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# **Meteorological Service**

**Annual  
Report  
1986**

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Department of  
Communications

# Meteorological Service

## Annual Report 1986

Meteorological Service,  
Glasnevin Hill,  
Dublin 9

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# FOREWORD

Continuing limitations on recruitment and the filling of supervisory posts created serious management problems in the Meteorological Service during the year. As older staff members retired and could not be replaced, it was necessary to redeploy staff in such a way as to cause minimum reduction in the level of services provided to users of meteorological information. This forced recasting of some sections has seriously hampered further development of the Service.

It was against this background of staff reductions and uncertainty regarding the future, that the long-awaited Review of the Service finally got under way in February. The Review body, comprising representatives from the Departments of the Public Service and Communications and from the Meteorological Service, is charged with carrying out a comprehensive examination of the Service and making recommendations on its structure, staffing and equipment requirements. In the belief that the structure of the Service could be better adapted to modern developments in meteorology, particularly in the technological field, the Directorate has been pressing for such a review for several years; it is to be hoped that as a result of the Review the Service will be enabled to develop along scientifically - based and cost-effective lines.

On 8 December 1986 the Service celebrated its Golden Jubilee, for it was on that day, 50 years before, that the Service came into being through the appointment of its first Director, Mr Austen Nagle. The occasion was marked by an official function attended by a distinguished gathering which included representatives of the scientific and business communities, Government Departments and meteorologists from home and abroad: the function was officially opened by Mr J Mitchell, T.D., Minister for Communications. The Jubilee is being further marked by a number of public events - exhibitions, Open Days, social and sporting functions and the publication of an Anniversary Book.

In this issue of our Annual Report we give a more comprehensive description of our activities than heretofore, including, where appropriate, background information on various aspects of our work. The practice of including an article on a special topic is continued; this Report includes a special article describing the results of a customer survey which was carried out in 1986. These results have proved to be very useful to the Service; we believe that they will be of interest to many readers both at home and abroad.

*D. L. Linehan*  
Director

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# Meteorological Service

## FUNCTIONS

- (1) The collection, analysis and publication of meteorological, geophysical and geochemical data;
- (2) Research in fundamental and applied meteorology;
- (3) The supply of weather forecasts, statistical information and scientific advice on meteorological matters to agricultural, industrial and public utility undertakings, the press, radio and television, maritime interests, and the general public;
- (4) The supply of similar information to Government Departments, Semi-State Bodies and the Defence Forces;
- (5) The provision of meteorological facilities for civil airlines and general aviation interests operating to and from airports in Ireland and/or flying over Irish territory, and the supply of general advice on the meteorological aspects of civil aviation.
- (6) Cooperation with the Meteorological Services of other countries on matters related to meteorology and the representation of Ireland at international conferences.

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# INTRODUCTION

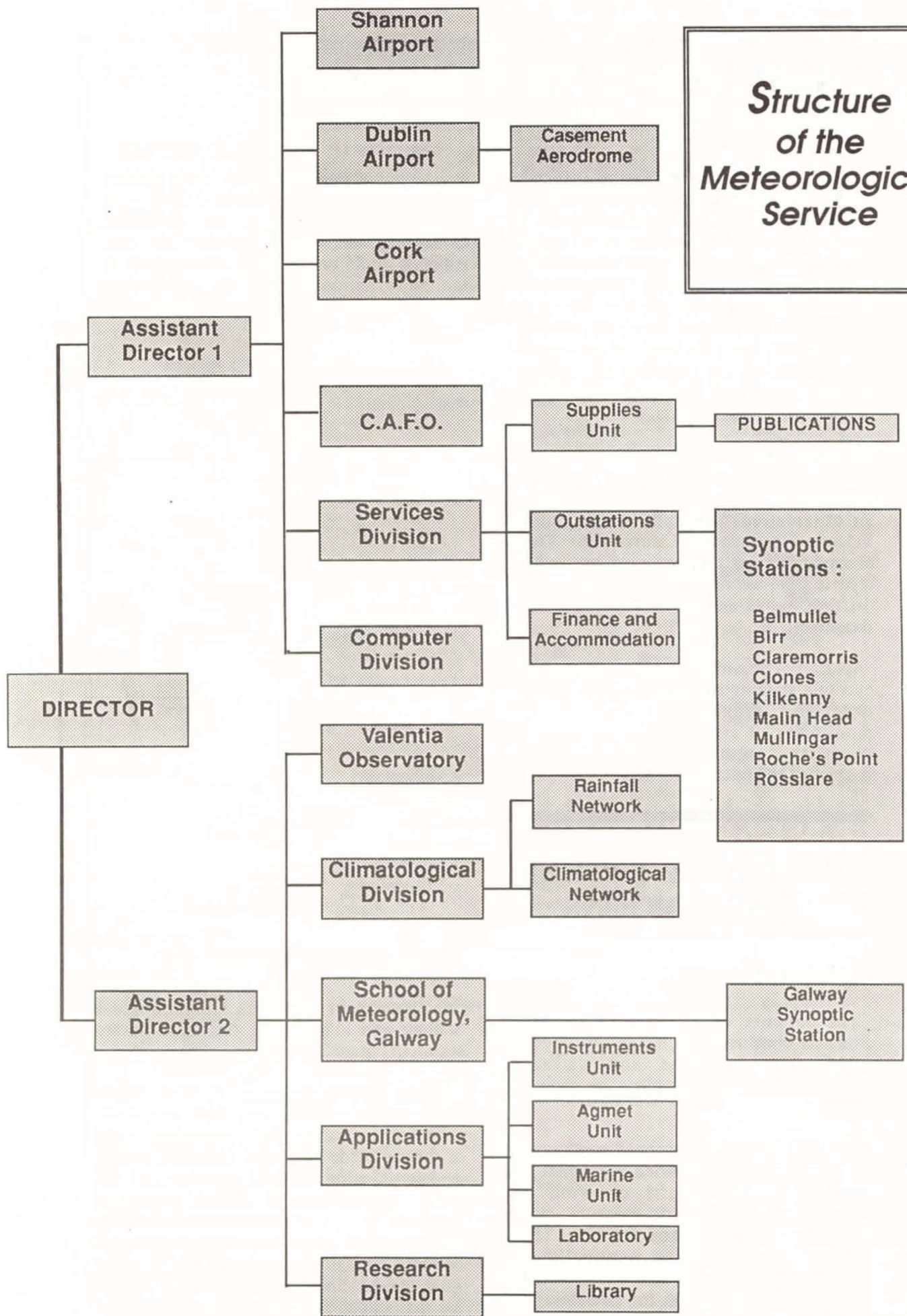
**T**he Meteorological Service produces weather forecasts and climatological information for the general public and for a wide range of specialised interests - aviation, agriculture, marine, industry, commerce, sports etc. In addition, the Service plays a major role in environmental and geophysical monitoring; it acts as National Coordinator of the European Monitoring and Evaluation Programme and is responsible for a comprehensive programme of geomagnetic and seismological observations at Valentia Observatory, Co Kerry.

The Headquarters (Directorate and Administration) of the Service are located at Glasnevin Hill, Dublin, as are the Central Analysis and Forecasting Office (CAFO), the Central Library and the sections dealing with Climatology, Research, Computers, Applications, Supplies and Instruments.

Forecasting offices are maintained at Dublin, Cork and Shannon Airports and at Casement aerodrome and 15 synoptic weather reporting stations are staffed on a 24-hour daily basis by Service personnel. The Training Division is located at Dublin Road, Galway.

This Report is divided into sections dealing separately with the various activities of the Service; an article on the results of a survey on the usefulness of weather forecasts is also included as a special topic.

# Structure of the Meteorological Service



# OBSERVING PROGRAMME

A basic requisite for the effective functioning of a Meteorological Service is the regular supply of reliable, accurate observations of the various meteorological elements at the earth's surface and at different levels in the atmosphere. In addition to serving as an essential input to the preparation of weather forecasts, weather observations form the basis of information and advice on the planning of weather-dependent projects and on environmental protection.

In Ireland, surface weather observations are provided from three reporting networks - synoptic, climatological and rainfall; upper-air observations are made at one station, Valentia Observatory, Cahirciveen. These observations are supplemented by weather reports from aircraft, ships, lighthouses and drifting buoys and by satellite and radar imagery.

Apart from providing weather reports, some synoptic stations are also involved in other observing programmes such as the monitoring of air pollution, atmospheric chemistry, solar radiation, phenology, magnetics and seismic activity.

## SURFACE WEATHER OBSERVATIONS

### Synoptic Stations

The network of 15 Synoptic Weather Stations continued unchanged throughout 1986. The locations and dates of establishment of these stations are shown in Figure 1.

Synoptic stations are manned continuously by Meteorological Service personnel and provide hourly reports of wind, air temperature, atmospheric pressure, cloud, humidity and significant weather. These reports are distributed nationally and internationally and are used for operational weather forecasting and for climatological purposes. Synoptic stations also provide regular (hourly, 3-hourly, 6-hourly or daily) measurements of rainfall, sunshine, and soil

temperature at various depths; many of them also participate in specialised observing programmes related to air pollution monitoring, atmospheric chemistry and solar radiation while one, Valentia Observatory, is the major national centre for geophysical measurements (see later sections of this Report).



Figure 1, Synoptic Network

### Climatological Stations

At the end of 1986, 82 Climatological Stations were in operation; their locations are shown in Figure 2.

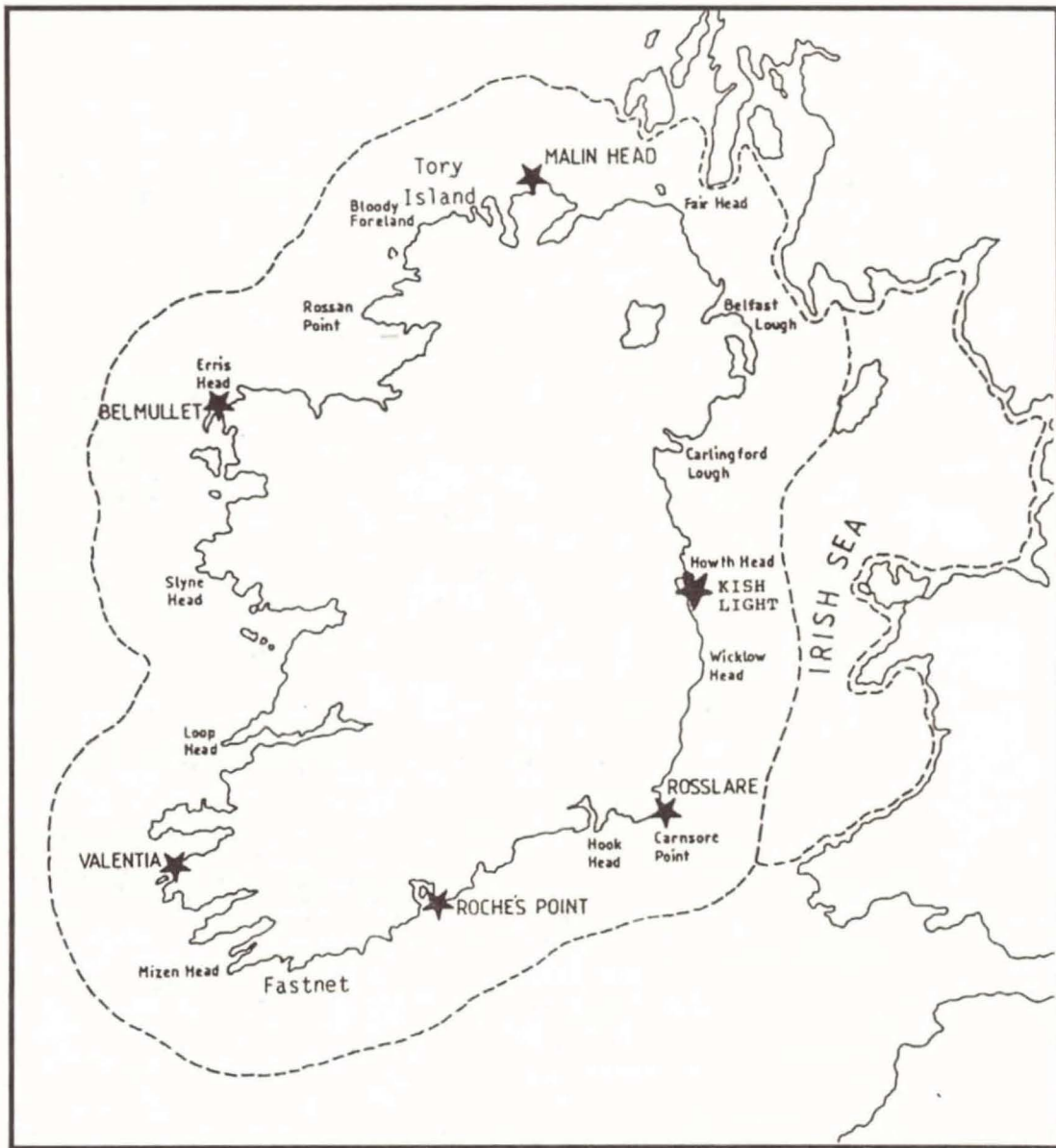
While all Climatological Stations report daily rainfall amounts and daily maximum and minimum values of air temperature, many of them provide additional information such as daily duration of bright sunshine, soil and earth temperatures at various depths at specified times, wind speed and air humidity at specified times. Most of the stations are operated by state or semi-state bodies or by local or educational authorities but a number are maintained by private individuals. All stations are regularly inspected by Meteorological Service personnel.





figure 3.

## Marine Weather Reports and Forecasts



★ Reports included in some sea area forecasts

----- Bounding of area covered in sea area forecasts

## Rainfall Stations

665 Rainfall Stations were in operation at the end of 1986. As their name implies, only rainfall is measured at these stations; daily rainfall amounts are measured at most stations while a number of them are equipped with rainfall recorders from which rainfall amounts for any period and rates of rainfall may be determined. Rainfall stations are maintained at a diversity of locations e.g. at schools, Garda stations, forestry stations and on private properties.

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## MARINE OBSERVATIONS

Since oceans and seas cover over two-thirds of the earth's surface, it is clear that meteorological observations from marine sources represent a vital input to weather analysis and forecasting. In addition, analysis of such observations over periods of years assist in the provision of information to marine interests on average and extreme conditions likely to be encountered in sea and coastal areas; such information is of particular interest to commercial shipping companies, to the fishing industry and to offshore drilling companies.

By far the most of marine meteorological observations come from ships; these may be stationary weather ships, operated and financed through international agreements or conventional merchant ships which report, using international codes, on weather and sea conditions being experienced during their sea passages. The reports are usually radioed ashore, generally to the nearest Meteorological Service. The meteorological equipment aboard these merchant ships, known as Voluntary Observing Ships, is usually supplied by Meteorological Services who are also responsible for the inspection, repairing and replacement of meteorological equipment.

Weather observations are also made at lighthouses and lightships and on offshore oil and gas platforms; through international

arrangements, increasing use is being made of floating buoys as platforms for automatic weather stations, particularly in sea areas outside the main shipping lanes.

During 1986, the Coastal Radio Stations at Valentia and Malin Head relayed 2,240 ships weather reports to the Central Analysis and Forecast Office in Dublin for local use in weather analysis and forecasting and for international distribution through the Global Telecommunication System (GTS) of the World Meteorological Organization (WMO). A further 1,090 weather reports were received from 5 Irish Fishery Patrol Ships and 130 reports from Irish vessels via British Coastal Radio Stations.

Eight voluntary Observing Ships are currently equipped by the Irish Meteorological Service. In order to check or replace ships' meteorological equipment, Port Meteorological Officers of the Service paid 20 visits to ships in Dublin, 6 in Cork and 8 in Rosslare. Visual observations of wind, weather and wave conditions were made 6 times daily at 5 lighthouses; Kish Light, Wicklow Head, Fastnet Rock, Loop Head and Tory Island (see Figure 3 for locations). Wave-height measurements from a Waverider Buoy moored outside the bar of the River Shannon were transmitted twice daily, when available, by the Loop Head lighthouse to the Central Analysis and Forecast Office (CAFO); the buoy downtime was about 30%.

Hourly weather reports continued to be received in CAFO from the automatic weather station on the Marathon Platform in the Kinsale Gas Field; the downtime of the station was just less than 11%. The Baylor Wavestaff at the platform was non-operational until mid-December when wave measurements were resumed.

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## UPPER-AIR OBSERVATIONS

Since the development, movement and intensity of weather systems at the earth's surface are influenced to a large degree by meteorological conditions in the atmosphere, it is essential for meteorologists to have regular, up-to-date information on conditions at various levels in the air above. Such information is collected at a network of upper-air stations from each of which a package of sensors attached to a hydrogen-filled balloon is released into the air, usually twice daily. As the package is carried aloft by the balloon, the sensors continuously measure values of pressure, temperature and humidity; these values are transmitted to the parent station at regular intervals during the ascent by means of small radio transmitter attached to the package. The path followed by the balloon is continuously monitored by ground-based radar and the wind at various levels is computed from successive points on the path.

Data from upper-air ascents form part of the basic input to weather analysis and general weather forecasting. They are also of particular importance in the preparation of forecasts for aviation and are an invaluable input to the prediction of the aerial propagation of pollutants and hazardous material.

The routine procedure of two radio-sonde ascents daily (at 1200 and 2400 GMT), was maintained at Valentia Observatory during 1986. The daily number of radar wind ascents was reduced from four to three from 2 January 1986 from which date ascents were made at 1200, 1800 and 2400 GMT.

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## OBSERVATIONS FROM SATELLITES

A new era in meteorology was born in April 1960 when the first meteorological satellite,

TIROS-1, was launched by the USA. Up to then, the character and movement of weather systems had to be determined by piecing together observations from land-based weather stations, ships, buoys, aircraft and upper-air stations; frequently, the large gaps between observation sites, particularly over oceans, led to great difficulties in determining the location and intensity of weather systems

The advent of meteorological satellites, with their capability of providing images of cloud distribution, extent and alignment and hence of pinpointing the position of fronts, depressions and anticyclones, provided meteorologists with powerful new means of improving the weather analysis and forecasting.

Figure 4 indicates the location of the meteorological satellites in operation in 1986.

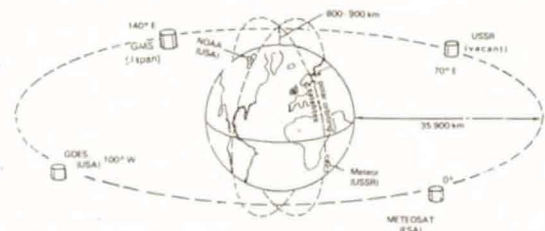


Figure 4

They include two different groups characterised by the type of orbit - polar-orbiting and geostationary. Polar-orbiting satellites are typically 800 to 900 km above the earth and pass near the north and south poles in a single orbit which takes about 100 minutes; they provide complete global coverage every 12 hours as the earth rotates beneath. The geostationary satellites lie in equatorial orbits at a height of 35,900 km, chosen so that a single orbit takes 24 hours and thus coincides with the earth's rotation; they thus appear at a fixed point in the sky

above a pre-selected meridian.

Of particular use to the Irish Meteorological Service is the European Space Agency's METEOSAT located above the Greenwich meridian; this geostationary satellite provides half-hourly images of the area over and around Ireland in both visible and infrared formats.

During 1986, satellite pictures from the European geostationary satellite METEOSAT 2 and the American polar-orbiting satellites NOAA 9 and NOAA 10 were received on a regular basis at CAFO and Shannon Airport. The satellite images were relayed from CAFO to Dublin Airport and Casement Aerodrome and from Shannon Airport to Cork Airport. Images received in CAFO continued to be used as part of the nightly television weather presentation on RTE 1.

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## WEATHER SURVEILLANCE RADAR

The usefulness of radar in meteorology stems from its capacity to detect the presence of water droplets in the atmosphere. In its simplest form, developed shortly after World War II, meteorological radar was extremely useful in the detection of rain, hail and snow. As radar technology advanced, meteorological radars became more sophisticated and more powerful so that meteorologists were enabled to make more accurate assessments of precipitation amounts in clouds and, using computerised radar systems, to continuously monitor and display on screens the location and intensity of rainfall. Since the range of individual radar installations is limited by the earth's curvature, images from a number of installations in Western Europe are combined to form a composite precipitation picture of the area.

The Digitised Radar System at Shannon Airport operated satisfactorily during 1986; digitised pictures were received both at Shannon Airport and CAFO and were transmitted to the British Meteorological Office at Bracknell. The Selenia radar at Dublin Airport required considerable maintenance during the year; because of its

age (it was installed in 1966), spare parts have become increasingly difficult to obtain.

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## GEOPHYSICAL OBSERVATIONS

Apart from being a synoptic and upper-air weather station, Valentia Observatory, Caherciveen also acts as the country's main geophysical observatory at which geomagnetic and seismic variations are monitored. In addition, staff from the Observatory carry out periodic country-wide magnetic surveys.

### Geomagnetism

Continuous records of the variations in declination, horizontal force and vertical force of the earth's magnetic field are provided by a system of variometers and recorders. Base line data are collected using Ruska Observatory Magnetometer (Declination), Proton Precession Magnetometer (Total Force) and Proton Vector Magnetometers (Horizontal and Vertical Forces).

The results of the Magnetic Surey carried out in September/October 1985 were published in 1986 under the title "The Secular Variation of Magnetic Declination in Ireland (1985)".

### Seismology

Since 1962, the Meteorological Service has been participating in the "World-wide standard seismograph network" organised by the United States Coast and Geodetic Survey. Continuous recording of seismic activity is effected through short - and long-period vertical and horizontal seismometers installed at Valentia Observatory in a specially prepared semi-underground vault.

The seismological recording programme was operated continuously throughout 1986; numerous requests from European and American institutes for copies of seismograms were responded to during the year.

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## SOLAR RADIATION MEASUREMENTS

The basic solar radiation programme of the Meteorological Service consists of the measurement of global and diffuse solar radiation on a horizontal surface at six synoptic stations (Valentia Observatory, Dublin Airport, Birr, Kilkenny, Clones and Malin Head) and of global solar radiation on a horizontal surface at Belmullet. Additional measurements are made at Valentia Observatory as follows:

- (i) Measurement of direct sun radiation at normal incidence,
- (ii) Monitoring of infra-red radiation,
- (iii) Continuous recording of the radiation balance,
- (iv) Continuous recording of total radiation on a south-facing vertical surface,
- (v) Continuous recording of total radiation on a south-facing surface shielded from ground-reflected radiation,
- (vi) Continuous recording of ground-reflected radiation,
- (vii) Thrice-daily observation of direct sun radiation, when sky conditions permit

All recording equipment is calibrated against a Linke-Feussner Actinometer which in turn is calibrated against an Angstrom Pyrheliometer which is maintained as a National Standard and is compared regularly with other National Standards at WMO International and Regional Comparisons

Valentia Observatory acts as the National Solar Radiation Centre from which all other solar radiation stations are supervised; it is also the Irish focal point for international solar radiation activities.

The solar radiation programme continued satisfactorily in 1986.

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## ATMOSPHERIC MONITORING

Since 1960, the Meteorological Service has operated an Atmospheric Chemistry Programme which entails the regular

collection and analysis of air and rain samples from a number of synoptic stations (nine at present). The samples are analysed for the following constituents: sulphate, chloride, nitrate, ammonia, sodium, potassium, calcium, magnesium, pH, acidity and conductivity in rain, and sulphate, sulphur dioxide, chloride, sodium, potassium calcium, ammonia and magnesium in air. The Service contributes to three international programmes: the Background Air Pollution Monitoring Programme of WMO, the European Air Chemistry Network and the European Monitoring and Evaluation Programme.

The Service also collaborates with the Nuclear Energy Board (NEB) by collecting and processing precipitation, tap water, total fallout and airborne dust samples for radioactivity measurement by the NEB.

During the period immediately following the Chernobyl nuclear accident in April 1986, the sampling programme for the NEB was considerably increased and there was also a sharp increase in the number of enquiries for information on radioactivity levels and related wind patterns.

# FORECASTING SERVICES

It is a common belief among the general public that the only forecasts available from the Meteorological Service are those which are presented daily in the newspapers, on radio and on television. In fact, while the preparation of those forecasts is an important activity of the Service, they represent just one aspect of the wide range of forecasting services available.

Since there are few human activities that are not weather-dependent to some degree, weather forecasts are in demand from a large variety of interests—farmers, sailors, flyers, builders, holiday makers *et al.* It is interesting to note that the first major efforts in organizing international meteorology were spearheaded in 1853 by a group of mariners in the USA and Europe who wished to establish a coordinated system of weather services for shipping. Later with the development of commercial flying, fresh impetus was given to meteorology by the demands of the burgeoning aviation industry for meteorological forecasts and information. In fact, the decision by the Irish Government of the day to establish a National Meteorological Service in 1936 was based on the realization that an important transatlantic air base would shortly be sited in Ireland and that that base would be required to provide a comprehensive meteorological service to aviation. Over the years since then, there have been ever-increasing demands for weather forecasts from all sections of the community. While in the early years of the Service these demands for non-aviation weather forecasts were met by the forecasters at the airports, their volume grew to such an extent that it was found necessary to establish a separate forecast office to deal with them. Thus, in 1960, the Central Analysis and Forecasting Office (CAFO) was established at the Headquarters of the Meteorological Service at 44 Upper O'Connell Street, Dublin; in 1979, CAFO was re-located at new Headquarters in Glasnevin, Dublin.

As its name implies, CAFO is the main analysis and forecasting centre of the Meteorological Service. There, surface and upper-air weather charts based on observations received from reporting stations located over a large segment of the Northern Hemisphere, are plotted and analysed and disseminated to the forecast offices at Dublin,

Cork and Shannon Airports. Twice daily, forecast charts at surface and upper-air levels for 24 hours and 36 hours ahead are produced by the Service computer based on numerical models developed in the Research Division.

These forecast charts form the basis of all forecasts prepared at CAFO and other offices. In addition, forecast products received from the European Centre for Medium-Range Weather Forecasts (ECMWF), located at Reading in the UK, covering periods of several days ahead, provide useful guidance in the preparation of forecasts as do the satellite and radar images referred to in other sections of this Report.

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## GENERAL FORECASTS

Weather forecasts for the general public are disseminated in four ways: through the newspapers, on radio, on television and by telephone.

### Newspaper Forecasts

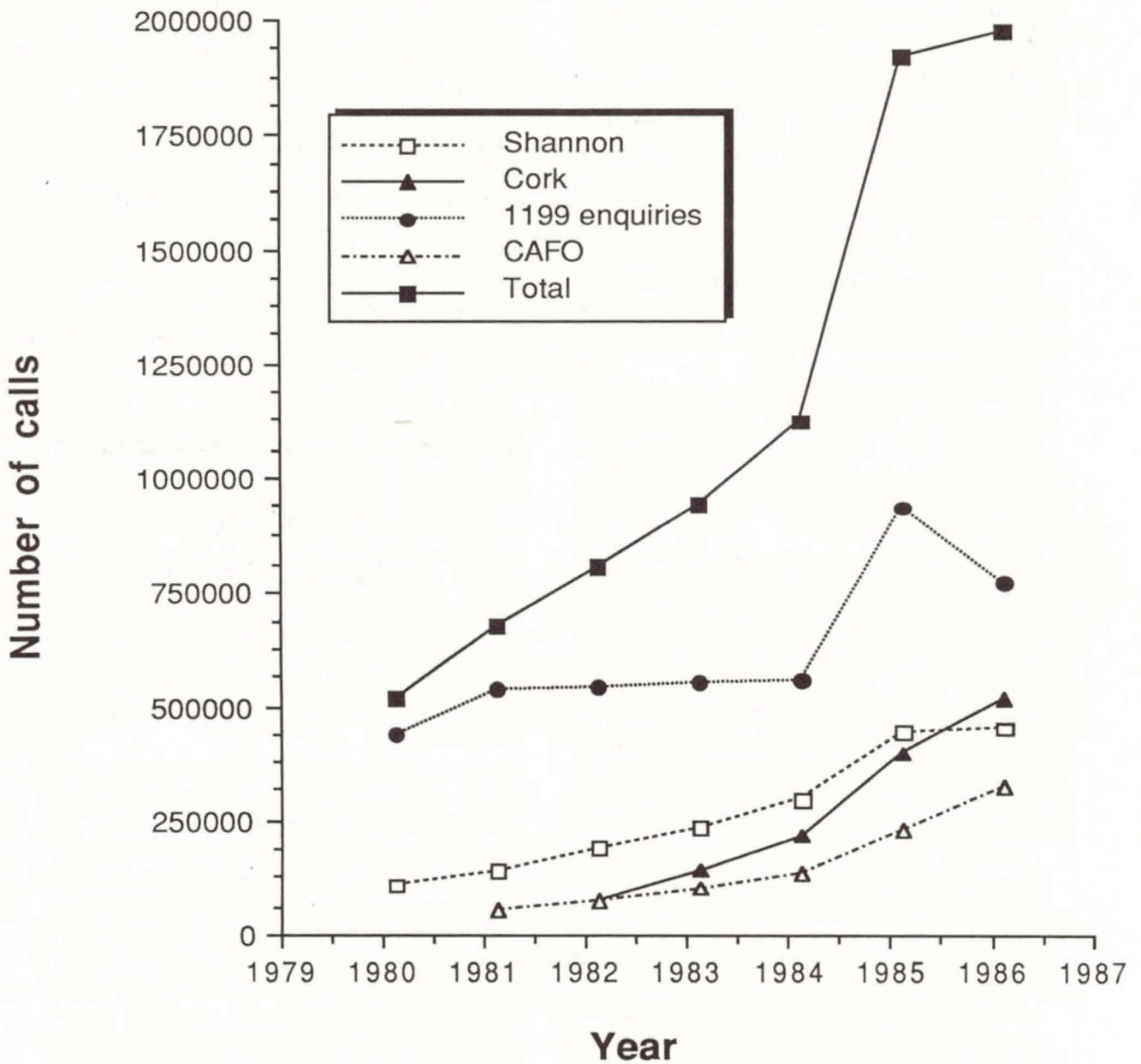
Weather forecasts are supplied to national daily morning newspapers, to Dublin evening newspapers and to national Sunday newspapers. These forecasts cover a 24-hour period with an outlook beyond that period and are accompanied in most cases by charts showing the current and forecast weather situations. In 1986, the practice was initiated of supplying Sunday newspapers with weekly weather outlooks for Ireland and major holiday resorts in Europe, the near East and North Africa. Weekly forecasts are also supplied to a number of provincial papers.

### Radio Forecasts

Weather forecasts are broadcast on national radio a number of times daily from the radio studio in CAFO. The broadcasts consist of: (a) a general forecast for 24 hours with a further outlook (b) a detailed sea area forecast for 24 hours with an outlook to 48

figure 5.

## Automatic Telephone Weather Forecasts 1980 to 1986



### ATWS Numbers :

Leinster and Cavan/Monaghan : (01) 425555	Dublin area : 1199
North Munster/South Connaught : (061) 62677	South Munster : (021) 964600
North Connaught/Donegal : (01) 424655	



hours (c) weather reports from coastal weather stations at Malin Head, Rosslare, Roche's Point, Valentia Observatory, Belmullet and at the Kish Lighthouse (these reports are included with forecasts twice a day). (d) an extended outlook for up to 4 days ahead (once a day).

The times of these broadcasts are changed by RTE from time to time.

Summaries of forecasts are also given by RTE personnel at the end of news summaries.

From 23 May 1986, Radio na Gaeltachta began its nationwide coverage: sea area forecasts were supplied thrice daily to this station.

Occasional local forecasts were supplied to Community Radio and weekly forecasts were supplied to Cork Local Radio.

During the period 17 July to 22 August 1986, special holiday weather forecasts for Europe and North Africa were supplied each Friday to Radio 2.

Sea area forecasts continued to be supplied to AMCS radio stations at Malin Head and Valentia at 6-hourly intervals. Forecasts for Dublin Bay continued to be supplied 4 times daily to AMCS Dublin Marine Radio.

Severe Weather Alerts were issued to RTE on 7 occasions during 1986.

## Television Forecasts

Weather forecasts are presented daily by a CAFO meteorologist after the main evening news on RTE 1 television.

Summaries of forecasts are given by RTE personnel after news summaries.

In 1986, CAFO meteorologists also presented forecasts on such television programmes as "Live at Three" and "Good Afternoon".

## Telephone Forecasts

Up to the year 1967, telephone requests from the general public for weather forecasts were handled by forecasters at the airports. With the large increase in the number of such requests, it was considered necessary to establish a system of recorded forecasts which would meet the needs of the majority of callers while leaving the forecasters more time to deal with requests for forecasts of a more specialised nature. Thus, a system of

recorded 8-hour forecasts for the Dublin area was initiated in 1967 followed by similar systems for other parts of the country. These systems, known as the Automatic Telephone Weather Service (ATWS) has proved to be immensely popular, as may be seen from Figure 5. Requests for specialised forecasts are still replied to personally by forecasters.

Forecasts for the Dublin area, which covers County Dublin and parts of the adjoining Counties of Kildare, Wicklow and Meath (basically the area covered by the telephone prefix 01) and which also includes a wind forecast for Dublin Bay and reports from the Kish Lighthouse are prepared in CAFO and recorded by Telecom Eireann; they can be received by dialling 1199.

Recorded forecasts for other areas are prepared and recorded by forecasters in CAFO and at Shannon and Cork Airports; the appropriate telephone numbers are shown under Figure 5.

In 1986, telephone requests for forecasts numbered 1.93 million, an increase of approximately 2% over the 1985 figures.

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## AVIATION FORECASTS

As already indicated, the Meteorological Service was established in 1936 primarily to meet the needs of the rapidly expanding aviation industry. Now, 50 years on, aviation interests still represent the major group requiring meteorological services and 35% of the staff of the Meteorological Service are directly employed in providing these services at the three state airports and Casement Aerodrome.

### Civil Aviation

In 1986, forecasting services provided for the civil aviation sector were at broadly the same level as in 1985. In all, meteorological documentation was supplied for some 36,000 commercial flights and 6,000 non-commercial flights. In addition meteorological information was provided for 157 training flights and some 25,000 telephone requests from pilots of light aircraft, airline personnel and Air Traffic Control were dealt with. Special aviation forecasts were also supplied for a number of air displays throughout the country. Local warnings of hazardous conditions (frost, gales, wind shear, squalls, snow and sleet) were issued as necessary by airport forecast offices; forecasters at Shannon Airport issued 470 warnings of hazardous weather conditions (SIGMETS) for aviation in the Shannon Flight Information Region.

An operational system for the provision of computer - generated route winds and temperatures for manual flight planning for some European routes using digital gridpoint data from the World Area Forecast System (WAFS) was introduced in May 1986.

Further steps were taken in the rationalisation of services to aviation by the installation of a computerised self-briefing system for air crews at Dublin Airport. This system, not yet complete, is designed to eliminate the requirement for forecasters at Dublin Airport with briefing and consultation

being available as required by telephone from forecasters at Shannon Airport.

### Air Corps

Meteorological support to the Air Corps has been provided by the Meteorological Service since the late 1930s. A fully-equipped weather-observing station at Casement Aerodrome is staffed on a full-time basis by Service personnel and forecasting services are provided by a meteorologist at the Aerodrome or, in his absence, by the meteorological office at Dublin Airport. Flight documentation and weather briefings are provided for training flights, search and rescue missions, fishery protection patrols, security operations, air exercises and flights (national and international) for the transport of government ministers and officials. Training courses in meteorology for Air Corps personnel are also provided by the Service.

From June 1986 onwards, international flights above 10,000 feet were provided with charts of significant weather, upper winds and temperatures based on RAFC products.

There was a significant increase during the year in the services required by the bases at Gormanston, Finner and Monaghan. More detailed meteorological information than heretofore was required for flights of the new Dauphin helicopters which were acquired during the year.

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## FORECASTS FOR AGRICULTURE

In view of the dependence of agriculture on weather conditions, it is not surprising that the farming community is one of the largest groups requiring weather forecasts. In the majority of cases these requirements are met through the ATWS but where forecasts are needed for specific agricultural purposes some farmers prefer to speak personally by telephone to the forecaster.

Special weekly forecasts for farmers are

supplied to some farming and daily national newspapers and are also presented by an agricultural meteorologist on a farming radio programme.

Weekly forecasts are supplied to AFT - An Foras Taluntais (The Agricultural Institute) from June to September and to ACOT - An Comhairle Oiliuna Talamhaiochta (The Agricultural Advisory Service) from April to July as input to Grass Production Simulation Models and Crop Tillage Reports, respectively.

Weekly forecasts are also supplied, on a fee basis, to some commercial agricultural companies.

Warnings of weather conditions suitable for the spread of potato blight and special frost warnings for fruit growing areas are added to radio and television forecasts when appropriate. Following on the difficult season of 1985, the 1986 season was again very severe in terms of "blight-weather": 6 blight warnings were issued in 1986 between 4 June and 28 August.

The meteorological input to the AFT/ACOT Agricultural Videotex Project (Agriline) was increased in 1986 by the addition of additional facilities for the inclusion of regional variations in the general forecasts, where necessary; 24-hour forecasts were entered four times daily and 5-day forecasts were entered once a day.

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## MARINE FORECASTS

Apart from the sea area forecasts and reports from coastal stations routinely included in the weather forecasts broadcast on radio from CAFO four times daily, a number of other forecasts specifically directed to marine interests are provided by the Meteorological Service.

Gale warnings are issued when necessary by CAFO and are broadcast with the weather forecasts from the CAFO radio studio and are also broadcast by RTE personnel on radio and

television. In 1986, gale warnings were in force for all or part of the coastal waters around Ireland for 75 periods during the year.

In addition to the forecasts for Dublin Bay available in the ATWS, daily forecasts for Dublin Bay are supplied four times daily to AMCS Dublin Marine Radio.

Forecasts are also supplied either on a routine or request basis to fish farming companies, to coastal engineering projects, to yacht and sailing clubs and to deep-sea trawling operators. In 1986, as in previous years, special forecasts were supplied to operators of drilling rigs off the Irish coast. 5-day forecasts of wind, weather, waves and swell were provided, usually twice daily, to five drilling companies during the year and a continuous weather watch was maintained on each rig site. In November and December 1986, regular forecasts for the Bantry Bay area were supplied to governmental and local authorities involved in averting oil spillages from damaged ships in the area.

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## FORECASTS FOR INDUSTRY

In 1986, special forecasts were supplied weekly or twice - weekly to a number of commercial firms including supermarkets, chemical plants and builders providers and to public utilities such as the Electricity Supply Board, Dublin Gas and Coras Iompair Eireann (The Irish Transport Company). State or semi-state bodies, such as Bord Baine (The Milk Board) and the Ordnance Survey were also provided with special forecasting services; warnings of severe weather conditions were issued to local authorities, the Defence Forces, the Office of Public Works and to a number of commercial concerns.

In connection with the Chernobyl nuclear accident in April, special forecasts were supplied to the Nuclear Energy Board.

## USEFULNESS OF WEATHER FORECASTS

As indicated earlier, weather forecasts are made available to the public in a variety of ways - through the newspapers, on radio and television and by telephone. Although it is known, in a general way, that most people are interested in the forecasts, more detailed knowledge of the extent of interest in and satisfaction with the presentation and content of the various forms of forecasts would assist the Meteorological Service in the planning of future developments in the area of public forecasting. In addition, knowledge of the usefulness of forecasts to their users would provide a basis for assessing the value of weather forecasts to the public not alone in economic terms but also in relation to such unquantifiable factors as human safety and comfort. For these reasons, the Meteorological Service carried out a postal survey in 1986 of various categories within the national community - the general public and specialised interests such as farmers, building contractors, local authority engineers, yachtsmen, consulting engineers and sporting associations. Some categories - such as aviation and offshore drilling interests, were not surveyed since in these cases sufficient knowledge of their requirements for, satisfaction with and use of forecasts had been acquired through regular contact over the years.

### Survey Results

Some 1000 completed questionnaires were returned; the response rate was 50%

from a random sample of 500 from the General Public and over 80% from a number of sectors such as Local Authority Engineers, Racecourse Managers and Lifeboat Stations.

Different groups within the community are particularly interested in forecasts of different weather parameters. The Survey indicated, that while forecasts of rain were most important to Market Gardeners and Building Contractors, frost forecasts were most important to Local Authority Engineers, Consulting Engineers and Managers of racecourses and golf-clubs, Wind forecasts were particularly important to engineers in Telecom Eireann and in the Office of Public Works as well as to marine interests while to the General Public and Tarmacadam Contractors forecasts of sunshine were most important. Forecasts of drying conditions figured prominently as being of importance to many categories; Farmers rated this parameter as being of greatest importance while several other categories (Stud Farmers, Market Gardeners, Sports Club Managers and the General Public) placed it high on their priority lists.

Table I lists the percentage first preferences expressed by respondents in the various categories for forecasts for various periods ahead. Not surprisingly, there are considerable differences between categories e.g. crews in lifeboat stations find 4-hour forecasts most useful while farmers prefer the longer-term forecasts; most categories favoured medium-term forecasts of 12 to 48 hrs.

Table II shows the percentage first preferences for the different sources of forecasts. Here again there are wide variations between categories: for the General Public and Farmers, television is the main source while specialised interests such as Racecourse Managers

and Local Authority Engineers indicate a strong preference for personal telephone forecasts.

With regard to the public perception of the accuracy of weather forecasts, Table III summarises the reactions of the various categories to the question '*Do you consider that 24-hour weather forecasts are reliable*', It may be seen from the Table that the percentages of those who considered that 24 hour forecasts were reliable at least 80% of the time varied from 60.8 in the case of farmers to 92.3 in the case of the personnel of lifeboat stations. To the more general question '*Do you consider that weather forecasts (generally) are reliable*', the sample of the general public category replied as follows: nearly always; 34.2%, usually; 39.7%, sometimes; 24.4% and rarely; 1.7%.

While the survey attempted to ascertain in precise terms the nett economic benefit of weather forecasts to the various commercial interests, the replies received were much too vague to be of any value in arriving at a valid assessment of the relevant cost/benefit ratio. Replies to the question '*Have weather forecasts any nett economic benefit for you*' (reply much, same, little or none) were, however, very useful in establishing qualitatively the respondents' perceptions of the economic value of weather forecasts to them; the replies are summarised in Table IV.

A major objective of the Meteorological Service is to provide weather forecast and warning services which would assist in the reduction of the dangers to life and property due to hazardous weather conditions: details of such services are given in the "Weather Forecasts" sections of this Report. An important aim of the 1986 Survey was to ascertain the extent to which the general public and the various specialised categories acted to protect life

and property on the basis of weather forecasts. As shown in Table V, decisions involving human safety based on forecasts of bad weather are taken by 58.7% of the General Public; in the case of some other categories the percentages are much higher e.g. 85.7% of Local Authority Engineers, 90.5% of Inshore Fishermen, 93.5% of Mountaineering / Orienteering clubs and 100% of lifeboat station personnel. The proportion of people taking precautions to protect property when bad weather is forecast is equally impressive e.g. 59.4% of the General Public, 87.1% of Farmers, 96.0% of Ships Masters and 97.5% of Inshore Fishermen.

## Conclusions

The Survey provided useful information on the attitudes of various sections of the community to weather forecasts, to their presentation and contents and above all to their usefulness. It is clear from the attached Tables and from the additional remarks from respondents that there is general satisfaction with the forecast services provided although many would prefer that more comprehensive services be provided on a regional basis. This latter point as well as others made regarding presentation and content of forecasts and the interpretation of weather charts will be valuable in planning further development of forecasting services.

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TABLE I

FOR WHAT PERIODS AHEAD ARE WEATHER FORECASTS MOST USEFUL TO YOU?

FIRST PREFERENCE

	4 hours	12 hours	24 hours	2-5 days
Building Contractors	9.4%	32.1%	43.3%	15.2%
Tarmacadam Contractors	21.4	35.8	21.4	21.4
Local Authority Engineers	4.0	36.0	48.0	12.0
Telecom/OPW Engineers	-	25.0	75.0	-
Consulting Engineers	6.2	15.6	68.8	9.4
Farmers	3.3	16.4	27.9	52.4
Stud Farms	-	23.0	38.5	38.5
Lifeboat Stations	44.5	33.3	22.2	-
Ship Masters	8.9	46.6	37.8	6.7
Inshore Fishermen	8.3	27.8	47.2	16.7
Fish Farms	-	-	50.0	50.0
Racecourse Managers	-	15.4	61.5	23.1
Mountaineering, etc. Clubs	3.6	32.1	50.0	14.3
Golf Clubs	8.0	20.0	48.0	24.0
Sports Clubs/Associations	6.3	31.2	37.5	25.0
General Public	9.5	31.2	41.1	18.2

TABLE II

## FROM WHAT SOURCES DO YOU OBTAIN WEATHER FORECASTS?

	Radio	RTE TV	Other TV	Newspapers	Personal Phone Call	Pre- recorded Phone Call
Building Contractors	30.4%	22.1%	2.5%	6.9	21.6	16.5
Tarmacadam contractors	13.3	40.0	-	6.7	13.3	26.7
Local Authority Engineers	17.4	13.0	-	-	60.9	8.7
Telecom/OPW Engineers	44.5	33.3	11.1	-	-	11.1
Consulting Engineers	21.9	53.0	6.3	3.1	6.3	9.4
Farmers	22.6	54.9	11.3	1.6	4.8	4.8
Stud Farms	36.3	27.3	18.2	-	-	18.2
Fish Farms	70.0	10.0	-	10.0	10.0	-
Racecourse Managers	23.1	7.7	7.7	-	38.4	23.1
Mountaineering, etc. Clubs	35.7	21.4	14.3	-	10.7	17.9
Golf Clubs	45.8	29.2	4.2	4.2	8.3	8.3
Sports clubs/Associations	10.7	42.9	-	7.1	17.9	21.4
General Public	26.9	60.6	7.8	2.1	1.0	1.6

TABLE III

DO YOU CONSIDER THAT 24-HOUR WEATHER FORECASTS ARE RELIABLE?

	90%	80%	65%	50%	OF THE TIME
Building Contractors	20.6%	44.1%	30.9%	4.4%	
Tarmacadam Contractors	20.0	55.0	15.0	10.0	
Local Authority Engineers	25.0	57.1	14.3	3.6	
Telecom/OPW Engineers	7.1	57.2	14.3	21.4	
Consulting Engineers	9.7	56.1	29.3	4.9	
Farmers	23.9	36.9	19.0	20.2	
Market Gardeners	13.8	44.8	31.0	10.4	
Stud Farms	15.0	40.0	35.0	10.0	
Lifeboat Stations	7.7	84.6	7.7	-	
Ship Masters	15.4	73.1	11.5	-	
Inshore Fishermen	13.6	54.6	25.0	6.8	
Fish Farms	22.2	33.4	22.2	22.2	
Yachtsmen	21.1	44.7	26.3	7.9	
Racecourse Managers	36.8	36.8	26.4	-	



TABLE IV

HAVE WEATHER FORECASTS ANY NETT ECONOMIC BENEFIT FOR YOU?

	much	some	litle	none
Building Contractors	23.7%	49.7%	17.5%	9.1%
Tarmacadam Contractors	52.2	30.4	8.7	8.7
Local Authority Engineers	37.0	55.6	3.7	3.7
Telecom/OPW Engineers	21.5	35.7	35.7	7.1
Consulting Engineers	2.3	20.4	34.1	43.2
Farmers	45.9	43.5	8.2	2.4
Market Gardeners	45.1	35.5	19.4	-
Stud Farms	18.2	68.2	9.1	4.5
Ship Masters	64.0	24.0	8.0	4.0
Inshore Fishermen	74.4	20.9	4.7	-
Fish Farms	22.2	44.4	22.2	11.2
Racecourse Managers	47.4	36.8	-	15.8

TABLE V

DO YOU EVER TAKE DECISIONS INVOLVING HUMAN SAFETY BECAUSE OF A FORECAST OF BAD WEATHER?

DO YOU EVER TAKE PRECAUTIONS TO AVOID DAMAGE TO PROPERTY BECAUSE OF A FORECAST OF BAD WEATHER?

	HUMAN SAFETY		DAMAGE TO PROPERTY	
	yes	no	yes	no
Building Contractors	43.2%	56.8%	75.3%	24.7%
Tarmacadam Contractors	36.4	63.6	71.4	28.6
Local Authority Engineers	85.7	14.3	75.0	25.0
Telecom/OPW Engineers	76.9	23.1	71.4	28.6
Consulting Engineers	43.6	56.4	60.5	39.5
Farmers	58.3	41.7	87.1	12.9
Stud Farms	45.0	55.0	54.5	45.5
Lifeboat Stations	100.0	-	70.0	30.0
Ship Masters	88.5	11.5	96.0	4.0
Inshore Fishermen	90.5	9.5	97.7	2.3
Fish Farms	66.7	33.3	87.5	12.5
Racecourse Managers	60.0	40.0	70.0	30.0
Mountaineering, etc. Clubs	93.3	6.7	53.3	46.7
Golf Clubs	53.9	46.1	73.1	26.9
Sports Clubs/Associations	55.9	44.1	58.8	41.2
General Public	58.7	41.3	59.4	40.6

# CLIMATOLOGY

**C**limatology - the study of climate - is a major activity of all National Meteorological Services. A detailed knowledge of climate is of vital importance in the planning of a large variety of projects ranging from land utilization, the construction of dams, reservoirs, drilling rigs, power plants and airports to the choice of holiday locations, at home and abroad.

## Climatological Network

A knowledge of the climate of a particular area is built up over the years from a series of observations of the various weather elements (temperature, rainfall, wind, humidity, sunshine etc) taken at representative sites in the area using standard instruments and observing procedures. In Ireland, a network of climatological stations provides the basic observations for the study of the Irish climate (see section on Observations).

The Climatological Division of the Meteorological Service is responsible for the supervision of climatological stations, the collection, quality control and archiving of their data, and the processing of climatological data into forms suitable for use by other branches of the Meteorological Service and by outside agencies. These processed data are used in the preparation of climatological publications, the investigation of particular aspects of the Irish climate and in dealing with requests for climatological information.

A total of 552 rainfall and climatological stations were inspected during 1986. Ten new rainfall and two new climatological stations were opened and thirteen rainfall stations and one climatological station were closed during the year.

## Publications

A basic, regular climatological publication, the Monthly Weather Report (MWR), is widely used as a source of information on Irish climate. It is published in separate sections:

Part I of the report contains data, mainly temperature, rainfall and sunshine values,

from climatological stations and also summarised data from synoptic stations including observations of atmospheric pressure, wind and the chemical composition of the atmosphere.

Part II is now published only annually (not monthly, as previously) and contains monthly rainfall values at some 700 stations.

Part III contains hourly values of the more important weather parameters at the 15 synoptic stations.

It is planned to amalgamate Parts I and III into a single monthly publication.

While the Monthly Weather Report is intended to meet the needs of those who require detailed climatological information, a second publication, the Monthly Weather Bulletin (MWB), available in the early days of each month, contains a more general description of the weather during the previous month, based on observations from the 15 synoptic stations only. The format of the bulletin was changed during the year to allow for the inclusion of illustrative material - maps, graphs and satellite pictures as well as short articles on meteorological topics.

During 1986, the Climatological Division was mainly occupied with the up-dating of the various parts of the Monthly Weather Report, the publication of the 1951-1980 sunshine averages, an Aeronautical Climatological Summary for Shannon Airport and various leaflets on the climate of Ireland. In addition, the second edition of the book "The Climate of Ireland" was completed and sent to the printers in December.

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## Special Reports

Special reports were prepared on the severe thunderstorms on the 27th/28th of June which caused widespread destruction, and also on two remarkable rainstorms in August. The first storm on the 5th/6th caused most damage in the south and southwest. The second one was the rainstorm associated with 'Hurricane Charley' on the 25th/26th which caused serious damage particularly along the east coast. On the 5th, 206.5mm of rainfall was recorded at Glenvickee (Caragh River Area), Co. Kerry, while 200.2mm was recorded at Kilcoole Co. Wicklow on the 25th. Both of these falls were well in excess of the previous highest daily fall anywhere in the country.

## Other Projects

A new method of contouring and shading maps of temperature, sunshine and rainfall

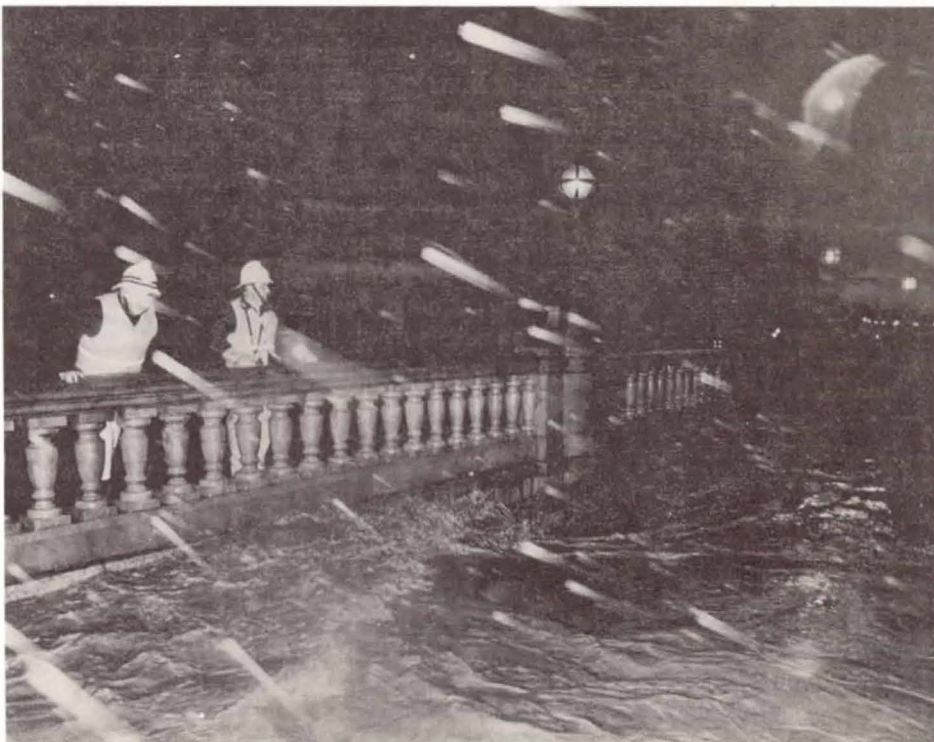
using computer graphics was developed over the year with the cooperation of Research Division

Investigations into the use of discrete autoregressive methods on sequences of dry and wet days were continued and a study was commenced on the development of a practical method of analysing extreme values

## Enquiries

The Climatological Enquiries office dealt with 5,900 requests for information during the year, an increase of over 1,300 on the previous year. Most of these enquiries came from a variety of business, industrial and professional customers, such as architects, engineers, building contractors, solicitors and insurance companies.

A member of the Enquiries Office staff was frequently required to appear in court as an expert witness. Numerous enquiries from pupils engaged in school projects were also dealt with.



*The bridge over the dodder at Ballsbridge in Dublin, during the storm on 25th/26th of August*

# RESEARCH

The Research Division is concerned with research and development in the following fields:

- (1) Computer analysis and forecast systems
- (2) Forecast verification systems
- (3) Computer graphics systems
- (4) Development and enhancement of Numerical Weather Prediction models.

The output from the Division has had a fundamental impact on the operations of the Meteorological Service in recent years in that the Numerical Weather Prediction models and the computer analysis forecast and graphics systems developed in the Division have come to play an essential role in the operational activities of CAFO and the forecasting officers at the airports.

The most significant development during 1986 was the introduction into operational use of a new computer forecasting model on 1 July. The numerical techniques used in the model are described in McDonald (1986) - (see Appendix: Publications). The advection is handled by a semi-Lagrangian scheme and the adjustment terms by a semi-implicit method; small residual terms are treated explicitly. In order to increase the accuracy of the advection process, an improved estimate of the upstream point is employed which allows the use of a 90-minute timestep. The advection and adjustment terms are handled together i.e. the model is unsplit. A staggered grid is used so that the two-grid interval noise problems associated with the E-grid are avoided. The CPU time for a 24-hour forecast is now 6 minutes compared to 24 minutes for the previous model; far less computer time is thus required without loss of accuracy.

The Numerical Weather Prediction model was used twice daily to generate forecasts out to 36 hours ahead.

Numerous amendments and enhancements were made to the data-handling, analysis and graphics systems.

The objective analysis system has been refined and now runs on a 150 km grid (previously 300 km.). This change has resulted in an improvement in the quality of the analysed fields as verified against the

analysis from the European Centre for Medium Range Weather Forecasts. The analysis programs have been speeded up considerably by a simple modification of the code and by reduction of the input/output.

Scientists from the Korean Meteorological Institute visited the Division in June to study the Irish Numerical Weather Prediction model and graphics system; the Irish model is now being successfully used in Korea.

The graphics software developed in the Division has been made available to developing countries through the Voluntary Cooperation Programme (VCP) of the WMO; copies of the software have already been sent to Meteorological Services in Brazil, Argentina and Turkey.

The Laplace transform method has been used to integrate a simple forecast model; it has characteristics which should be useful for continuous data assimilation. Another approach to this problem, integration of the "slow equations", is currently under investigation.

Several projects were carried out in cooperation with other Divisions. Among these are; (1) extraction and processing of forecasts to provide wind data to Aer Lingus for flight planning (with Computer Division), (2) development of routines for automatic analysis and plotting of temperature, rainfall and sunshine maps (with Climatology Division) and (3) routines to display forecasts of cumulonimbus tops and freezing levels, and the modification and extension of software to provide forecast flight-path winds (with Met. Office, Shannon Airport.)

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## Meteorological Service Library

The Library is located in the Headquarters building in Glasnevin; within the administrative framework, it forms part of the Research Division. It functions primarily as a technical library for the staff of the Meteorological Service but it has also a national function, being the only library in the country devoted entirely to meteorological subjects.

The Library contains about 4,000 monographs, 10,000 reports, many volumes of climatic data and non-book material such as slides, films, microfiches, microfilms and audio tapes. It receives about 100 current journals and keeps bound sets of the most important ones.

A computerised catalogue and retrieval system initiated in 1982 is available on line to staff members having access to a terminal linked to the mainframe computer of the Service.

1986 was a year of considerable inter-library activity. The Meteorological Service Library undertook the preparation and computerization of a comprehensive file of information relating to State libraries. It is planned to publish a selection of this information in the form of a Directory of Government Libraries, and the Department of the Public Service has agreed to fund this project.

Computerization of library stocks has facilitated a further participation in various co-operative schemes. Details of journal holdings have been supplied to the Library Council for inclusion in its SHIRL (Serial Holdings in Irish Libraries) data-base.

Periodically a magnetic tape containing ISBNs (International Standard Book Numbers) of all books catalogued is supplied to the Council for inclusion in its ISBN data-base. As a result stocks of books and journals are more accessible for inter-library loan both here and in Britain.

The first number of a regular staff newsletter was produced this summer. It was printed by the Stationery Office, and copies were given to all serving and retired staff. The Librarian also undertook the preparation of the anniversary book, to be published early in 1987.

# COMPUTERS AND COMMUNICATIONS

The computer system of the Meteorological Service at its headquarters in Glasnevin has for some years been based on a DEC-2050 mainframe computer (used for numerical weather prediction, graphics, climatological data processing, research projects and as a general-purpose computer) and two DEC PDP 11/40 mini-computers (used mainly for meteorological telecommunications).

## New Computer Equipment

Delivery was taken in 1986 of the second part of a new DEC VAX 11/780 system which will replace the 11/40 minicomputers. The system will be introduced operationally when the considerable amount of software development will have been completed.

Other acquisitions during the year were:

- (1) A DECmate III Word Processor and DEC Rainbow Personal Computer with DEC LQPO2 daisywheel printer: these provide a two-station word processing system for the Service.
- (2) A Canon LBP-8A1 laser printer and Canon LBP-8A2 laser printer: these are used as output devices at Dublin Airport and Headquarters.
- (3) A DEC LA34-VA graphics matrix printer; this is used as a hardcopy unit attached to the Dublin Airport graphics terminal.
- (4) Two Racal-Milgo MPS9629 V29 modems which enable the Glasnevin/Bracknell circuit to be upgraded from 1200 to 2400 bps and will allow for multiplexing techniques to be utilised on this circuit in the future.
- (5) Two Lion Systems 4960 modems and two DCA AS1M3 multiplexors; these units will allow for error-controlled synchronous communication between the Glasnevin computer system and the proposed self-briefing facility at Dublin Airport.

In addition, the Service has agreed to participate in a jointly-funded project organised by the European Centre for Medium Range Weather Forecasts (ECMWF), whereby hardware has been acquired by the Centre and software

developed to enable member states with VAX computers to communicate easily with ECMWF; four other countries are participating in the project.

## Data Communications

Among the developments in data communications in 1986 were:

- (1) the upgrading of the Glasnevin/Bracknell circuit to 2400 bps in August. This change was effected mainly to accommodate additional World Area Forecast System data.
- (2) In November, the MOTNE Conference circuit linking Dublin Airport and London Airport was removed from service; this circuit was used for many years to obtain meteorological data for some of the smaller British airports. Arrangements were made to have most of these data routed on the AFTN.
- (3) In August, the selection of North American airport forecasts available in the computer databank was greatly expanded through arrangement whereby these data are routed from London to Dublin on AFTN.
- (4) The facility for interrogating the meteorological databank by telex was publicised in an Aeronautical Information Circular in May. A manual describing the system was made available and was in much demand, mainly by private flyers. Increasing use of the facility was made by private operators and bodies such as Aer Lingus and the Air Corps.
- (5) A VDU and laser printer-based system for interrogation of the meteorological databank was developed as part of the self-briefing facilities to be installed at Dublin Airport.

## Data Processing

(a) Automatic Data Extraction: the suite of programs for the extraction and checking of international weather reports received from the GTS was enhanced to cater for the reception of SATEM reports i.e. temperature profiles derived from satellite soundings.

(b) Objective Interpretation of Computer Forecasts: methods of forecasting

maximum and minimum temperatures for Dublin, based on the "perfect prognosis" techniques, were developed and implemented during the year.

An interactive system for forecasting short-range minimum air and ground temperatures was developed.

A verification study was carried out of meteograms for Dublin and Shannon Airports, derived from ECMWF data.

(c) Processing of Gridpoint Data: from August onwards additional World Area Forecast System (WAFS) data were received twice daily from the WAFS Centre in Bracknell; software was developed to enable these data to be used eventually as the basis

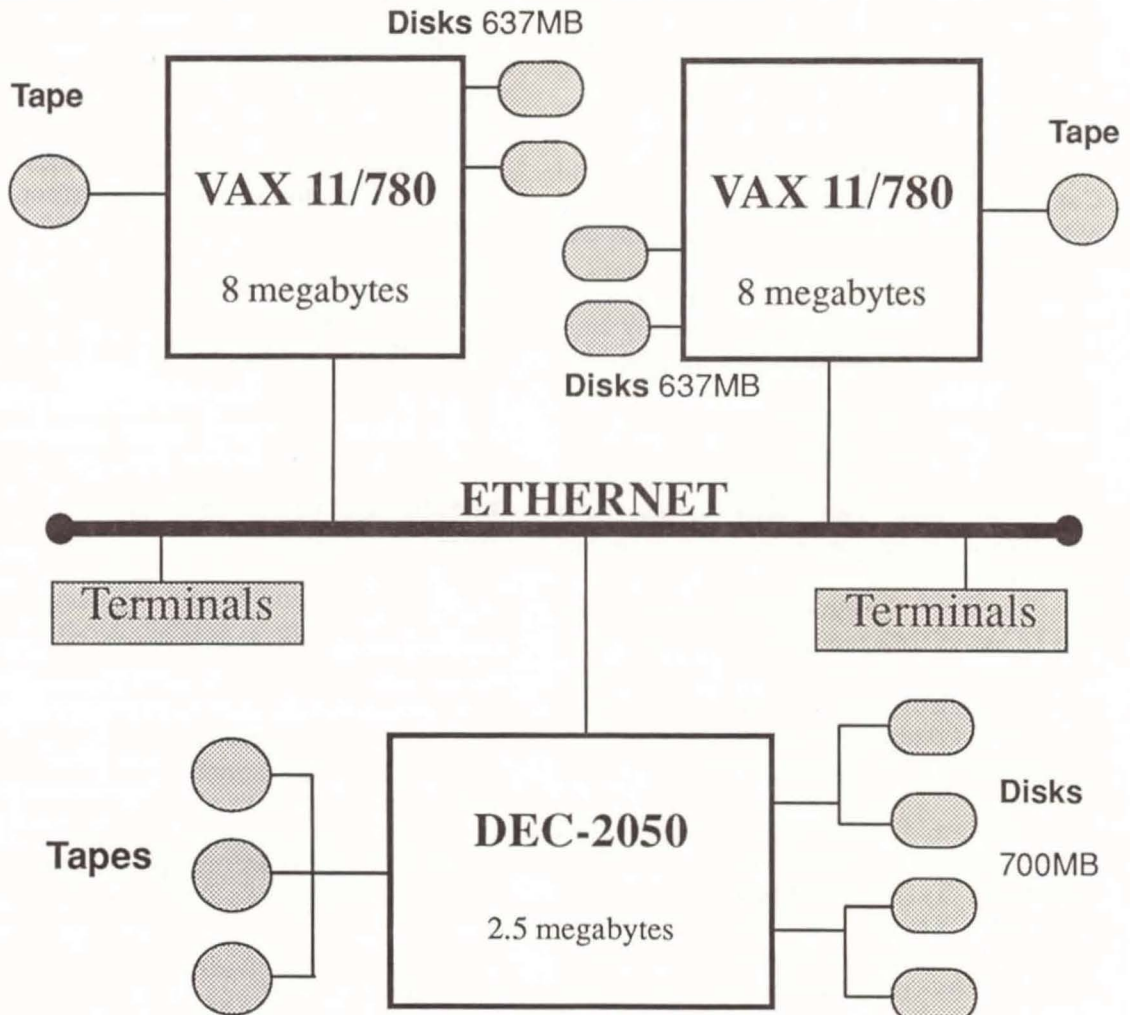
for the Northern Hemisphere coverage of forecast wind and temperature data supplied each day to Aer Lingus for computer flight planning.

(d) Climatological Data Processing: Division personnel continued to be heavily involved in replying to enquiries for climatological information and in the development and production of the new Monthly Weather Bulletin.

(e) Specialist Meteorological Services: software for the production of 5-day running means of soil temperatures was developed for the Agricultural Meteorology Unit.

figure 6.

## Proposed Computer Configuration for the Meteorological Service





# INSTRUMENTS AND EQUIPMENT

While specialists in meteorological instrumentation are located at Valentia Observatory and at Dublin, Shannon and Cork Airports, the overall responsibility for the purchase and maintenance of instruments and equipment rests with the Instrument Unit at Headquarters.

In 1986 the Unit, in addition to carrying out routine maintenance on instruments and equipment for the networks of synoptic, climatological and rainfall stations, was also engaged in the following activities:

(1) Transmission of Satellite Signals: tests were carried out in conjunction with RTE technicians on the transmission of satellite signals from Glasnevin to the RTE studios in Donnybrook. The results were very promising and it is expected that use will be made of the pictures received on live television programmes. Progress was made on the substitute for the D900 used to format satellite signals for transmission to Dublin Airport and Casement Aerodrome. Radio interference continued to be a major problem in satellite reception; late in the year, the Interference Section of the Department of Communications was requested to assist in the location and elimination of various sources of interference.

It is expected that repair work on satellite systems will be facilitated by the use of a Marconi signal generator which was acquired in December.

(2) Anemometers: work progressed on improving the lightning protection on anemometers at Dublin and Shannon Airports. Both anemometer systems were damaged during electrical storms in June; the Dansk Impulsfysik Anemometer at Shannon Airport suffered particularly serious damage.

(3) Searchlights: the modification of cloud height searchlights at synoptic stations continued: the stations at Malin Head and Cork Airport still remain to be fitted with the necessary modifications.

(4) Facsimile Recorders: the overhaul programme of the older facsimile recorders was completed during the year. As these recorders are nearing the end of their useful lives and the cost of repairing them is

very high, it has been decided that they will be phased out of service. A second digital K949 recorder, purchased during the year, has been giving very good performance.

(5) Barometers: the second Vaisala Digital PA11 barometer was installed at Cork Airport in December. A third PA11 was delivered in November: after tests, it will be installed in Shannon Airport.

(6) Digital Recorder: A Chessel digital recorder was installed in Shannon Airport in October in replacement of the Honeywell temperature recorder which dates back to 1968. After some initial faults were eliminated, the new recorder proved to be very accurate. An investigation into the replacement of mercury thermometers with platinum resistance thermometers and telemetry lines was begun in December. If successful, it is planned that such a system be installed at each synoptic station.

(7) Automatic Weather Stations: studies were undertaken in conjunction with An Foras Taluntais (The Agricultural Research Institute) on the determination of the most suitable Automatic Weather Station and Data Logger for use in the climatological network.

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# MARINE METEOROLOGY

Apart from having overall responsibility for the making and collection of weather observations from Irish ships and from lighthouses and buoys near the Irish coasts (see section on Observations), the Marine Meteorology Unit provides research support to CAFO for the supply of special forecasts to marine interests (see section on Weather Forecasts). In addition, the Unit is involved in the study of climatic conditions in Irish coastal waters, in the supply of marine climatological information and in the international aspects of marine meteorology. Wind and temperature measurements from the Marathon Platform are quality - controlled and archived within this Unit.

In 1986, work continued on detailed analysis of about one million quality-controlled weather reports made in Irish waters by ships of many nationalities over the past 100 years. In addition, wave data for 7 grid-points around Ireland were archived.

Marine climatological data were supplied for feasibility studies in fish-farming projects, coastal construction and sea transport. Reports were prepared for official enquiries

and for legal and insurance concerns on conditions which prevailed during accidents at sea.

The waves approaching the Atlantic and Celtic Sea coasts may have travelled thousands of miles or may have been generated locally. The successful prediction of such waves requires a knowledge of wave conditions over much of the North Atlantic over several days. A numerical wave model, developed by the Norwegian Meteorological Institute and adapted in the Marine Meteorology Unit is run twice a day on the Service computer and is used as a basis for wave forecasts provided to interested parties. The input to the model consists of surface winds over the North Atlantic and Western European waters which are derived from the Service's numerical weather model.

In the area of international cooperation, Ireland continued to participate in the NAOS Agreement and in the European COST-43 Agreement concerning ocean observing stations (see section on International Cooperation).



*Irish passenger ferries provide meteorological information and contribute to an archive of climatological data (Photo B & I Lines, Ltd.)*

# AGRICULTURAL METEOROLOGY

The Meteorological Service has, from its earliest days, paid special attention to the needs of agriculture for meteorological information and advice. In general, farmers require reliable weather forecasts for as long a period ahead as possible while the requirement of agricultural advisers, planners and research scientists is usually for agroclimatological data and expert advice on weather-related aspects of agriculture such as the incidence of diseases and pests and variations in the yield of agricultural crops and animal performance.

Weather forecasting services to agriculture are supplied by CAFO (see section on Weather Forecasting) and by the forecast offices at airports while the Agricultural Meteorology Unit, based at Headquarters, is responsible for all other meteorological services to agriculture and for research and investigations in agrometeorology.

Agricultural Meteorology is by its nature an interdisciplinary science which calls for close collaboration between meteorologists and agriculturalists. It is not surprising, therefore, that the activities of the Agricultural Meteorology Unit are carried out in conjunction with agricultural advisory and research institutions, the Department of Agriculture and University Faculties of Agriculture. Effective liaison is maintained through regular meetings of the AGMET Group, members of which are drawn from the various agricultural bodies and institutions and from the Meteorological Service. An Agrometeorological Bulletin is prepared early each month by the Agricultural Meteorology Unit and circulated to agricultural advisers and research scientists and to a number of commercial enterprises: the bulletin contains summaries of the weather over the country during the previous month and special articles on agrometeorological topics.

The weather during 1986 was particularly unfavourable for agricultural production: temperatures were well below average and in some places it was the wettest year in over 30 years. The wet Summer gave rise to a high incidence of plant disease and high levels of potato blight infection were reported. The Agricultural Meteorology Unit, which has the responsibility for monitoring conditions favourable for the spread of potato blight,

issued 6 blight warnings between early June and late August; these warnings were broadcast on radio and television.

Cooperation continued with the Department of Agriculture in providing an advisory service to farmers on the incidence of certain animal diseases. The high incidence of nematodiriasis was indicated in advance by meteorological data and subsequently confirmed by veterinary reports. A warning of much higher-than-average incidence of liver fluke disease based on meteorological and veterinary laboratory reports was issued by the Department of Agriculture during the Autumn.

Although outbreaks of Foot and Mouth (F & M) disease are extremely rare in Ireland, it is essential that effective control measures be planned for use in the event of an outbreak. Since the airborne spread of the disease virus is known to be a major factor in the epidemiology of the disease, the Meteorological Service will be called upon to provide a significant input to the central programme to be implemented if and when an outbreak of F & M occurs. To provide such input a computer F & M model, purchased in 1986 from British authorities and capable of simulating the dispersion of the disease is being adapted by the Agricultural Meteorology Unit for Irish conditions.

The Fire Warning Service, initiated in 1985, was again operated in 1986. This Warning Service, concerning the existence of fire hazards and based on the study of meteorological conditions, is provided to the Forestry and Wild Life Service of the Department Fisheries and Forestry. The service was provided by synoptic stations at Casement Aerodrome, Kilkenny, Cork Airport, Shannon Airport, Claremorris and Mullingar during the months of April and May, the months of greatest risk of fires.

Weekly climatological data and forecasts of certain weather parameters were provided to the Johnstown Castle Research Centre of An Foras Taluntais (the Agricultural Institute) as input to a computer grass production simulation model: predictions from the model were published in the farming press.

The joint AFT/ACOT Agricultural Videotex Project (Agriline) which was initiated in

December 1985 was continued in 1986 in two areas, East Leinster and South Munster. The aim of the project is to provide a practical data base of current agricultural and meteorological information for farmers and agricultural advisers. The meteorological information available in the system comprises one-day weather forecasts, five-day outlooks and a selection of agroclimatological tables. The "Weather" section of Agriline now runs to 68 pages of information out of a total of 3600 pages and accounts for 13% of accessions to the systems.

The Service continued its cooperation with ACOT in the provision of forecast and climatological information (and likely weather effects on diseases and farming operations) for inclusion in the weekly Crop Tillage Report. The Service also participated in the ACOT exhibition stand at the National Ploughing Championships in October.

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## Phenological Observations

The observations from four Phenological Gardens were collected and forwarded to the International Directorate of Phenological Gardens Programme (IPG). The Spring phases in the Garden at Valentia Observatory were up to four weeks late in 1986 due to the exceptionally harsh conditions which prevailed. A special report on the Phenological Garden at Valentia Observatory (by E. Murphy and T. Keane) was prepared for the German publication *Arborreta Phaenologica*.

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## CLIMATE, WEATHER AND IRISH AGRICULTURE



## AGMET Group

The Agricultural Meteorology Unit continued its active participation in the work of the AGMET Group. During the year the Group published a textbook entitled "Climate, Weather and Irish Agriculture" (*featured on the left*). The book, edited by T Keane, describes the inter relationships between weather and agriculture and examines meteorological effects which cause year-to-year variations on agricultural production.

The Agricultural Credit Corporation sponsored the book which was launched by the Minister for Agriculture, Mr Austin Deasy, T.D. in November; the publication has received favourable reviews from the national press and international meteorological journals.

# STAFF TRAINING

Apart from a short period immediately after the establishment of the Meteorological Service during which the first Irish meteorologists were trained at Imperial College, London, it has been the practice to train staff members within the Service. The Training Centre has been at different places over the years; initially located at Valentia Observatory, it was moved to Dublin Airport in the 1940s, to Rosslare in 1957 and finally to Galway in 1979.

The number of trainees in the Service has dropped dramatically in recent years due to Government policy on recruitment to the Public Service; in 1986 only 6 recruits to the Meteorological Service were trained at the Galway Centre. The low levels of recruitment and training have allowed the staff of the Training Centre to become involved in a new Training Programme for Foreign Meteorologists. Under this Programme, meteorologists of different grades from developing countries have the opportunity of receiving suitable training at the Galway Centre. The Programme is supported by the Department of Foreign Affairs and by the World Meteorological

Organization and the United Nations Development Programme.

## Overseas Students

In June 1986, a student from the Meteorological Service of Lesotho successfully completed the Meteorologists course and was then given on-the-job training at Shannon Airport. In October, a new Meteorologists course specifically designed for overseas students, was inaugurated. It includes a 7-month course in theoretical and practical meteorology, a practical project, 3 months on-the-job training in aviation meteorology at Shannon Airport and a short familiarisation course at Headquarters; five students, from Jordan, Lesotho, Oman, Tanzania and Zambia participated in the course. It is hoped by means of this Programme, to utilise the spare capacity of the Training Centre during a period of low recruitment, to contribute to Ireland's overseas aid programme and to provide revenue for the Service.



*Overseas students (1986/1987 Meteorologists Course ) with training officer, Mr. S. O Laoghog*

# ADMINISTRATION

Continuing Government restrictions on recruitment, career development and payable overtime are causing serious difficulties in many areas of the Service. By the end of 1986 the staffing of most sections had dropped below optimal levels and several supervisory posts remained unfilled. While existing staff strove to maintain normal levels of services to the general public and specialised interests, there were, inevitably, some curtailment of services from time to time during the year. The situation was exacerbated by the continued absence of an adequate grading structure within the Service although the establishment of such a structure has been advocated by the management for several years. The appointment, in February 1986, of a Review Body to examine the structure of the Service and to advise on staffing and equipment requirements gave rise to hopes that the Service might, at last, be placed on a firm structural base. The Review Group, comprising members from the Departments of the Public Service and Communications and the Meteorological Service examined all aspects of the Service's activities and made detailed comparisons with the functioning of Meteorological Services abroad; by the year's end, there was no indication that the Group had completed its study.

In preparation for the centralisation of services to aviation at Shannon Airport, further steps were taken in the provision of a self-briefing facility for pilots at Dublin Airport. The facility will become fully operational when the Service's new VAX computer has been installed.

## Staff Numbers

Staff numbers serving on 31 December 1986 were as follows:

Director	1
Assistant Director	2
Senior Meteorologist	9
Meteorologist	42
Principal Meteorological Officer	6
Senior Meteorological Officer	35
Meteorological Officer	143
Assistant Meteorological Officer	31
Other grades	31
TOTAL (full time)	300
Part-time staff	14
Overall total	314

The total of 300 full-time staff represents a decrease of 7 on the equivalent figure for 1985.

## Career Breaks

At the end of the year, 11 staff members had opted for Career Breaks under a scheme introduced in 1985. The scheme has created difficulties for the Service since, while, in theory, replacements are available immediately, it is found that, in practice, delays in recruitment and training result in posts being left vacant for considerable periods. One Meteorologist, serving at ECMWF, continued on leave-of-absence without pay.

## Obituaries

We regret to record the deaths of two staff members during the year:

*Richard J (Dick) Breen*, Senior Meteorological Officer, died on 20 January at the age of 53. He served at Dublin and Shannon Airports, the Agricultural Meteorology Unit and in the Climatological Division and was known and respected throughout the Service for the high standards he maintained in his work. He will be sadly missed by his family, friends and colleagues.

*Liam Hayes*, Paperkeeper, died on 25 March after a short illness. Liam served in the Print Room for five years and his work was always of the highest quality. Although he was employed in the Service for a relatively short spell he had come to be well liked and respected by his colleagues in Headquarters.

We have also learned, with regret, of the deaths of two former staff members: *Patrick Howley*, who retired as Senior Meteorological Officer in 1981, died on 20 January. Paddy had served for many years at Headquarters and Shannon Airport and was one of the best-known and popular members of the Service.

*Rita Granville*, a former member of the clerical staff in the Service, died on 8 May. After the death of her husband Tommy Keenan a Senior Meteorological Officer, Rita

worked for some years in the Service before marrying Gerry Granville who retired as Assistant Director in 1980.

## Retirements

There were six retirements during the year:

*Alan Heussaff*, Meteorologist, retired on 22 July. A native of Brittany, Alan joined the Service in September 1952 and after initial training at Dublin Airport he was transferred to Shannon Airport where he served until July 1958. He then returned to Dublin Airport where he served until his retirement.

*Maurice Keane*, Principal Meteorological Officer, retired on 7 September after serving since July 1940. His 46 years of service made him the longest-serving member of the Meteorological Service to date. After training at Valentia Observatory, he was posted to the Meteorological Office at Foynes but returned to Valentia Observatory in 1943 and was promoted Senior Meteorological Officer in 1951. In 1964, he was transferred to Dublin Airport and in 1969 he joined the Marine Unit at Headquarters. In 1980 was transferred to the Climatological Division

where he was promoted Principal Meteorological Officer and served as inspector of rainfall stations until his retirement.

*Louis Power*, Senior Meteorological Officer, retired on 15 January. He joined the Service in 1948 and after training served at Dublin Airport until 1952. He was then formally assigned to the Outstations Unit in Headquarters but over the subsequent years, he spent numerous periods on temporary transfer to various synoptic stations. In 1971 he was transferred to CAFO where he was promoted Senior Meteorological Officer in 1979. In 1984 he was transferred to the Climatological Division where he served until illness caused his early retirement.

*James Fox*, (Casement Aerodrome) and *Mary Kehir*, (Claremorris) who were both part-time Cleaners retired on 8 August and 22 August, respectively.

*Christine Madden* who had served for a short period as Telephonist in Headquarters was obliged to retire on 27 March due to ill-health.

# INTERNATIONAL COOPERATION

Since weather systems move, sometimes with great rapidity, across political frontiers, close international cooperation in the field of meteorology is clearly essential. From the earliest days in the development of meteorology as a science, much thought and energy have been devoted to the establishment of a global system linking all meteorological services together so that weather data and information could be freely and rapidly exchanged on a world-wide basis.

The Irish Meteorological Service has, since its establishment, been actively involved in the international aspects of meteorology, on a global scale through the World Meteorological Organization (WMO) and the International Civil Aviation Organization (ICAO) and on a regional scale, through close collaboration with the Meteorological Services of other European countries and in recent years through membership of the European Centre for Medium Range Forecasts (ECMWF) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and participation in European Community projects in meteorology.

## World Meteorological Organization (WMO)

WMO, a specialized agency of the United Nations, is the international body responsible for coordinating the activities of national meteorological services throughout the world. As already indicated (see section on Observations), Ireland provides an important input to the Global Telecommunications System (GTS) of WMO through the surface weather observations from its network of synoptic stations and upper-air reports from Valentia Observatory. In return, surface and upper-air observations from a large area of the Northern Hemisphere are received in Ireland through the GTS. Representatives from the Meteorological Service participate regularly in planning and other meetings of WMO, notably in sessions of the Congress, Regional Association (Europe) and Technical Commissions and in meetings of Working Groups dealing with specific aspects of meteorology.

In 1986, the Director, who is Ireland's Permanent Representative with WMO,

attended a session of the WMO Regional Association (Europe) in Potsdam; Dr J R Bates (Assistant Director) attended a session of the WMO Commission for Atmospheric Sciences in Sofia; Mr T Keane attended a session of the WMO Commission for Agricultural Meteorology in Madrid, Mr P Lyons attended a session of the WMO Commission for Aeronautical Meteorology in Geneva and Mr D Murphy attended a session of the WMO Regional Working Group on Meteorological Communications in Geneva. Dr Bates was also Director of an International Symposium on Numerical Weather Prediction, held in Tokyo and a Workshop on Numerical Weather Prediction, held in Erice, Italy. In connection with the Service's contribution to assistance to Meteorological Services in developing countries (see section on Research) Dr J Hamilton was seconded as a WMO expert in February.

## International Civil Aviation Organization (ICAO)

ICAO is the specialized agency of the United Nations which is responsible for the international coordination of all matters relating to civil aviation. As weather conditions play such a vital role in aviation operations, an important aspect of ICAO's functions is to coordinate the services supplied by meteorologists to civil aviation. Such coordination entails the standardisation of meteorological observations at airports and of the terminal and en-route weather information supplied to crews, flight dispatchers, air traffic control personnel and airport authorities. The activities of ICAO in the field of aeronautical meteorology are carried out in close collaboration with WMO at international level and involve joint planning meetings, technical conferences and working groups. At national level, meteorological services and civil aviation authorities work closely together to ensure optimal levels of meteorological services to aviation.

The Irish Meteorological Service is regularly represented at ICAO, and Joint-ICAO/WMO meetings and conferences dealing with aeronautical meteorology. In 1986, Mr P A Lyons attended a meeting of the Meteorological Advisory Group (METAG) of the European Air Navigation Planning Group (EANPG) at the ICAO European Office in Paris.



## **European Centre for Medium Range Weather Forecasts (ECMWF)**

ECMWF was established in 1975 by a group of European countries, including Ireland, with the purpose of improving the quality of weather forecasts for periods of 4 to 10 days. The centre is located at Reading in the United Kingdom and is financed by contributions from 17 Member States who also make available the necessary personnel. All products of the Centre are available to participating countries and are received by computer link on a regular daily basis at the forecasting offices of the Irish Meteorological Service where they are extensively used as guidance material in the preparation of forecasts to the general public and specialised interests.

The Director represented Ireland at meetings of the ECMWF Council during 1986, Mr W H Wann, Assistant Director of the Service and Chairman of the ECMWF Technical Advisory Committee (TAC), attended meetings of the ECMWF Council, TAC and Finance Committee during the year, Mr B McWilliams attended meetings of the Finance Committee and Messrs. J V Ryder and R G Kavanagh attended technical meetings dealing with computers and telecommunications.

## **European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)**

EUMETSAT is an organisation of European States, established for the purpose of implementing an operational meteorological satellite programme for Europe. In 1986, EUMETSAT took over the running of the present European geostationary satellite, METEOSAT II, from the European Space Agency (ESA). It is envisaged that the present Meteosat series of satellites will be continued and that new satellites will be deployed in 1987, 1988 and 1990.

The EUMETSAT Convention was ratified by Ireland in 1985 and during 1986, the Director represented the country at meetings of the EUMETSAT Council and Mr B McWilliams attended meetings of EUMETSAT groups

dealing with financial and other aspects of the organisation.

## **North Atlantic Ocean Stations Agreement (NAOS)**

As indicated in the section on Observations, weather reports from fixed weather ships are an important input to the global weather observing network. The financing of these ships (at present 3) in the North Atlantic is undertaken by a number of European countries, including Ireland, who are signatories to an agreement known as the North Atlantic Ocean Station (NAOS) Agreement. The NAOS Board normally meets once a year to decide on all matters relating to the operation of the North Atlantic weather ships. In 1986, as in former years, Ireland was represented at the NAOS Board Meeting by Mr W.G. Callaghan.

## **European Cooperation in Science and Technology (COST projects)**

COST-43: This project, in which a number of European countries participate, is concerned with the establishment of an experimental network of ocean observing stations in waters of the North Atlantic to measure and report environmental data in real time. The Irish participation in the project is mainly concerned with the deployment of drifting buoys equipped with automatic weather stations, in the vicinity of Iceland. During 1986, meetings of COST-43 in Brussels and De Bilt were attended by Mr W G Callaghan.

COST-72: This European project is concerned with the establishment of an integrated system of weather radar installations in Western Europe. A meeting of COST-72 in Munich in February 1986 was attended by Mr G McDonald.

## **Meetings of Directors of Western European Meteorological Services**

Directors of Western European Meteorological Services meet annually to discuss matters relating to closer cooperation between Services. The Director attended the 1986 meeting which was held in Zurich.

# APPENDIX 1

## PUBLICATIONS DURING 1986

### (a) Meteorological Service Publications

1. The Climate of Ireland (second edition) by P K Rohan.
2. Technical Note No. 48 - "Numerical Forecasting Using Laplace Transforms: Theory and Application to Data Assimilation" by Peter Lynch.
3. Monthly, Seasonal and Annual Mean and Extreme Values of Duration of Bright Sunshine in Ireland, 1951-1980 by D Keane.
4. Monthly Weather Report: Part I to December 1985, Part III and 1985 Annual Summary to November 1986.
5. "Climate of Ireland" series of leaflets (temperature, rainfall sunshine and wind).
6. Information leaflets - "Climate Services", "Marine Services", "Services to Agriculture", "Services to Aviation", and "Services to the General Public"
7. Internal Memorandum No. 110/86 - "An Introduction to the Nature and Measurement of Solar Radiation" by K G Commins.
8. Monthly Weather Summary, January to December 1986.
9. Agricultural Meteorological Bulletin, January to December 1986.
10. Meteorological Service Annual Report 1985.

### (b) Other Publications

1. "Computation of the Stream Function and Velocity Potential and Reconstruction of the Wind Field" by S J Bijlsma, L.M. Hafkenscheid and Peter Lynch. Mon. Weather Rev., 114, 1547-1551.
2. "Unrolling DO-loops in an Objective Analysis Suite" by J. Hamilton, LAM Newsletter No.12.
3. "Computing Tomorrow's Weather" by Peter Lynch, Technology Ireland, July / August 1986, pp 32-37.
4. "A Semi-Lagrangian and Semi-implicit Two Time-level Intergration Scheme" by A. McDonald. Mon. Weather Rev., 114, 824-830.
5. "Comparison of Wind Speeds Recorded Simultaneously by a Pressure-Tube Anemograph and a Cup-Generator Anemograph" by S S O Laoghog. Met. Mag., 115, 178-185.
6. "Climate, Weather and Irish Agriculture" T Keane (General Editor) published by AGMET Group C/O Irish Meteorological Service.
7. "The Phenological Garden at Valentia Observatory, Ireland" by E Murphy and T Keane. In Arboretta Phaenologica - Mitteilungen der Arbeitsgemeinschaft Internationaler Phaenologischer Garten No. 30, 1986.
8. "The Use of computers in the Meteorological Service" by J F Ryder, Irish Computer, November 1986.
9. "The Meteorological Service - 50 years on" by Paraic Carrigan, Seirbhis Poibli, vol. 7, no. 3, Mean Fomhair 1986.

# APPENDIX 2

## A SELECTION OF LECTURES GIVEN BY STAFF DURING 1986

1. "Filtering, the slow equations and continuous data assimilation" by Peter Lynch at the 8th ENGLAM meeting, Madrid.
2. "Semi-Lagrangian models for Numerical Weather Prediction" by J R Bates at The joint Royal Meteorological Society/Irish Meteorological Society Meeting, Trinity College, Dublin.
3. "Techniques of initialization" by Peter Lynch, *ibid.*
4. "Computer Graphics in the IMS" by J Hamilton, *ibid.*
5. "The Work of the Central Analysis and Forecast Office" by P MacHugh, *ibid.*
6. "The Meteorological Service and its role in agriculture" by T Keane, to the Irish Tillage and Land Use Society.
7. "Radio in Meteorology" by G McDonald, to Amateur Radio Society of Ireland.
8. "Modern Forecasting" by P MacHugh, to Irish Association of Master Mariners.
9. "Weather for Sailing" by C Byrne, at St Enda's Community College, Limerick, at course for yachtmasters.

# APPENDIX 3

## SPECIAL TOPICS IN PREVIOUS ANNUAL REPORTS

1975	Development of the Meteorological Service
1976	Valentia Observatory
1977	Our Voluntary Observers
1978	The Meteorological Office at Foynes
1979	The New Headquarters Building
1980	The Use of Computers in the Meteorological Service
1981	The Use of Satellites in the Meteorological Service
1982	The World Climate Programme
1983	Telecommunications in the Meteorological Service
1984	The Central Analysis and Forecast Office
1985	The Meteorological Service - The First 50 Years

