



On the move
Keeping traffic flowing

A fresh outlook
Climate change and
aviation

Wild blue yonder
Forecasts for the marine
industry

Barometer

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All of our commercial services are central to the Met Office's strategic plan. Providing first-class services to the transport sector is a key element, explains **Nick Jobling**, Chief Financial Officer.

Driving ambition

While much of our work provides services to protect and inform the general public, our business with the transport sector provides net value to UK PLCs and makes an important contribution to Met Office revenues. As the theme of this *Barometer* is transport it is therefore fitting that, as Chief Financial Officer of the Met Office, I am introducing this issue.

Accurate weather forecasts result in considerable financial as well as safety benefits for our transport customers. From gritting the roads, to offshore projects in the North Sea, we help our customers run to schedule and save money — often by improving efficiency. For example, we help the global aviation industry save money through improving fuel efficiency by using the jet stream to fly across the Atlantic.

Another area of work covered in this issue is our Chronic Obstructive Pulmonary Disease (COPD) Forecast Alert Service, Healthy Outlook®, which warns people with COPD when cold weather may make their condition

worse (page 3). The pioneering service helps to keep COPD patients well and out of hospital. It also presents a big opportunity for us, and we aim to provide more services and greater value in this area.

Our COPD Forecast Alert Service and our work for the transport sector are key to our strategic success creating value for our customers and the UK.

This issue of *Barometer* looks at various aspects of our work with the transport industry. For our marine customers, we recently launched a new version of Safesee™, our online marine weather service. One of our customers, SubSea7, a subsea engineering and construction company, uses Safesee™ to help make crucial decisions that minimise downtime and improve safety (page 6). Products like this are crucial to the marine business as it continues to grow and seek international opportunities.

I recognise that most business markets are tough because of current economic conditions and high levels of competition. We should not be

downbeat though since we continue to provide competitive advantage to our customers. To help them stay ahead and deliver our strategic intent, we must understand exactly what our customers need. The recent 'What If?' sessions that we have run with our marine customers helps us understand our customers and have generated ideas for product innovations.

We supply the vital weather information that keeps roads moving and travellers safe during winter (pages 7 & 8). Early indications are that for the UK, this winter is likely to be wetter than last year. It is also likely to be milder than last year, so precise forecasting of cold snaps will be essential to help decide whether to grit the roads.

As our climate changes, Met Office climate change consultants are helping the aviation industry look ahead. A project developed by Eurocontrol, the body responsible for the safety of air navigation in Europe, and the Met Office has studied the anticipated

changes in weather patterns and their impact on the aviation industry (pages 9 & 10).

To complete the mix of the different transport areas, *Barometer* also looks at our environmental forecasts for the rail industry. One of the key services provided by the Met Office Rural Environment Team is assessing the threat of leaf and tree fall for the rail industry (page 17).

More companies are realising the benefits of our weather forecasts. However, the only way that we will be able to truly fulfil our customers' needs is by understanding their requirements and delivering innovative products. Our commercial success depends on our scientific success and everything we do must be backed-up by the very best science. I'm sure you will be fascinated by our planned increases to the resolution of the global forecast model (page 15). Not only will the increased resolution further improve the accuracy of our forecasts, it will help to drive our customers' ambitions.

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Better lives with Healthy Outlook®



Our pioneering Healthy Outlook® service, which helps people with Chronic Obstructive Pulmonary Disease (COPD) keep well during the winter months, has had a major update.

The service monitors the weather and levels of circulating respiratory infections, forecasting environmental conditions that can make the symptoms of people with COPD worse. An automatic phone call warns COPD patients when these conditions are on the way. In addition, a patient pack full of advice enables people to keep themselves well and out of hospital.

The service has been running for five years, but has seen some big changes this year. For the first time, the patient packs are available in eight different languages. The presentation of the advice has also been simplified into an illustrative format to make it easier to understand. This helps to make our service accessible to the widest possible audience. It is hoped this will help lots more people benefit from the service, extending our reach as far as possible.

Leading the way at WCC-3

The Met Office had a high profile at the recent World Climate Conference-3 (WCC-3) in Geneva. Organised by the World Meteorological Organization, the event saw scientists and politicians come together to discuss how climate research can help decision-making for the future.

Presentations were made by Met Office scientists during the scientific segment of the event, held during the first three days. Met Office scientists also played an advisory role to the UK delegation during the two-day political segment.

The key outcome was a Conference Declaration which agreed to develop a Global Framework for Climate Services. This will aim to make more information on adapting to climate change available to a wider range of users, especially those in developing countries. This will greatly help efforts to reduce the risks and realise the benefits of our changing climate by enabling more people to include climate information services in their decision-making. With continued support from UK Government, we hope to play a major role in the development and implementation of the framework.



Take-off for new service

A new service to help airline operations and flight planners make key efficiency and safety decisions has been launched. ClearFlight™ is a global briefing service designed to make aviation weather information easier to access and interpret. It provides all the information needed in one place, which is available 24/7 in an interactive world map layout.

Customers can also tailor the system to their own needs by introducing warning thresholds which are key to their particular operations. ClearFlight™ adds to our range of services for the aviation industry, that already includes our global aircraft de-icing alerts, which have been proved to cut delays by up to 84% and reduce costs by up to 30%.

Our OpenRunway® service also helps airports plan ahead to mitigate the effects of the weather, ensuring staff and resources are in the right place to keep runways clear and flights on time.

Prince Charles' visit

His Royal Highness The Prince of Wales described the work of the Met Office as crucial during his visit to the Met Office in Exeter in September. Climate change is of great concern to The Prince and his visit gave him the chance to further his knowledge by meeting with some of the world's leading scientists from the Met Office Hadley Centre.



His Royal Highness had a tour of the Operations Centre, and was shown some of our forecasting capabilities. In a speech to Met Office staff, His Royal Highness said, "Your work here is of crucial importance in informing so many people around the world of the nature of the threat, the huge challenges we all face."

Dr Richard Betts, Head of Climate Impacts at the Met Office and expert on the rainforest, said, "There can be no mistaking The Prince's drive and energy in keeping the issues facing the world's rainforests in the public's minds. Our discussions affirmed the importance of saving the rainforests around the world, as a vital element in combating climate change."

**COLD
COMFORT**
STATE OF PLAY



In September the Met Office attended Cold Comfort — an exhibition and conference for the winter service industry. Now in its 18th year, the event attracts practitioners and engineers from across the industry and British Isles, such as the highways agencies and their contractors, meteorological sensor providers, and plant, equipment and salt suppliers.

The UK's winter maintenance industry has been under closer scrutiny than usual with the events of last winter, which saw heavy snowfall and pressure on salt supplies. The theme of this year's show was 'state of play'. It focused on how everyone can pull together to overcome the challenges that winter presents and improve the efficiency and effectiveness of winter services.

We showcased our capabilities in being able to provide a full service — from day-to-day operations through to climate consultancy. Cold Comfort also provided the opportunity to talk to our customers so that we can continue to develop our road science and products, particularly route-based forecasts.



Photo: Alamy



From left to right: Andy Brown; Professor Julia Slingo, Met Office Chief Scientist, presenting the prizes to Jarmo Koistinen and Malcolm Kitchen; Julia Slingo and Caroline Isaacs, from IBM, presenting award to John Gloster.

Met Office scientists awarded prizes

Three Met Office employees were presented with prizes at the prestigious Royal Meteorological Society conference which took place on 29 June–2 July at the University of Reading.

Malcolm Kitchen was the recipient of the Hugh Robert Mill prize for 2008. Awarded every two years, this prize is for contribution to the science of rainfall measurement. This year, it was awarded to Malcolm and Jarmo Koistinen of the Finnish Meteorological Institute for contributing to the development of weather radar in their respective countries (UK and Finland).

John Gloster was given the IBM Award for meteorological innovation that matters. John received the award for his work with colleagues in developing the capability to provide forecast information of when and where disease-carrying midges would cause an outbreak of the bluetongue virus. The tactical use

of this forecast information helped in the vaccination of at-risk herds and in halting the spread of disease. This helped to alleviate significant personal and financial impact within the farming community.

Andy Brown was awarded the Buchan Prize. This prize is awarded annually to members of the Society for a paper or papers published in the previous five years in the Quarterly Journal, the International Journal of Climatology or Atmospheric Science Letters and adjudged to contain the most important original contribution or contributions to meteorology. Andy's contributions have been in the fields of boundary layer turbulence and orographic processes.

Looking back at summer



In April our seasonal forecast for the summer (June, July and August) stated that there was a 65% probability of a warmer-than-average and near- or drier-than-average summer. The headline we used to communicate this was, “Odds on for a barbecue summer.”

Although the forecast was for a drier and warmer summer than average it did not rule out the chances of seeing some heavy downpours at times. However, the forecast suggested that a repeat of the very wet summers of 2007 and 2008 was unlikely.

Many areas of the UK had a heatwave at the end of June and beginning of July. The hottest temperatures since the record-breaking month of July 2006 were recorded this summer. Various locations reached or exceeded 30 °C, with Wisley, Surrey recording a sizzling highest temperature of 31.8 °C.

The Wimbledon tennis championships around that time were virtually rain-free, enjoying the best weather at the tournament since 1995. The new roof was only used once — initially for a passing shower — but the decision to leave it closed allowed a piece of history to be made as Andy Murray’s match continued into the night. While not completely dry, Glastonbury Festival, the Ashes Test Matches and the British Open Golf Championship all had much better weather than in recent years.

In stark contrast, July became wet, soggy and disappointing and this poor weather coincided with the start of the school holidays for many. In July, temperatures were generally above-average but there was above-average rainfall in most areas.

Things improved generally through August, particularly across the south-east, and many people enjoyed some spells of fine, dry and locally hot weather. Meanwhile, many northern and western areas experienced a lack of sunshine.

All of our forecasts, particularly on seasonal timescales, are subject to the variability of the

world’s weather systems — and the UK is in a particularly complex location to forecast. When we presented our summer forecast we worked hard to ensure that the probabilities and uncertainties involved in long-term forecasts were communicated.

Long-term forecasts have their limitations and seasonal forecasting is a developing area of meteorology. Although these forecasts are not as accurate as our short-term forecasts, they do help to predict what may happen for a season ahead. It’s crucial that we continue to drive forward developments in seasonal forecasting and climate change predictions. We have seen vast improvements in our short-range forecasting over the last 50 years due to our continuing research programme and we are confident that we will also continue to see improvements in our seasonal forecasts.

Did you know?

- > Summer 2009 was warmer than both 2007 and 2008.
- > Unlike 2008, all three summer months recorded temperatures above 30 °C.
- > UK mean temperature over June, July and August was 0.6 °C above the long-term average at 14.7 °C.
- > UK rainfall was 318.5 mm, 40% more than average.
- > In the South East of England rainfall was very close to normal and temperature was 0.6 °C above normal.
- > In western Scotland 60% more rain than normal fell through the summer months, although it was almost 1 °C warmer than normal.



Photos: Rex Features

The summer was warmer and wetter than average, with mixed weather and wide contrasts across the UK, and through the season.



Photo courtesy of SubSea 7

Safesee™ the way ahead

The latest version of Safesee™ is giving marine customers a dynamic global view of the changing weather picture.

Offshore weather has always been hard to predict: calm one day, a howling gale the next. Thanks to the Met Office's updated Safesee™ system, marine businesses are now able to get a clear picture of what lies ahead, anywhere in the world.

It's an invaluable system for marine and offshore businesses — such as oil, gas and renewable energy companies, ferries, ports and harbours — where just small variations in the weather can have a huge impact on productivity and profitability.

"In the past, we've been at the mercy of the elements. The weather, prevailing environmental conditions, significant waves and very strong subsea currents can make our work very challenging," explains Charlie Brown, Marine Logistics Manager, from leading subsea engineering

and construction company Subsea 7. "The new innovations in Safesee™ allow us to make more informed operational decisions, reducing downtime and helping us plan ahead."

One of the most significant additions has been the introduction of a global map viewer. Based on Google maps, this enables people to visualise weather elements over their operating sites and make the most of good conditions to get things done.

As Gillian Boyle, the Met Office's Marine Marketing Manager, says, "It's all about bringing the weather to life. In the past there was lots of good information, but it relied on people being able to interpret the data. The new system enhances the visual experience — it plots the weather layers over customer sites."

With Safesee™, decisions can be made up to 14 days ahead to take advantage of the best weather windows. Our shorter range forecasts enable planning at a more granular level and our hourly nowcast makes it possible to react to dramatic weather changes instantly.

Available 24/7, the updated Safesee™ builds on the original system's strengths, adding more innovative features such as animated weather cycles, 'hover-over' summaries for important sites, a lightning proximity alert and news updates. These have been developed in response to customer requests.

"We continually work with our customers to understand how we can improve our services to make their operations safe and cost-effective," adds Iain Ralston, the Met Office's Marine Business Manager. "Safesee™ pulls a lot of specialist weather information into one site, in a way that's very visual, enabling customers to make informed decisions when it really matters."



What's new?

The upgraded Safesee™ system comes with enhanced functionality including:

- > **GLOBAL MAP VIEWING:** brings the weather to life using maps where you can click and zoom in on different areas of the world, viewing operational sites such as oilfields.
- > **TIME-LAPSE FUNCTIONALITY:** users can see how weather conditions change over time.
- > **LIGHTNING PROXIMITY ALERTS:** gives warnings when lightning is detected within a set distance of customers' sites.
- > **NEWS SECTION:** enables us to share important news with customers at sea.

With memories of February 2009 still frozen in our minds and the prospect of increasingly warmer, wetter winters ahead — the UK road transport industry's need for accurate weather forecasts is more important than ever.



Aileen Semple, Met Office Business Manager for Road & Rail

Every winter, the travelling public faces potentially dangerous problems — such as icy roads that haven't been salted and sparkling hoar frost at dawn melting into lethal black ice by rush hour.

As Business Manager for Road & Rail at the Met Office, **Aileen Semple** helps ensure Britain's road network stays safe. Her team helps deliver the OpenRoad service, which, for over twenty years, has provided round-the-clock weather information to local authorities, the Highways Agency and their contractors.

Aileen says, "OpenRoad helps councils decide when to treat the roads. We offer different types of forecast information to meet the needs of our varied customers; these include 24 hour general hazard weather forecasts, which can be for a large geographical area, or climatic domain as well as our site-specific road forecasts and our new innovative route-based forecasting."

Early warnings

In February's extreme conditions, the OpenRoad service played a vital role in picking up the signals for the severe snow even earlier than the Met Office's usual five-day forecast. This year poses an even greater challenge as more marginal nights are predicted, resulting in road surface temperatures often being a little bit either side of freezing.

Aileen recalls, "The level of detail we provide is critical — from minimum temperatures, to centimetres of snow and drifting levels. And rather than a vague 'Ice is expected tonight' kind of forecast, OpenRoad provides a more specific forecast; 'High risk of icy patches forming after midnight, clearing by 9am'."

All products, including route-based forecasts are offered on the OpenRoad dedicated website. Aileen explains, "Our new higher resolution modelling allows for hundreds of thousands of site-specific forecasts along every route in the UK, visualising changing road surface temperatures and state — in a clear and intuitive way."

Variable colour codes indicate the RAG (Red, Amber, Green) status and whether roads need to be salted overnight. So 'Red' equals danger (ice, frost and

Keeping the roads moving



snow), ‘Amber’ equals caution (marginal nights) and ‘Green’ means no problems (wet and windy, dry and mild). This gives our customers a convenient headline of conditions followed by a detailed forecast.

Since 2007 two dedicated vehicles equipped with meteorological instrumentation have logged the changing weather conditions and vehicle location second by second during 190 survey runs conducted around the UK. These detailed surveys have enabled us to verify our route-based forecasts and further refine our road surface temperature model.

On-site help

When working with England’s Highways Agency, Aileen says, “Our forecasters are co-located with Highways Agency staff in the National Traffic Control Centre in the winter months, so they are right there to give advice on adverse weather and its impact.”

Following the salt crisis earlier this year, COBRA (Cabinet Office Briefing Room A), relied on the Met Office to highlight where the trouble spots needing salt would be around the UK. Ensuring the right treatment is given at the right time will hopefully prevent the kind of treacherous snow and ice problems we saw back in February.

Future-proofing winter

As one of 12 Met Office Climate Change Consultants, Erika Palin helps government and commercial customers work towards future-proofing their operations against climate change. The Climate Change Consultancy team uses the Met Office Hadley Centre’s expertise to study how projected future changes might impact on customers. “Last winter,” Erika recalls, “many councils ran low on salt and had to resort to using table salt to treat the road surface. After looking at climate projections we see the number of frost days is very likely to decrease and fewer gritting episodes are likely to be necessary in the future. However, the climate’s natural variability means that some winters will always be colder than others — so climate change doesn’t mean that we’ll never get cold winters, just that there won’t be as many.”

Getting into potholes: weather and road damage

Climate Change Consultancy is only part of the story, however; understanding future climate impacts is clearly linked with understanding current vulnerability to weather. The weather has many effects on the road surface — an example being potholes, which result from repeated freeze/thaw cycles of water in surface cracks as the temperatures hover around freezing. The Scientific Consultancy team brings the Met Office’s scientific capabilities to bear on practical problems, by conducting bespoke weather-related investigations for customers. Scientific Consultants have recently studied how the weather affects road salt usage — though necessary for safety, salt can damage the road surface, so predicting winter salt usage is a balance of safety and cost-effectiveness. The team has also looked at correlating weather events with damage to roads — an important issue for organisations like local authorities, who have to repair those potholes.



Scotland’s Trunk Road Network

Scotland is renowned for bearing the brunt of extreme weather during winter causing hazardous driving conditions. Since 2005, Alan Motion — as Government Business Manager for Transport Scotland — has been strategically supporting Scotland’s extensive trunk road network. He and his team inform the general public if the weather is likely to significantly affect their journey and how best to travel safely. This is different to the Met Office’s OpenRoad service, which focuses on advising the commercial sector on winter road maintenance.

Nowcasting predictions

Met Office forecasters up in Aberdeen utilise existing data and short-period forecasts, which are constantly refreshed over a six-hour period. This ‘nowcasting’ approach provides frequently updated weather information for the motorways, A roads and bridges on the Traffic Scotland website.

Signs of the times

Within Traffic Scotland’s control room in Glasgow the controllers also use the information to inform the Variable Message Signs across the trunk road network. “These fixed and mobile Matrix signs rely hugely on the Met Office’s input,” Alan says, “along with advice from on-the-ground road teams, local authorities and the Police.”

A fresh outlook



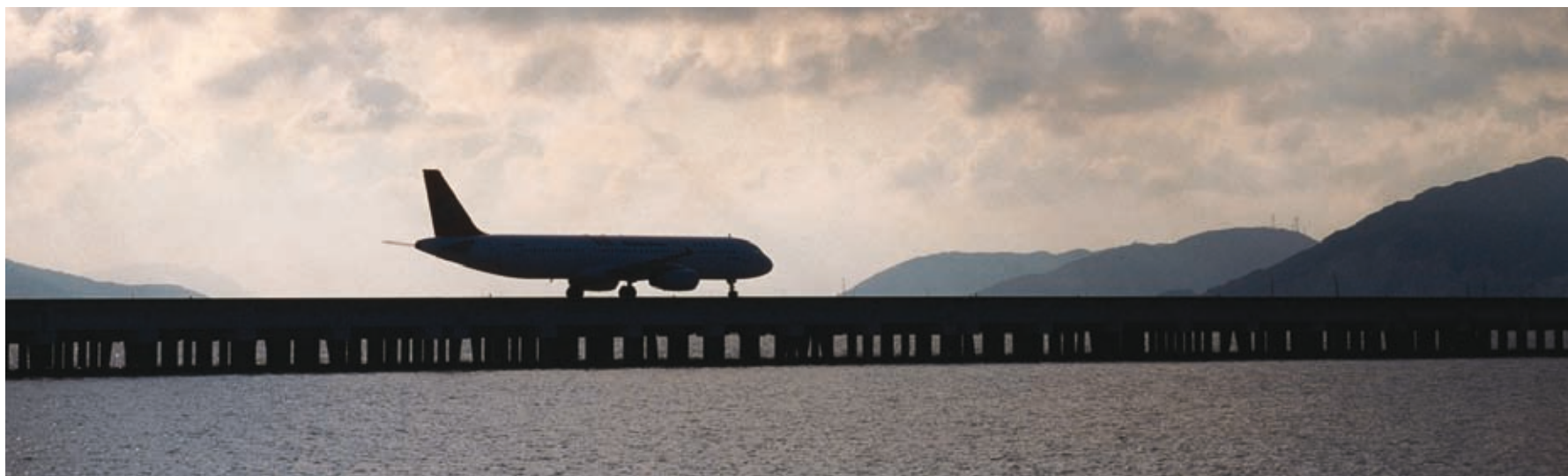
Having recognised its effect on climate change, the aviation industry is now turning its attention to the impact of climate change on its operations. Working together, the Met Office, Omega and Eurocontrol are helping the industry plan for an ever-changing future.

For the aviation industry, keeping airports and flights running smoothly means staying abreast of long-term changes in weather patterns. Planning for tomorrow's challenges is how the industry stays one step ahead — whether it's predicting how tourists could react to even hotter temperatures in today's holiday hot spots, or even studying the long-term viability of airports located near the coast.

In 2008, Eurocontrol — the body responsible for the safety of air navigation in Europe — asked the Met Office and Omega — an aviation sustainability partnership — to study how weather conditions are changing in the long-term and, crucially, how this might affect the future of aviation. The end result was a review of climate impacts on aviation operations in Europe — from shifts in snowfall to potential changes in severe convection.

A flood of information

When the Met Office, Omega and Eurocontrol began their investigation with some basic background research, they discovered just how devastating the affects of climate change could really be for aviation. As Met Office Climate Consultant, Rachel McCarthy discovered, “We found roughly 34 major European airports were based on the coast or in floodplain areas. Due to the lengthy mixing processes in the ocean, its long memory, if you like, sea levels will continue to rise even as we cut back emissions. Aviation needs to adapt to the changes that are coming, as well as mitigate to prevent further change. The impact of rising sea levels could be severe for airports without proper plans in place.”



“As well as climate model data, the aviation industry is also benefiting from our expert, impartial advice and in-depth understanding of the science behind the climate.”

Yet this is just the start of the problem. “Some airports are built on artificial or reclaimed land stretching out into the sea or on floodplains,” she continues. “If you think how many smaller airports are in a similar position, perhaps with fewer resources and less strategies in place to deal with flooding, you can see how 34 could be a very low estimation of those at risk.”

But it’s not just sea-level rise that poses a threat to the smooth running of airports in Europe. Increasing global temperatures throughout the 21st Century will result in less snow and frost overall — meaning some areas will experience an increase in borderline conditions. This does not mean however that airports will necessarily be unable to prepare. “Places that only have marginal cases of snow and frost at the moment may want to look into a specialised de-icing service or a tailored forecast. Our aim is to make airports realise this change could affect them very significantly,” says Rachel.

Streaming ahead

The jet stream, which can dictate much of the weather over Europe, and provides the upper-level high-speed winds that influence routing and flight

times, is being studied very closely. However, it is not as easy to determine the impact of climate change on the jet stream as on variables such as temperature or sea level.

As Rachel says, “Because it is difficult to record wind speeds in the jet stream, the observational record isn’t very long. This means it is hard to distinguish between natural cycles relating to its movement and the impact of climate change on it. However, our observational capabilities, research and modelling are improving all the time. Already there is some indication that the jet stream is moving northwards over time.”

Aviation could also be impacted by changes in the magnitude or frequency of severe convection, as storms disrupt flight paths. However this too is a complex area, as convection occurs on spatial scales that are difficult to represent in global climate models. “To understand convection better, we also judge it against aspects of climate change we’re much more certain of, such as temperature rise,” explains Rachel. “As the atmosphere warms up it will be able to hold more water and therefore it has greater potential for convective activity. So as well

as climate model data, the aviation industry is also benefiting from our expert, impartial advice and in-depth understanding of the science behind the climate.”

Setting sights

It’s this understanding that really helps the aviation industry explore what to expect from weather conditions in the future — and how best to face them. If hotter temperatures cause water shortages or rationing for example, aviation will need to keep a close eye on their water supplies, just to stay in operation. Without water, an airport simply cannot run.

After all, one of the most poignant potential affects of climate change is the impact on tourism. As temperatures in Europe change and popular holiday destinations such as Spain and France grow ever hotter, the aviation industry could face a huge shift in demand. “Several studies indicate that average summer temperatures in the Mediterranean could increase by up to six degrees by the end of the century,” explains Rachel. “If these places become just too hot for people, we may see tourists choosing currently less popular areas, like Eastern Europe, for their breaks. The future of aviation and tourism could look very different indeed.”



In their elements

What does winter mean to you? For most of us, the impact of winter on our working lives often means no more than dressing warmly, hoping the roads stay clear and trying not to slip on icy pavements. But for some people, their jobs mean being at the frontline of weather all the time. Come rain, shine or snow.

We asked an AA man, a cross-channel ferry captain, a train driver, an airline pilot and a coastguard what winter meant to them and the vital role the Met Office’s forecasting plays in helping them do their jobs.



Stuart Topp

AA Patrolman of the Year 2009/10

Based in Central London

14 years in the job

“The types of breakdown I attend certainly depend on the weather. More cars break down during the colder months. And you get more battery problems and punctures when it’s raining. Winter’s always busy for the AA, and 99% of the time I’m on a motorcycle, so I bear the brunt of it even more.

The Met Office forecast service is really important. It helps keep me up to date and influences how I approach the day. I can only carry a small amount of stuff with me so once I leave in the morning I have to know I’ve got what I need. The snow in London last year and the Oxford floods in 2008 were particularly challenging times for me. In fact, I got specifically relocated to deal with calls during those extreme periods.

Compared to being stuck in an office, I love working outside and meeting people. The AA gives us superb kit to deal with all conditions, so I’m generally happy whatever season it is.”

“Winter’s always busy for the AA, and 99% of the time I’m on a motorcycle, so I bear the brunt of it even more.”



Captain Robin Bent

Duty Captain, P&O Ferries

Based in Dover

3 years in the job

“It’s great being the boss of a cross channel ferry, sailing over 12,000 people in the summer. As you can imagine, the weather forecast is crucial in helping us plan for days and weeks ahead. We get the forecast from the Met Office daily, which dictates what type of cargo we’re allowed to carry. During the windier winter months, for instance, we can’t transport livestock or horses.

Passenger safety is also affected by the weather — and, of course, my onboard speech to the customers when we leave port. It can also impact on scheduling... but it would have to be very severe for us to be late. And because the crew sleeps onboard for a week at a time we also have to consider fatigue. In rough winter weather, one week can feel like two.

We use the wind data provided by the Met Office a lot. It’s extremely important to get wind speed and force correct as this affects the ship. When the weather is particularly bad, the Met Office provides information about where we can shelter from the wind if we can’t get into Dover or Calais.

Sometimes we have to wait up to 12 hours to get into our berth. This happens a few times every winter so the weather is certainly a deciding factor if we are a happy ship or not.”

“The weather forecast is crucial in helping us plan for days and weeks ahead.”



Matthew Grist

Train driver for First Great Western

Based in Westbury

Driver for 2 years

“Weather certainly affects my style of train driving. In winter it’s harder to stop and pull away from stations than in the summer, for example. And we always need to check the forecast before we start work every day to see what we’re up against.

It’s really critical that the guard knows whether it’s going to rain or if high winds are going to be a problem. In the autumn as well, we need to know if there are leaves on the line, which can make it very slippery. (Turn to page 17 to find out more about Met Office leaf-fall forecasts.)

If it wasn’t for the Met Office giving us a heads-up of what’s happening, we wouldn’t be able to plan ahead, or even where we’d be driving the train that day. Ice is without doubt the most dangerous weather condition. Ice and metal tracks don’t mix well, so in all these circumstances we drive slower and accelerate and brake more cautiously.

The job is great because we get to interact with customers and we always have a different view out of the window. The worst thing is the hours, especially when you have to start at 3 a.m. some days and work on weekends.”

“We always need to check the forecast before we start work every day to see what we’re up against.”



Captain David Thomas

Chief Flight Training Pilot, British Airways

Based at Heathrow Airport

Been at BA for 16 years

“As a pilot, the weather makes the difference between an easy day and a hard day. In winter we plan ahead a lot more. You need to spend time going through the forecasts so you have an idea of what lies ahead at your destination. Snow, ice and wind are the main things — these have a significant effect on fuel and meeting scheduled times.

The planning department get the Met Office forecasts a long time before I do. So when I get in to work the best route has already been planned in order to avoid strong headwinds and therefore make the plane more fuel-efficient. The first thing I do is look at the forecast at the destination, plus I look at alternative destinations to use as a contingency plan. The forecasts provided by the Met Office are vital to us from both a safety and economic point of view.

Being a pilot is fantastic. It’s very challenging and unpredictable, so it keeps you interested. No two days are the same, especially in winter.”

“The forecasts provided by the Met Office are vital to us from both a safety and economic point of view.”



Martin Bidmead

Watch Officer at the Maritime Rescue Coordination Centre

Based at Falmouth, Cornwall

13 years in the job

“Weather affects us on a daily basis and is instrumental in all we do. In the winter, we get fewer leisure users coming here and Search and Rescue is used mainly for commercial mariners and fishermen. Improvements in weather forecasting and modern communications now make sure mariners have an up to date forecast at their fingertips. Despite all that, there are problems occasionally and people are still susceptible to injuries in bad weather and have to be evacuated to safety.

Every coastguard gets information from the Met Office — the UK coastguard stations even broadcast every three hours to mariners. We also use a digital system (NAVTEX). This allows us to communicate accurate weather information in a digital format to shipping within a 200 mile radius and allows them to plan routes ahead. NAVTEX also determines if we need to send out a lifeboat or a helicopter or deviate commercial vessels to the rescue scene.

The best thing about my job is knowing that when someone contacts us, we have the ability and resources to help them — no matter where they are in the world.”

“Weather affects us on a daily basis and is instrumental in all we do.”

Studying the skies



It is estimated that approximately 50,000 commercial flights take to the skies every day, worldwide. To fly safely, every one of those relies on accurate information about the weather — both in the skies and at ground level. The need to get accurate information to the airline industry fast, is greater today than ever.

Even the most accurate weather predictions are of little use unless they get to the right people at the right time. In aviation, the need for up-to-the-minute information is greater than almost any other industry. That's why the Met Office provides a range of forecasts in a variety of ways to help airlines and airport operators around the world. These include services such as 24 hour Satellite Distribution (SADIS), significant weather charts and even urgent 'text message' style warnings sent direct to flight control to keep them informed of severe weather events in the next few hours.

Advanced warning

Having a good understanding of likely weather conditions helps enormously at the planning stages of a flight. Powerful storms and strong headwinds can have a huge impact on the amount of fuel a plane uses and, therefore, how much it needs to carry. As Nigel Gait, International Aviation Manager for the Met Office explains, "Our forecasts for destination airports and en-route weather conditions provide pilots and dispatchers with the details they need in the flight-planning stage to carry sufficient fuel for the flight and to divert if the worst ever happens."

But in addition to its routine forecasts, the Met Office also provides services that help while planes are in the skies, including an emergency warning system that relays urgent text-style messages to flight control — quickly and simply. Severe turbulence warnings can be sent via the Aeronautical Fixed Telecommunications Network (AFTN) and on to pilots, even at the last minute. "We can alert air-traffic control to a thunderstorm in the next couple of hours, giving them time to re-route flights or stop refuelling if necessary," Nigel says.

An enlightening forecast

It's not just 'normal' weather that can affect airlines. In certain parts of the world, phenomena such as



volcanic ash is a real hazard. Iceland, for example, has a volcanic eruption roughly every five years. The Pacific Rim — including countries such as Indonesia — see a huge amount of volcanic activity year-round. Where this ash goes and how it disperses depends to a large extent on the prevailing weather. Nigel explains, "We always keep a close eye on these areas to prevent cases like the one in the 1980s — where a British Airways Boeing 747 lost all four engines temporarily after flying into a volcanic ash cloud."

To add to the industry's challenges, conditions on the ground as well as in the skies can be just as critical to safety and the smooth running of operations. In sub-zero temperatures, planes need de-icing before they can fly, which is a costly process that needs to be planned in advance. And, as Nigel explains, "fog, snow, ice and even electrical storms create problems and delays for aircraft on the ground".

A smooth operation

European air space is among the busiest in the world, and the current air-traffic management system suffers from several inefficiencies, such as using air-traffic control boundaries that follow national borders. In October 2001, the European Commission adopted proposals for a Single European Sky (SES), to create a community regulator for air-traffic management within the European Union, Norway and Switzerland. In future, Single European Skies plans to merge upper European airspace, currently divided into national regions and will organise this airspace uniformly, with air-traffic control areas based on operational efficiency, not national borders. Also, it will integrate civil and military air-traffic management.

"If you're flying from the UK to Italy for example, you pass through various air-traffic areas, each with slightly different air navigation systems,"

"Our forecasts for destination airports and en-route weather conditions provide pilots and dispatchers with the details they need in the flight-planning stage to carry sufficient fuel for the flight and to divert if the worst ever happens."

Nigel explains. "SES aims to make the whole process more efficient and cost-effective — and information from the Met Office is a key part of that."

In the 1990s the Met Office also developed its Satellite Distribution system (SADIS), which provides unified weather information to countries around the world — even those in the most remote areas. It covers around 60 per cent of the Earth's land surface and, as Nigel says, "SADIS is a fast and efficient way to reach countries where telecommunications are less reliable — such as parts of Africa."

The Met Office is constantly looking for new ways to help the aviation industry, whatever challenges it faces. So whether it's a matter of predicting severe storms, the movement of ash from volcanoes, or delivering consistent weather predictions to far-flung corners of the globe, the priority is always keeping people moving and keeping them safe.

The additional computing power provided by our new supercomputer has enabled us to increase the vertical resolution of our operational global Numerical Weather Prediction (NWP) model and the North Atlantic European (NAE) model. Here, Met Office scientist Sean Milton describes the improvements to the models and the resulting forecasts.

Smaller the better

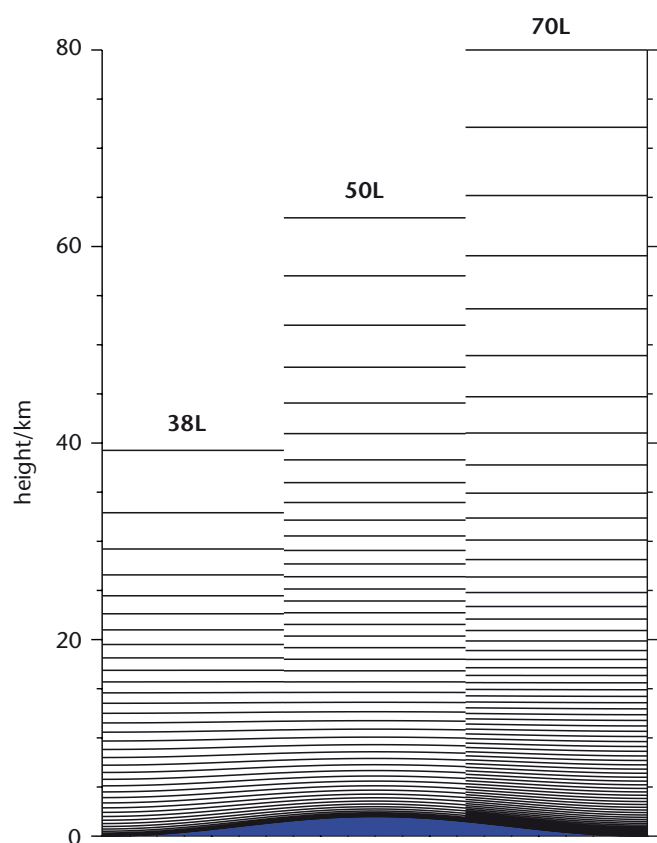


Figure 1: 38, 50 and 70 level vertical configurations for the Unified Model.

NWP models such as the Met Office Unified Model™ split the atmosphere into a three-dimensional grid of boxes to solve equations of atmospheric motion. The size of the grid-boxes are chosen to be as small as possible, subject to operational time-constraints and available computing resources, because errors in NWP models are generally proportional to the size of the grid-boxes.

This autumn, the number of grid-boxes (levels) used vertically has been increased to 70 in the operational global and NAE models. Previously, 50 levels were used in the global model and 38 levels were used in the NAE model. The distribution of the levels in these three configurations is shown in Figure 1. For all three level sets, the finest resolution is concentrated near the ground so that the most important layer, the atmospheric boundary layer in which we live, is as well resolved as possible. As resolution increases, smaller scale features determining the weather can be reproduced more accurately.

The spacing of the levels becomes steadily wider apart further away from the ground and is coarsest at the top of the model domain. As can be seen by comparing the three levels sets, most of the additional resolution of the 70 levels set has been concentrated in the troposphere (the lowest 15 km of the atmosphere). In addition, the top of the model atmosphere (the model lid) has been raised to 80 km so that both the stratosphere and mesosphere are wholly contained within the model domain. Previously, the model lid in the global model was located at 65 km, while in the NAE it was at 40 km.

The increased vertical resolution in the troposphere gives a better representation of smaller scales of motion and smaller vertical structures and so will improve our forecasts to a wide range of customers. This includes forecasts of jet stream winds used by the aviation community to reduce flight times and costs on transits such as from the USA to Europe (see pages

13 & 14). Increased resolution in the boundary layer allows a better representation of features such as temperature inversions, which are important for trapping heat and moisture near the ground and in the formation and evolution of boundary layer clouds such as stratocumulus which are widespread across the continents and oceans.

Another benefit of increasing the vertical resolution is the improved use of observations. This benefit applies equally to existing conventional observations such as radiosonde balloon data as it does to newer satellite observations such as those obtained from the IASI instrument (Infrared Atmospheric Sounding Interferometer that estimates and monitors trace gases like ozone, methane or carbon monoxide) aboard the METOP meteorological satellites. Results from trials of the 70 levels have shown a closer fit to observations in our data assimilation system which means a better set of initial conditions from which to start our weather predictions. One of the benefits of raising the model lid to 80 km is that it provides us with a better representation of the whole of the stratosphere, which should improve longer range predictions (from 15 days to a season) since the influence of the stratosphere on tropospheric weather becomes increasingly significant for longer lead times.

The recent increase in vertical resolution is the latest step in our continued improvement of our representation of the atmosphere. The number of levels has increased from 19 levels back in 1998 through to 70 levels now. At the same time, improvements to the horizontal resolution have been made. In spring 2010 the next increase in the global model horizontal resolution, from 40 km to 25 km, will be implemented. Further ahead, in 2011, we plan to implement a global model with 16 km horizontal resolution and 100 levels, bringing even more benefits to our detailed forecasting capability.

Science profile

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



Sean Milton

Manager Global Model Development & Diagnostics

In the world's intensely complex weather systems, even the smallest errors can affect the accuracy of weather modelling. When errors occur in the Met Office's global Numerical Weather Prediction, it's the job of Sean Milton and his team to make sure they are identified and acted on.

Error finder

Errors in weather forecasts can arise from a number of sources. From the limitations in the physics and dynamics of the forecast model and in the resolution at which it is run, and from uncertainties in determining the current state of the atmosphere used to initialise the forecasts. Coupled with the inherent complexity and chaotic nature of the weather — errors are part and parcel of forecasting. At the moment the Met Office runs a global model on a grid with a resolution of 40 km. But weather events that happen on a much smaller scale still feed into larger systems and can affect the bigger picture.

"It's our job to study the systematic errors over many individual cases and attempt to spot patterns in where they are coming from," says Sean, adding, "We are constantly trying to push the resolution of our models higher so we can reduce errors further."

"We monitor the system using various diagnostic techniques — comparing the models against observations on the ground and from aircraft or satellites. Our findings are then fed back into the model, so we have a continually improving system."

An eye for detail

Sean joined the Met Office in 1986, following a Physics degree at the University of Sheffield. "I did courses on geophysical fluids and that sparked my interest in meteorology. But when I joined the Met Office what really inspired me was the global modelling side of things." Sean began his career researching into predictability in 30-day forecasts, but has since moved to studying weather and model errors on shorter timescales.

Over the years, Sean has seen the model change radically. When he started, the Met Office used a resolution of 100 km and now it's down to 20 km for the global model. "In terms of performance, accuracy and the scale of phenomena it's made a huge difference."

Better together

For Sean the greatest rewards come from collaboration. This, he explains, is the key advantage of the Unified Model™.

"We use the same model across all of the different timescales. This means advances in one area can be adopted in another. For example, on the longer climate change timescales they build complex physics into the model — some of this code, like modelling dust uplift and transport, we've taken and implemented into the weather prediction models."

It's a collaborative approach that extends beyond the Met Office as Sean and his team are working with universities and other National Meteorological Services to compare the model with satellite data and other observations — including work in Africa, Europe and the Arctic.

The pursuit of perfection

Of course, Sean and his team are not standing still and they hope to reach a resolution down to 16 km by as early as 2011. These advances will touch other areas too, with more complex calculations covering air quality, atmospheric chemistry and the influence of ocean-atmosphere interactions on weather prediction timescales.

"We're already looking at putting things like dust and other aerosols and an improved representation of the ocean into the global weather model," Sean adds.

It is this pursuit of perfection that makes the Unified Model™ such a globally respected system. And thanks to the work of people like Sean, the model just keeps on getting better.



Leaves on the line

Although leaves on train lines have been considered a national joke, they are as dangerous for trains as black ice is for cars. Just one of the important services provided by the Met Office Rural Environment Team (MORET) is assessing the threat of leaf and tree fall for the rail industry.



Office Rural Environment Team (MORET), a specialised team of Met Office scientists, is based at ADAS in Wolverhampton.

To predict where leaves on the line will cause problems, the Met Office has teamed up with environmental consultancy ADAS to produce a leaf-fall and low adhesion forecast system. The Met

MORET helps ADAS to deliver tailored solutions to environmental and rural problems that require both a meteorological and environmental application of science. MORET works to solve a variety of problems including predicting leaves on the line for the railway industry, assessing the threat of falling trees on key transport and utility infrastructure.

Vicky Chapman, MORET Senior Scientist says, “Leaves on the line are as dangerous for trains as black ice is for cars. Leaves trapped between the train wheels and

tracks are subject to immense pressure, producing a slippery, Teflon-like layer of black material. This layer reduces the braking efficiency of trains. This can lead to trains not stopping at red lights or stations, increasing the risk of collisions.”

During the autumn, it is harder for trains to accelerate and brake efficiently. In difficult conditions, train drivers adjust their driving style which can cause train services to lose time. To complicate things further, railhead conditions are made even more slippery in certain weather conditions — for example, if there is light rain or dew.

MORET’s Leaf Fall Service provides Network Rail, the train operating companies and London Underground with early warnings, which help them to plan mitigation strategies such as water-jetting trains and clearance work. Reducing leaf fall risk on the rail network not only improves safety, but also helps avoid costly delays and any associated negative public perception of the railways.

“Forecasting these problems is particularly difficult as leaf fall depends on a variety of weather factors such as frost, wind, precipitation, the amount of daylight and temperature. But it also varies, depending on the types of trees growing in a particular location. Our predictions help our customers to anticipate problems and reduce the impact on the travelling public and rail safety,” explains Vicky.

But it is not just leaves that MORET are concerned with — they also provide forecasts of potato blight outbreaks, climate change impacts on agriculture, and air quality modelling and expert witness services for planning enquiries for livestock, food and sewage plants.

As Martin Buckland, ADAS’s Director of Sales and Marketing says, “The combination of MORET’s world class meteorology skills and high quality weather data alongside ADAS’s practical understanding of the living, growing environment, modelling and software development skills enables us to provide a unique service to a wide range of clients. I think we’re only just discovering the power and value of the models and tools we can provide, and I’m looking forward to developing some new and exciting services alongside MORET.”

➡ Turn to page 11 to find out how Met Office forecasts help train drivers plan ahead.

Star gazer

Sir Patrick Moore

From the moon landings to Morecombe and Wise, Sir Patrick Moore has led an exceptional life and perhaps popularised astronomy more than any other person in history.

Sir Patrick's interest in astronomy was first piqued when his mother gave him a copy of *'Story of the Solar System'* by GF Chambers. He was just seven and it was, "Not a normal boy's book," Sir Patrick admits, "but from that moment onwards I was hooked." And after serving in the RAF as a navigator for five years during World War II, he settled into home in Sussex and began focusing on astronomy — using a homemade reflecting telescope in his garden.

A rich life

Sir Patrick's life has been anything but pedestrian. His big personality has led him to appear on such classic TV shows as Morecombe and Wise and The Goodies where he was quite at home parodying himself. He appeared as the Gamesmaster in the show of the same name for six consecutive years in the 1990s and he has written many

fiction and non-fiction books. While his talent for music (he taught himself the xylophone) led him to compose a large body of work including two operettas and perform at Royal Variety Performances. He even once accompanied Albert Einstein in his violin rendition of The Swan — which was unfortunately not recorded.

But of course, Sir Patrick is best known for presenting The Sky at Night. He has personally presented every single episode of the 52 year run except for

one, due to food poisoning. Through all this, he still states his worst moment as being "...when I swallowed a bluebottle live on air. It buzzed all the way down."

Weather aware

There is an obvious and strong link between astronomy and the weather as Sir Patrick states, "With clouds around, you can't see anything." This is a constant challenge for astronomers and has caused him many frustrations while presenting the Sky at Night including one particular show he recalls from the 1960s:

"We were supposed to do a live view of Saturn, which was very exciting at the time but the night was mostly cloudy. It was so frustrating that the episode became quite infamous and still pops up on clip programmes today."

Sir Patrick operated one of the original amateur weather stations, providing readings to the Met Office and was heavily involved with the organisation during the war. Unsurprisingly, he feels amateurs also have a lot to offer to astronomy.

"Astronomy is one of the few sciences in which the amateur can play a really useful role. For example, they have always been to the fore in discovering comets and novae, hunting for supernovae, and monitoring events happening on the planets."

Historic moments

Sir Patrick's knowledge of the moon is so extensive he was involved in the lunar mapping used by the NASA Apollo space missions and was a presenter of the BBC's coverage of the moon landing, 40 years ago.

"I remember it vividly," he says. "I was very nervous. After all, going down to the moon had never been done before, and if they'd made a faulty landing they couldn't have got back. There would have been no rescue for them."

Having achieved so many accomplishments in so many different ways, one could be forgiven for expecting Sir Patrick to take things a little easy from now on. But his love for astronomy is still a driving force in his life.

"I am 86 now. I will go on as long as I can. All I want to achieve now is the promotion of astronomy and helping to encourage others into the role. That's my aim now — to help people and encourage them into astronomy."

"All I want to achieve now is the promotion of astronomy and helping to encourage others into the role."



Head in the clouds

Looking up at contrails, the mind wanders to where the plane that made the contrail may be going — where the passengers may be headed for.

Condensation trails form in the wake of aircraft when the air is sufficiently cold and humid. They are long thin clouds of ice crystals left behind jets at around 30,000 feet. They are often short-lived, but if the air has enough moisture in it, they can last for a long time before they evaporate. Contrails have well-defined edges, even as they fade away.

Not to be confused with contrails are smoke trails. Smoke trails can look very like contrails and are used to enhance aerobatics exhibitions. For example, the Royal Air Force Aerobatic Team, the Red Arrows, often uses different coloured smoke trails in their displays.

Photo: Mark Machin

