



The Met.Office

ANNUAL



REVIEW



1994/95



The Met. Office Charter Standard for the Public 1995/96

We aim to serve the public by providing the following services-

Up-to-date weather information and forecasts

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

Our performance standards for forecast accuracy and customer satisfaction in 1995/96 are

to attain an accuracy of 84% for the 24-hour national forecasts broadcast at 1755 by BBC Radio 4 and to attain a satisfaction score of at least 80% for the general public forecasts on BBC Television and Radio 4.

Our achievements in 1994/95 were

a forecast accuracy of 85%,
a satisfaction score of 81%.

Weather warnings

We will issue warnings of severe weather

through radio and television,
to emergency organisations such as the police and fire services.

We will also provide warnings of adverse road conditions

to the police,
to local and national radio.

Our performance standard for these warning services is based on the satisfaction expressed by members of emergency organizations. This is measured in a survey conducted each year. In 1995/96 the standard is to attain a satisfaction score of at least 80%. Our achievement in 1994 was 79%.

We will provide gale warnings and marine forecasts for radio.

Our performance standards for these marine services are based on targets set for the accuracy of gale warnings. In 1995/96 these are to attain a success rate of at least 81% with no more than 18% of false alarms for gale warnings issued 6-12 hours ahead for shipping. Our achievements in 1994/95 were

a success rate of 85%,
a false alarm rate of 13%.

Advice in emergencies

We will provide warnings of coastal flooding to the National Rivers Authority and the police.

Our performance standards are agreed with the Ministry of Agriculture, Fisheries and Food, the government department responsible for coastal flood protection and warning. Our targets are related to timeliness of issue, identification of major surges and the minimization of false alarms. All four targets were achieved in the eight months ending 30 April 1994 (few significant surges occur during the summer months). The most important target is to issue warnings to the National Rivers Authority and police forces concerned a minimum of 12 hours in advance of a major surge. There were two in the eight-month period, those of 14 November 1993 and 28 January 1994, and the target was achieved.

We will provide weather advice for the statutory authorities in environmental pollution emergencies.

These emergencies may arise, for example, from the accidental release of toxic chemicals into the atmosphere, and our response to them is given the highest priority. A performance target has been introduced for 1995/96 and is to provide specialised weather information within 30 minutes on at least 85% of occasions.

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.

We measure our performance by the high demand for our educational services. During 1994 over 7,000 enquiries were answered by our education section.

Measuring how we are doing

Monitoring our forecasts

We continually monitor our performance. For instance we compare the forecast with what is observed and measure its accuracy. Forecasts have been steadily improving over the years and this is reflected in the performance targets set for our forecasts on radio and television and for our gale warnings.

Public surveys

We use independent consultants to make regular surveys. We welcome your comments and will react positively to them. Satisfaction scores are calculated using a scale of 1 (very dissatisfied) to 5 (very satisfied). The average value, scaled to lie between 0 and 100, is the percentage satisfaction score.

Performance targets

We have a number of performance targets in addition to those set out here. We review our targets each year and set standards for quality of service, accuracy and increases in efficiency. Further information on these targets, and our performance against them, may be found in our Annual Report and Accounts.

Finding out more

You can contact your nearest weather centre, or the Enquiries Office at Bracknell.

We will be pleased to answer any questions you may have on our services, and you can ask for a brochure describing them and the Met. Office. You can also find out about our services from programme magazines, newspapers, and in telephone directories under 'weather'. We want to hear your views and learn if you are satisfied with our services.

Should you have a complaint

Please telephone the Enquiries Office or, better still, write in. We aim to respond to a complaint within five working days of its receipt, or at least provide you with an acknowledgement and an estimate of when a full reply may be expected.

RAISING THE STANDARD

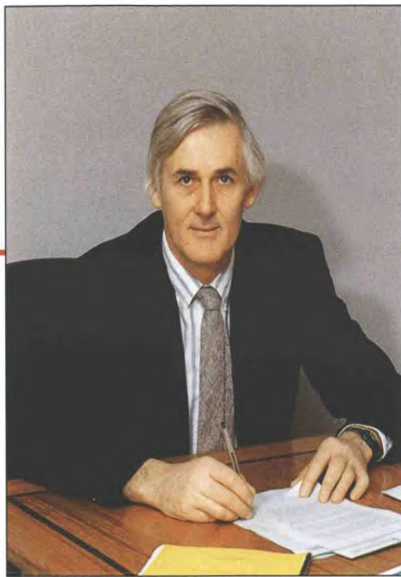




The Met.Office

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A handwritten signature in black ink, reading 'J.C.R. Hunt'. The signature is stylized, with the first letters of each name being prominent.

J.C.R. Hunt Chief Executive

Chief Executives Foreword

This year, our fourth as an Executive Agency, saw the organisation under review, as part of the Defence Costs Study. Its recommendations were accepted by the Ministry of Defence and HM Treasury. The first of the study's main conclusions was that The Met. Office should remain a world-class science-based organisation within the public sector. The second, that The Met. Office should change its administrative and financial framework to become a Trading Fund, is being implemented, with shadow Trading to start in mid-1995 in anticipation of full Trading Fund status from 1 April 1996. The first two stages in the implementation of these plans have been a change in the structure of our organisation — in order to improve the focus on our wide range of customers, as set out in our Framework Document — and the adoption of the commercial accounting system used by our sister agency, the Defence Evaluation and Research Agency.

Against this background of change, The Met. Office has achieved some outstanding results during 1994/95. The most notable of these is the significant improvement we have made in the accuracy of UK and worldwide forecasts from our numerical prediction model, resulting particularly from the close collaboration between our research and Central Forecasting teams. This, combined with recent progress in climate research, also produced marked improvements in climate simulation and prediction. While improvements in our day-to-day forecasting accuracy underpin much of our operational work, those associated with climate research further enhanced the scientific basis for the UK Government's presentation at the First Conference of the Parties of the UN Framework Convention on Climate Change held in Berlin in April 1995. We are also proud and pleased that Dr Paul Mason, our Chief Scientist, was elected to become a Fellow of the Royal Society.

Under its Director, Bernard Herdan, who has now left us to become Chief Executive of his own Agency, our Commercial Services (CS) Division had another excellent year, achieving 8% revenue growth and making a highly valued £3.1m contribution to

our core costs and general overheads. This result was achieved in the face of vigorous competition from the private sector. However, it is significant that some 44% of our CS revenue came through joint ventures with the private sector. The result confirms that the activities of our CS Division are definitely not subsidised by the Defence vote. The services provided to the UK and UN Defence forces have been further developed, with specialised numerical forecasts and tactical forecasting advice provided by our staff working alongside the Servicemen on location around the world.

We have met four of the six key Business Plan targets, narrowly missing the other two. We met the essential cash limit key target by delivering our agreed programme of activities within budget. This was achieved partly through the introduction of efficiency measures in most Departments and partly through the successful introduction of a programme of voluntary early retirement. This latter initiative has allowed us to reduce overall staff numbers by 151 over the year, yielding considerable cost-savings, equivalent to some £4m in a full year.

Work has continued to develop a new pay scheme based on the value of individual jobs and a reduction in the number of staff grades. While progress has been slower than originally planned, the new scheme is expected to be in operation from 1 November 1995. There have also been productive negotiations about increases in pay, and about certain reductions in the number and value of pay-related allowances. After some hard bargaining, and goodwill from all parties, agreement was reached. We expect the same robust but realistic relations to continue as we progress to Trading Fund.

From its inception in 1854, The Met. Office has made a vital contribution to the safety of the nation — the theme of the World Meteorological Day on 23 March 1995. In more recent years, the economic benefits of meteorological services have also become increasingly valued here and throughout the whole world. These economic benefits were highlighted at a World Meteorological Organization

(WMO) conference held in Geneva in September 1994 — just one of the many WMO programmes to which our staff made significant contributions. Other contributions have included the work on new methods and protocols for international warnings of meteorological and other natural disasters, and on a new co-ordination framework for the Inter-Agency World Climate Programme.

Our international focus is not just confined to WMO. Every year, more of our operational and research projects depend on collaboration with international partners. In the last year, collaboration with other European National Meteorological Services culminated in the approval in principle by the European Commission of the ECOMET scheme for a concerted approach to the provision of service, data and products in Europe. We also made progress in forming EUMETNET, a co-ordination framework for optional programmes designed to improve and to economise on the European-wide meteorological infrastructure. In the forum of the International Civil Aviation Organization (ICAO), Met. Office staff were heavily involved with the organisation and implementation of the SADIS (Satellite Distribution System) programme, particularly in Africa.

The speed and number of the changes we have faced during 1994/95 have made this a difficult year for all of us. Further changes and challenges are inevitable as we make the transition to Trading Fund. I am delighted at the progress we have already made and I am grateful to my staff for their loyalty and commitment; I am confident that they will rise to the challenges of new technical and financial responsibilities. I also feel sure that they will participate fully in developing the new organisation and will press on with the exciting advances we are making in all aspects of meteorology.

A graphic with a dark, textured background. The text '84%' is large and white, with 'accuracy' and 'for Radio 4' in smaller white text below it. A thin red line extends from the right side of the graphic across the top of the page.

84%

accuracy
for Radio 4

Key Targets and Performance 1994/95

Quality

- To achieve at least 80% of all Business Plan targets for customer satisfaction, forecast accuracy and timeliness

This target was not achieved.

34 of the 44 Business Plan targets (77%) for customer satisfaction, forecast accuracy and timeliness were met, and seven were missed marginally. Of the remainder, one was not met due to a policy change and two were not completed during the year.

- To attain an accuracy of at least 84% for the 24-hour national forecasts broadcast at 1755 by BBC Radio 4

Achieved.

The accuracy of the forecasts was 85% when averaged over the whole year.

These forecasts are produced by our staff working at the BBC Weather Centre in TV Centre, London. Since the forecasts are based on guidance from the Central Forecasting Office, Bracknell, this measure is used as an indicator of the accuracy of all our forecasting output.

A graphic with a dark, textured background. The text 'Increase Efficiency' is in white at the top. Below it, '2%' is written in a large, stylized white font, with a lightning bolt graphic integrated into the number '2'.

Increase Efficiency

2%

Efficiency

- To increase efficiency in individual business areas by between 2% and 3%, typically, through improvements in quality and volume of service and reduced unit costs

An efficiency increase of more than 2% was achieved across the Office overall; one Business Area fell marginally below the 2% level.



Resources

- To deliver the agreed programme within the Business Plan cash limit of £75m

Achieved.

The cash out-turn was £73.6m.

- To reduce net expenditure, as shown in the Annual Report and Accounts, to £93.2m, representing a decrease of 9.1% on the 1993/94 budget (both at 1994/95 prices)

Achieved.

Net expenditure was £91.4m.



- To provide a net contribution to core and general overheads of £3.6m from commercial services (excluding CAA and DOE), representing an increase of £0.3m over the 1993/94 budget (both at 1994/95 prices)

Not achieved.

Commercial revenue has increased from £19.1m in 1993/94 to £20.6m this year, a growth of 8%. However, the net contribution to core and general overheads was £3.1m. The shortfall was due to changes in internal accounting procedures introduced after the target was set.

Key Targets for The Met. Office 1995/96

Cash limit

£78.3^m

- To achieve Trading Fund status on 1 April 1996

Quality

- To achieve at least 80% of the Business Plan external targets for customer satisfaction, forecast accuracy and timeliness.
- To attain an average accuracy over the UK of at least 84% for the 24-hour national weather forecasts broadcast at 1755 by BBC Radio 4.

Resources

- To deliver the agreed programme within the Business Plan cash limit of £78.3m.
- To reduce net expenditure, as shown in the Annual Report and Accounts, to £90.3m, representing a decrease of 2.6% on the 1994/95 budget (both at 1994/95 prices).
- To provide a net contribution to core and general overheads of £3.8m from Commercial Services (excluding CAA and DoE).

Efficiency

- To increase efficiency in individual Business Areas, as given in the Business Plan targets for each area, mainly through improvements in quality and volume of services and reduced unit output cost.

Reduce
net expenditure

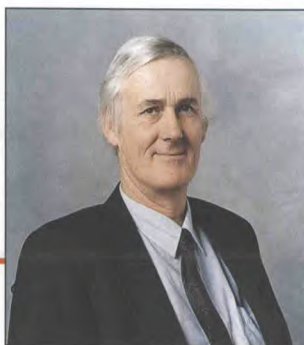
£90.3^m

CS contribution

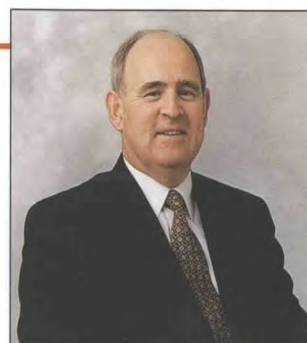
£3.8^m

Management Structure

The Met. Office Board (at 1 April 1994)



Prof. Julian Hunt PhD FRS
Chief Executive



Dr Peter Ryder CB PhD
Deputy Chief Executive



Martyn Bittleston
Director of Finance
& Administration



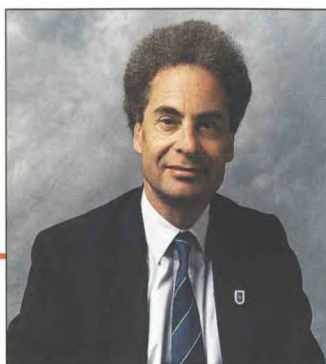
Bernard Herdan MA C Eng MIEE
Director of Commercial Services



Dr Paul Mason PhD
Chief Scientist

The Management Board of The Met. Office is responsible for the day-to-day running of the Agency's operations and for ensuring that the customer's requirements are met.

On 1 May 1995, a new management structure was created for The Met. Office with new posts and appointments at Board level. Bernard Herdan, on completion of his contract, left the Office to take up an appointment as Chief Executive of the Driving Standards Agency. The post of Director of Commercial Services, redesignated Director of Services and Business, was filled by Mike Nicholls, previously Director of Observations.



*Colin Flood,
Director of Central Forecasting*

Services for the public

A range of services is provided to the public under the terms of our Charter Standard which also contains information on performance targets and our achievements against them. The targets, relating both to accuracy and customer satisfaction, are challenging and are reviewed each year. The Charter Standard is published annually and is distributed widely as well as being available on request.

Most of our media services, including many of the familiar weather forecasts on TV and radio, are provided commercially. This minimises the cost to taxpayers, takes full advantage of the latest presentation and production techniques, and helps maintain the highest standards. In addition to these, a number of services are provided for the public good including those essential services connected with public safety. These range from the provision of severe weather warnings for the country as a whole, to the broadcast of forecasts and warnings for shipping. The main highlights of these public services are described below, while those for the media are described in the section on

Commercial Services.

National Severe Weather Warning Service

The National Severe Weather Warning Service provides both Flash and Early warnings of severe weather. Flash warnings are issued to emergency organisations and to radio and TV companies for broadcast to the public within a few hours of the expected onset of severe weather. Early warnings advise emergency authorities when severe conditions are expected to be widespread and can be issued several days in advance, with the public kept informed through scheduled radio and TV forecasts.

During the period April 1994 to March 1995, 98 Flash messages were issued, and Early warnings were issued for 22 events.

The effectiveness of the service is measured through an annual survey of customers in emergency organisations. This is carried out each summer, and in 1994 satisfaction levels with the service remained high. 84% of respondents were satisfied or very satisfied and only one respondent (1%) expressed dissatisfaction. Even so, we fell marginally short of achieving our challenging satisfaction target in the Charter Standard. To meet the need for additional information regarding the warning service, a booklet was produced and distributed in early 1995. It has been extremely well received.

The main feature of the 1994/95 winter, as in the previous year, was the copious rainfall with many areas of the country experiencing flooding. During the weekend of 10/11 December 1994, places in the west of Scotland had over four inches of rain in 36 hours. The ensuing floods engulfed low-lying land and housing estates in the Glasgow area, making 700 people homeless with damage estimated at over £100m. Further flooding occurred when torrential rain fell over Wales from 26 to 28 December 1994 causing many of its rivers to breach their banks. In the Wye Valley, farmland was badly flooded as rivers rose to their highest levels for 15 years. Continued heavy rain during January, which gave London its wettest January for 50 years, put many rivers in England and Wales on flood alert. In Yorkshire and north-east England, some river levels rose to the highest ever recorded. At the beginning of March, towards the end of the mild, wet winter, a deep depression brought heavy snow to much of Britain.

Storm Tide Warning Service

The number of storm surges on the east coast were fewer than normal due to the prevalence of winds from a south-westerly direction. The most significant surge occurred over the New Year period. Although adequate warning was provided, NRA



*Dr Howard Lyne,
Public Met.
Service Manager*



*Windsurfer making
the best of things
during the floods
of December 1994*

Anglian region reported damage to defences that will cost £0.8m to repair. As a corollary, the number of surges on the west coast was above average. Fortunately only a few of these posed any serious risk of flooding.

Revised arrangements for negative surge warnings, reported in last year's Annual Review, worked well for a significant surge that occurred on 31 January 1995. Tidal levels between Cromer and the Thames Estuary were reduced by 1.7 m or more with the low-water level at Lowestoft being 0.74 m below Chart Datum, the lowest tidal level there since 19 December 1982.

Pollution emergencies

When there is an atmospheric pollution emergency, The Met. Office provides forecasts of the expected spread of pollutants to the emergency services and appropriate government departments. We are also a centre within the World Meteorological Organization (WMO) for providing services in the event of an international environmental emergency. Speed of response in these situations is vital and the highest priority is given to this service. Performance targets based on response time have been included in this year's Charter Standard for the first time. In addition to immediate weather advice, we will aim to provide specialised weather information within 30 minutes on at least 85% of occasions.

National Meteorological Library

A new integrated library automation system was introduced to the National Meteorological Library. By connecting to the Central Data Network of The Met. Office, Library users will be able to make use of the facilities from the comfort of their own office. In addition, the new system has enabled the Library to make savings in excess of those required by the recent market testing exercise.

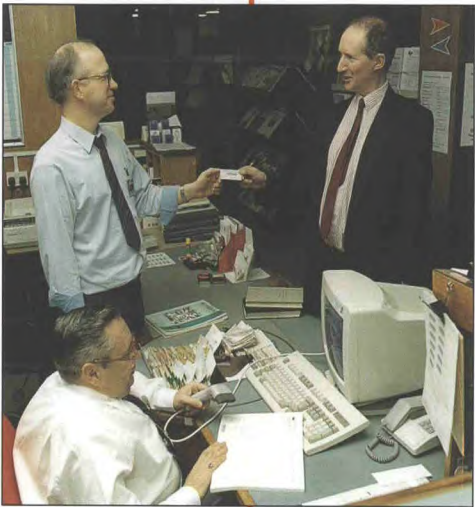
Education

Market research showed a very high level of satisfaction with the award winning MetFAX Education dial-up fax service for schools, and the two resource packs "The Weather Story" and "The Weather Machine". A CD-ROM entitled "Windows on the Weather" was produced with The Advisory Unit from Hatfield, and interest in the Meteorological Self-briefing Terminal (MIST) has continued to grow within the education sector. During 1994, over 7,000 enquiries were answered by Met. Office Education Services and the involvement of teachers with the development of new products will continue in 1995.

Three one-day meteorological courses for secondary school teachers were held plus a twilight course for primary teachers. During 1995, it is intended to hold the secondary school courses at several Weather Centres across the country.

Enquiries and complaints

The Enquiries Officer at Bracknell handled 8,784 enquiries from the public during 1994, a 55% increase over 1993. In the same period, the numbers of complaints remained almost constant at 346, a decrease of ten from 1993.



Mike Nicholls, Director of Observations, receives his new Library user card

A student gets to grips with analysing the weather at an 'Introduction to Meteorology for Teachers' course at The Met. Office College





*Dr Jim Caughey,
Director of Defence Services*

Defence Services

I am pleased to report that, against a background of changing needs, the Defence Services (DS) Division has achieved its main objectives and all of its primary targets. It is particularly pleasing that we achieved a customer satisfaction index of 0.87, well above the 0.82 target. At the same time, efficiency improved by 7.5%, again significantly above target.

Efficiencies

As part of the continuing 'Options for Change' programme, a further five forecasting sites were closed with a saving of 28 staff. At Gibraltar, plans to replace three UK-based forecasters by Gibralterians were warmly welcomed across the community and the three staff are currently undergoing intensive training at The Met. Office College.

Mobility

The Mobile Meteorological Unit (MMU) was stretched to the limit throughout the year. As well as supporting numerous military exercises both in the UK and overseas, the Unit provided continuous service at Split in Croatia, Gioia del Colle in Italy and Incirlik in Turkey, all in support of UN operations.

A particularly demanding task was the support provided to STRONG RESOLVE 95, a major exercise held in Norway in late February and early March to test the NATO Combined Joint Task Force and Reaction Forces. Directed by the Principal Forecast Office, High Wycombe, in close liaison with Fleet Weather and Oceanographic Centre, Northwood and the Norwegian Meteorological Institute, three MMU forecasters were deployed to assist the host nation at Oerland, Trondheim and Stavanger. A fourth forecaster supported the UK Mobile Force Helicopter Unit, working in Arctic conditions in tented accommodation.

Service Development

During the year, an improved night illumination Tactical Decision Aid (TDA) was issued to all DS, and Royal Navy Air, stations for use in supporting night-vision goggles and other image intensifiers. Forward Looking Infra Red (FLIR) systems see the 'thermal contrast' and, consequently, predicting the background temperature contrast is important in forecasting the effectiveness of FLIR. To allow this, a surface temperature prediction model has been delivered and an assessment of performance has shown predictions of surface temperatures with a root-mean-square error of less than 1 °C, well within the required accuracy. Work is now needed to exploit this model for use in a FLIR TDA.

One of the tasks of our stations on Army ranges is the provision of specialised meteorological data to support gun firing. A joint study was completed, with HQ Director Royal Artillery, Larkhill, to investigate the potential of using forecasts from the Mesoscale Unified Model (MUM) to produce these data. MUM profiles for Larkhill were compared with on-site radiosonde data and the results showed that it was possible to produce equivalent meteorological messages to those prepared using radiosonde measurements. To exploit this capability, we have developed a dial-in facility to enable selected outstations to obtain MUM profiles and to produce automatically the messages required.

With the availability of powerful PCs in the outfield, it has become possible to provide sophisticated application models for use by forecasters. Outstation trials of a model for predicting fog and low cloud, developed by the Atmospheric Processes Research (APR) division, have identified a number of areas where the model needs further improvement and these are to be addressed.

Service Delivery

A rugged prototype Mobile Outstation Display System for use by the MMU was built using off-the-shelf components. Trials with the RAF demonstrated to the military the benefit of such a system and contracts have now been let for the delivery of five further systems.



*A routine balloon
launch at Larkhill*



*Monitoring sound levels
during tank firings on
Salisbury Plain*



Frank Dalton,
Head of CAA Services



Aviation Services

Within the UK

1994/95 saw continued growth in the number of customers using MetFAX as a means for accessing up-to-the-minute weather forecasts and aerodrome reports. The PC-based MIST system has also started to attract customers. The improved version of MIST for use by offshore helicopter pilots finally became operational and was warmly welcomed.

The introduction by the Civil Aviation Authority (CAA) of their Meteorological and Aeronautical Information Retrieval System (MARS) into Heathrow, Gatwick and Stansted enabled us to withdraw Met. Office staff supporting this service by the end of March 1995. Further staff savings will be possible during 1995 when MARS becomes operational at the other airports served by the CAA.

International

1994 was a significant year in international aviation, not least because December 1994 saw the 50th anniversary of the International Civil Aviation Organization (ICAO). The event was celebrated at The Met. Office with a ceremony attended by Lord Goschen (then Transport Minister for Aviation), and representatives from the Civil Aviation Authority (CAA), the European Office of ICAO, and the Department of Transport.

In August 1994, The Met. Office signed a contract with Matra Marconi Space for a Satellite communications Dissemination System for aeronautical meteorological data (SADIS). The implementation of SADIS, undertaken by The Met. Office on behalf of ICAO, significantly improves the availability of aviation data in Africa, Europe, Asia and the Middle-East. It will allow the distribution of new high-resolution global forecast upper-wind and temperature data. This will improve the accuracy of the information used for flight planning which is expected to lead to cost savings by the airlines. SADIS will also allow the collection and dissemination of aerodrome weather reports

and forecasts, and the timely distribution of warnings of hazardous en-route weather, improving the data available to a pilot before take-off. The new service is due to become operational during June 1995, marking a significant step for ICAO and the industry.



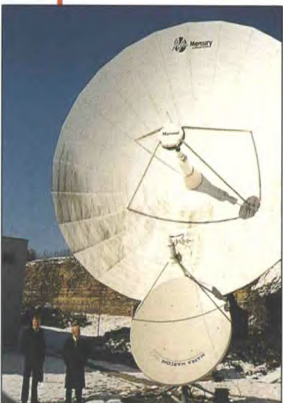
The International
Aviation team

The Central Forecasting Office (CFO), in its capacity as an ICAO World Area Forecast Centre (WAFC — London) for aviation, commenced operational production of significant weather (SIGWX) charts for the domestic European area and the Europe to Asia region, previously the responsibility of the ICAO Regional Forecast Centre (RAFC) Frankfurt. In March 1995, future developments were reviewed by an ICAO Study Group meeting attended by representatives from The Met. Office. The Study Group endorsed proposed plans to extend the SIGWX forecasts for the full globe.

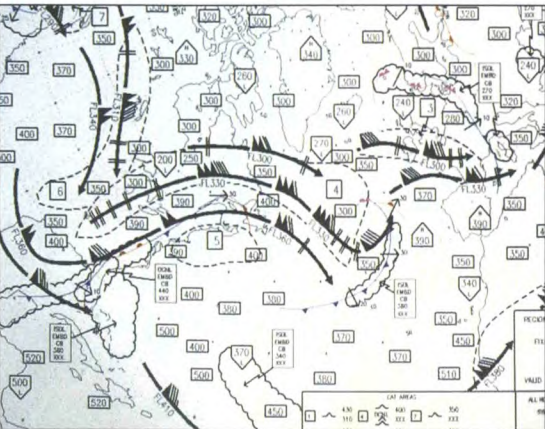
Training in aviation meteorology
and systems

A Met. Office/WMO seminar, aimed at improving the understanding of numerical weather prediction products for aviation, took place in July and has become an annual summer event. A successful one-day seminar for airline and operator staff also took place in June 1994 giving information about the new data that will become available via the SADIS satellite broadcast. On behalf of ICAO and the SADIS project, experts from The Met. Office will support a number of international seminars during 1995.

To improve the understanding of weather information provided by self briefing facilities in the UK, special courses for private pilots took place at The Met. Office College. These proved to be beneficial and very popular.



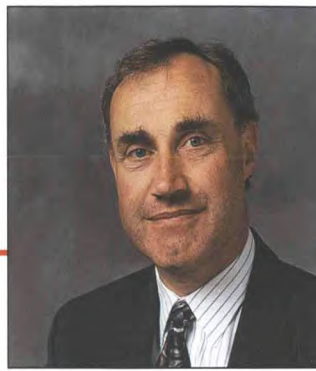
A two-way VSAT dish
(foreground) with the
Mercury Communications
uplink to INTELSAT,
used by SADIS



SIGWX charts for
Europe to Asia region
are now produced
routinely at Bracknell



Commercial Services



*Roger Hunt,
Deputy Director, Commercial Services*

Financial Results



*Alan Douglas,
Marketing Director*

This year has seen excellent and continuing growth from our commercial services. Commercial Services (CS) revenue, of £20.6m, was 8% up on last year and, although it fell 2% short of this year's target, it represents an increase of more than 80% since we became an Agency. Pleasing growth in revenue has been apparent in a number of sectors, and the proportion relating to international sales now exceeds the target of 10%.

This year has also seen an improvement in the level of our financial contribution to core infrastructure and general overheads, and the increase targeted in the Business Plan was almost achieved. An independent audit of the level of CS contribution, conducted by Touche Ross as an outcome of the Defence Cost Study, validated our own assessment and confirmed to MoD that there is no cross-subsidy for commercial activity from the Defence vote.

Many efficiencies and improvements were made, including the deployment of the Outstation Production Unified System (OPUS) at all Weather Centres and their integration into a Wide Area Network. It was also decided to close our Weather Centres at Plymouth and Nottingham (effective from April/May 1995) as part of a network rationalisation programme, customers being transferred to other nearby Centres.

Collaboration

Growing collaboration with private-sector partners and other National Met. Services (NMS) has been crucial to our continued success. Such partners have made major inputs to the development of new services, operational activities, software systems development, marketing and sales. 44% of our commercial revenue is now earned through such partnerships, permitting continual growth in revenue with reducing staff numbers and fixed-costs.

A new agreement has been signed this year with Wimpey Environmental relating to the joint offshore services in the Far East operated from The Met. Office/Wimpey Singapore Office, now being subsumed into an agreement with GEOS, a joint-venture between Wimpey and Fugro BV. Another agreement was signed with AGI Ltd to licence and market semi-automatic observing systems.

Memoranda of Understanding were signed with the Dutch Met. Service KNMI, Météo France, and the Polish Met. Service, all related to commercial collaboration. A collaboration contract is about to be signed with the Chinese Met. Administration. Close collaboration with all west European NMS is being pursued through the formation of ECOMET, an Economic Interest Grouping which will open up the European continent to services offered by all members. ECOMET will also facilitate the wholesaling of European data and products to the European private sector on equitable terms. At time of writing, the final steps leading to the formation of ECOMET are being completed.

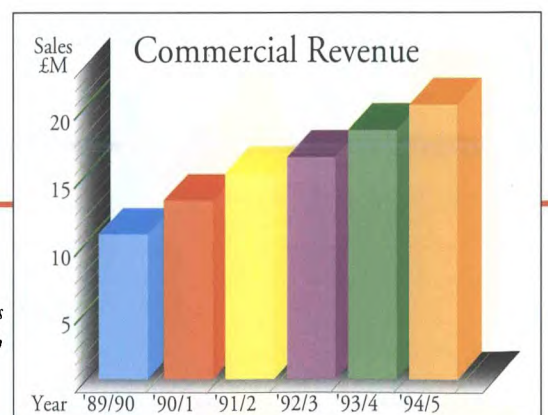
Economic Benefits

A major conference on the Economic Benefits of Meteorological and Hydrological Services was mounted in Geneva in September 1994 under the auspices of the WMO. The Conference was chaired by Bernard Herdan, Director of Commercial Services at The Met. Office, and the UK made numerous contributions to this milestone event. The main conclusion from the Conference was that the economic benefits of the services under discussion are globally estimated at between \$20bn and \$40bn, a multiple of between five and ten times the cost of the world's National Meteorological and Hydrological Services.



*Dr Peter Francis
Director of Production
and Service Provision*

*Commercial revenue shows
excellent continuous growth*



Innovative new graphics were introduced to the ITV national weather service in January 1995



Television and Radio

Television continues to be a major source of business, accounting for 21% of all revenue earned in CS. However, it is also an area of strong and growing competition, both from the UK and overseas. Emphasis has therefore been placed in developing ways of exploiting new technology in the production of weather broadcasts to ensure they are cost effective and attractive. The success of this approach was demonstrated by the retention of the ITV national service by Independent Weather Productions (IWP), The Met. Office's commercial TV Business Unit, following an open tender. Based at the LNN Studios, the innovative graphics service started in January 1995 and has been very well received.

Success was also achieved by IWP when they won the contract to provide a weather service to the major new cable TV station in London, Channel 1. Among other items, the service features regularly updated weather observations from a network of schools in the area. On the international front, IWP began a new service for Channel 5 in Sweden at the end of 1994.

Services with the BBC continued to develop. BBC Worldwide launched a European news service during the year, featuring regular weather input from the BBC Weather Centre. Arrangements were made for the Office to receive American radar and satellite data direct from a private weather company for use on the new BBC World service. We were delighted that Bill Giles, Head of BBC Weather Centre, was awarded an OBE in the January 1995 New Year's Honours list.

Commercial radio has grown further. An important new service began with London News Radio, the most substantial service ever produced for an independent UK radio station.

Electronic Distribution

Premium-rate telephone services continued to provide a major source of revenue through our partnership with Telephone Information Services Plc. Met. Office premium-rate dial-up fax services also continued to grow, with approximately one million calls, an increase of about 35% on the previous year. Collaboration started with Delrina (UK) Corporation who produce the popular WinFax PC fax software. A range of

MetFAX products is being promoted by Delrina in the WinFax package, these products having been designed specifically for PC screen viewing.

The MIST PC weather system, developed in conjunction with Matra Marconi Space Systems, is showing good growth with sales running at typically two new customers every week. An agreement was reached with Farmplan to distribute MIST to the agricultural sector.

Marine Weather Group

The Marine Weather Group was launched early in 1994 to provide a single brand name and umbrella organisation for the wide range of marine and offshore services supplied by four units within the Office.

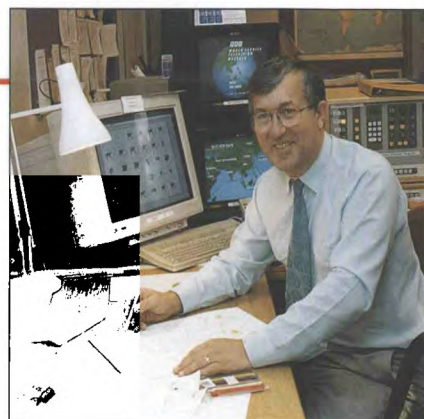
Aberdeen Weather Centre continues as the major provider of offshore forecasts to operators on the European Continental Shelf.

Forecasters now utilise new production software that allows greater flexibility and efficiency in the presentation of wind and wave guidance.

The new Singapore forecasting office gained many new contracts over a wide area from the Arabian Sea to Hong Kong, and attracted much favourable comment on the standard of service. There is excellent co-operation with other NMS in the region.

The Marine Consultancy Unit completed a major study of design criteria for an oil terminal in the Arabian Gulf, and also provided expert advice to a consortium planning a new natural gas processing plant on the coast of Oman. Demand from maritime lawyers and insurers remained high for advice on weather-related shipping accidents worldwide.

Metroute, our ship-routing service, served vessels of all sizes over all oceans. Of particular interest was a catamaran ferry on passage from UK to New Zealand, travelling at 30 to 40 knots and therefore requiring good advance warning of high seas.



*Bill Giles,
Head of
BBC Weather Centre*

"It's a refreshing change to get such clear and accurate forecasting. The format is very easy to use — you can find what you want instantly."

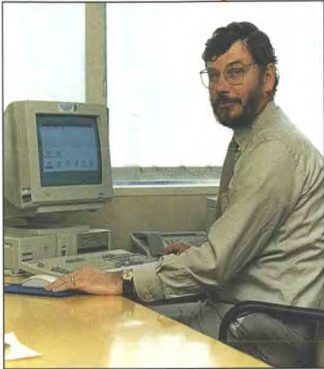
Capt. R.S. Holt, Barge Master, South Seas Driller

"We again extend our gratitude for the quality of your forecasting service ... We believe your service assisted greatly in our survey planning, and in the ultimate safety of our vessels."

R. Evans, Project Manager, Rascal Survey (Malaysia)



Land Transport



*Dr Bill Moores,
Product Development
Manager*

The OpenRoad ice warning service for local and highway authorities has had another excellent year. New sensors were installed in West Sussex and Dumfries & Galloway with additional sites added in Northern Ireland. Forecasts were required for 246 sites around the UK, representing 44,500 individually tailored forecasts issued during the season. For the first time, forecasts used output from the mesoscale model, leading to significant improvements in forecast accuracy. 95% of forecasts gave good guidance up to twelve hours ahead.

Most rail industry services were combined into a single contract with Railtrack, making it one of The Met. Office's major customers. Dedicated forecasts were also provided for Eurotunnel.

Building & Construction



*Peter Baylis,
Director, CS
Administration*

This year saw the addition of a new service to the SiteWise range for building and construction customers. Tailored specifically for users of the New Engineering Contract, the service gives a summary of the weather each month for a particular location and provides a comparison with that expected to occur once in ten years. The data are used to settle extension to contract disputes.

Site-specific forecasts were produced for a wide range of road projects, including the Foston-Hatton-Hilton Bypass in South Derbyshire, the A52 on the outskirts of Nottingham and the M63 Stockport to Princess Parkway.

Climatological data and analyses are used to ensure that proposed new structures satisfy BSI Building Design Codes. Studies undertaken during the year have included investigations of water penetration of buildings caused by driving rain events.

Legal and Insurance

A number of requests were received from the insurance industry regarding the use of statistical weather information to identify areas of the UK most prone to severe weather. One company purchased a large quantity of data in order to build a wind-storm model which will help to better quantify the risk faced by insurers from severe weather events. A new service, in final development, will provide

weather information direct to companies computer systems, enabling insurers and loss adjusters to speed up the processing of weather-related claims.

Environmental Services

Interest in the impacts of environmental and health pollution heightened during the year. An asthma epidemic in June, associated with thunderstorm activity, led to an analysis of this episode by our Metstar Business Unit. We also participated in an experiment involving several hundred London school-children and a pilot initiative on weather, pollution and health in Berkshire.

The UKADMS dispersion model, developed in collaboration with, and owned by, Cambridge Environmental Research Consultants, came into use in environmental impact enquiries. The model has also been developed to run in forecast mode, principally to help industry with emissions management.

1994 saw the launch of sunburn forecasts on media weather bulletins. The service, funded by DoH, was used by the Health Education Authority as part of their 'Sun Know-How' Campaign at cricket test matches.

Our twenty-year association with the Agriculture and Development Advisory Service (ADAS) for the provision of agrometeorological and, increasingly, environmental services, was further strengthened through negotiations leading to a new three-year contract.

Commercial Training Courses

To meet the growing market for meteorological information and, more importantly, its effective use, training courses for specific market sectors have been provided at The Met. Office College on a repayment basis. So far, courses have taken place for aviators, teachers, operations and management staff from the Electricity industry, highway engineers, TV presenters and yachtsmen.

Because The Met. Office has taken a lead in the commercial development of meteorological services, we are now well placed to offer training to staff from other NMS. During the year, revenue has been generated from courses for students from The Netherlands, Switzerland, Denmark, Spain and Hong Kong.



*Dr Dave Griggs,
International Manager*



International

Voluntary Co-operation Programme

The Met. Office continued to be a donor to the WMO Voluntary Co-operation Programme which helps developing countries to improve their meteorological infrastructure and services.

As one example of this year's projects, we continued our support for Meteorological Data Distribution systems (MDDs) with installations in the Seychelles, Mali, The Gambia, Nigeria, Tanzania and Zambia. Further systems have also been procured for Eritrea, and Senegal for installation in the coming year. For those countries to which we have already donated MDDs, extra receivers were provided so that they can receive data over a new channel from Toulouse, France. These projects have been carried out in partnership with the Natural Resources Institute (NRI), the scientific arm of the Overseas Development Administration.

We provided funds for the provision of radiosondes to various newly independent states from within the former Soviet Union. In addition to continuing our programme of donating climate computer systems (CLICOM), we also supported the setting up of a CLICOM Area Support Centre in Malaysia.

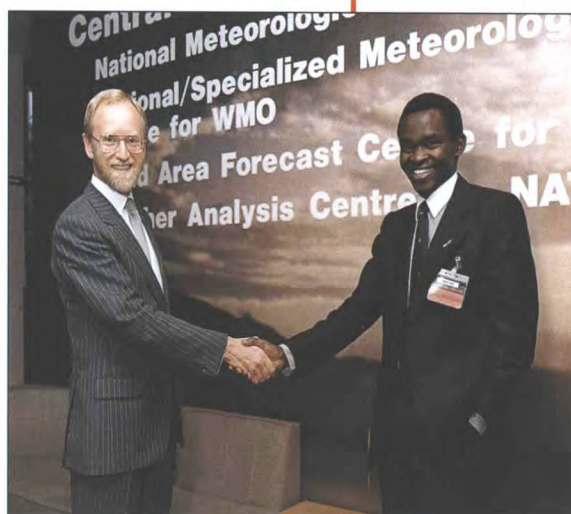
In another partnership with NRI, a low-cost PC-based TV weather presentation system was donated to the African Centre of Meteorological Applications for Development in Niger. Other systems are also being procured for The Gambia and Kenya as well as an upgrade to the existing system in Ethiopia.

Support was provided to a total of 42 students from 24 countries on a wide range of training courses.

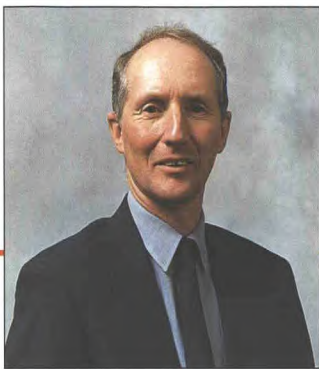
References to other international initiatives are included in a number of sections throughout this Review.



*WMO Regional
Association I (Africa)
Eleventh Session*



*Ignatius Gitonga
from the Kenyan
Meteorological Service,
seen here with
Dave Shaw,
Director of Central
Forecasting Systems,
visited The Met. Office
on a two-month
WMO Voluntary
Co-operation
Programme fellowship*



Mike Nicholls,
Director of Observations



Observations

Earth-based

As its contribution to the WMO World Weather Watch (WWW) programme, The Met. Office sustained a land-based UK observing network of 30 surface sites, with eight stations taking upper-air measurements, six of these being collocated. Three overseas stations also contributed upper-air data to WWW, a sub-set of these stations undertaking a variety of measurements for other environmental programmes.

The UK marine observing network, consisting of instrumented buoys, and Automatic Weather Stations (AWS) on platforms, islands and light vessels, was maintained despite very severe weather for much of the year. An agreement with the French Meteorological Service to jointly establish a moored buoy in the Bay of Biscay was concluded and the equipment was ready for deployment in March 1995, creating a 'defensive' network of nine such buoys around the UK. The Royal Sovereign Light Tower was replaced by a new AWS on the Greenwich Light Vessel, in the English Channel south of Newhaven.

The United Kingdom fleet of Voluntary Observing Ships now numbers 588. The newest recruit, P&O's prestigious liner *Oriana*, was also the UK's fiftieth ship to be fitted with distant reading equipment, enabling air and sea temperatures to be read from a console inside the ship's bridge.

Ocean Weather Ship *Cumulus* was deployed further south than previously in a more useful location for storm detection. In April 1994, the vessel co-operated in a ten-day exercise with the US NASA Shuttle Planet Earth Mission, providing comparative measurements for the shuttle's sea wave data.

By the end of the year the international Aircraft to Satellite Data Relay (ASDAR) programme had expanded to fifteen operational systems with contracts in place for the installation of four further systems early in 1995.

We also maintained a secondary network of 213 UK land stations, ten more than last year, most operated by auxiliary observers. The network of 43 AWS was completed early in the year, with all sites equipped with an enhanced set of sensors. Major milestones

were the equipping of three AWS, all in Northern Ireland, with laser cloud-base recorders from which cloud groups are reported automatically; and the introduction of visimeters to 14 systems to provide automatic measurements of visibility. Following the installation and commissioning of a further seventeen Semi-Automatic Meteorological Observing Systems (SAMOS), measurement programmes are now totally or partially automated at 112 land stations. A commercial variant of SAMOS, built by AGI Ltd, was procured by the Irish Meteorological Service.

The UK climatological observing network was maintained at 509 sites with 19 automatic climate data loggers. The rainfall network comprises 4022 sites, a reduction of 21 compared with last year.

Satellites

On 30 December 1994, the latest polar-orbiting satellite, NOAA-14, was launched. During its two-year lifetime, the ninth and last Stratospheric Sounding Unit (SSU) provided by The Met. Office will complete a series of global stratospheric temperature measurements unbroken since 1978.

The first AMSU-B humidity-sounding instrument provided by The Met. Office was integrated on to the NOAA-K polar orbiter, scheduled for launch in 1996. Two further flight models have been built, accepted and calibrated for use on NOAA-L and NOAA-M. Plans for the future European polar orbiting meteorological satellite are being reconsidered following a directive from the US President instructing NOAA, the Department of Defense and NASA to converge their meteorological satellite systems by the middle of the next decade.

We were delighted that Derek Painting, Director of Operational Instrumentation, was awarded the LG Groves Memorial Prize for Meteorological Observation (1993); and that the MBE was awarded to the Voluntary Observers Mrs Mary Davidson and Stanley Pickles in the Queen's Birthday Honours List (1994) and Jess Hunt and Henry Aitchison in the New Year's Honours List (1995).



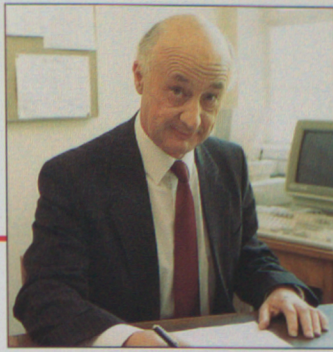
Technicians regularly service observational equipment, in this case a Laser Cloud-base Recorder



The 'Oriana' is the latest vessel to join the UK fleet of Voluntary Observing Ships



Buoys are built, tested and dismantled prior to deployment. These are now in use in the Atlantic, 200 miles off the west coast of Ireland



*Dr Roger Wiley,
Director of Information Technology*

Information Technology (IT)

Information Systems

The principal business of The Met. Office is to deliver meteorological services to its customers. Since many of these customers work in operational environments which demand up-to-the-minute weather forecasts or products, speed is of the essence to ensure that perishable information is delivered in a timely fashion.

IT has a mission-critical role to play in the transmission of observational data, in numerical weather prediction, in the organisation and presentation of information, and in the delivery of customer services. Over 90% of Information Systems resources are devoted towards this production process, the balance being applied in support of finance, accounting, personnel management, management information and administrative systems.

IT also plays an important part in improving the efficiency and effectiveness of business processes, whether previously automated or not. Industry continues to offer rapid improvement in the price and performance of IT Systems and these improvements continually offer new opportunities to expand and improve customer services while reducing overall costs.

The IT Infrastructure

For over 30 years, the IT Infrastructure of the Office has been composed of two main, and separate, components — central computing and telecommunications. During this year, the operations sections of both areas have been brought together into a single working unit. A significant improvement in efficiency has been achieved by the elimination of overlapping functions while maintaining quality of service.

Two other areas, which made intensive use of staff effort, have also been re-examined. These areas were concerned with data monitoring and manual handling of various messages. Revised manning levels have produced further significant efficiencies. In combination, the reduction in input costs stemming from the above measures has largely met the target of improving Divisional efficiency by 2.5%.

Following on from the successful merger of the operational sections, the supporting areas were reorganised into sections providing systems support and user services. Some savings arose from this process and the posts released were used to form a small Information Systems Strategy and Consultancy Group. This group is felt to be critical to the development of coherent policy and strategy which will match the organisation's information systems and technology to its future business objectives.

IT Projects

The Weather Information Network (WIN) is being planned to replace a number of analogue and digital networks with a single, resilient, high-speed digital network. It will provide facilities for the collection of observations, transfer of data between Met. Office HQ, Weather Centres and forecast offices, and also play a role in the delivery of services to customers. Early in 1995, a short list of three potential bidders was agreed and discussions and demonstrations are now taking place. The new network, which will use the Defence Packet Switched Network as main bearer wherever possible, is to be completed in 1996. Substantial savings are expected to result from network rationalisation and the replacement of obsolete equipment which has become expensive to operate and support.

Administrative Support Systems

The systems set up to support financial and accounting operations for The Met. Office as an Agency were not sufficient to meet the requirements of a Trading Fund. Arrangements have been made with the Defence Evaluation and Research Agency to use their accounting system as the heart of The Met. Office's system. The system is to operate from the 'shadow' trading year, starting in April 1995.



*The Cray Y-MP C90/16256 is used
for numerical weather prediction,
the climate prediction programme
(under contract to the DoE)
and research*



Dave Shaw,
Director of Central Forecasting Systems

Forecasting

All operational forecasting is now based on the output from our Unified Model, a sophisticated numerical computer model that utilises surface and upper-air observational data from around the world. Within the global model, there is a limited area model (or regional model) that gives more-detailed forecasts for an area covering the North Atlantic Ocean, Europe and much of the North American continent. Even more detail is available to the forecasters from a mesoscale model which can predict local weather phenomena around the UK. The models are continually being updated, based on considerable research and testing within the Office.

Improvements to the operational models

Several improvements to the operational numerical weather prediction (NWP) system have been introduced during the year, extending both the range and quality of its products. The UK mesoscale

model output was expanded to produce a continuous cycle with four forecasts per day. In autumn 1994 and January 1995, new versions of the global model were implemented, including improved representations of the atmospheric processes of gravity wave drag and orographic roughness. Another step forward was the introduction of a new method for

representing tropical cyclones within the model, based on collaboration with the City University, Hong Kong. The new scheme has been extremely well received by all users, producing substantial reductions, of around 30%, in the errors of predicted cyclone-track movement.

This has allowed us to improve the quality of forecasts passed to the main tropical cyclone forecasting centres in the world thus helping to reduce damage and the loss of life.

The combined effect of the introduction of these refinements has been an increase in accuracy significantly greater than the annual 2% target for improvement.

Global and regional forecasting and use of observations

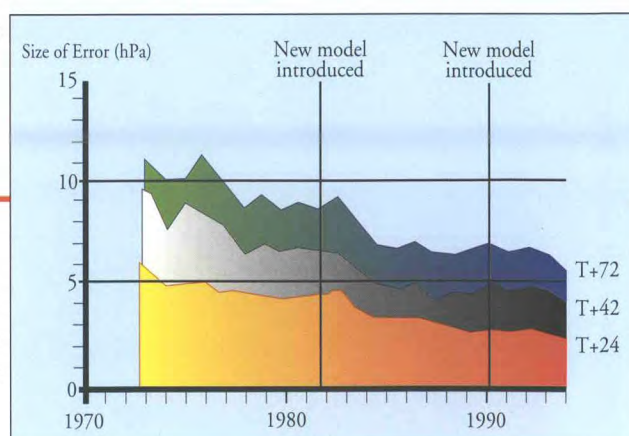
Investigations have been carried out into the way in which observations benefit numerical weather predictions, and the best use of the available resources. Results of recent so-called 'impact studies' confirm the importance of radiosonde data over North America and winds reported by aircraft there and over the Pacific and Atlantic Oceans. The impact on the regional model of additional information immediately upwind of the UK is also being assessed.

In common with other weather forecasting institutions, we are moving towards using variational methods of data assimilation. While work continues on this line of development, a number of improvements have been made to the existing data assimilation system, notably for humidity data; resulting analyses have proved much more consistent with the model formulation. The changes have removed the deficiency in total precipitation in the first few hours of the regional model forecast and reduces the cold and moist bias in middle latitudes in the global forecasts.

Martin Stubbs,
Director of the Central
Forecasting Office, and
Professor Julian Hunt,
Chief Executive, take a
close look at the
'latest' chart



Reducing errors in our
global forecasting model
output means increasing
benefit for our customers



Production of Significant Weather (SIGWX) charts

The aim of this project has been to develop a semi-automated method for producing civil aviation Significant Weather charts for the whole globe. Graphical editing facilities are applied by a forecaster at a workstation, allowing maximum use to be made of 'first guess' fields produced objectively by the operational NWP system. Completion of this project allowed the transfer of operational production of the European/Asia and European domestic chart areas from Frankfurt to Bracknell at the end of March 1995.

HORACE

The HORACE project, to develop an interactive workstation data and product display system, has made steady progress. It is now in operation at the forecast offices at HQ RAF Strike Command (HQSTC) and at the Royal Navy's Fleet Weather Oceanographic Centre. A limited form has been in use since the turn of the year in our Central Forecasting Office, Bracknell, and new facilities will be added gradually over the next few years.

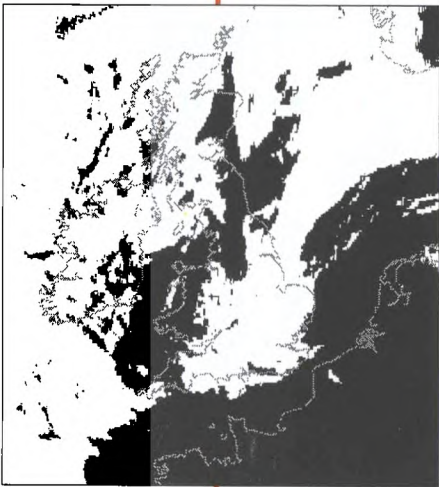
Satellite Imagery

A feasibility study has demonstrated how a successor will be developed to the existing AUTOSAT II satellite data reception system at Bracknell, which automatically generates visible and infrared images from geostationary and polar satellites. The AUTOSAT III system is expected to be substantially cheaper to run than that currently employed. The development phase will begin in 1995.



NIMROD

At present, forecasts of precipitation for up to six hours ahead are on the semi-automatic interactive system FRONTIERS. This uses a mix of radar and satellite data with a range of options from which the forecaster can choose. An automated replacement of this system, NIMROD, has now been developed and underwent an operational acceptance trial in early 1995. The trial consisted of subjective assessments by CFO staff and objective assessments of forecasts. Results showed that NIMROD produced some improvement upon the existing FRONTIERS output but not sufficient to meet the demanding acceptance criteria. It was decided to make further enhancements to the system before resuming the trial later in the year.



The fog probability predictions (shaded grey) from the mesoscale model (top), made at 1800 GMT on 13 October 1994, compare well with the satellite picture for the same time, 0800 GMT on 14 October 1994 (significant cloud and fog shown in white)

Automation of forecasts

As a result of the increasing accuracy of the NWP, it is becoming increasingly cost effective to automate certain elements of the forecast process for particular products. A necessary step towards this goal is to have a verification system which will permit assessment of automated forecast parameters and verbal scripts at successive stages of the forecasting process. Such a system is now being developed and a new applications development team is proposed from 1 April 1995 to take these ideas further.



HORACE team



*Dr Mike Cullen,
Director of Forecasting Research*

Medium-range forecasts

A working group has been established to look at how 'ensemble' forecasts can improve the usefulness of medium-range forecasts, i.e. for three to five days ahead. The Met. Office is collaborating with the European Centre for Medium-range Weather Forecasting in developing methods of 'ensemble' forecasting. In this approach, a large number of forecasts are run from slightly different initial conditions in the numerical model, reflecting the inherent errors caused by insufficiency of data.

Results from the first ten experimental cases, carried out during the year, demonstrate the value of a new approach in which sets of ECMWF and Met. Office NWP forecasts are combined. Although, inevitably, this produces a greater range of solutions than either ensemble alone, the combination does show a gain in predictability of the order of half a day over the individual model ensembles. Probability forecasts derived from the joint ensemble are also more skilful than those derived from the separate models. Some initial feedback has already been given to forecasters and a more substantial range of assessment products is under development.

Probability forecasts

During the year, probability forecasts have been used increasingly. They have proved particularly successful in emphasising the risk of severe weather (without being unnecessarily alarmist) and have been well received by the emergency authorities and certain commercial customers. We have also made greater use of probabilities in the day-to-day media forecasts, for example in showery situations. In the medium-range period, it is expected that ensemble forecasts will provide a more quantifiable assessment of probabilities.

Oceanographic forecasting

The Forecasting Ocean Atmosphere Model (FOAM) is being developed to produce analyses and forecasts of the ocean temperature and salinity structure. Based on the ocean component of the Unified Model, it uses observations of the ocean to adjust the model fields in the same way that the atmosphere models do for weather forecasting.

Regular runs of a prototype for FOAM were started in August 1994, and synoptically the results are very encouraging. Evolution of the depth of the mixed layer is of particular interest to the Royal Navy. In early September 1994, FOAM responded realistically to the passage of deep Atlantic depressions by deepening the mixed layer.

Advice to the aviation authorities

Interest in the subject of freezing rain in elevated layers has heightened considerably following the crash of the American Eagle ATR 72 near Chicago on 31 October 1994. This crash was provisionally blamed on icing, and aircraft of this type were forbidden by the US and European airworthiness authorities from flying in freezing rain or drizzle. This precipitated immense interest in the climatology of freezing rain. A climatology of freezing rain is being accumulated from the Unified Model and extra diagnostic products made available. These initiatives have generated provisional answers to many of the key questions raised in enquiries into the accident.



*Dr Peter White,
Director of Atmospheric Processes Research*

Atmospheric Processes

Applied research plays an essential part in improving the ways that forecasting and climate models represent atmospheric phenomena, such as clouds, rainfall, radiative exchange, turbulence and the influence of hills and mountains. Such research is most effective if it is fully integrated with that being undertaken elsewhere, great benefits accruing from participation in major international field experiments. To encourage this important exchange of ideas, discussions have taken place with the European Commission on funding for European Union scientists undertaking research with the Meteorological Research Flight's C-130 aircraft.

Under agreements with the Natural Environment Research Council (NERC), six collaborative airborne research projects proposed by UK universities and research institutes were approved during the year, and continued support has been given to the Joint Centre for Mesoscale Meteorology, established by The Met. Office and Reading University in 1988.

Observations, collected by the C-130 aircraft during the 1993 European Cloud and Radiation Experiment, and other international experiments, were used to test and evaluate a new radiative transfer scheme developed for the Office's weather and climate prediction model. The new scheme is expected to reduce systematic cold biases in the model, to improve cloud forecasts and to allow more-realistic representation of the effects of aerosols in climate predictions. It works well for cloud-free air but better methods of representing clouds having patchy distributions within the model's grid squares need to be devised. The radiative properties of ice particles in high clouds are also difficult to represent adequately, but studies of data obtained during collaborative airborne experiments have led to encouraging progress in identifying ways of making improvements. Experiments using a very-high-resolution cloud-scale numerical model have also indicated that radiative effects in the cloud tops of tropical squall lines may be responsible for increasing rainfall by some 30%.

The structure of the air near the ground, which determines the drag at the earth's surface and the turbulent transfer of heat and moisture into the

atmosphere, is not well predicted by the forecast model in some weather situations. In order to make improvements, studies have been carried out into low level winds during summertime convective conditions and into some night-time stable air-flow over hills. Use has been made of experimental data obtained by the Cardington Met. Research Unit and results from the very-high-resolution numerical models.

The Royal Commission's 1994 report on Transport and the Environment, in which Met. Office evidence was quoted, has increased public concerns about traffic-generated pollution. In response to requests by the Department of the Environment (DoE), we have created an improved version of the Office's urban air quality prediction model which became operational in March 1995. The new model is expected to improve the reliability of forecasts of occasions when concentrations of air pollutants exceed thresholds designated by the European Commission.

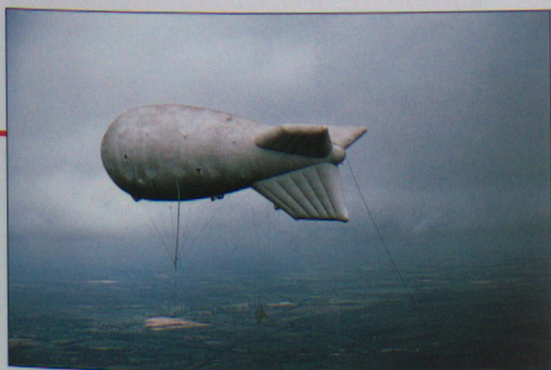
The validation of long-range pollution forecasts was addressed by the 1994 European Tracer Experiment in which very small quantities of an inert gas were tracked by the C-130 aircraft and by surface observations.

The subsequent concentrations of the tracer were forecast by models from several countries, the Office's pollution transport model predicting the concentrations well.

Three-dimensional chemistry models have been developed to replace existing one- and two-dimensional models, and improved estimates have been made of natural and anthropogenic pollution emissions dating from before the industrial revolution to well into the next century. This research has been undertaken in response to recommendations published in the 1994 Working Group reports of the Intergovernmental Panel on Climate Change aimed at improving forecasts of the climatic consequences of photochemical pollutants.



The Met. Research Flight C-130 'Snoopy' has played a vital role in gathering data used in developing a new radiative transfer scheme



Experimental data from the Cardington Research Unit balloon help researchers to improve the modelling of low-level heat and moisture transfer into the atmosphere



Dr David Carson,
Director of Climate Research

Climate Research

The issue of climate change due to man's activities is one which continues to maintain a high profile. Work on monitoring and prediction of climate variability and change is the main focus of the Hadley Centre which is jointly funded by The Meteorological Office and the Department of the Environment. The Centre also hosts the Technical Support Unit for Working Group I of the Intergovernmental Panel for Climate Change, charged

by WMO and UNEP with completing a new Scientific Assessment during 1995.

Climate change prediction

Coupled models of the atmosphere, oceans, land and sea ice are essential tools for climate prediction. The Hadley Centre coupled model has been used in two experiments to predict climate change from 1860-2050. In the first experiment, carbon dioxide (CO_2) was varied to represent the observed historical increase in greenhouse gases from 1860-1990; from 1990-2050, an increase of 1% per annum was assumed. In the second experiment, the direct effect of the historical temporal and geographical distribution of anthropogenic aerosols was included. When driven by greenhouse gases alone, the simulated global mean warming exceeds the observed value by

about 0.5 °C at 1990. With inclusion of aerosols, the difference between the model and observations is reduced to 0.1 °C, bringing it into much better accord with the 20th century record and increasing confidence in the model's ability to predict future climate. For the next century, both simulations predict an accelerated rate of warming and of the sea-level rise, the latter amounting to around 3 cm per decade, even after allowing for the cooling effects of aerosols.

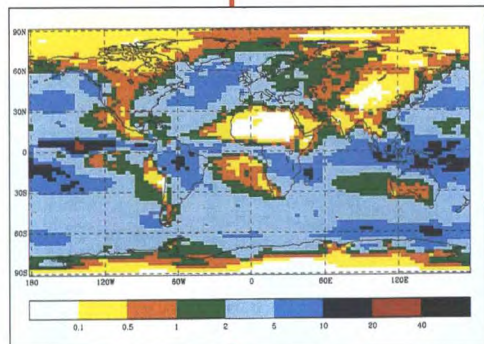
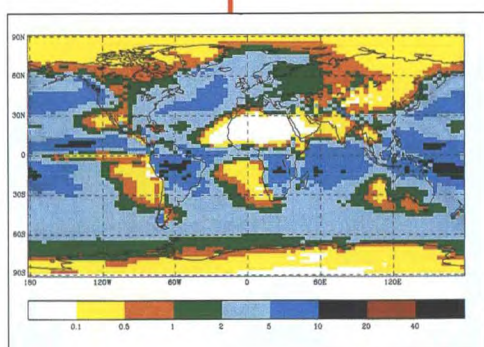
The Secretary of State for the Environment, the Rt. Hon. John Gummer, was briefed on these new results prior to his participation in the first conference of the parties to the UN Framework convention on Climate Change, held in Berlin, 27 March to 7 April 1995. A summary brochure, and presentation, of results by the Hadley Centre scientists also attracted a good deal of attention at the Berlin meeting.

Some of the most serious impacts of climate change are likely to occur from changes in the frequency of extreme events such as high temperatures or strong winds. Results of previous experiments on model sensitivity to a doubling of CO_2 are being analysed to investigate changes in variability and extremes. High-resolution regional simulations have also been obtained for Europe by nesting a limited-area version of the atmospheric model into the global version.

One method of establishing the trustworthiness of predictions of future climate change is to investigate the model's ability to predict past climates. This is being done in simulations of the mid-holocene (about 6000 years ago) in collaboration with the international Palaeoclimate Modelling Intercomparison Project.

Model development

Continual refinement of the various components of the coupled model is an essential task. The task is guided by continued verification of simulations of present day. Thus, for example, further efforts have been made to verify and develop the model's radiation codes and to improve its layer cloud, orographic roughness and gravity wave drag schemes. Increasing attention also is being given to simulation of aerosols in the model. Development of a version of the coupled model with a high-resolution ocean component and sea ice has now been completed and further attention given to methods of ocean model spin up and to modelling the ocean carbon cycle. Work on simulation of the land carbon cycle has led to further advances in representing the interactions between vegetation and evaporation. Further development of land surface schemes has also included the effects of frozen soil and snow patchiness. Some of the above work is undertaken in collaboration with universities and NERC institutes.



A comparison of a model simulation of summer precipitation in present-day climate (top) with best estimates of observed values (mm/day)

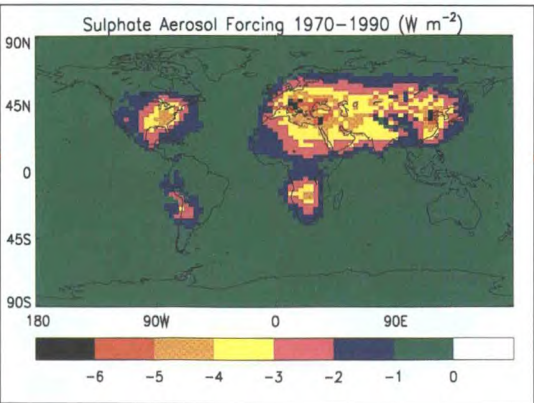
Climate monitoring

Analyses of observed data are essential, in order to test models and to study and monitor climate variability and trends. Further improvements have been made to a range of databases and are being helped by more-efficient data capture and better quality control. A new approach to the homogenisation of radiosonde data has revealed a likely artificial cooling of the radiosonde record for the lower stratosphere since 1979. A major development has been the creation of a new version of the Hadley Centre's data set containing global sea ice and sea surface temperatures, from 1871 until the present day. It gives much improved representations of sea surface temperature patterns in earlier, data-sparse, years and incorporates better sea ice data. Analyses of worldwide mean sea level pressure and daily maximum and minimum temperature have continued to be developed. The latter confirm earlier calculations that recent warming has occurred mainly at night.

Temperature measurements over land and at the sea surface showed 1994 to be the third or fourth warmest in the record (data voids continue to give uncertainties in ranking). A reason for the undoubted greater warmth in 1994 compared to the previous two years (about 0.12 °C globally) is likely to be the waning of the cooling influence of the 1991 eruption of Mount Pinatubo.

Climate variability and seasonal prediction

Experiments on the causes of interdecadal climate variability using the Unified Model have entered their second phase consisting of runs for the period 1903-93 which include rising concentrations of greenhouse gases (expressed in terms of CO₂ equivalent). These have been compared to runs for 1949-93 with fixed CO₂. The experiment with changing CO₂ clearly better represents the observed trend, though the perturbing effects of aerosols and volcanoes have yet to be included.

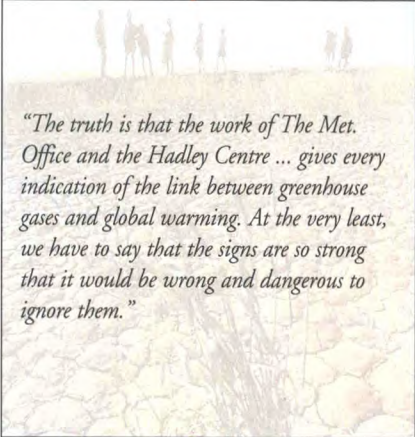


On interannual time-scales, the largest climate fluctuation is the El Niño-Southern Oscillation (ENSO) phenomenon. The Hadley Centre's coupled high-resolution tropical Pacific Ocean/atmosphere GCM has been shown to realistically simulate ENSO events and associated rainfall patterns. It is now being used in hindcast experiments of ENSO which include data assimilation to initialise the ocean structure. The close connection between sea surface temperature anomalies and atmospheric circulation can be exploited to predict seasonal rainfall in certain sensitive areas. Forecasts for NE Brazil and tropical North Africa were again made in 1994/95. This year, the statistically based methods used in the past have, this year been supplemented by the addition of AGCM-based extended-range forecast information from The Met. Office Forecasting Research Division. A first forecast of East African 'short rains' has also been made.

Middle atmosphere

Analyses of the middle atmosphere carried out using a version of the Unified Model data assimilation scheme are being used in a variety of applications. Many of these centre around the Upper Atmosphere Research satellite, data from which have been successfully analysed using the assimilation scheme. A particular study has been made of the winter of 1993/94 in which a number of interesting dynamical phenomena occurred. The analyses have also been used in collaborative studies to help interpret observations of ozone depletion over the northern hemisphere during the winter of 1992/93. The work also includes a variety of modelling studies using a configuration of the Unified Model which extends through the troposphere to the lower mesosphere.

We were pleased that James Murphy, from the Hadley Centre, was awarded the LG Groves Memorial Prize for Meteorology (1993); and that Dr Tony Slingo and Mark Webb, also of the Hadley Centre, were awarded the Len Curtis European Award of The Remote Sensing Society (1993/94).



"The truth is that the work of The Met. Office and the Hadley Centre ... gives every indication of the link between greenhouse gases and global warming. At the very least, we have to say that the signs are so strong that it would be wrong and dangerous to ignore them."

*The Rt. Hon.
John Gummer,
Secretary of State
for the Environment,
speaking in the
House of Commons*

The presence of sulphate aerosols in the atmosphere, arising from man's activities, leads to significant radiative cooling over much of the continental northern hemisphere



*Dr Bob Riddaway,
Director of Training*

Human Resources

Personnel

At the end of March 1995, the Agency employed the equivalent of 2323 full-time staff, a decrease of 151 during the year. 50 staff joined the Agency, of whom 22 were graduates, the lowest number for many years. Resignations remained at a low level, those leaving being mainly people with computing skills. The overall reduction in numbers largely reflects the Office's continuing effort to improve efficiency, often linked with the further utilisation of computer-based systems.

This was the first year in which the Chief Executive had delegated responsibility for pay negotiations. Agreements for 1994 were reached with both industrial and non-industrial Trade Unions and included important steps toward our longer-term pay strategy. Non-industrial staff accepted a reduction in shift and weekend premium payments; industrial staff agreed several changes which are expected to lead to them having the same terms and conditions as other staff in 1995.

Negotiations for the 1995 settlement are in progress. It has been agreed, subject to final negotiation, to move from paying staff according to grade to paying a rate for the job, and to introduce a single pay agreement for all staff. These changes will give increased flexibility of working practice and simplicity of administration which will contribute to the efficiency of our future operation as a Trading Fund.

Good progress has been made on management training. In particular, people involved in management of projects, both large and small, have had training. Core competencies for senior and middle managers have been agreed and relevant training opportunities are being developed.

The programme to improve the training of Met. Office Personnel Managers has resulted in three people being awarded the Graduate Diploma in Personnel Management.



*Colin Macey,
Director of
Personnel Management*

Training

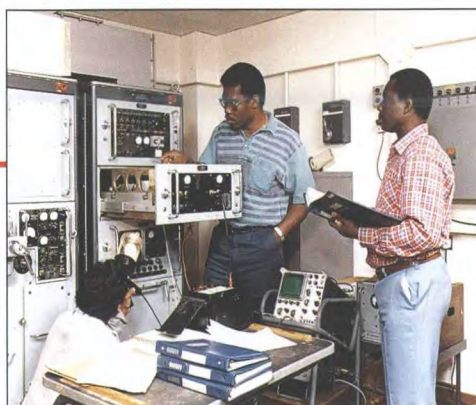
The Met. Office College is a world leader in the provision of meteorological training, attracting students from many parts of the world to its courses. In the last year, 99 students from 30 different countries were trained at the College or under its auspices.

On average, all Met. Office staff attend the college for some form of training at least every six years. During 1994/95, the College ran 47 courses for R&D staff, forecasters, observers and others for whom a knowledge of meteorology would enhance performance. These courses lasted from three days to 18 weeks. There were also 28 courses for technicians and computing staff. In all, we provided 2,400 student weeks of training, with 400 of these being for students from outside The Met. Office.

Developments in technology, and the need to satisfy the requirements of customers, has increased the range of skills required by meteorologists. Consequently, the skills and knowledge required by forecasters have been carefully assessed, and their training programme changed. There is now a greater emphasis on script-writing, broadcasting, observing and working in teams. The training requirements of other groups of staff have also been reassessed. In each case, the process has led to an agreed set of aims and objectives for the training courses and, usually, shorter courses.

Increasingly, there is co-operation between academic institutions and the training establishments of the National Meteorological Services. The Met. Office College has taken a leading role in this by stimulating the international exchange of training materials and contributing to the setting up of a European project for the development of computer-aided learning.

An options study has been undertaken to consider the strategic development of the College. It is clear from this that there is the potential for a joint venture that would still allow the training requirements of The Met. Office to be met whilst reducing costs and stimulating the further commercial development of the College. This is an exciting prospect!



*Every year, The Met. Office
College provides an eight-
month electronics course for
overseas students*

To find out more about our services, you can contact your nearest Weather Centre or the Enquiries Office at Bracknell.

Weather Centres:

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Belfast	01849 422804
Birmingham	0121 717 0571
Bristol	0117 927 9272
Cardiff	01222 390420
Glasgow	0141 248 7272
Leeds	0113 245 7703
London	0171 696 0573
Manchester	0161 477 1017
Newcastle	0191 232 3808
Norwich	01603 630164
Southampton	01703 220646

Enquiries Office:

01344 854455

Past weather and climate information can be obtained from our Bracknell Headquarters or

Belfast Climate Office	01232 328457
Glasgow Climate Office	0141 303 0110

International Marine and Offshore services enquiries:

+44 (0)1224 211840

International Commercial Enquiries:

+44 (0)1344 856283

Recruitment:

For information please write to the Recruitment Manager at the address below

Information on our Library and Archive, including the loan of weather books, videos, slides, etc., can be obtained from The National Meteorological Library at Met. Office Headquarters: 01344 854841

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