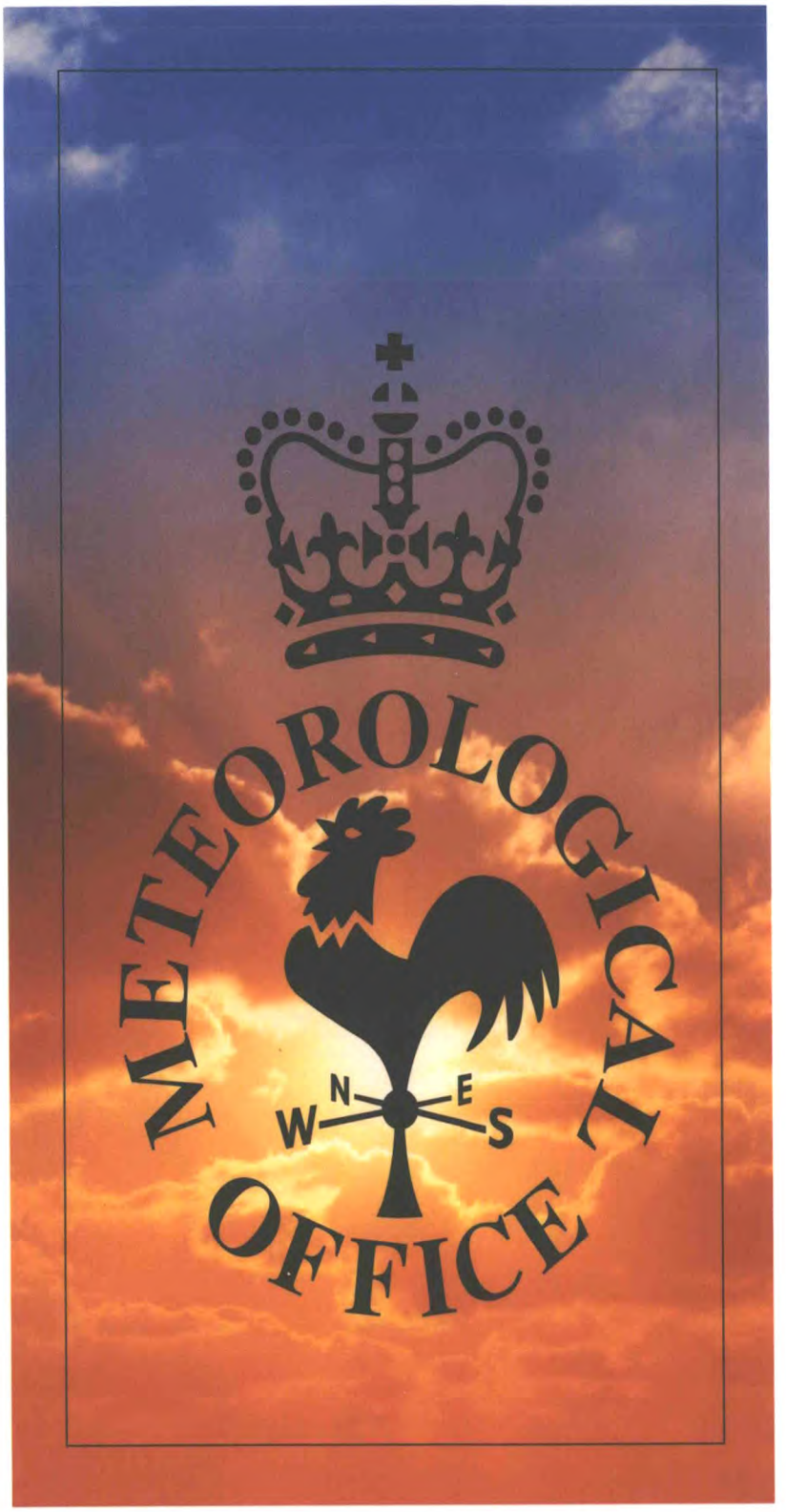


Annual Review

1992/93

The Met. Office was originally established in 1855 to aid shipping. Now, thanks to a sophisticated combination of high technology, human skills and innovative research and development, our services extend to the general public, defence, civil aviation, industry, commerce and education. Here, we review the Met. Office's activities over the last year. Other publications in this series are listed on page 28.

The Met. Office wishes to acknowledge the contributions made by the following in supplying photographic material:

National Rivers Authority,
Heerema Offshore Construction Group BV,
Associated Press,
Central Office of Information,
The Independent/Martin Hayhow.
Sue Cunningham – RGS

ISBN 0 86180 305 1

 Published by Corporate Communications, The Met. Office, London Road, Bracknell RG12 2SZ.

Contents

Met. Office Charter Standard for the Public

We aim to serve the public by providing –

Up-to-date weather information and forecasts

We will provide weather information and forecasts through radio and television, newspapers, telephone and facsimile services.

Warnings

We will issue warnings of severe weather through radio and television and to emergency organizations such as the police and fire services. We will provide warnings of adverse road conditions to the police and to local and national radio. We will provide gale warnings and marine forecasts for radio.

Advice in emergencies

We will provide warnings of coastal flooding to the National Rivers Authority and the police. We will provide weather advice for the statutory authorities regarding pollution emergencies caused by the release of toxic chemicals into the atmosphere, oil spills and nuclear accidents.

Weather and climate information

We will maintain the National Meteorological Library and Archive at Bracknell which you may visit free of charge, and develop low-cost publications containing basic weather and climate information for schools and the general public.

To enable us to achieve this we will –

Operate around the clock

To keep our forecasts up to date we work 24 hours a day, every day of the year.

Monitor the weather continuously

We will maintain a comprehensive UK network of observing stations. We also have access to observations from all other parts of the globe through our membership of the World Meteorological Organization. If we do not know what is happening today, we cannot forecast for tomorrow.

Be at the forefront of meteorological science

We are proud of our international reputation for the quality of our research which underpins all services to our customers. The Hadley Centre plays a leading role in the prediction of climate change and the effects of global warming.

Exploit modern technology

The Met. Office uses modern, well-proven technologies in its operations. The computers which run our numerical weather prediction models are among the most powerful in the world.

Play a leading role internationally

We play a full part in the development of meteorological science and operations through international collaboration. The Met. Office is a world centre for the provision of forecasts to civil aviation.

To measure how well we are doing we will –

Ask you in public surveys

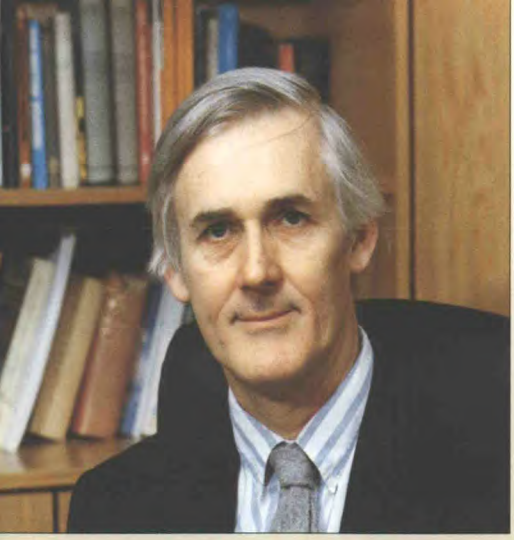
These are conducted regularly by independent consultants among a representative sample of the public. They give you an opportunity to comment on our performance and say what weather services you use, how they could be improved, and what new ones you would like. We welcome your opinions and criticisms and will react positively to them.

Monitor our forecasts

We continually monitor all aspects of our performance. We compare weather forecasts with what is observed and measure its accuracy. Forecasts have been steadily improving over the years.

Set performance targets

Our performance targets are set each year. These, and our performance against them, are published in our Annual Report and Accounts. Some of these targets are based on the results of our public surveys and measure how satisfied you are with our performance.



Chief Executive's foreword

Looking back on my first full year as Chief Executive, I am very pleased to report that the Met. Office has carried out its business with considerable success, and to thank, once again, our staff for their dedication and professionalism. We have an established position as one of the world's leading Meteorological Services, with our operational commitment to observing and forecasting the weather for the UK, Europe and the World. This was maintained without a break around the clock and throughout the year, providing a truly professional global service. Our scientific reputation is high and is essential to increasing the quality of our meteorological services to the public, our customers in defence, aviation, commerce and the public services.

This annual report provides a broad review of the services and activities of the Met. Office, it is accompanied by separate, more-detailed publications concerning the accounts and a review of scientific and technical activities. It also details various highlights of our activities For example, as the UK's national meteorological service we provided warnings of severe weather; procedures for these have recently been strengthened to ensure more-accurate and timely advice for the public and emergency services. Our early warnings of heavy rain in South Wales and tidal surges in East Anglia alerted the public and emergency services, enabling them to take safety and preventive measures; forecasts of high winds alerted traffic controllers on the Dartford bridge over the Thames.

By contrast, predictions of settled weather enabled critical engineering projects, such as construction of the second River Severn bridge, construction of a crane in China and launch of a Trident submarine, to be carried out safely and efficiently. Fair-weather forecasts for film makers in Italy helped save time and costs. And longer-range forecasts of rain and temperature for 15 to 30 days ahead enabled UK forces with the UN in Bosnia to plan their operational logistics saving time, money and lives.

Examples like these, at home and abroad, demonstrate a growing appreciation of the benefits of accurate, specific and timely weather predictions.

Our largest single customer is the Ministry of Defence, for whom we provide forecasts for training and military operations anywhere in the world. In the past year this included support for air and ground forces in northern Iraq and in Bosnia. We have continued to improve our tactical advice concerned with the impact of meteorology on weapons, sensors and military operations generally.

As one of two World Area Forecast Centres for Civil Aviation, many leading civil airlines use our global forecasting capability to plan their routes to save fuel costs and avoid areas of severe weather and turbulence. We also provided warnings to aircraft on the distribution of potentially damaging dust following the eruption of Mount Pinatubo in the Philippines in 1991.

Environmental issues continue to play an important role. We have been designated as a regional centre for predicting atmospheric dispersion of chemicals or pollutants. Under contract to the Department of the Environment our Hadley Centre for Climate Prediction and Research continued to play a full role in advising the UK Government and international community on the climatic impact of increasing greenhouse gases. We continued to be key players in the Intergovernmental Panel on Climate Change (IPCC) whose scientific assessments underpinned the Climate Convention signed by the UK at the UN Conference of Environment and Development (UNCED) at Rio de Janeiro in June 1992.

Despite the recession we achieved an impressive growth in our commercial activities with a 22% increase in invoiced value income and a corresponding growth in contribution to the core costs of the Office. Growth in international sales has been substantial and progress has been made towards a European agreement (ECOMET) for open commercial provision of meteorological services throughout Europe. New commercial services for aviation, operated jointly with the CAA, have developed rapidly during the year.

Good observations are the foundation of good forecasts. In 1992 we strengthened our observing network over the ocean to the west of the British Isles; on land we increased the number of automatic and semi-automatic observing stations. We continue to benefit greatly from the observations made by our partners in the World Meteorological Organization.

Good progress has been made towards completing and testing our Microwave Humidity Measuring Instruments (AMSU-B) being built under contract by British Aerospace, and a new weather radar, co-funded by the National Rivers Authority, was installed in Devon. A new European Community collaborative (COST) programme has begun to ensure that the weather radars in all European countries are compatible and contribute to improving short-range forecasting throughout Europe.

Our research programme led to further developments in our range of weather prediction models; we successfully introduced an operational model for producing local and regional forecasts for the British Isles. It is a measure of our international standing that by the end of 1992 many other national meteorological services were using our global forecasting model.

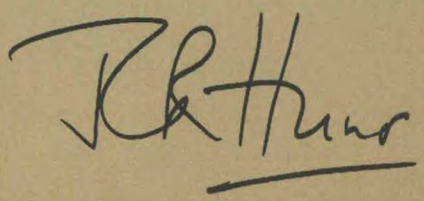
The Office has continued to play an active role in the WMO, and under the aegis of the WMO has been closely involved in new dialogue on the commercialization of meteorology.

Collaboration with private sector companies has been an essential element in the Met. Office method for developing new products – an early demonstration of the effectiveness of appropriate market testing of Met. Office policy. This has led to important developments such as MetFAX, which distributes up-to-date forecasts and weather information to pilots, yachtsmen and schools. In association with British Aerospace our PC-based Meteorological Information System (MIST) has been introduced, giving military and commercial customers ready access to meteorological data and forecasts.

We have now introduced a Quality Improvement (QI) programme. One of its first remits was to look carefully at the aims of our organization and establish a Met. Office Charter for staff (reproduced in our 1992/93 Annual Report and Accounts). Quality Improvement is a systematic approach to continuously improving our products, services and working practices.

We continued to recruit scientific and technical specialists of all ages. These were amongst the 200 staff trained at our College along with meteorologists from several other meteorological services.

Through all this activity, we have demonstrated that by encouraging and developing our staff and by national and international collaboration, the Met. Office will continue to provide the world-class meteorological service that the public and our customers have come to expect.



J.C.R. Hunt Chief Executive

The Met. Office – Who we are

The people

Since April 1990 the Met. Office has been an Executive Agency within the Ministry of Defence. It is managed by the Chief Executive, Professor Julian Hunt, assisted by four Directors, responsible for Operations, Research, Commercial Services, and Finance and Administration. The directors, and their responsibilities during 1992/93 were:

Julian Hunt: Chief Executive. Responsible to the Secretary of State for Defence. Professor Hunt is well known for his research on magneto-hydrodynamics, turbulent and stratified flows and dispersion modelling. His work has been used in building design, siting wind-energy generators and air pollution control. He is an Honorary Professor of the University of Cambridge, and was a founding director of Cambridge Environmental Research Consultants Ltd. He is a fellow of the Royal Society and was appointed Chief Executive of the Met. Office in January 1992.

Peter Ryder: Deputy Chief Executive and Director of Operations. Responsible for the coordination of all operational activities. These are to provide services to the public, civil aviation and defence, to make observations, and to provide the essential supporting functions of central forecasting, computing and telecommunications. Dr. Ryder joined the Meteorological Office in 1967, researching into ozone distribution, cloud physics, fog, mesoscale dynamics and helicopter icing before moving into support and services.

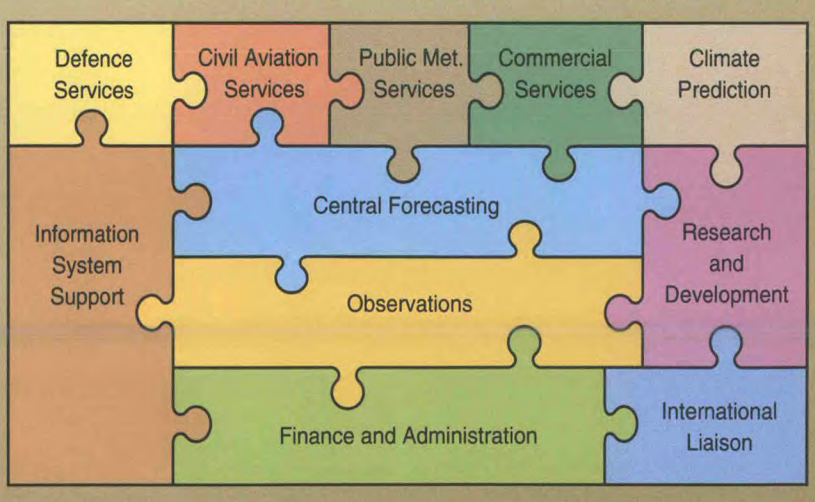
Peter Ryder has been supported by Colin Flood, Director of Central Forecasting, Frank Singleton, Director of Observations, Jim Caughey, Director of Defence Services and Roger Wiley, Director of Communications and Computing.

Paul Mason: Chief Scientist and Director of Research. Responsible for managing the research programme, for the Agency's scientific and technical standards and for providing advice on meteorological matters. After joining the Office in 1967, Dr. Mason worked on a variety of research projects, specializing in boundary layer flow, turbulence and atmospheric dispersion before becoming Director of Research in 1991. He is currently President of the Royal Meteorological Society.

The Director of Research has been supported by Peter White, Director of Atmospheric Process Research, Mike Cullen, Director of Forecasting Research and David Carson, Director of Climate Research.

Bernard Herdan: Director of Commercial Services. Responsible for all aspects of the provision of Commercial Services including sales, marketing, production and service provision and product development. Before joining the Agency, Mr. Herdan was Managing Director of Defence Technology Enterprises, a company licensing military technology for civil applications. He has also worked for the European Space Agency, BIS Mackintosh and British Aerospace. As Director of Commercial Services he is responsible for revenue targets,

All our forecasting services for defence, aviation, commerce, industry and education depend on the international observation network, advanced information systems and continuous investment in meteorological and climatic research.



Members of the main board, from left in the front row – Bernard Herdan, Peter Ryder, Julian Hunt, Paul Mason; Other directors mentioned in the text – second row – Roger Wiley, Colin Flood (centre), third row – David Carson, Jim Caughey and far right, Peter White.

broadening customer awareness of the benefits of using weather intelligence and developing our responsiveness to customers.

Michael Bowack: Director of Finance and Administration. Responsible for finance, planning, personnel, training, and legal and administrative services. Mr. Bowack is a Chartered Accountant and held a number of financial and managerial posts with Imperial, RTZ and Plessey before his appointment as the first Director of Finance and Administration on the introduction of Agency status.

The Office's headquarters is at Bracknell, Berkshire but is represented at over 100 other sites in the United Kingdom and overseas. Many of these are observing sites or local forecasting offices, meeting the specialized needs of customers. About half of its staff are based at Bracknell.

Recruitment and training

Considerable effort is devoted to recruiting staff of the right quality. As part of the Civil Service, we are committed to the fundamental principles of recruitment by fair and open competition and selection on merit, and we are an equal opportunities employer.

We recruit around 200 people each year, of which rather more than half fill scientific and technical vacancies and the remainder a wide variety of administrative and support posts.

Because we are strongly science-based, we are very interested in recruiting graduate scientists, many of whom should have potential to fill senior posts in years to come. The main need is for graduates in mathematics, physics, meteorology or computer science, but specialist skills and knowledge are required in information technology, instrument technology and physical chemistry. As our commercial work expands there is an increasing need for science graduates with business skills, experience or qualifications.

Training in meteorology is undertaken at our College at Shinfield Park, near Reading. We are now developing a distance learning programme, taking advantage of modern technology. Interactive computer-aided learning, video and other professionally designed learning packages are all being used.

Staff are encouraged to realize their potential through a wide variety of means. Support is given to younger staff in particular to study for further qualifications. Approximately 10% of staff are engaged in training programmes at any one time.

As Met. Office work covers a wide range of subjects, graduate recruits can develop their careers in many different ways, depending upon their skills and interests, for example research, computing, commercial services or forecasting.

We have now appointed an expert to develop a professional, well-researched and coherent management training programme, to complement the Office's established reputation of scientific excellence.

Approximately £3.5m is spent on training each year – a substantial investment in human resources which emphasizes our commitment to our customers and staff.

Shinfield College provides residential training for our own staff and students from national meteorological services around the world.

Corporate planning

The Office now produces each year a 5-year corporate plan and a 1-year business plan, to ensure that it develops in a well-managed way, and to justify the resources to be provided from public funds.

The 1993–98 corporate plan and the 1993–94 business plan anticipate a shift away from public funding towards greater dependence on commercial income, and the need for continuing improvement in the quality of products and their delivery to customers.

The Business Plan includes a number of challenging, but realistic, financial and quality targets. Our performance is reported in the Annual Report and Accounts. (See back page for details.)

Quality matters

Quality Improvement Programme

Early in 1992 Julian Hunt introduced a Quality Improvement programme and in March, formed a Council to direct it. In May a full-time Quality Improvement Director, Francis Hayes, was appointed. Initially, much of the activity has been to promote Quality Improvement in practical ways, by enabling staff to take direct responsibility for improvements. About 20 pilot activities have been set up. A Quality Audit Team investigated staff's attitudes towards the Met. Office, its management, their workplace, jobs, and morale. Many strengths and weaknesses were identified, enabling them to propose improvements based on facts. A second audit team is investigating responsiveness to customers.

Problem Solving Groups have been set up in the Contracts section and at the Met. Office College.

Quality Targeted Teams have already redefined the role and operation of the Board and developed the Met. Office Charter, which sets out our mission and the organizational values necessary to fulfill it. The Charter will eventually guide all our programmes of work, our decision-making and working culture.

As an example, for the first time, nearly a third of our staff, across the country, participated directly in question and answer sessions with the Chief Executive.

The corporate and business plans have been approved by the Secretary of State for Defence, the Rt. Hon. Malcolm Rifkind.

Inter Group Effectiveness Workshops aim to improve customer-supplier relationships between departments. A workshop was held with representatives of Central Forecasting and Short-range Forecasting Research divisions.

Other quality improvement projects were carried out by students on College courses, to propose improvements in their places of work – and gave them power to implement them. Without exception, all projects have been well-founded, and most have led to real improvements.

Building Quality into Commercial Services

New key-product monitoring schemes for our commercial products have been introduced. Each Weather Centre forecaster is allocated a product – OpenRoad, Weathercall, local radio broadcasts, for example – and has to ensure that it conforms to customers' needs for content, presentation and timeliness; quality is monitored explicitly for seven days each quarter.

Regional television forecasts are monitored daily and once every three months all the television weather forecasts are videotaped. These are used to check presentation standards and consistency of meteorology between national and regional stories presented by the Office – and its competitors.

Our customer satisfaction scheme now includes a quarterly canvass of more than 50 customers, and results have been excellent. Adverse comments or low ratings are followed up immediately. Automated systems are also being developed to rapidly verify the accuracy of forecasts in the form delivered to customers.

Quality teams are comprised of staff from a wide range of functions and seniorities, from administrators to senior management. Quality Improvement Director Francis Hayes is seated second from left.

Severe weather impacts life and property directly and also influences other events such as accidental releases of pollutants.

Our services

Public services

Our public commitment is to help emergency organizations safeguard life and property, and as part of our Quality Improvement programme, this year we introduced our Charter Standard for the Public – reprinted at the front of this Review. The most familiar face of the Met. Office – weather forecasts on radio, TV, newspapers and over the telephone – are services provided commercially, and described in the Commercial section.

National Severe Weather Warnings

This service provides warnings to the British public and the emergency services in the event of severe weather. Early warnings, often issued several days in advance, are sent to emergency authorities, while the public is also kept up-to-date through scheduled forecasts. Within a few hours of the event emergency 'Flash' messages giving greater detail are also sent to radio and TV for broadcast to the public.

In order to verify compliance with the emergency services' needs, we surveyed them. This showed that over 90% were either satisfied or very satisfied with the overall service. A report on the survey was also produced and distributed to recipients.

Risk assessments were trialled in the early warnings during the last quarter of the year. These give a measure of the confidence in the warning and should help the authorities in their planning. The results of the trial will be fully assessed before a decision is made whether to introduce the assessments permanently.

The main severe weather events in Britain during the year were associated with frequent thunderstorms and heavy rain during the summer months and with severe gales during the winter, particularly over Scotland. The most noteworthy of these gales was associated with an exceptionally deep depression to the north of Scotland on 10 January which contributed to the break-up of the oil-tanker *Braer* on Shetland. The forecasts were particularly accurate.

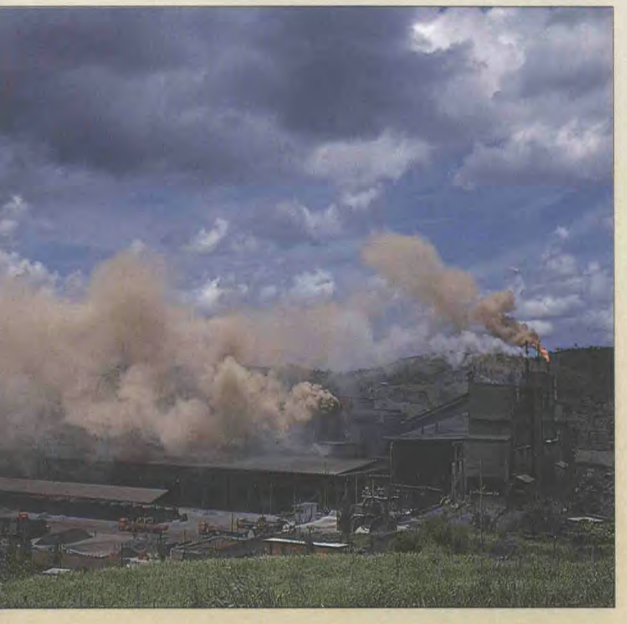
Fourteen flash messages involving snow were issued during the winter of 1992-93.

Storm Tide Warnings

This service for the Ministry of Agriculture, Fisheries and Food, provides information on the expected heights of wind-driven storm surges and surface waves. Warnings are issued when danger levels are likely to be reached. A new workstation was installed during the year which allows higher-resolution models to be run for the locality. The first of these, for the Bristol Channel, was installed by the Proudman Oceanographic Laboratory during the last quarter.

We issued warnings up to 24 hours in advance of the coastal flooding which occurred in many places in eastern England on 21 February, giving the authorities good time in which to take action. The high astronomical tides predicted for early March initially generated much media interest. Fortunately, the weather militated against the risk of flooding and intensive contact between ourselves and the media eventually allayed public fears.

Storms battered the Norfolk coast in February 1993, resulting in a holiday chalet at Hemsby, Great Yarmouth, sliding into the sea.



The Education MetFAX won a gold medal for innovation from the Geographical Association.

Pollution emergencies may be the release of toxic chemicals or radioactive material into the atmosphere, or spillage of oil into the ocean.

Pollution Emergencies

The Met. Office provides weather information to help cope with pollution emergencies. For example, the Office supplied meteorological information to help deal with the oil pollution caused by the wreck of the oil-tanker *Braer* in the Shetlands in January. A long-range transport model (NAME) became operational during the year. Although developed for nuclear emergencies such as Chernobyl it can also be used for other pollutants and natural phenomena such as volcanic dust. Our expertise in this area was recognized by the World Meteorological Organization (WMO) appointing us as one of the four world centres concerning the transport of pollutants in international emergencies. The responsibility is shared with the USA, Canada and France. It will take effect from 1 July 1993.

Shipping

Forecasts and warnings for the North Atlantic and coastal waters around the British Isles continued to be provided within the requirements of the International Convention for the Safety of Life at Sea.

Education

There were significant achievements during 1992 in our support to education. Teachers' Resource Packs for 5-7 and 7-11 year olds were produced and have proved a resounding success in primary schools. The Office, the BBC and Educational Publishing jointly produced a new weather video and resource pack for older children. The new MetFAX service for schools, which delivers weather information via dial-up fax, has proved highly successful.

Public Response

Each year the Met. Office commissions independent surveys to find out what the public thinks of us. By responding positively to the findings, we aim to ensure that the public remains happy with our performance; over 80% use television as their main source of weather information and over three quarters watch forecasts at least six days a week. Research showed conclusively that levels of satisfaction with the main national TV services on BBC and ITV remain high at over 90%. Nevertheless, areas for further improvements have been identified and we continue to develop presentations which put over the information in an interesting and informative way.

In the spirit of the Citizen's Charter initiative, a full-time Enquiries Officer was appointed at the beginning of the year at Bracknell to provide a direct line for the public to contact the Met. Office with their enquiries and criticisms. The address and telephone number are inside the back cover together with the numbers of the weather centres. Levels of complaint have been very low, but every one has been followed up promptly.

All the Forces' activities require climatological advice and continuous, extensive forecaster services.

Defence Services

The break-up of the Soviet Union and relaxation in East-West tension has led to a fundamental reappraisal of NATO and national strategy and to an expectation of a 'Peace Dividend'.

The work of Defence Services Division is guided by annual Statements of Requirement produced by the three Armed Services and other elements of MOD. These new principles emphasize mobility and flexible response.

Manpower and Mobility

The new principles obviously affect our Mobile Meteorological Unit, which has already had an increased requirement placed upon it to participate in exercises. The Unit is therefore being expanded to include two more full-time posts.

The 'Options for Change' programme has also stimulated a reorganization in the UK into 3 regions under Regional Meteorological Officers responsible for supplying defence forecasting services across their area. This was successfully achieved on 1 October 92. Manpower is steadily being reduced in the UK and RAF Germany. When fully implemented by late 1995, a saving of over 60 staff directly committed to the RAF and PE(Flying)/DRA will have occurred. Services to the Army are less affected – indeed, increased provision is being made for support to the Army Air Corps.

Meanwhile, an outbreak of peace in the world has been less easy to identify! RAF Tornado aircraft have returned to the Gulf for southern Iraq operations, and aircraft stationed in Turkey continue to protect the safe havens in the north (for which an officer of the MMU has been permanently deployed); Bosnia and Somalia also continue to make demands on our resources.

Technology

Tactical environmental advice is being provided to military commanders through acquisition, development and trial of mission-specific 'Tactical Decision Aids' (TDAs). A sophisticated TDA, the USAF Mk. III infrared TDA, has been trialled at Boscombe Down. The TDA, designed to predict target acquisition ranges for infrared (IR) sensors, has proved effective in predicting times when IR sensors will be ineffective, but further work is required before predictions are of sufficient accuracy for operational work in the Harrier's navigational systems.

Trials of the University of Salford's acoustic model have also continued at Shoeburyness, to help reduce noise nuisance around MOD ranges. An extensive database of acoustic and meteorological data has now been assembled and the current model shows an improvement of 2-4 dB in accuracy over its predecessor, especially in the downwind enhancement area.

We have now drafted an Information Technology Strategy Document which will be integrated into the wider Met. Office Information Strategy. The main aim is to improve the quality and value of services. This will be achieved by introducing a new graphics display system (HORACE) and by extensive use of a number of available networks to transmit messages electronically.

Defence Services has also continued its close involvement with the Government's National Response Plan to deal with potential nuclear incidents. The 92-site (85 at Met. Office sites) Radioactive Incident Monitoring Network (RIMNET) is now complete and measurements are automatically passed to the DOE's Technical Co-ordination Centre (TCC). Defence Services personnel have been trained in the use of the Centre's IT systems and data from the Nuclear Accident Model (NAME) has been successfully passed to the TCC.

The Office has provided forecasting and climatic services to Forces on detachment to the Somalian and Yugoslavian relief operations.

Initially, the new WAFC system will produce computer graphics of significant weather conditions for transatlantic flights, but will be developed to produce details worldwide.

Aviation Services

International

During the last year, together with Washington's WAFC, Bracknell has been developing a new high-resolution global wind and temperature product, which will lead to more-accurate route planning and savings in fuel consumption.

Efficient transmission of this new high-resolution information will be achieved using computer coding techniques, but will still need high-speed communications links to handle the volume of information. Improved links are being planned under the ICAO. They include satellite broadcasts of the new data, combined with regional significant weather and wind charts, needed for pre-flight documentation.The Met. Office is working on a satellite service, planned by the European ICAO members, under the direction of the Civil Aviation Authority (CAA). This will enable data up-linked from Bracknell, to be broadcast throughout Europe, western Asia, the Middle East and the whole of Africa. Planning for the project is complete, for implementation in 1994. The final stage of the WAFC system will be reached when both Bracknell and Washington are able to provide global significant weather information, in addition to global wind data. During the year we have evaluated an automated method of providing significant weather conditions and trained the forecasters in its use. When this has been done, Regional Forecasting Centres will probably be gradually phased out, leading to cost savings for the airlines.

The Office actively supported international aviation through the International Civil Aviation Organization (ICAO), with Bracknell's Central Forecasting facility as one of the World Area Forecast Centres (WAFC)

National

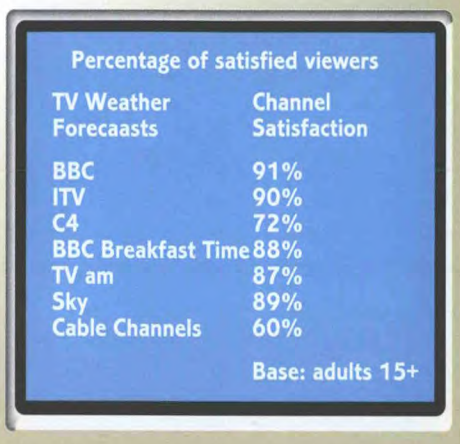
Together with the CAA, we have been improving national services during the year. The Met. Office's commercial automated fax system now broadcasts flight documentation information to aerodromes, providing good quality copies for flight briefings. There is also a dial-up request service (MetFAX) for pilots to select the charts and texts they need, from their home or office.

Through the CAA, the PC-based MIST system (described elsewhere) has been installed in each crew room of off-shore helicopter units flying over the northern sector of the North Sea. In Scotland, MIST is linked with Aberdeen Weather Centre and Bracknell, enabling up-to-the-minute reports and forecasts to be assessed quickly by pilots before take-off. During 1993, the system will be extended to cover the southern North Sea, the Irish Sea and other western coastal waters. These units will be linked the forecasting centre in Manchester as well as Bracknell.

We are working closely with the CAA to develop automated observing systems for aerodromes, and to assess the need for improved surface wind reports. This will give pilots better information during take-off and landing.

Information and support has been given during the year to official air accident investigations, which may lead to recommendations for improving advice given to pilots, to improve safety in the future.

MetFAX aviation services for light aircraft and private pilots of all descriptions saw a record number of accesses during the year.



Commercial Services

In the three years since we became an Agency, revenue from commercial services has grown steadily. During the past year alone, revenue has grown by 22%, even during this period of severe recession. Revenue from commercial services is an important method of maintaining downward pressure on the cost of the Met. Office to the taxpayer.

Sales and Marketing

Growth in revenue and achievement of business plans rely heavily on increasing professionalism of our marketing and sales activities. Particular emphasis has been placed on developing our market research expertise, access to business databases and business planning. Development of a commercial ethos within the Office has been greatly helped by comprehensive training programmes.

The Weather Centre Network

Weather Centres are vital in adding value with local meteorological knowledge and familiarity with local customer requirements. Customers need access to local forecasters and appreciate the highly tailored service. Weather Centres also provide vital emergency warnings as part of our public service commitment.

An important project begun this year, OPUS, will rationalize the computer systems at Weather Centres and network them. It will also automate telecommunications between customers, Bracknell and the Weather Centres. The new networks will improve data exchange and present a standard interface to operators.

After 28 years in High Holborn, London Weather Centre moved to a new, modern building in Clerkenwell Road. We took the opportunity to upgrade its technology and ensure the new Centre had capacity to cope with growth in its services. Important land transport services provided by London Weather Centre include those for British Rail, Dartford Bridge, Docklands Light Railway, the M25, and EuroTunnel.

Dissemination of information

This year has seen continued growth of 'Artifax' for regular delivery of faxes, and rapid growth in the use of the dial-up 'MetFAX' database. 'MetFAX' was accessed about half a million times, peaking at more than 3000 a day during Summer. This level of usage has been boosted by new marine, aviation and education products.

Delivery of weather information to desktop PCs has also developed this year with MIST (Meteorological Information Self-briefing Terminal). MIST has been bought by users in aviation, water, energy, utilities, education and offshore services, an illustration of the diversity of applications for this innovative system.

Private Sector Relationships

Partnerships with the private sector are essential if we are to develop our services, particularly dissemination of weather information. For example, Telephone Information Services (TIS) operates all our premium-rated telephone services and Vodata Ltd. our MetFAX transmissions. Computer Newspaper Services provide many of our weather services to newspapers, and Vaisala TMI is an important partner in the OpenRoad services to local authorities.

Data and products which the Met. Office generates as part of its core activities are also available to our private sector competitors. Considerable effort has been devoted to ensuring, and demonstrating, that we are operating a level playing field with the private sector in this respect. The international implications of this resulted in plans for the formation of ECOMET, as reported in the International sections of this Review.

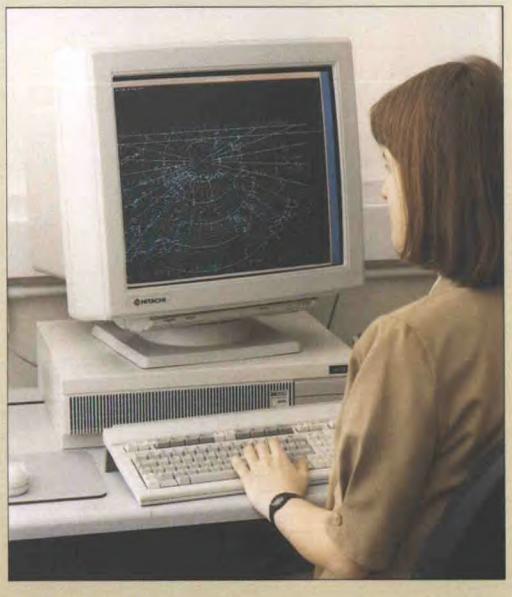
The Media

The year also saw modest growth in revenue from our services to the BBC, largely because of increased demand for new or more complex regional services, as well as for Breakfast Television and World Service TV.

And, despite the upheaval caused by changes in franchises of commercial television, services to independent television supplied by our International Weather Productions (IWP) business unit have also grown. The Met. Office also received international recognition when we won six awards at this year's International TV Weather Forecasters' Festival in Paris. Much of our success is due to our innovative graphics systems, as well as the professionalism of presenters.

Detailed market research is essential to developing our services

MIST gives users instant access to a host database through leased or dial-up lines, so they can manipulate the information on their own PCs to meet their own needs.



Services to the newspaper industry have continued to develop, although trading in a difficult recessionary market. Our partnership with CNS has enabled us to offer continuing upgrades and enhancements.

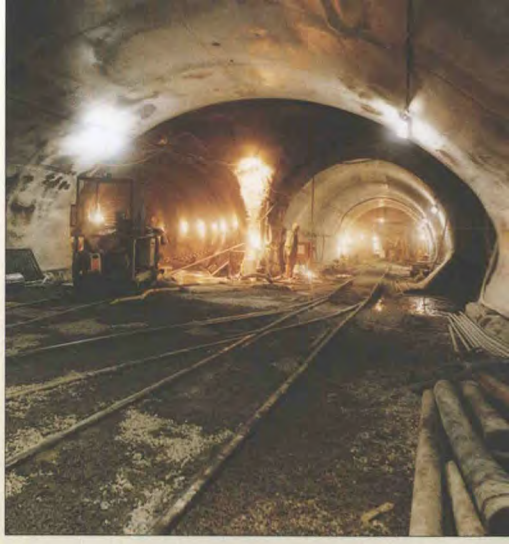
In July we launched, with TIS, the new Farmcall service, with sponsorship from Monsanto Agrochemicals, Dalgety and Farmers' Weekly. The forecast identifies 'windows of opportunity' for farmers over the coming five days. We also launched a substantial upgrade to MarineCall by including automated coastal weather reports using concatenated speech.

A substantial market research exercise was conducted by TIS to guide the development of future services.

At the opening of LWC, Lord Sainsbury commented that "Met. Office information is immensely valuable for a company like Sainsbury which has a highly sophisticated and effective computer system controlling the flow of perishable and seasonable foodstuffs".

Our agrometeorologists with ADAS are engaged upon countryside smells, while ensuring a comfortable life for pigs!

Siân Lloyd won the top Prix des Preséntateurs and awards also went to Bill Giles of BBC Weather Centre for BBC National and World Television services.



We provided services to EuroTunnel during the construction phases, and expect to provide operational services when the Channel Tunnel opens.

We were deeply involved in supporting rescue operations and pollution control after the Braer disaster.

Land Transport

OpenRoad has had another excellent year with improved frost prediction accuracy. On roughly 9 out of 10 nights last winter, road engineers received excellent guidance on whether or not to spread salt on the roads. New software has been introduced this year to enhance production and communications of OpenRoad graphics. Forecast information is constantly compared with actual conditions measured by road surface sensors at more than 200 sites round the country. Weather radar is also playing an increasingly important role, detecting where imminent precipitation could wreck a salt run. Lincolnshire, Essex, and Northern Ireland have installed new sensor systems this winter.

OpenBridge services have assumed great importance in managing traffic flow over new private-sector toll bridges, because of the direct bearing weather conditions have on profitability. We are involved in important new bridge construction projects including the Skye Bridge and the second Severn crossing.

We continue to provide forecasts to British Rail, transmitting them directly into BR's computer system for access by their staff all over the country. These include snow warnings, wind-chill, wind speeds, air and ground temperatures, and – during the summer – warnings when temperatures will rise above the level where rails could buckle. A study was undertaken to identify the combination of weather variables most likely to cause disruption due to leaf-fall; the results were incorporated into the service this winter.

Offshore and Marine

Demand for offshore services in the North Sea has continued to be buoyant.

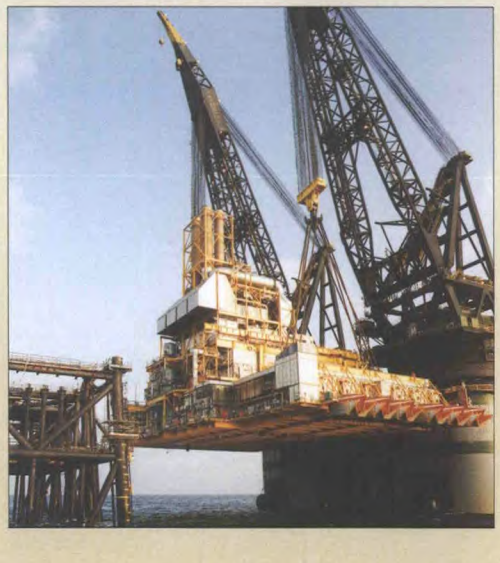
For example, the Dutch company Heeremac planned to install two massive deck structures for Amoco's production platforms. Wind speed, direction and sea swell were all critical to the operation's safety, and we supplied a forecaster from the Aberdeen Weather Centre who spent 31 days aboard a crane barge to provide site forecasts. The Heeremac project engineer said: "His superb work accurately predicted weather windows for installing these decks on the North Everest and Lomond platforms. Winter operations are always a tricky business and it is vital to have confidence in sea state predictions before embarking on lifting modules of this size".

January saw the launch of the largest submarine to be built at Vickers Shipbuilding and Engineering yards at Barrow-in-Furness – the first of the Vanguard (Trident) class. It had to negotiate a narrow channel, dredged specially for the launch, to make its first trip out to open sea. Weather was a critical factor for a safe passage. Again we publicly received high praise for the accuracy of Met. Office forecasts and close, effective liaison with the customer.

Metroute, the Met. Office shiprouteing service, has seen a 25% increase in numbers of routeings this year compared with last.

When the oil tanker *Braer* first ran into trouble off the Shetland Islands in January this year, Met. Office forecasters became closely involved, since weather was bound to be a major factor in the safety of the crew and the well-being of the Islands. When the vessel's engines failed, our forecasters on the Shetland Islands were immediately contacted to provide continuously updated forecasts in order to judge where and when the drifting vessel might come ashore.

Because of the minimal hull clearance there was only a very small 'weather window' for the launch.



A total of over 36 000 OpenRoad forecasts were issued during this winter to 153 customers.

The deck module of Amoco's platform weighed 9000 tonnes, the same as 80 fully-laden jumbo jets.

Utilities

Gas and electricity industries continue to require forecasts to estimate demand, as well as support to their operational activities. The water industry relies on short-term and long-term forecasts of precipitation to optimize their pumping operations.

We handled an increasing number of enquiries about siting and constructing wind farms in south-west England and Wales, the Isle of Man and Scotland. We now supply a renewable energy service and expect increasing activity in other areas such as wave and solar energy.

Consultancy Services

Weather advice and weather sensitivity information from The Weather Initiative (TWI) have proved effective for many companies, ranging from groceries to garden equipment, clothing to chemicals and brewing to biscuit making. Inadequate intelligence in weather factors costs British business more than one billion pounds each year. TWI promoted its role in improving business performance through successful regional seminars under the headline 'Discover the Missing Link – weather intelligence'.

Our ability to provide detailed weather data and expertise to legal and insurance clients has sustained growth in this market, with increased demand for our staff to appear as expert witnesses in court cases and marine tribunals. Several major storms during the past six years have alerted the reinsurance industry to the need for more accurate assessment of risk exposure, and we have provided consultancy in this area. There is also a growing interest in contingency insurance for major outdoor events; American firms have sought advice, data, and forecasts from the Met. Office this year as they develop this type of business on this side of the Atlantic.

During the year we studied fog and other relevant weather factors for the A1(M), the M1, the proposed Hobnet Bypass in Shropshire, the Wainscott Bypass in Kent, and the Hereford Bypass. As well as producing study reports, the Office is also represented at the Public Inquiries.

Met. Office staff working for ADAS (the Agricultural Development and Advisory Service) are making valuable contributions to assessing the impact of odours from intensive livestock farms, as the environmental effects of farming receive closer scrutiny.

'Metstar', the new research and development consultancy, has completed a successful first year of trading. Contracts have been undertaken for EUMETSAT, Jersey Public Services Department, Thomson CSF in France, Logica and SD-SCICON. Important proposals are being evaluated by the National Rivers Authority and the Royal Observatory in Hong Kong, relating to the construction of the new airport. We are developing our services in urban meteorology, and the meteorological aspects of environmental consultancy and service provision.

Another seventeen SAMOS (semi-automated meteorological observing systems) were installed this year, adding to the 23 already in operation.

The Technology of Forecasting

Global observing systems

The Meteorological Office contributes to the Global Observing System in the form of measurements and observations made from manned and automated stations in the United Kingdom and overseas. Data are also collected from buoys and ships at sea, aircraft in flight and from satellites orbiting the earth. 1992/93 has seen significant progress across a wide front, although pressures on funding have necessitated some retrenchment too.

Environmental concerns are increasing the need for new parameters to be observed and measured, and more-accurate, site-specific forecasts require a greater number and more timely observations. But changes in the observational network have to be achieved not only against a background of having to cut expenditure, but also ensuring an uninterrupted sequence of observational data – essential for research into long-term climate change. Improved technology helps to achieve this, particularly automating the collection and distribution of data, and sharing costs with other services.

A network of approximately 300 stations is maintained in and around the United Kingdom to make regular observations and measurements of pressure, wind, temperature, visibility, cloud and precipitation. Over land, 30 key sites are manned 24 hours a day by professional observers to provide sufficient information for the broad scale of weather systems.

To define the weather in detail, and detect local variations due to towns, cities, hills, valleys and coasts, further stations report throughout the 24 hours at selected sites. Only 30 of these remain fully manned, four less than last year, while three more are now wholly automated, bringing the total of these to 38. Eleven are now partially manned, against last year's seven.

None of the wholly automated sites yet has a full complement of sensors, but the delivery of laser cloud-base recorders and visiometers will go a long way to correcting that deficiency.

A further 130 supplementary observing stations are maintained to meet specific requirements for meteorological observations at airfields or along low flying routes and motorways. Half of these are manned by auxiliary observers such as coastguards and power station staff, the majority of whom have been equipped with lap-top PCs into which they enter the observed weather. Each PC performs quality control checks and codes the data before transmission to Bracknell via a modem and standard telephone line.

The open ocean buoy network became fully operational this year.

On the continental shelf the Office maintains a network of 62 marine observing stations, 30 of which are automated, sited on islands, buoys, oil and gas platforms, towers and light vessels. Where possible wave characteristics and sea temperature are measured. Five buoys are now operating on the western edge of the continental shelf, extending from 48° to 62° north. Three more light vessels were equipped with automatic weather stations.

On 12 October the Cobbacombe radar in Devon was opened by the Minister for Agriculture, Fisheries and Food, the Rt. Hon. John Gummer. It fills an important gap in the network over the high ground of South Wales and south-west England.

Reports from merchant ships provide valuable weather data over the North Atlantic and other oceans of the world.

Through exchange with other WMO participants the global archive of marine data has now reached 76 million observations dating back to 1854.

ASDAR, an automatic system fitted to civil aircraft, delivered high quality information from otherwise data-sparse areas of the world. Measurements of temperature, wind, height and position are made every 7 minutes at cruising level and more frequently at predetermined levels during climb and descent. A WMO consortium led by the UK is managing the

Each Cray can sustain over 1000 million arithmetic operations each second making the Office's facilities among the most capable in the world.

During the year we took delivery of some 20 cloud-base recorders and 35 visiometers.

project. The Met. Office has funded 5 of the 8 systems in service, but plans to increase our investment in ASDAR have been shelved to save costs.

The UK contribution to upper-air soundings from merchant ships on the North Atlantic will cease at the end of the next financial year. However, it has proved possible to maintain operations from the Ocean Weather Ship *Cumulus.*

A programme of observations from St. Helena, which had been at risk, has been maintained by providing a more cost-effective solution.

In addition to its membership of and collaboration with EUMETSAT, described in the International section, the UK Met. Office contributes instruments to the US polar orbiting satellites. The engineering model of the UK component of the Advanced Microwave Sounding Unit has been despatched to NASA, the first flight model is currently being tested in vacuum and the other two flight models are expected to be delivered from British Aerospace in 1993. These will fly on NOAA satellites in the second half of the decade.

Information Systems

Our business is firmly based on adding value to information – and information is the lifeblood of forecasting. It is needed for archiving data and research, as well as to run our business. The production line starts with information from observations; from these are generated customers' weather forecasts.

At the heart of our information technology strategy lies the Meteorological Telecommunications Centre (Met. TC) and the Central Computing installation (COSMOS). These exemplify the technical excellence which the Office must achieve to meet our customers' demands at acceptable cost. The main message-switching system routes hundreds of thousands of messages a day within seconds and is planned to be available for all but four hours in a year.

Large-scale scientific computing is carried out by two Cray Y-MP8/864 computers, one for numerical weather prediction and general meteorological research, the other, funded by the Department of the Environment, for research in climate change. Even with this level of power, compromises have to be made between quality of modelling and timeliness of output. As a result of the drive to be more responsive to our users' needs, plans are being developed to merge the operations of Met. TC and COSMOS. Customers will then see a single focal point rather than two distinctly separate areas of management. This development has happened because of the convergence of computing and telecommunications technologies in recent years.

The Weather Information System (WIS) is a broad strategy for reducing costs and improving effectiveness of the delivery and presentation of information, both to external customers and weather offices remote from Bracknell. Cost savings arise from rationalizing networks, less paper output, and the lower costs of maintaining up-to-date equipment. Rationalizing networks also enables us to offer a wider range of products and services. From the technical viewpoint there are three main components to WIS – the Outstation Display System (ODS), the Weather Information Network (WIN) and the Outstations Production Unified System (OPUS).

ODS has now been fully deployed at Weather Centres and airfield offices, but is hampered by limited flow of data. The full benefits of ODS will depend on implementation of WIN, still under discussion with MoD because of the benefits to be obtained from integrating it with their telecommunication infrastructure. OPUS has reached the prototype stage. Weather Centres will be linked through a local area network and use the back-up ODS as a file server. In effect, OPUS and ODS will provide mutual backup.

Operational Forecasting

Forecasting is a highly skilled scientific and technological process. Large computers and fast communications develop numerical models of the atmosphere, but experienced scientists are necessary to interpret the output. The increasing reliability of weather forecasts is also due to new and sophisticated methods of obtaining the data.

To use an analogy with the retail industry, raw observational data has a short sell-by date. Observations are made and exchanged worldwide every six hours and the whole process of forecasting must be done within this time-span. Production of the early evening forecast for radio and television will have started around midday with global observations of the actual weather conditions. Over 75 per cent of these observations arrive at Bracknell well within three-and-a-half hours.

Before being used, data are quality controlled by computer, which highlights any observations which require a value judgement to be made by a forecaster. Quality controlled data are then used to analyse the atmospheric state. The computer then calculates changes in observed conditions with time. All these processes take less than an hour, so that within five hours of the observations first being made, forecasters are presented with a set of conditions from the global model for six days ahead.

Interpreting the computer's output is a highly skilled process, requiring critical assessment, especially in data-sparse areas. Also, numerical models have recognizable characteristics, due to the need to simplify the mathematics because of limited computer power. Forecasters recognize this, and also use satellite and radar imagery, which are readily available to them, but cannot be directly input to numerical models. These, and other factors, are taken into account before issuing the definitive forecast; the duty chief forecaster at Bracknell provides this guidance to the weather centres and outstations.

For example, during 1992 forecasters provided much better advice on the probability of rainfall the following day at twelve UK sites than did the model alone. Part of the forecaster's skill is to assess the likelihood of events, to give them the proper emphasis in a forecast. This requires not only a sound understanding of the physical processes, but a good measure of experience as well.

Most forecasts produced by the Met. Office are for the United Kingdom and eastern part of the North Atlantic, but not exclusively so. The value of our unified model for handling tropical storms is now well known by other met. services, and its guidance is now requested by several of them.

Forecasts were also provided for the Territorial Army Team's attempt on Everest. It was very rewarding to speak on the telephone to climbers on the mountain, via satellite, who told forecasters that they were experiencing winds predicted for them by the Met. Office – the day before.

Prediction of rainfall by the forecast model has improved during 1992. The model gave very good or useful advice for rainfall on 78% of 24-hour forecasts, a significant improvement over its guidance prior to July 1991. This is reflected in improved forecasts issued to customers. Accuracy of the early evening radio forecast for the following day continued to improve during 1992; 85% of the forecasts for wind, weather, cloud and maximum temperatures were considered to be correct. With continued fine tuning, this high success rate of the numerical model and the forecasters' skill is not only expected to be maintained, but show further improvements.

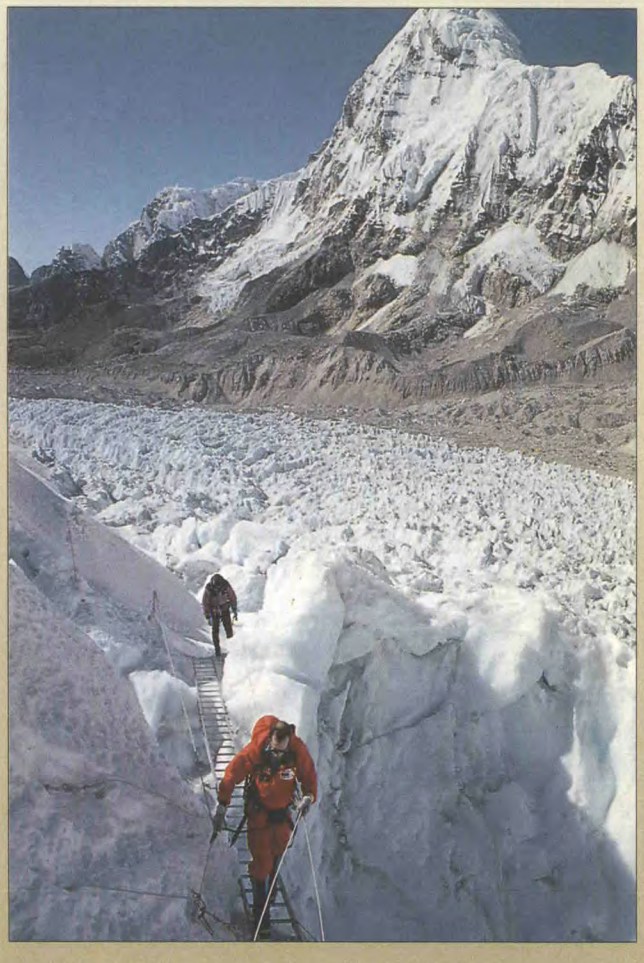
Forecasters become familiar with the characteristics of numerical model outputs, and add considerable value to the computer's forecast.

● – *receive global observations*

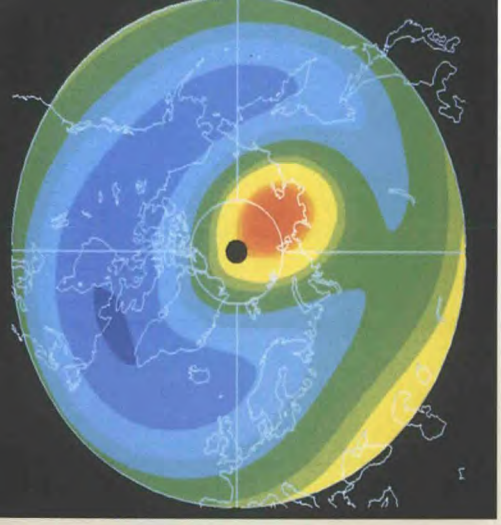
● – *compute forecast*

● – *interpret, refine & issue forecast*

The Everest expedition crossing the Khumbu icefall.



Last year, Beijing, Guam, Melbourne, Pretoria and Mauritius all received assistance in forecasting tropical storms.



Idealized 3-D simulation showing the implied formation of an ozone hole in an atmosphere with doubled carbon dioxide concentrations.

Research

The C-130's capacity and endurance make it ideal for atmospheric research.

Only through our continued emphasis on front-line research can we continue to stay ahead of our competitors. Our scientific expertise in weather and climate research has earned us a worldwide reputation for excellence.

Forecast Research

Most of the Office's forecasting is now dependent on numerical models. However, simpler techniques are used to supplement the models for very-short-range forecasts, and tools are also required which can be used directly by the forecaster in the field.

The main highlight of the year has been the inclusion of full, three-dimensional data into the unified model for mesoscale forecasting. (The previous model only assimilated surface and cloud data.) The result has been a significant improvement in short-range cloud forecasts. Another major development was towards automating FRONTIERS for forecasting precipitation. This allowed many more products to be delivered, at lower cost. Longer-term developments will include combining the guidance obtained from the model with the simpler techniques used to automate FRONTIERS. This will provide an integrated system for forecasting key weather parameters up to 6 hours ahead.

There have also been some major developments in using satellite data in the unified model. Firstly, a trial has been conducted with local processing of global satellite temperature soundings. This can use the latest unified model forecast, rather than climatology, as a first guess and can therefore extract more information from the data. Secondly, quantitative cloud data has been extracted from satellite images, and is now available to the data assimilation process.

In longer-range forecasting, a joint project with the European Centre for Medium-range Weather Forecasts (ECMWF) has been started, to study the use of ensemble forecasting (which gives an indication of the reliability of a forecast), for time-scales up to 30 days ahead. Since both the Centre's and our unified model will be used, it should be possible to learn a great deal about the relative model characteristics.

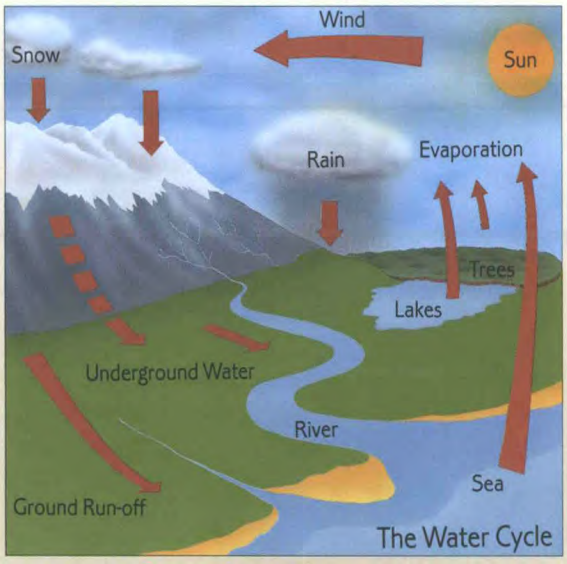
Forecasting requires detailed knowledge of atmospheric processes, and to this end, a number of major experiments are being carried out. Cardington's research unit has been studying how the heterogeneity of the Earth's surface influences momentum, heat and moisture exchanges between the atmosphere and ground. Experimental results obtained from surface and tethered-balloon instruments in the Vale of the White Horse (Oxfordshire) are being used to verify the models.

Forecasting frontal waves is very important for short-range forecasting of precipitation. Numerical models are variable, and classical theories do not adequately explain their characteristics. In spring 1992, the Joint Centre for Mesoscale Meteorology carried out an experiment (FRONTS92) to investigate the structure of frontal waves; the Office's C-130 aircraft used dropsondes and radar to observe patterns of dynamics and precipitation within them. Typical results are illustrated in our Technical and Scientific Review of 1992/93 (see inside back cover for details).

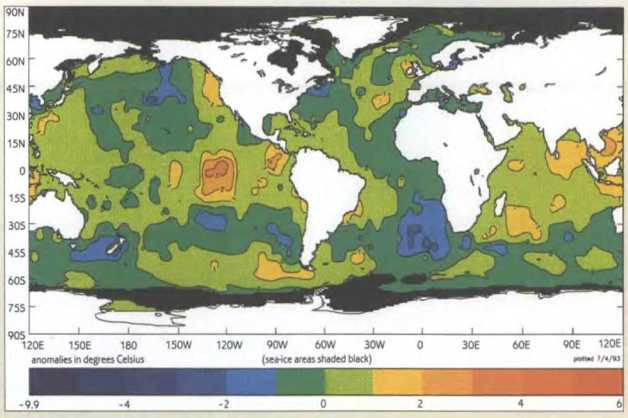
The C-130 also took part in two major international experiments. One was to study stratocumulus cloud, which is very difficult to forecast. However, predicting its distribution is essential for forecasting frost, fog and sunshine. The second experiment studied the interaction of tropical oceans with the atmosphere. Since the tropics are the main source of heat and moisture for the atmosphere, understanding this process is essential, both for global weather forecasting and climate research.

Climate Research

Climate change continues to attract much scientific, political and public attention and debate. The Hadley Centre is making a major contribution to our knowledge of the subject through its research into prediction of long-term global climate change, and its regional distribution. For this, we need models which can simulate today's climate, and to develop our understanding of the factors which control it. An essential tool for this work is a model which couples the atmosphere with oceans, land surfaces and areas of the Earth covered in ice such as polar and mountainous regions.



The new globally complete monthly archive of sea surface temperature here shows the major features of El Niño in 1877-1878.



Instruments to monitor wind, temperature and humidity are suspended from tethered balloons up to a mile above ground.

To provide the data with which to test our models, key parameters are analysed – particularly historical records of sea temperatures, air temperatures over oceans and land masses, as well as wind and surface pressure data. Collaboration with other institutions, particularly the University of East Anglia's Climatic Research Unit, is very important to this work. Many millions of sea surface temperatures have now been analysed and combined with sea-ice data. As a result, we have produced the first globally complete, monthly fields of sea surface temperature and the extent of sea ice, from 1871 to the present day. This is now contributing to studies of atmospheric variability over the past century.

We continue to refine the models needed for prediction of climate change. Techniques for representing the coupling between models must be enhanced, as well as ways in which to describe the physical processes. Recent developments include new radiation schemes which allow inclusion of effects due to minor trace gases and aerosols in the atmosphere, and a better way of representing the atmosphere's behaviour as it interacts with the land surface. We have also improved the representation of convective clouds and rainfall.

The trend is now also to include land vegetation and ocean biology to model the carbon cycle explicitly, and we are working closely with other universities and NERC to develop such schemes.

Following the publication of the Hadley Centre's report on the first transient experiment, which studied the impact of gradually increasing the concentration of greenhouse gases, a second experiment has now begun using the climate version of our new unified model. We are also exploring techniques for deriving detailed regional predictions of climate change. Other studies have included examining the impact of different cloud schemes on the model and the change in storminess caused by doubling the present day's concentration of greenhouse gases.

To enable proper representation of ocean currents, ocean models need to be run at higher resolution than their atmospheric counterparts. A version of the global coupled model with a higher-resolution ocean model has been developed. Because of its computational expense, it is being used initially for studying the role of the ocean for variability on the interannual time-scale, including intermittent warming of the Pacific Ocean associated with El Niño. We are also testing alternative ocean models in a collaborative project with the James Rennell Centre.

Variations in sea surface temperatures form an important component of seasonal forecasting. This year, experimental seasonal rainfall forecasts were extended to three regions of tropical North Africa, as well as the Sahel. These, and the forecast for the northern Nordeste of Brazil, all showed significant degrees of skill.

Ozone depletion studies are being given a new impetus by the Upper Air Research Satellite (UARS). The Met. Office is using a special version of the unified model to combine all available data from UARS to produce a changing, three-dimensional view of the middle atmosphere. This is being complemented by studies whose aim is to understand the new results emerging from the UARS mission. A related study, using a photochemical model, has indicated that there is a possibility of increasing Arctic ozone depletion with increasing concentrations of greenhouse gases.

While visiting the Met. Office in February 1993, Professor Obasi, Secretary-General of the WMO held a press conference at the London Weather Centre.

The International Dimension

Europe

EUMETSAT/ESA

Following a wide-ranging and lengthy debate, the European Space Agency (ESA) in November 1992 agreed proposals to provide Europe with a comprehensive ability to monitor the Earth from space, well into the next century. The Met. Office represents the UK on the Council of the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and is an active partner of the British National Space Centre which represents ESA.

The new programme will launch the ENVISAT and METOP satellites into polar orbits in 1998 and 2000 respectively to provide data such as atmospheric temperature and humidity, cloud distribution, land and sea surface temperatures, ice distribution and wind and waves at sea.

Views of the Earth from Meteosat-4, which have become such a familiar part of almost every TV weather forecast, will continue to be supplied, while the second generation of Meteosat, being developed with ESA, is expected to be launched in 2000. These satellites, and the optimization of their instrumentation to make best use of the data, will pose major technical and financial challenges over the next few years.

ECMWF

We have made increasing use of ECMWF's 10-day forecast during 1992 as its accuracy has improved. At the same time, we have sought to restrict the growth in ECMWF's budget and focus its attention on medium-range forecasting, rather than diversification into other areas.

European Climate Support Network

Many European countries are undertaking new climate research programmes. The European Climate Support Network (ECSN) was initiated in 1992 to co-ordinate these projects, so that we use our resources efficiently and exchange scientific knowledge effectively. Professor Julian Hunt was one of 13 signatories. ECSN is governed by a board consisting of the Heads of Member Services, with a Secretariat established in the Spanish Meteorological Institute in Madrid.

The Met. Office is offering consultancy to China for introducing commercial services

ECOMET

Work has continued on the formation of ECOMET, an Economic Interest Grouping between West European National Meteorological Services. Its objective is, on the one hand, to preserve and enhance exchange of data, products and value-added services between member Meteorological Services and, on the other, to allow all to benefit from the single European market. ECOMET will provide access to European data and products for private sector competitors, and increase the range of value-added services on a European scale.

In December 1992, a formal submission was made to the European Commission, seeking some exemptions from European competition law, and dialogue with the Commission is now engaged. A catalogue of products and tariffs has been prepared as well as standard licence agreements. Discussions were held in Brussels in September 1992 between national meteorological services and the private sector.

Commercial activities in Europe.

While discussions have continued in ECOMET, the Met. Office has been developing its commercial activities in Europe. Our IWP business unit won a new Norwegian contract, to receive meteorological data from Norway at Camden Lock, convert it into a complete graphical presentation package and transmit it back to Bergen, where it is broadcast with Norwegian presenters. IWP now also provides forecast products for Swiss and German television, Sky Satellite channels and a new service just started on the Swedish TV3 satellite channel, broadcast from the UK.

A number of European national meteorological services, such as Spain, Sweden, Austria and Hungary, are developing their commercial activities and have turned to the Met. Office for consultancy and training. This has not only enabled us to transfer our expertise, but also strengthens ties with other met. services.

Forecasts were provided to the Dalian shipyard in China to assist the lifting of a 3450-tonne, 182-metre crane gantry into position.

Upper-air ascent programme in the Seychelles, funded by the Met. Office.

In the studio gallery with IWP trainers Alex Hill (left) and Sally Galsworthy (seated), are presenters Toirl Torvig, Reivun Hormoy and Siri Kalvig of Norway's TV2 channel

Worldwide

WMO Executive Council Decisions

One of the main purposes of the World Meteorological Organization (WMO) is organizing free, timely and systematic exchange of observations between national meteorological services. The Met. Office strongly supports this by participating in most of the WMO's constituent bodies. Professor Julian Hunt is now an active member of its Executive Council (EC), succeeding Sir John Houghton.

The Met. Office is closely involved with the Intergovernmental Panel on Climate Change (IPCC). Its scientific activities currently include studying hypothetical greenhouse gas emission pathways that might lead to stabilization, and developing guidelines on preparation of national inventories of man-made gases and removal of greenhouse gases.

Following the example of ECOMET, the WMO is also now considering how to reconcile worldwide, free exchange of meteorological data and products with growing commercial activity. A WMO working group recommended controlling the distribution of some categories of data and products, and adopting guidelines for relationships with the private sector. The UK Met. Office has, naturally, been actively involved in this debate.

Voluntary Co-operation programmes

During the year, three wind finding radars were installed – in Port Moresby (Papua New Guinea), Nairobi (Kenya) and Colombo (Sri Lanka) as part of the WMO's voluntary co-operation programme. Four Meteorological Data Distribution (MDD) systems were donated to Kenya, Ethiopia, Ghana and Zimbabwe, which allow them to receive weather data and charts via satellite. Other projects included sending a satellite receiving station to Belize and a pressure calibration system to the Caribbean Meteorological Organization.

Training always forms an important part of the VCP programme. This year fellowships were awarded for courses in the UK, ranging from basic instrument maintenance to degree courses. Funds were also given to Regional Meteorological Training Centres in developing countries to train local staff, and to help them develop high-quality lecture materials using desk-top publishing. Discussions have been undertaken with several national meteorological services, outside Europe, who are developing their commercial services. Consultancy or commercial training have been offered or provided to China, Argentina and New Zealand; discussions have been held on collaboration with the private sector in Japan.

Notable developments of our commercial services outside Europe this year have included the BBC World Service Television global weather forecasts, which are now transmitted to Europe, Asia, Africa, Canada and on airline in-flight video services. We have also provided offshore services to Vietnam and Thailand for the first time.

International Defence Services

The Met. Office takes a leading part in NATO – our Director of Defence Services is chairman of the group responsible for planning and co-ordinating meteorological support for NATO forces in the post-Cold War environment; the Command Meteorological Officer to the Supreme Allied Commander Europe (SACEUR) is a member of Met. Office staff, and is responsible for implementing much of this new policy; the Deputy Chief Met. Officer, British Forces Germany, is planning support of the British-led Allied Rapid Reaction Corps.

The Office's Telecommunications Division is contributing to the redesign of military meteorological communications in Europe; Chief Met. Officer Strike Command is preparing for High Wycombe's new role as HQ Allied Forces Northwest Europe and the Met. Research Flight continues to make an invaluable contribution to weather reconnaissance in NATO exercises.

Even while the Liberian-registered 'Braer' was being loaded in Norway, Met. Office forecasters had seen the first signs of the deep low which was to hit the Shetlands.

Weather Highlights of 1992/93

Spring 1992 in Britain began with threats of drought, caused by persistent dry spells, insufficient rain between them, and the previous unusually dry summers. May was warm with average rain, June very warm and sunny but with so little rain as to renew concern about our water supplies. The rest of 1992 was near normal – but with some interesting events.

From the 7th to the 9th of August a plume of very warm wet air moved north-east from Spain and across Biscay, with outbreaks of thunder. Storms moved further into France, grouping into several self-perpetuating clusters. One of these crossed south-east England and moved up the east coast; another crossed the Channel near the Isle of Wight heading towards the Tees. This second storm created a squall line that persisted for many hours, with the highest official gust of 48 knots recorded at RAF Odiham in Hampshire. South Farnborough had 28 mm of rain in an hour and at least thirty houses were struck by lightning.

On the 22nd to 23rd of September in the south-east of England it rained! A depression moving slowly north, brought prolonged heavy rain, many places getting more than 50 mm; parts of Northamptonshire and Lincolnshire had over 75 mm. It was after this that there was a report that the River Pang in Berkshire was in flood, having previously been dry for many months because of over-abstraction from its aquifer source.

Thereafter, the south had a mild winter, with hardly any snow. But over the North Atlantic, January was remarkably violent, as a series of intense depressions moved east and north-east. There was a near-record low of 916 hPa near Scotland on the 10th, and it was the hurricane-force winds around this which broke up the oil tanker *Braer*. The huge seas seem to have emulsified and dispersed the entire cargo (local wildlife fled for shelter from the storm earlier, and may have largely escaped). Sand dunes moved distances up to a mile, burying some island archeological sites, and uncovering others which had been buried for a 1000 years or more.

Seven days later another intense low brought more gales and heavy rain to Scotland. Cairn Gorm recorded a wind speed of 130 knots, flooding along the Tay caused at least £10m of damage, and most road and rail links across the Forth and Clyde valleys were cut.

For many parts of southern Europe and the Middle East it was a record Winter. January started very cold; in Turkey, Erzurum recorded an all-time low of -34.6 °C, resetting the record for the third time this winter. The Danube was more than 60% covered by ice in Slovakia and all shipping movements were stopped because of the danger. Central and southern Italy had their coldest days for seven years; Calabria (the 'toe') had it largest snowfall since the 1970s and Messina had its first snow for 25 years.

North America dominated the international weather news. One of the most damaging Atlantic hurricanes on record, 'Andrew', crossed southern Florida on the 24th of August and finally made landfall near Galveston, scene of a similar disaster in 1900. Meteosat-4 tracked its route from western Africa as an incipient disturbance on the 12th August. By the 15th, it began to get organized near the Cape Verde Islands and as it neared the USA, was tracked by Meteosat-3.

The Eastern seaboard of the USA was then hit by the worst storm in 30 years on the 11th and 12th of January. It brought gales, heavy rain and snow, did $650m worth of damage and killed thirteen people. Tides as much as 2 m above normal severely tested sea defences; cars were submerged in Manhattan, and La Guardia airport closed by flooding when the sea wall collapsed. Winds of 45 knots gusted to 70 knots, and there was a total of 80 mm of rain. Most of it then turned to snow and with the gale, drifting was severe. In Boston, the equivalent of 82 mm of rain fell as snow in 12 hours, closing Logan International Airport.

However, this proved to be just a warning of what was to come. On the 13th of March 'The Storm of the Century' developed near Florida and swept up the Eastern Seaboard with hurricane-force winds and snowfalls of up to a metre. Some places as far south as Alabama had 30 cm of snow (and no snowploughs!) and New York's airports were closed for two days.

Winter was extremely wet in south-west Mexico and the USA. El Niño produced repeated rainstorms and California and Arizona had several floods. Tijuana on the Mexican border was especially badly affected by repeated flooding and considerable loss of life.

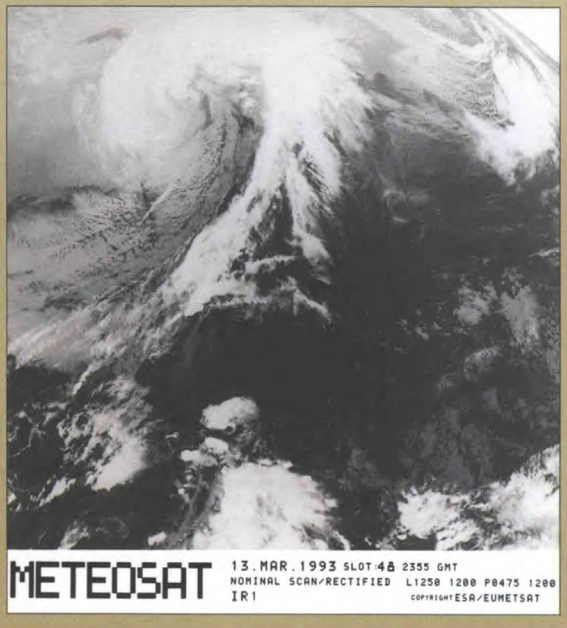
The meteorological event that caused the greatest immediate loss of life occurred in November when cyclone '10B' appeared just east of Sri Lanka on the 12th. It soon crossed the island, killing 13 with falling trees and damaging thousands of

homes with floods and landslides. Emerging almost unscathed by this experience the storm wound up to almost hurricane intensity, dawdled around the southern tip of India and up the west coast. Over the next few days many places in Tamil Nadu and Kerala had over 200 mm of rain (Madras had 271 mm). This massive rainfall filled dams to overflowing and caused floods and landslides which claimed at least 250 lives and rendered some 25 000 homeless. Kochi Airport was closed on the 14th by knee-deep floodwater on the runway and huge seas damaged the breakwaters of the port of Tuticorin, closing it pending a new hydrographic survey.

In New York, the 'Storm of the Century' caused damage to insured property estimated at $1.6 bn.

The now-forgotten drought.

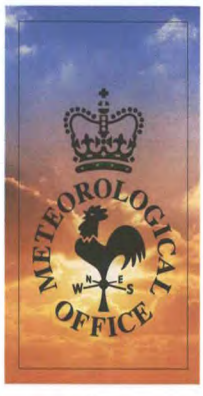
Hurricane 'Andrew' tracked by Meteosat-3, on loan from EUMETSAT to the Americans for just such a purpose.



In Florida, the 'Storm of the Century' caused about fifty tornadoes, killing at least 26 people.

Met. Office Annual Report Publications

The Met. Office publishes its annual reports in three booklets, the *Annual Review, Annual Report and Accounts*, and *Scientific and Technical Review.*



Annual Review
1992/93

The Annual Review *gives a summary of all the Met. Office's activities during the year. It covers new developments in public services, defence and commercial services and gives a résumé of research and development work, as well as providing a focus on our international interests and quality procedures. Its broad view of the Met. Office is of particular interest to those who do not specialize in meteorological science, but who have an interest in the use of weather intelligence.*

Annual Report
and Accounts
1992/93

Full details of the Met. Office's accounts are provided in the Annual Report and Accounts, *which gives the Income and Expenditure Accounts, accounting procedures, and performance against targets, as required by the Treasury as a result of the Met. Office's status as an executive agency.*

Scientific and
Technical Review
1992/93

The Scientific and Technical Review *gives a more-detailed account of the research work currently being carried out at the Met. Office. Among the many topics it covers are forecasting research, numerical models, use of new satellite data, plume dispersal, etc. It describes progress being made in climate change research at the Hadley Centre and the Met. Office's contribution to the IPCC. The* Scientific and Technical Review *contains a detailed bibliography of papers published by scientists at the Met. Office over the last year, and is a valuable guide for everyone engaged in research into physical and numerical processes in weather and climate.*

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Copies of the Met. Office's *Annual Review, Annual Report and Accounts* and the *Scientific and Technical Review* for 1992/3 are available free of charge from the Enquiries Officer, The Met. Office, London Road, Bracknell, Berkshire RG12 2SZ. Telephone 0344 854455

Copies of the Report and Accounts are also available from HMSO.

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