National Science and Engineering Week Seminar Thursday, 18th March 2010

UK SCIENTIFIC EXCELLENCE SERVES THE WHOLE PLANET

Professor John Beddington, the Government's Chief Scientific Advisor

National Science & Engineering Week (12-13 March 2010), with its celebration of UK science and its theme this year of 'Earth', is a good opportunity to focus on the value and relevance of the Met Office to the UK and the wider world.

The Met Office is a notable British science success story, operating from a UK domestic research base that is second only to the US on the majority of leading indicators.

The information the Met Office provides is of great value to the UK and also of global importance. Accurate forecasting will be crucial in resolving uncertainties over the way events such as droughts, monsoons and *El Nino* affect specific localities. For example, the Met Office is the Volcanic Ash Advisory Centre for the North Atlantic. They conducted crucial modelling analysis during the disruption to air traffic caused by the Eyjafjallajökull Volcano eruption, providing essential information on the spread of the ash plume.

Against the backdrop of climate change it is no exaggeration to say that the work of the Met Office is not just world-beating but may be world-saving and in introducing the other contributors on this theme I can do no better than set out the nature of the challenge we face.

The Copenhagen Accord provided a commitment by signatories to hold the increase in global temperatures below 2°C, and more than 70 countries have submitted pledges to reduce emissions. Despite its shortcomings, the Copenhagen Accord is an important step forwards. For the first time, all of the world's largest greenhouse-gas emitters have signed up to a framework for co-operation on one of the biggest challenges of our time.

If we do not meet the target of holding global temperature rise below 2°C, the Met Office predict the impacts will be wide-ranging. The risks include an increased danger of forest fires in many parts of the world; reduced crop yields across the Americas and Asia; a reduction in run-off in the Amazon basin and elsewhere; rising sea levels; an increase in the frequency of drought events in the Mediterranean basin and other areas; the Greenland and West Antarctic ice sheets at increased risk of irreversible decline; and tropical cyclones becoming more intense and destructive. Rising levels of carbon dioxide will also drive ocean acidification, with a significant impact on fisheries. There are, of course, uncertainties in all predictions of future change, particularly on regional scales, and we must be sure to communicate these uncertainties accurately and effectively, but the evidence is clear that climate change is a problem we cannot ignore.

I am concerned by the number of people who, despite the compelling evidence that exists, doubt the threat that man-made climate change presents. Proper scepticism is part of the scientific process and should be welcomed, but ignoring what is clear from real-world observations cannot be justified. The hard science behind the forecasting and observation will be key to improving our understanding of the challenges we face. The Met Office and UK science have a crucial role to play in continuing to develop this, as well as in communicating the evidence effectively to a wide and sometimes sceptical audience.

. . . the evidence is clear that climate change is a problem we cannot ignore. . .

WHAT IS SEAMLESS WEATHER FORECASTING? HOW CAN WE FORECAST YEARS AHEAD, AND MANAGE THE GLOBAL FINANCIAL RISKS PROFITABLY?

INTRODUCTION TO THE MET OFFICE

John Hirst Chief Executive, Met Office

Today, I want to give you an overview of the Met Office and what we do. Many people are unaware of the depth and breadth of our work, so I can usually guarantee that, at some point, the thought: *"Wow, I didn't know they did that!"* will cross your mind.

Our aim is: *"To be recognised as the best weather and climate service in the world"*. It's not enough for us to simply be the best. We want to be recognised as such by our customers, collaborators and competitors and we have set up benchmarking work to check our service and the value for money we give against the other leaders around the world.

Our strength comes, in part, from dealing with weather and climate as a combined entity. That is, literally, under one roof and using much of the same science. And we are the only institution in the world with this capability.

We're probably best known for forecasting the weather over the short term - 3 to 4 days. And we have measures that show our operational forecast accuracy over that period is the best there is.

The development of supercomputing and, with it, numerical modelling has come a long way in recent years. Climate science is now well established, with its core predictions now thoroughly peer reviewed and accepted by the vast majority of scientists. The challenging work is now in forecasting the outcomes that are possible across the world under different scenarios and communicating sometimes complex science to the public.

A new area of science is in the intermediate periods, from months to a decade ahead. The media coverage of the Met Office's seasonal forecasts has been extensive and not entirely complimentary; demonstrating a need for us to learn more about who may benefit from the science and how best to communicate it. Some sectors – financial markets and Operations Managers across industry – understand the real benefits of such science, even at this developmental stage but it is of less benefit, however, to a member of public deciding if they need an umbrella today.

We have many world-leading scientists working at the Met Office but, to ensure we achieve our best, we also work closely with others worldwide. This includes sharing our supercomputer with NERC; working closely with both UK and international academia; fulfilling our role as UK representative within the World Meteorological Organization; and working in conjunction with other countries' National Meteorological Services. For example, we're working with Bureau of Meteorology in Australia that uses our Unified Model under license, to develop and improve the model for our joint benefit.

All this research feeds through into the Met Office operations, which in turn drives the research so that we're constantly developing and improving.

Beginning with our daily forecasts on TV, on radio and online – provided by our Public Weather Service – there's a drive to improve availability and quality, but in tandem, we're developing ever more tailored products and services. From these we generate revenue and the profit from these tailored services is reinvested, limiting our cost to the tax payer; maximising value for money; and funding further development.

Another aspect of our core role is the provision of the National Severe Weather Warning Service which lets people, emergency responders and, when necessary, the emergency command structure know in advance that the weather may take a turn for the worst. Meanwhile, the Met Office Hadley Centre has been recognised as leading the world in climate-change research and services, and makes a significant contribution to the Intergovernmental Panel on Climate Change.

Some of our less well-known services include environmental monitoring. Here the Met Office again works alongside emergency services to give guidance on the spread of volcanic ash, or diseases such as Foot and Mouth and Bluetongue in cattle. We also have staff serving in a military reserve unit of the RAF, stationed abroad in countries in conflict.

We provide services for healthcare, most notably to sufferers of COPD (Chronic Obstructive Pulmonary Disease). By notifying individual patients of the likelihood of the kind of weather which aggravates the condition, this service has been shown to save lives and the cost of hospital admissions.

We also provide forecasts for utilities companies, the construction industry, airlines, shipping, road gritting, sporting events, mining companies, the oil industry, the insurance industry, private pilots, leisure sailors, balloonists… The list goes on. The range of Met Office customers is vast because the weather touches all our lives.

I hope I've been able to provide you with at least one, *"Wow, I didn't know that!"* and an outline of some the important work that goes on at the Met Office.

WHAT IS SEAMLESS WEATHER FORECASTING? HOW CAN WE FORECAST YEARS AHEAD, AND MANAGE THE GLOBAL FINANCIAL RISKS PROFITABLY?

A GLOBAL CLIMATE SERVICE FOR THE UK

Dr Vicky Pope, Head of Climate Change Advice, Met Office

CLIMATE SCIENCE

Introduction to the basic science with the evidence of climate change

http://www.metoffice.gov.uk/climatechange/science/controversy/facts.html

CLIMATE SERVICES: STATEMENT OF INTENT

The vision:

- To deliver the most trustworthy predictions of how climate may vary and change over the coming weeks and decades.
- To interpret those predictions in terms of the risks of hazardous weather and climate extremes
- To provide products and advice to help society plan for and adapt to climate variability and climate change in a timely fashion

EXAMPLES OF CLIMATE SERVICES

UK Climate Projections 2009

Climate change is affecting our world now and, because of greenhouse gases already released, we are guaranteed further changes in the coming years and decades. While the extent of these changes will be influenced by the emissions we release today and in the future, any level of change will pose many potential threats and some possible opportunities. It is, therefore, essential to understand these issues so we can start adapting right away for the changes to come.

The UK Climate Projections 20091 are a major step forward in addressing this need for the UK. The Met Office Hadley Centre produced an ambitious and comprehensive analysis of regional climate change for UKCP09. The projections provide probabilistic information on how the UK's climate could change in the 21st century based on state-of-the-art climate models, observations and statistical analysis, combined with expert knowledge. The projections are a key part of a programme of decision support tools and measures from the UK Government to both encourage and support action to prepare for the impacts of our changing climate.

THAMES ESTUARY 2100 PROJECT

Key points

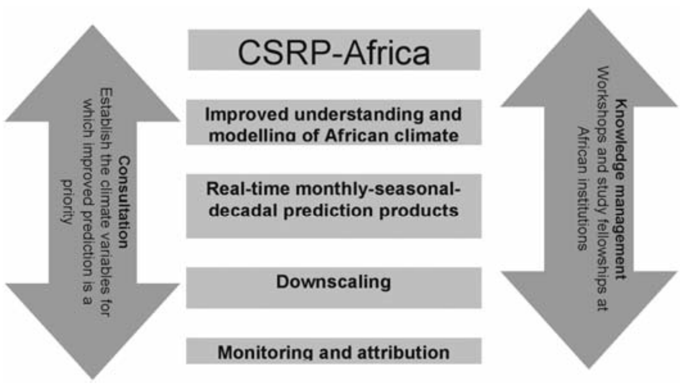
- Advice to Environment Agency
- Simulated flood in the Thames Estuary
- Model projections
- Average sea level - most likely 20-80cm 2m possible
- Intensity and frequency of storm surges up to 0.7m
- Inform future design improvements to the Thames Barrier

Background information

http://www.metoffice.gov.uk/corporate/pressoffice/2008/pr20080923.html

THE DFID-MET OFFICE HADLEY CENTRE AFRICA CLIMATE SCIENCE RESEARCH PARTNERSHIP (CSRP)

- Over next 10 years comprehensive climate services will be developed internationally
- Focus on monthly to decadal timescales of near term adaptation (unavoidable climate change)
- Natural climate variability and man made change both important – extremes focus
- Current climate models indicate some levels of skill for regional predictions but there is much to be done to improve them – process focus.
- Will need strong links to application modelling and risk analysis
- Adaptation is regional – international collaboration and user engagement is critical



WHAT IS SEAMLESS WEATHER FORECASTING? HOW CAN WE FORECAST YEARS AHEAD, AND MANAGE THE GLOBAL FINANCIAL RISKS PROFITABLY?

CLIMATE SERVICES – A NEW INDUSTRY EMERGES

Dr Matt Huddleston FRMetS,
Principal Consultant,
Climate Change, Met Office

In the communication of weather and climate perils, each side of a debate are apt to rally around any evidence that supports their cause. There have been many examples of this in recent years as the implications of climate science have impinged on political and social debate, with for example low levels of artic sea ice being attributed to the worsening of man-made climate change, and likewise the recovery some glaciers in Greenland being used to show it has stopped.

These variations may be influenced by man-made change to some degree, but are in fact largely natural in origin. As with the old fable of the blind men describing an elephant, seeing too small amount of a problem can lead to wrong assumptions. Some of these *natural variations*, such as the Pacific wide El Nino phenomenon, impact on human endeavours globally, and also in this case act as a modulation on top of any underlying longer trend from either natural or man-made sources. As with any complex system, a narrow view of a short lived event may hide significant underlying trends in the opposite direction.

The revolution in weather and climate science has been driven forward by increasing computational power. The underlying rules which govern the movement of heat, energy and moisture of the earth's environmental system can be encapsulated, coded and tested and so enabling our daily weather forecasts. Forecasts of weather for 3 days ahead are now as good as forecasts of tomorrow 20 years ago, and indeed the Met Office daily global forecasts are world leading in terms of accuracy and relied upon by everyone from our military operations in Afghanistan to disaster management efforts in Africa.

Three factors govern the use of computational resource:

(1) the detail to which one wishes to analyse environmental risk. A case in point is the latest IBM supercomputer at the Met Office has enabled a stunning improvement in the forecasts of impacts of extreme rainfall for flooding events such as those in Morpeth in 2008. Such short-range weather models now resolve down to 1.5km allowing local mountains and coasts to be more fully resolved. The forecasts from the models look astonishingly like satellite images as they resolve more detail than ever before. Application to climate forecasts also allows changes in weather to be captured over decades – which is critical for understanding the actual impact of our changing climate.

(2) the complexity can be increased to match more of the processes observed in the real world. The atmosphere interacts with these and the complex dance of energy, heat and moisture between the systems defines the variations in our climate. To date this has included the addition of the oceans, land surface, land ice, atmospheric gases such as ozone and methane, aerosols such as desert dust, volcanic ash, black carbon and cooling sulphur, sea ice, ocean biology, crops and forestry and even natural fires. King among these for forecasting beyond 2 weeks ahead is the world's oceans. Indeed the top 3m of the ocean holds more heat than the entire atmosphere and yet the average depth of the ocean is more than 3km. As the ocean moves heat around our planet, the atmosphere responds and interacts defining future weather patterns and impacts.

(3) there are uncertainties in science, not just from our understanding but also some inherent but quantifiable uncertainties in the chaotic

weather-climate system itself. This means that individual events such as a hurricane may not be predictable more than 2 weeks ahead, but the likelihood of more hurricanes over the coming June-November Atlantic season can be forecast. This is the difference between a weather and a climate forecast – one relies on knowing the here and now well enough to forecast the near future. The second relies on knowing the boundaries that drive the atmosphere such as the ocean temperature.

One forecast is not enough to quantify risk – the uncertainties need to be sampled and different scenarios explored. This leads to "ensemble" forecasts – meaning that we may need to run a forecast 10, 50 or 100 times to increase certainty to the level at which decisions can be made.

The combination of weather and climate forecasting technologies and these 3 factors, together with understanding of natural climate variations on a 1 month to 10 year timescale thus opens a new chapter in the management of risk in countless human endeavours. These are the timescales on which we can respond and react, and put mitigating responses in place. It is the timescale of the life of a government or a CEO. It is the timescale on which we can adapt to a changing climate.

As such we have a new paradigm – that of the climate service. Many institutions globally are involved, and it is fair to say that the UK has an expertise and lead in the science and it's application to real world decision making. Our goal is:

- To deliver the most trustworthy predictions of how climate may vary and change over the coming weeks to decades;
- To interpret those predictions in terms of the risks of hazardous weather and climate extremes, and of the potential for dangerous climate change;
- To provide products and advice to help society plan for and adapt to climate variability and climate change in a timely fashion;
- To provide ongoing scientific advice on the climate benefits and risks associated with mitigation policies.

Examples of such services are already emerging. In giving an early warning of potential floods in West Africa in 2008, the International Federation of Red Cross and Red Crescent Societies put food reserves and emergency stocks in place such that most countries received needed supplies in a matter of days after flooding occurred compared to an average of 40 days in the past, thus ameliorating human suffering and fostering community recovery.

Tropical storms are devastating no matter where they hit and adaptation mechanisms include the global insurance and re-insurance industry to distribute the costs of devastation. In the Atlantic, a forecast of the number of tropical storms for 2005 using today's technology shows a very high chance of a season that had never occurred. The outcome was indeed a record breaking year with hurricanes such as Katrina and Wilma causing colossal damage and loss. Lloyds reported losses of more than £3bn. Key to note is that this technology is not reliant on past data – it is not an empirical or statistical analysis. It thus allows forecasts of things that have not previously occurred – and as green houses gases continue to accumulate in the atmosphere and the earth system moves into new climatic territories, this will be a critical tool to enable us to adapt.

The costs of natural climate change can also be assessed. For Europe, a study commissioned by the Association of British Insurers showed insured losses from winter wind storms for the UK could rise by 25% to £827 million for slight southward shift in storm track; a scenario in which more storms hit London.

To summarise, the UK now has the world's first climate service. Initially it is two fold focusing on the needs of Africa for DFID and a set of proposals to address core insurance industry needs. It is a nascent science but one of great promise which has largely become possible of the globally unique co-location of weather and climate research at the Met Office, and experience in the daily delivery of science to enable all manner of users make decisions to protect the environment, property and the security of life.

REDUCING BUSINESS RISK FROM CLIMATE CHANGE

Christopher N Bray, Environmental Risk Policy Management, Barclays

Presentation available on the website.

A REINSURANCE MODEL FOR GLOBAL CLIMATE

Matthew Foote, Research Director, Willis Research Network

Britain's public spending on science has doubled in real terms over the past 10 years to more than £6 billion, but the country's future as a leader in scientific research and innovation is by no means secure.

A new report by the Royal Society, which urged the new government to ramp up spending on scientific programmes, showed that, over the past 15 years, public expenditure on research and development as a percentage of GDP has been on a steady decline. According to estimates from the Institute of Fiscal Studies, planned public spending cuts of around 6.4% per year through 2012, if applied to science, would threaten the UK's position at the forefront of global science and risk our long-term economic health. Meanwhile, UK businesses' contribution is not enough to plug the gap. British industry spends around 1% of GDP on scientific research and development – around half that spent by business in the US, Japan and Germany. Without a renewed focus on investment in science, the Royal Society warned, the UK could fall behind other countries – especially emerging economies such as China, India and Brazil, all of which are expanding their funding in scientific research.

The nationwide decline in science-related investments comes at a time when governments and industry from around the world are calling for more sophisticated data to help them prepare for an increasingly volatile climate. This is particularly true of the global reinsurance industry, which, by its very nature, is defined by the impact of extreme events.

Valued at around $213 billion of annual gross written premium in 2009, the industry provides effective financial protection from extreme events to the world's insurance companies, governments and commercial organisations.

The industry is faced with significant challenges – particularly an increasing trend in year-on-year losses, regulation of capital provision, and a steady growth in the worldwide value of insured assets within high-risk areas. Catastrophe losses from extreme weather events continue to rise, and while reinsurance provides insurers and others with the ability to stabilise their loss potential over long periods and deal with the impacts of extreme events, the quantification of that risk is difficult and subject to considerable uncertainty. The problems posed by climate variability and the particular effects on insurance are therefore ultimately ones related to the problems of uncertainty when estimating potential loss.

The impacts of extreme events are measured in terms of a 'probable maximum loss' and expressed as an exceedence probability of a loss over a given period. Reinsurance risk decisions are based upon a combination of loss history, risk appetite and other factors, where possible future losses are estimated using quantitative models that simulate the range of possible extreme events that could affect a given region. These models, known as catastrophe models, form the basis for assessing the impacts of current and future extreme events.

These models combine representations of the range of potential extreme events, the assets being insured, and their likely damages, and translate them into loss probabilities.

. . . Catastrophe losses from extreme weather events continue to rise . . .

Insurers and reinsurers each have key issues that influence their view of extreme 'catastrophic' risk, including:

- How forecasting skill (at varying temporal scales) of event likelihood and severity can be improved through better modelling and data;
- How global teleconnections such as the El Nino Southern Oscillation (ENSO), whose influence is partially evident in available historical datasets, have a physical influence on varying extreme weather distributions, and;
- How the likely frequency, severity and location of extreme events can be represented.

For the public sector, catastrophe models can be invaluable tools to identify which regions and sectors of the economy are most exposed to extreme events.

Conventional methods of modelling extreme weather events to tackle these and other questions rely in large part on available historical datasets. By their nature, however, the recording of extreme events and their impacts are infrequent and inconsistent, and can place a significant limit on the confidence placed in extreme event loss estimation.

The key question of how both natural and anthropogenic climate variability influences the distribution of extreme weather events globally, and how this changes the frequency and severity of extreme event risk, is therefore difficult to assess through the use of historical data alone.

Climate models have, until recently, been limited to broad, global or regional assessment of climate parameters, such as sea surface temperature, making their application to extreme weather catastrophe modelling difficult. Recent advances in climate modelling, used in conjunction with some of the world's largest supercompters, are now enabling scientists to resolve, or 'see', complex weather events, such as tropical cyclones within the global climate models, complementing the information provided by the historical record. More sophisticated modelling techniques are also allowing us to assess the regional impacts we can expect from a dynamic climate. These developments hold profound possibilities for the future, and are particularly crucial as more frequent and severe weather events hasten our need to understand and evaluate atmospheric related hazards.

. . . by 2011 supercomputers employed by the Met Office will deliver close to 1 trillion calculations per second, enabling more detailed global models of extreme weather . . .

. . . future losses are estimated using quantitative models that simulate the range of possible extreme events that could affect a given region . . .

As a result, climate modelling is now moving into the front line of both economic and political debate, driven by the ability to generate outputs which include representations of the extreme weather events that ultimately affect people and property. It is the medium and laboratory to assess the current and future risk of environmental change.

UK academic research, particularly that being undertaken by the National Centre for Atmospheric Science, the Met Office, and others, is leading these advances by harnessing the power of these higher resolution climate models and high performance computations. According to the Royal Society, by 2011, the supercomputers employed by the Met Office will deliver close to 1 trillion calculations per second, enabling more detailed global models of extreme weather and improved predictions of regional climate change.

Such advances, based on climate science programmes funded by the UK, will influence not only the development of the next generation of reinsurance catastrophe models, but long-term policy and financial investment decisions, and will cement the UK's position as a world-class hub for climate science research.

As Dr Robert Kirby-Harris, chief executive at the Institute of Physics recently observed: *"It is important to maintain our investment in both curiosity-driven research and research that addresses the global challenges we face at a time when other countries are doing so much to increase their focus on science and science education. The UK cannot afford to fall behind".*

"AND NOW, THE WEATHER… AND CLIMATE CHANGE"

Peter Gibbs,
Broadcast Meteorologist

For over 150 years, the Met Office has pioneered the science that makes today's advanced weather and climate forecasting possible. The development of supercomputing and, with it, numerical modelling allows us to support the UK in ways far beyond the broadcasts that make us a household name. But when it comes to communicating them to the nation, weather and climate change require very different approaches.

Imagine sitting in BBC Radio 4's *Today* studio, waiting to present the weather forecast. A journalist is being interviewed about some of the worst flooding for half a century. As the interview ends, you look towards John Humphries who asks, "Just before the forecast…tell me. Are these floods due to climate change?" Now try putting a single severe weather event in the context of long-term climate change and presenting the UK forecast in one-and-a-half minutes.

WEATHER

The weather is very complex. While one part of a town may be affected by heavy showers and flash floods, another can stay completely dry. An increase of just 10mph in wind speed in a storm can lead to an exponential increase in damage. These are just some of the everyday challenges weather forecasters face.

Improved models allow us to see in detail the areas at risk. They were behind the Met Office's advance warning of disruptive snowfall last winter, when we accurately predicted that snow was on its way – where it would fall and how long it would last – with a very high accuracy rate. Today, our computer forecasts are fed directly into BBC Weather's graphics system allowing important detail to be presented to the public.

But with increasing forecast accuracy comes another communication challenge: there's a lot more information to cover in a broadcast. While BBC TV and radio are vital in getting clear, accurate and timely information out to the public, particularly when severe weather strikes, other media are increasingly being used. The internet and mobile devices now allow customers to choose how much detail they want, and where and when they want it, adding to the reach and challenge of broadcasting.

And these days, it's not enough to simply forecast the weather. More and more we're being asked to predict its impacts. Last winter, just 5 cm of snow falling during rush hour was enough to cause chaos. A much bigger fall of 30 cm of snow overnight saw many people choosing to stay at home.

Supercomputers also allow us to use ensemble techniques to forecast the weather 3–6 days ahead. Here, the forecast is run many times from slightly different starting conditions and, depending on whether the results converge or deviate, gives us a useful measure of confidence. Where there are uncertainties, percentages can be a helpful way of communicating them to some sectors such as the financial markets. But they're of less benefit to a member of public deciding if they need an umbrella today.

CLIMATE

Despite the sub-zero temperatures that gripped Britain, January 2010 was globally the hottest on record – an announcement that was greeted with derision in parts of the press. While scientists don't have a problem with the global view, someone shivering in the snow is likely to feel highly sceptical. People naturally judge on personal experience, so if the Met Office says it's going to rain tomorrow and they get wet, they believe us next time. With climate change a lot of the information is counter-intuitive, which makes it even more of a challenge to convey.

On this occasion, our cold, snowy January was outweighed by warmer than normal conditions elsewhere. Remember the lack of snow at the Winter Olympics? This really emphasises the difference between weather and climate. Weather is the temperature, precipitation (rain, hail, sleet and snow) and wind, which change hour by hour and day by day. Climate is the average weather and the nature of its variations that we experience over time.

So, while the floods in Cumbria last November – the focus of our fictional *Today* broadcast – cannot be used as the smoking gun for climate change, severe weather is expected to occur more frequently as the climate continues to get warmer.

At the Met Office, we believe it's perfectly reasonable for climate science to be questioned and tested. We continue to do the difficult science that informs the British public, businesses and Government on how the climate may change in the future. We also take great care not to overstate our findings, presenting them clearly so that the facts stand up by themselves.

COMMUNICATING WEATHER & CLIMATE CHANGE – A MEDIA VIEW

Michael McCarthy,
Environment Editor,
The Independent

On Thursday 30 April last year, at 10.30 am in the forenoon, in a small room inside the Royal Institution in Albermarle Street in Central London, the Met Office chief forecaster rose to his feet and told a dozen assembled journalists that it was "odds-on for a barbecue summer" – and at that moment there began a pubic relations disaster.

It was a PR disaster which goes to the heart of the difficulty of communicating both weather and even more, climate change, which is that you are not reporting company results, of a new drug discovery, or anything which has happened, but that in every case, you are making a prediction about the future, which is of course uncertain, and more, you asking ordinary people to take a bet on it.

The barbecue summer affair turned so sour because, in a certain way, the Met Office went further than it ever had done in a forecast, and when that could not be justified, and what was forecast did not happen, everything fell apart. One is reminded of the fact – although of course one would not want to labour the comparison – that we justified going into Iran in 2003 on the basis that Saddam Hussein had weapons of mass destruction, and when none could be found, in many people's eyes, the case for war disintegrated.

But let's look closely at what happened last April 30. The chief forecaster was giving the seasonal forecast for summer 2009, and to be fair to him and the Met Office, when he said it was odds-on for a barbecue summer, he was making an accurate report, and using language precisely.

The odds he was referring to were 65-35. That meant that the Met Office supercomputer had run 50 different simulations of the weather over the coming summer, in what is known as an "ensemble" of forecasts, and 65 per cent of these had indicated it would be warmer and drier than average, while 35 per cent had indicated the opposite.

On one level the forecaster was simply reporting that, and the Met office was indeed saying that there was a 35 per cent chance of rain – which of course is how it turned out.

But in using those figures he was dealing with what is known as a "probabilistic forecast", useful in commercial risk assessment and in the insurance world, but something the public are not really used to, so in 2009 the Met office decided to "put some flesh" on the bones of its dry percentages.

That's where they went further than they ever had before; and the excess – the mistake – was in the use of metaphor. The word "barbecue" did something terribly dangerous: it ignited hope.

It conjured up a dream of patios and charcoal aromas, which after the washout summers of 2007 and 2008, was the most tremendous piece

. . . The word "barbecue" did something terribly dangerous: it ignited hope. . .

seasonal forecasting for the general public.

Yet if it's a problem is you're asking people to take a bet on the future, with weather, you're asking them to take an even greater bet on the future with climate change.

Indeed, the principal difficulty with communicating the threat of global warming is that its effects take place in years to come, and on the whole, people are not bothered about that. As Groucho Marx said: why should I care about posterity? What's posterity ever done for me?

Politicians know that ordinary people care most about a certain number of immediate interests: their finances, their health, the education of their children. The future can wait, especially if there is doubt over it, and so, if ordinary people's feelings are the beginnings of political will, it is very hard to construct a widely backed political impetus to tackle climate change. This was evident at last December's UN climate conference at Copenhagen, where it was clear that virtually all the politicians taking part were doing so with very little mandate from an engaged public; they were acting as top-down leaders, out on their own, and perhaps that accounts for some of the conference's failure.

What has carried the movement to deal with global warming for the past 20 years has been what one might call a narrative: a general belief among the public, fostered by senior scientists and bolstered by mounting evidence in the real world that the climate is indeed warming, and that we are responsible for that.

It's important to recognise that in the last three months something has happened to

> . . . To get a perfect forecast you would need an infinite amount of data, but with the few million data points we now have we can get a good picture of the next five or six days. . . .

of good news; the phrase was chosen to make headlines, and indeed it did. It was reported everywhere; in the Daily Express it was the front page lead story. And the chief forecaster went further: he said: "We do not see the London bus syndrome of three wet summers coming in a row. The likelihood of that happening is extremely small.'

That was a hostage to fortune if ever there was one: July turned out to be one of the wettest summer months on record, and by the end of it, the resentment from a public whose hopes had been so firmly raised for hot dry evenings on the patio was so intense, that, amidst a torrent of criticism, the Met Office felt obliged to issue a public apology.

But it didn't end there, and painful though this is to recount, the Met office then proceeded to get the winter seasonal forecast wrong.

Issued on September 29 last year, the winter seasonal forecast for 2009-10, said that "winter temperatures are likely to be near or above average over much of Europe including the UK. Winter 2009/10 is likely to be milder than last year for the UK, but there is still a one in seven chance of a cold winter".

As it turned out, we have just experienced the coldest winter for 31 years.

Following the barbecue summer affair, this brought down on the Met Office a torrent of extremely unpleasant criticism, ranging from attacks on individual bonuses to the suggestion that its contract to provide weather services for the BBC might not be renewed, and anyone who works with the Met Office and likes and admires its personnel, as I do, cannot but have felt a lot of sympathy.

But beyond sympathy, what are the lessons that can be learned?

The main one is that weather forecasting is still an inexact science.

Of course, it's better than it ever was. Modern weather prediction involves assembling millions of pieces of data from around the world – wind speed, air temperature, air pressure, humidity – and working out on the world's most expensive supercomputers how these phenomena will act on each other, simply according to the laws of physics. To get a perfect forecast you would need an infinite amount of data, but with the few million data points we now have we can get a good picture of the next five or six days.

However, accurately predicting longer than that – to make a seasonal rather than a weekly forecast – is very much harder, as a tiny difference in the data inputted at the beginning of such a program can make, over time, an enormous difference in the outcome. This is the meaning of the often-misquoted "butterfly effect" - the microscopic atmospheric perturbation caused by a butterfly flapping its wings might eventually, in theory, result in a hurricane.

It means that the variability of the weather is infinite, and will always be surprising us. So even though the public craves and will always crave certainty, caution is probably a better option in the medium term, and a badly bruised Met office has clearly now come to this conclusion, and decided to end this; I would venture the view that this narrative has in part imploded.

The reason is a tragic one: the politicisation of the issue.

I think it's fair to say that this polarisation began on the left. With the collapse of socialism, the future of the climate became a substitute issue for young radicals to take up, people who were rebellious in their tenor, did not dress in suits, might eat lentils and came together in climate camps to attack power stations. More seriously, they began to express their conviction as an ideology, and treat those who dissented as heretics. Thus arose the widely-used phrase "climate deniers", which, with its evocations not only of heresy but also of Holocaust denial, seems to me inappropriate; I don't use it. I use the word sceptics.

To this politicisation from the left, there was eventually an instinctive, hostile response from the right. If these long-haired types were supporting the climate change issue, with their unceasing puritan demands that we stop using our cars and cover the countryside in wind turbines, then those on the right were against it. It was a gut feeling as much as anything, but they were strongly backed in their opposition by the fossil fuel industries, who of course have much to lose through anti-climate-change measures, and they were confirmed in their gut feelings by the fact that the warming itself has been on a plateau for the last decade (although the latest forecast from the Met Office suggests that the warming will resume its progress this year).

So with this issue of atmospheric science, which will affect all our futures, it is now broadly the case that, if we leave aside the scientific community, those who think climate change is a mortal threat are on the liberal-left, whereas those who profess it to be all an exaggeration are on the right.

A number of factors have recently combined to give the sceptic side of the argument great impetus: the affair of the University of East Anglia emails, in which climate scientists may be considered to have behaved inappropriately; the sloppiness of some of the science of the UN's Intergovernmental Panel on Climate change; the failure of the Copenhagen conference; and not least, the freezing winter, which instinctively makes people think the idea of global warming is simply a non-starter.

> carbon dioxide concentration has risen by 23 per cent since 1958 and is continuing to rise ever more quickly.

> . . . at Copenhagen, it was clear that virtually all the politicians taking part were doing so with very little mandate from an engaged public . . .

For the first time, the climate-sceptic argument has gained a real purchase on public opinion, and the narrative which has been generally accepted for the last two decades, of an acceptance of the reality and menace of the problem, has to some extent disintegrated.

Difficulties with weather prediction and difficulties with climate change prediction are, it may be noted, to some extent being conflated in sceptic circles, such as parts of the Tory party, the Spectator magazine or the Daily Express, where the Met office's troubles with seasonal forecasting are being used to attack its climate expertise; the whole institution is damned as "warmist".

Warmists and deniers – isn't that just a terrible polarisation of a scientific issue?

What are we to do about all this?

The first thing is to follow Corporal Jones's advice: don't panic. Climate sceptics are having their moment in the sun. That's all right. Debate is good, But nothing in any of the East Anglian emails, or the mistakes in the IPCC's impact predictions, has remotely altered the basic science, which is that molecules of certain trace gases help retain the sun's heat in the earths atmosphere, and that we are rapidly increasing the second most important of these, carbon dioxide. Its concentration has risen by 23 per cent since 1958 and is continuing to rise ever more quickly. There can be no doubt that this will not be effect-free.

What that effect will be, we will have to wait and see, but eventually we will get our 40 degree summers in the UK and everything that will follow, and people will see that their own immediate interests are indeed threatened, and they will clamour for their politicians to act, sceptics or no sceptics.

Although by then, of course, it will be too late.