says Jim.

Heading south

The Met Office Marine Consultancy team works all around the globe. "One day we can be as close as Wick on the northern Scottish coast and the next, we can be on an oil rig off the coast of Saudi Arabia," says Jim. But for the six-month period spanning spring and autumn in the UK, the majority of the team's work is focused on the North Sea.

The Marine Business team's new challenge is to further develop business in the southern hemisphere — and they've recently hired new international account managers to do exactly that.

"At the moment, our team is made up of 10 people, but we've just devised a new training course to get our land forecasters up to speed with the technicalities of marine forecasting. That way we're ready when the new business comes in," says Jim.

The team has big plans for the year ahead. As Jim says, "Our training course is going really well — and by next year, the team will have grown to 15 people. With more people, and a focused push to find new clients further afield, we're hoping to find fresh opportunities so we can work offshore, 365 days a year."

Thought bubbles

Helen Czerski

Physicist. Oceanographer. TV and radio broadcaster. Dr Helen Czerski's CV is as diverse as it is impressive. But the one thing holding all the many strings to her bow together is science. And her ability to communicate complex ideas, simply, to a wide-ranging audience.

From an early age, Helen's regarded physics as her 'toolbox' for unlocking the most interesting aspects of the natural world. But her actual science career began following her BA and MSci in Natural Sciences and PHD in experimental explosive physics from the University of Cambridge — when she joined the Atmospheric Physics Department at the University of Toronto and Los Alamos National Laboratory in the USA.

There, she had her first brush with experimental atmospheric science. But it was specifically the study of small-scale phenomena that led Helen from experimental explosives to 'bubbles' — an important scientific area because of the huge impact they have on the ocean and the atmosphere.

She is currently a Natural Environment Research Council (NERC) Research Fellow at the Institute for Sound and Vibration Research (ISVR) at the University of Southampton. Here, her particular focus is on bubble coatings, bubble plumes in breaking waves and how bubbles influence air-sea gas transfer.

Bubbles in action

Bubbles affect the way sound and light travel through the water. So detecting and counting ocean bubbles can contribute to more accurate weather and climate models.

But measuring bubbles out at sea isn't easy. Helen uses high-speed photography and acoustic devices to pick up on the sounds bubbles make — which change according to their depth.

"We know that bubbles act like vehicles across the ocean surface. Carbon dioxide and oxygen from the atmosphere go down into the ocean and sulphur based compounds from ocean plants come back up, spitting particles into the atmosphere. It's examining the way these bubbles carry gas into the ocean that helps scientists understand how the sea and atmosphere link together to form clouds and control the climate."

Science for everyone

As well as frontline science, Helen also works as a co-presenter on programmes such as BBC2's Dara O'Briain's Science Club and Orbit: Earth's Extraordinary Journey. It's through her media work that Helen gets to educate and enthuse the general public about the natural world — something she feels strongly about.

One of her most recent programmes was Operation Iceberg, involving six gruelling weeks on the icy sea between Greenland and Canada. Working with a team of scientists, Helen and other presenters investigated the formation and break up of icebergs.

"I like showing the actual scientific process. All too often, documentaries take the 'rabbit out of the hat' approach, rather than analysing the data and then asking intelligent questions." In fact, Helen reckons they did some of their best research directly on the iceberg itself. Contrary to what many people might think, the age of satellites and advanced computer technology doesn't replace hands-on research when measurements are needed.

"When you're out at sea, you have to deal with floating about in a glorified tin can and, as in our case, have a polar bear staring at you! I think it's important to show how hard-won this information is to gather."

Ultimately, Helen believes that, "Science isn't somewhere else — it's here." She revels in her career's combination of physics and Earth sciences and, loves how it lets her "look up into the grey, rainy clouds and think about what's happening..."

"Because even a little bit of knowledge, makes for a better day."

Probing the clouds

This picture, taken by Graeme Nott, Met Office Senior Scientist and Instrument Specialist, was during a flight into Friedhelm, a storm over Scotland on 8 December 2011. The photo was taken towards the end of a two-flight sortie investigating the storm.

The cloud physics probes, which measure the size and number of cloud droplets and ice particles in cloud, can be seen under the wing of the aircraft.

The research flight formed part of the DIAMET (DIAbatic influences on Mesoscale structures in ExTratropical storms) project: a university-led project aiming to improve the forecasting of severe weather over the UK.

For more information see www.ncas.ac.uk/index.php/en/diamet-introduction