THE IRISH METEOROLOGICAL SERVICE

THE FIRST FIFTY YEARS
1936—1986

Edited by
Lisa Shields

DUBLIN
THE STATIONERY OFFICE
1987

COVER ILLUSTRATIONS

FRONT COVER: The Meteorological Service Headquarters at Glasnevin, Dublin (Photo: Jack Healy)

BACK COVER: Satellite Photo taken on St Patrick's Day, 17th March, 1986, at 1155 GMT. This spectacular photo was taken from the geostationary satellite METEOSAT-2, 35,900 km above the equator at the Greenwich meridian. The African continent is conspicuous in the centre. Ireland, visible near the top of the picture, is cloud-free, but a deep depression with its associated front is approaching from the west. Frontal depressions are also visible in the southern Atlantic. The white cloud masses in the centre of the picture are large convective systems in the inter-tropical convergence zone, where the trade winds meet. Such systems are responsible for the heavy rains in the tropics. The contrast between the albedo, or reflectivity, of the equatorial rain forests and the Sahara desert to the north is seen very clearly

(METEOSAT image supplied by the European Space Agency; notes by Peter Lynch)

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Message from the President of the World Meteorological Organization (WMO)

It is with great pleasure that I convey my congratulations to the Irish Meteorological Service on the occasion of the 50th Anniversary of its establishment.

During my period as President of WMO and previously as Vice-President and member of the Executive Council of WMO, I have come to know of and appreciate the contribution of the Irish Meteorological Service to international meteorology.

Successive Directors and staff members of that Service have played an active role in the activities of WMO; their high levels of scientific knowledge coupled with a sound pragmatic approach to problems have won the admiration and respect of their international colleagues down through the years. It is a measure of the esteem in which the Irish Service is held in international circles that two Presidents and a Vice-President of WMO Technical Commissions have been drawn from its ranks.

Since, from a meteorological point of view, Ireland occupies a prime strategic position on the western flank of Europe, the Irish Meteorological Service is called upon to make a vital contribution to the Global Observing and Global Telecommunications System of WMO's World Weather Watch. That this contribution has been made continuously and efficiently over the years is a tribute to the management of the Service and the devotion of its staff. Indeed, it is widely accepted that the Irish Service is a model of its kind for its size.

I extend cordial greetings to the Director and staff of the Irish Meteorological Service on this happy occasion. I sincerely hope that the excellent tradition of service to the Irish and international communities, which they and their predecessors have built up since 1936, will be continued for the next 50 years — and beyond.

R.L. Kintanar
President, World Meteorological Organization

UACHTARÁN NA hÉIREANN
PRESIDENT OF IRELAND

BAILE ÁTHA CLIATH 8
DUBLIN

9 Nollaig, 1986

Dear Mr. Linehan,

It gives me very great pleasure to send warmest greetings and congratulations to the Meteorological Service on the occasion of its fiftieth anniversary. We are all deeply indebted to it for the excellence of its work.

To you personally and to all the members of the staff of the Service I send my best wishes for the years ahead.

Rath Dé oraibh,

Pádraig Ó hIrighile

Uachtarán na hÉireann

Mr. D.L. Linehan,
Director,
Meteorological Service.

Message from Jim Mitchell TD
(Minister for Communications)

As far as most people are concerned, the Meteorological Service begins and ends with the daily weather forecasts disseminated by the various communications media, helping us all to plan our everyday business, domestic and leisure activities. This, however, represents only a small part of the activity of the Service.

Even in terms of forecasting, a wide range of very detailed and specialised information is made available by the Service on an ongoing basis to industry, agriculture, civil aviation, shipping and the construction trade, information without which these businesses would find it almost impossible to plan and function effectively.

Furthermore, the service carries out upper-air and geophysical observations, research into climatology, liaises and shares information with foreign meteorological administrations, and trains its own staff to the standards needed to operate the comprehensive up-to-date meteorological service that a modern nation requires.

This entire operation involves approximately 300 people located at the Meteorological Office's headquarters at Glasnevin, and at airports and other strategic and often lonely outposts throughout the country. The Service is attached to the Department of Communications and in fact accounts for approximately one-fifth of that Department's total staff complement.

It is fitting that the Service's 50th Anniversary be properly honoured and appropriate too that the opportunity be taken to warmly congratulate the members of the Service and pay tribute to their work and achievements over the years. I do so with a heart and a half. Well done and thank you to all who have served in the Meteorological Service over the past 50 years. Congratulations on your Golden Jubilee and may your high standards of service continue in the years to come.

I hope that the publication of this book will result in a wider recognition of the undoubted value of the Meteorological Service to the community in the past and an ever more important contribution in the future.

Jim Mitchell T.D.
Minister for Communications

Introduction

by Donal Linehan, Director of the Meteorological Service

Fifty years have seen many changes in the development of our Meteorological Service. Today, when we are actively engaged in incorporating the most modern methods and technology into our operations (against a background of restrictive circumstances), it is interesting and indeed refreshing to reflect on the evolution of the Service from its earliest days. The scene now is a far cry from that in Foynes when a small group wrestled with the clues provided by a few scattered weather reports. The contrast with the modern age of computer weather models, radar and satellite imagery is remarkable.

We are fortunate to have, as contributors to this book, present and former staff members who have memories and knowledge of those early times. Their recollections form the basis of an instructive and valuable record of an exciting era in the history of both meteorology and aviation in Ireland.

Many readers will probably be surprised to learn that there was a considerable interest and active participation in meteorological matters in this country several hundred years before 1936. We owe much to the early observers who diligently recorded day-to-day variations in the weather. Their records add greatly to our knowledge of the climatology of Ireland.

Inevitably there is much in this book concerning aeronautical meteorology which was indeed the *raison d'être* of the Service in the late 1930s and 1940s. At that time the general public was hardly aware of the existence of the Meteorological Service and during the last war any information on weather was a closely guarded secret.

Today, as we can judge from the demand for weather forecasts, people are very much aware of that aspect of our work. While a major effort is still necessary in meeting aviation requirements, the supply of weather forecasts to the general public and specialized interests takes up much of our time. We like to think that this is because we are getting better at our job, and of course we have also to thank television, radio and newspapers for the prominence which they give to our forecasts. However, as the Minister for Communications notes in his special message, there are other activities of the Service which are not so well known; some of these are described in the book.

All the work of the Meteorological Service is concerned with the provision of information and advice to those who need it for safety, commercial, environmental, recreational and other reasons. It is our hope, which I believe is not unduly optimistic because of the steady advancement in meteorological theory and techniques, that in the future our products will be of increasing relevance to the economic progress of the country.

We should not forget that the meteorological community sets a very good example in the matter of international cooperation; the 160 or so national meteorological services who are members of the World Meteorological Organization collaborate fully with one another. This stems from the realization that weather knows no barriers and that each nation depends on all others to cooperate in making and transmitting weather observations and forecasts. In addition, Meteorological Services find it easy to come together for special purposes and form particular groups of which there are many examples. We are proud to be a part of this tradition, and look forward to its continuation.

It is fitting that I conclude by thanking our contributors and the Anniversary Coordinating Committee for all their hard work in compiling this book. A special word of thanks is due to the editor, Lisa Shields. She played a leading part in this production, which I hope readers will find interesting and informative.

D. L. Linehan

Editorial preface

The 50th anniversary of the establishment of the Irish Meteorological Service is being marked by a number of activities such as exhibitions, open days and social functions. In addition, it was considered that this was an appropriate occasion for the publication of a review of the Service and its evolution over the past 50 years. It was felt that such a review, apart from being of historical value, would serve to increase public awareness of the Service and its work.

The book is divided into three sections; the first deals with the history of the Service and with international meteorology and the second describes the current functions of the Service. The third section, written by present and retired members of the Service, is a miscellany of personal reminiscences and of articles on various aspects of meteorology in Ireland and on some of the activities of the Service, past and present.

No attempt has been made at a rigid standardization of the material received from contributors; it is believed that the resulting wide variation in the style of presentation in the various articles enhances the originality and readability of the book.

Acknowledgements

This publication would not have been possible without the cooperation and support of many individuals and institutions. The editor wishes to express grateful acknowledgements:

- to the contributors who gave their time and effort in preparing the various articles;
- to members of the Meteorological Service for their valuable help and editorial advice — in particular to Michael Connaughton and Tom Keane;
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- to Douglas Sealy for help with Irish language material;
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- to the Director of the National Library of Ireland for permission to reproduce a page of the 1682/3 Kilkenny weather diary;
- to any copyright holders whose material may have been used inadvertently;
- to Dara Fitzgerald, typist in the Climatological Division, who keyed in the text of the book.

A HISTORICAL PERSPECTIVE

A brief history of the Meteorological Service

by Dermot O'Connor

ESTABLISHMENT OF SERVICES

The Meteorological Service was established in December 1936. Its first commitment was to take over the existing meteorological organization in Ireland from the British Meteorological Office. The transfer took place on 1st April 1937; on that date, the organization comprised Valentia Observatory, four telegraphing reporting stations, operated by part-time observers, at Malin Head, Blacksod Point, Birr and Roche's Point, 18 climatological stations and 172 rainfall stations. Valentia Observatory was the only establishment staffed by official meteorological personnel and the staff there were also taken over by the new Service. It derives its name from the fact that it was originally established on nearby Valentia Island. Observations commenced on the Island as far back as 1860. The accommodation on the Island was rather cramped and, in 1892, the Observatory was transferred to a large house (its present home) on a 30-acre site on the mainland. The immediate tasks were to expand the meagre observational networks and to set up a forecasting organization for the then imminent series of experimental transatlantic flights to and from Foynes.

The first Forecasting Office, in the former Monteagle Arms Hotel in Foynes (Photo: C.J. Gillman)

The Service was fortunate in that its first Director, Mr Austen H. Nagle, had had considerable administrative experience in the British Meteorological Office before taking up his post in Ireland. His knowledge of the United Kingdom organization and his contacts with key personnel there, coupled with his great energy and his organising ability, were invaluable assets in the building of an entirely new Service. The Service was also fortunate in that two distinguished continental meteorologists — Dr Mariano Doporto from Spain and Dr Leo Wenzel Pollak from Czechoslovakia — joined it before the war. Of vital importance, in the formative years, was the generous assistance received from the British Meteorological Office in terms of guidance, men and materials.

PRE-WAR YEARS

For the first transatlantic flights, in the summer of 1939, the Meteorological Office at Foynes was manned by staff lent by the British Meteorological Office. These included Mr S.P. Peters (in charge) and Mr J. Harding — later Assistant Directors of the British Meteorological Office — Mr D.A. Davies, who later became Secretary-General of the World Meteorological Organization, and Mr Hubert H. Lamb, later Professor at the University of East Anglia. Already, however, at that time the first groups of Irish Meteorological Officer Cadets and Meteorological Assistants had been recruited and were being trained and initiated in operational duties.

EXPANSION OF THE SERVICE

The last of the British staff on loan left in March 1941. Hubert Lamb had joined the Irish Service and. was responsible for the training of new entrants to the Service. By then, the Meteorological Service comprised:

- (a) a small headquarters office (located at 14/15 St Andrew Street, Dublin);
- (b) the Meteorological Office at Foynes, and its associated synoptic reporting station, providing service to civil aircraft, to military aircraft operating from Baldonnel and Rineanna and to the Defence Forces;
- (c) a synoptic station at Dublin Airport;
- (d) the observational station network taken over from the British Meteorological Office.

Dr Doporto took over as Officer-in-Charge at Foynes for a period after Mr Peters left and was succeeded by Mr Lamb.

Group of meteorological cadets at Foynes with Peters, Nagle and Davies (Front, from left: Arthur Morgan, Paul Brown and Shane Tierney; back, from left: Sean McWilliams, S.P. Peters, Leslie Leech, Austen Nagle, Austin Bourke, D.A. Davies and Fred E. Dixon) (Photo: F.E. Dixon)

By the end of 1943 a forecast office at Dublin Airport was providing a service to cross-channel flights, and had also relieved Foynes of responsibility for the service to the Air Corps and the Defence Forces generally. By then, also, three newly built stations — at Clones, Claremorris and Mullingar — had been added to the network of Telegraphic Reporting Stations; Air Corps personnel at Baldonnel were providing a limited service of observations; two additional climatological stations were in operation and the network of rainfall stations had increased dramatically to 450. (The station at Clones was closed early in 1944, and was not re-opened until official staff were posted there in 1950.) It should be acknowledged that this rapid expansion in the rainfall network was achieved mainly through the good offices of the Department of Justice and the Commissioner of the Garda Síochána who permitted the Service to install raingauges at suitable Garda stations. Warm thanks are also due to the hundreds of Gardaí who, over the years, have so willingly and generously cooperated with the Meteorological Service in making, recording and transmitting the rainfall measurements. The cooperation of other Government departments and some of the state-sponsored bodies, who helped in the expansion of the rainfall network, must also be acknowledged.

44 Upper O'Connell Street, Headquarters of the Meteorological Service from 1943 to 1979

War-time restrictions and staff-recruitment difficulties prevented the application of meteorology to industrial and agricultural problems, while censorship did not allow forecasting for public interests.

In 1943, the headquarters of the Service moved to 44 Upper O'Connell Street, Dublin. By the end of 1944, the rainfall network comprised over 530 stations. From that point on, there was a slower rate of expansion to the present network of some 650 rainfall stations. The Meteorological Office at Foynes was closed in 1946 and the last of the staff transferred to the land aerodrome at Rineanna — the present Shannon Airport — which had been staffed as a synoptic station since 1944, though a limited service for aviation had been provided there before that.

INCREASED STAFF

From 1943 onwards, considerable efforts had to be made to convince the Department of Finance of the need for a substantial increase in staff for the Meteorological Service to provide a service for the sudden, sharp increase in transatlantic civil aviation which was expected as soon as the war ended. In May 1946, a realistic complement, totalling 241 in the technical meteorological grades, was finally approved; this is not far below the present authorised complement of about 270 in technical grades.

A reorganization and extension of the network of telegraphic reporting stations, henceforth known as synoptic stations, was initiated in the late forties. During the fifties, official staff were posted to Claremorris, Mullingar and Clones. New stations, manned by official staff, were erected at Birr, Malin Head, Roche's Point, Belmullet (replacing Blacksod Point), and Kilkenny. A Training School, combined with a synoptic station, was erected at Rosslare. Official staff were posted to the synoptic station at Baldonnel, now Casement Aerodrome, and a dependent Meteorological Office to serve the Air Corps was set up there. When Cork Airport was opened in 1961, it was staffed as a synoptic station and dependent Meteorological Office from the outset. It was not possible to post forecasting staff there until 1966.

WEATHER OBSERVATIONS

In 1951, the cooperation of Irish Shipping Ltd. was enlisted in a scheme whereby their ships were equipped by the Meteorological Service with instruments enabling ships' officers to carry out weather observations at sea. Later, the B & I company and Irish Continental Lines joined the scheme. Regrettably, observations from Irish Shipping are no longer available. In 1971, arrangements were made with the Commissioners for Irish Lights whereby lighthouses provided supplementary weather reports to the Meteorological Service.

Upper-air observations of pressure, temperature and humidity by means of radiosonde were inaugurated at Valentia Observatory in 1943. Measurements of the radioactivity of air and precipitation were begun in 1957. The chemical analysis of precipitation began in 1958 and the chemical analysis of air in 1961.

In the mid-sixties, the meteorological satellites launched by the United States were equipped with Automatic Picture Transmission (APT) facilities which made it possible for other countries to receive transmissions from these satellites as they passed over. Shortly afterwards, equipment to receive these pictures was installed at the Meteorological Office, Shannon Airport, following experimental reception using improvised equipment.

CONTACTS WITH THE PUBLIC

On 1st April, 1948, the Meteorological Office at Dublin Airport assumed responsibility for the weather forecasts broadcast on Radio Eireann. From the same date, the Meteorological Service began the issue of a monthly weather report. From 1952 onwards, forecasts were supplied to the daily newspapers. During the fifties, the demand for service from the general public and from agricultural, industrial and other interests increased to the point where it was no longer possible for the Meteorological Office at Dublin Airport to cater for the forecasting requirements of these interests. Accordingly, it was decided to set up a Central Analysis and Forecasting Office (CAFO) at headquarters. This office was opened by the Minister for Transport and Power on 23rd March, 1961 (World Meteorological Day).

The number and variety of requests for forecasts increased rapidly following the establishment of CAFO. So much so that it was found necessary in 1967 to set up an automatic telephone weather service (ATWS) for the Dublin area. The ATWS service has since been extended to other regions, and now deals with over two million calls a year.

THE LAST TWENTY-FIVE YEARS

A small Research Unit was set up in 1962. Initially, it concerned itself with co-ordinating the activities of members of the staff who had undertaken independent research projects, many of them in their own time, and with an investigation of methods of extended-range forecasting. More recently it has been more concerned with research in numerical weather prediction.

The demand for climatological information and for advice in relation to various weather-sensitive activities has been rapidly increasing since the early sixties. To meet these demands, automatic data processing was introduced in the Climatological Division. This, in turn, facilitated the Service in taking steps to fulfil its advisory function on the applications of meteorology.

In the mid-sixties, it was apparent that meteorology was passing through a period of rapid change. The plans adopted at the fifth Congress of the World Meteorological Organization (WMO) in April 1967 indicated even more rapid changes in the following decade. There were changes, too, as regards the users of meteorology; a lessening of emphasis on the international aviation side matched by an increasing concern about national requirements (agriculture, industry, transport, etc.). The Service recognised that it had to reorient itself to meet the altered circumstances and changing demand and that the changes had to be designed primarily to meet Irish problems, to help in the implementation of national agricultural and industrial plans and to keep step, where appropriate, with national developments in science policy, research and education.

Accordingly, a five-year development programme (1968–73) was drawn up in late 1967–early 1968 which included proposals for the setting up of a new upper-air station in the south-east, the modernisation of the communications system, the acquisition of a computer with the capacity and speed required for numerical analysis and forecasting, the setting up of a mobile observing unit for local weather studies, the extension of the observational routine

Kish Lighthouse: Irish lighthouses provide supplementary weather reports (Photo: Irish Helicopters Ltd.)

at synoptic stations to cover radiation and soil-moisture measurements, the acquisition of equipment for direct reception of weather-satellite information, the installation of weather radar at Cork Airport, the transfer of the training school from Rosslare to Galway, where it would be associated with the UCG School of Oceanography, and a staffing complement appropriate to the reorganised Service.

The programme met with the agreement of the National Science Council. Progress in its implementation was blocked, to a large extent, by the lack of suitable accommodation at headquarters to house the necessary specialist units and processing equipment. The accommodation problem was solved when all headquarters staff were brought together in a new custom-built building at Glasnevin in mid-November, 1979. The new building was officially opened by Mr Albert Reynolds, Minister for Transport, on 19th June 1980. Although the eighties have been difficult because of staffing and finance problems, the only parts of the development programme which have not been implemented are the upper-air station in the south-east and the mobile observing unit for local weather studies.

The present Headquarters building at Glasnevin (Photo: J. Hamilton)

Directors of the Service from 1936 to the present

(Photo: Irish Times)

AUSTEN NAGLE

Austen H. Nagle was born in Birmingham in 1903, graduated from the Imperial College of Science and Technology, University of London, and served in the British Meteorological Office from 1927 to 1936. He was appointed Director of the newly formed Irish Meteorological Service in December 1936, and left the Service in 1948 to take up a senior post in the United States Weather Bureau. He continued to play a prominent part in international meteorological affairs until his retirement in 1973, and attended the official opening of the new Headquarters at Glasnevin in June 1980. He died in Washington, D.C., in 1984.

(Photo: Irish Times)

MARIANO DOPORTO

Dr Doporto was born in Cáceres, Spain, in 1902, and studied physics at the Universities of Madrid and Barcelona. He joined the Spanish Meteorological Office in 1921, and was in charge of the weather forecast centre at Barcelona at the outbreak of the Spanish civil war. Soon afterwards he left Spain and joined the Irish Meteorological Service in 1939, serving first at the flying-boat station at Foynes. In 1948 he was appointed Director. He was the author of many scientific papers, and the Service underwent considerable development under his administration. He died suddenly in Dublin in September 1964.

(*Photo:* F. E. Dixon)

AUSTIN BOURKE

Patrick Martin Austin Bourke was born in 1913. He graduated from University College, Cork, in 1933, gaining a gold medal and the Peel Memorial prize as outstanding graduate of the year. He was to fulfil this academic promise, as he later obtained an M.Sc. with first class honours, and two doctorates for his outstanding work on potato blight.

Dr Bourke was one of the first batch of seven meteorologist cadets recruited to the Meteorological Service early in 1939. He served as meteorologist at Foynes, Rineanna and Dublin Airport, and was later in charge of the Meteorological Office at Dublin and Shannon Airports. He was appointed Assistant Director in 1948 and Director in 1965. He is known internationally as an expert in agricultural meteorology. (See his article elsewhere in this book, 'Half a lifetime with potato blight'.)

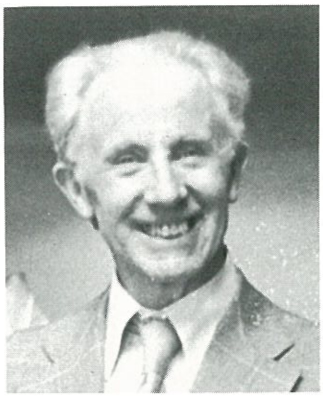
(*Photo:* Irish Times)

DONAL LINEHAN

Donal L. Linehan was born in Cork in 1923, and studied there at the University College. He graduated with degrees in Civil Engineering and Mathematical Science, and was awarded the Peel Memorial Prize and Pierce Malone Scholarship in 1944.

Mr Linehan joined the Meteorological Service in March 1946 and spent the next 29 years working in the sphere of aeronautical meteorology being successively in charge of the Meteorological Offices at Cork and Shannon Airports. He moved to Dublin in 1975 in charge of the Central Analysis and Forecast Office. He was appointed Assistant Director in 1979 and Director in 1981.

Mr Linehan played an important part in the planning and design of the new Meteorological Service Headquarters at Glasnevin, working closely in liaison with the architect; his engineering background made him eminently suitable for this role.



(*Photo:* Irish Times)

KILIAN ROHAN

Patrick Kilian Rohan was born in North Tipperary in 1916. He studied mathematics in University College, Dublin, and received his M.A. degree in 1939. He joined the Meteorological Service as meteorologist in 1940, serving first at the Foynes flying-boat base. He was appointed Officer-in-Charge at Shannon Airport in 1948. Between 1948 and 1970 he was very active in the field of international meteorology, serving as Vice-President of the WMO Commission for Aeronautical Meteorology from 1964 to 1967, and as chairman of the ICAO panel on aeronautical meteorological telecommunications in Europe (MOTNE) from its inception in 1959 until 1971. In 1964 he spent six months as a consultant to ICAO (the International Civil Aviation Organization) in Montreal.

In 1970 Mr Rohan moved to Dublin as head of the Climatological Division. His book *The climate of Ireland* was published by the Stationery Office in 1975. He was appointed Assistant Director in 1975 and Director in 1978. He served as President of the European Centre for Medium Range Weather Forecasts (ECMWF) in 1980. Since his retirement he has played a leading part in the production of the book *The climate of Dublin* (1983), and has successfully brought to completion the second revised edition of *The climate of Ireland*, just published.

The first two Directors: Austen Nagle and Mariano Doporto

by Dermot O'Connor

AUSTEN NAGLE

Austen Nagle had been Secretary of a Staff Association in the British Meteorological Office before he became Director of the new Irish Service. So in a real sense he was a poacher turned gamekeeper. In the negotiations with the establishment people in the Department (Industry and Commerce it was then) and with the Department of Finance he fought very hard to get satisfactory salary scales for his staff; the outcome was short of his aspirations. In his own case he was offered, and accepted, parity with the Principal Architect of the Office of Public Works. It was only when he was leaving the Meteorological Service in 1948 that he discovered that the Principal Architect had obtained an increase in salary shortly after these negotiations which was not applied to himself. Naturally, he was furious. Nagle also had strong views about age limits for entry to the Meteorological Service. He succeeded in getting higher upper limits (25 years to 30 years) and as a result obtained many recruits who were mature and correspondingly more responsible.

Nagle worked most unconventional hours. He rarely arrived in the Office before 11 am. Then he worked continuously except for a break of one to two hours for a light lunch until the departure of the last bus to Dundrum. Many times he missed that bus and had to get a taxi. He was a great cat fancier; judging by the amount of fish he bought for them in Moore Street, he must have had quite a number. Sometimes he forgot to get the fish in Moore Street and had to go to a chip shop for it.

Mr Nagle was highly regarded in international circles. He was elected President of the IMO Commission for Aeronautical Meteorology. The IMO (International Meteorological Organization) was a non-governmental organization and precursor of the present World Meteorological Organization (WMO) which is a specialised agency of the United Nations. He became friendly with Dr Reichelderfer, the Chief of the United States Weather Bureau, who offered him a job in Washington. At this time (early 1948) Nagle had aspirations to becoming the first Secretary-General of the new WMO and thought he would have a better chance of the job if he were sponsored by the US Weather Bureau than he would have as Director of the Irish Meteorological Service. So he accepted the US offer, and moved to Washington. He reckoned without the US-USSR 'Cold War' which erupted shortly afterwards. At the crucial WMO meeting which selected the Secretary-General of WMO, Nagle stayed in the running until the last ballot. There he was defeated by D.A. Davies, the Director of the Meteorological Service of one of Britain's African Colonies — the same Mr Davies who had worked in Foynes under Nagle.

In some ways Nagle, though hard-boiled, was naive. When he went around saying his farewells, he told Doporto how impressed he was by the goodwill he found everywhere. Doporto deflated him by quoting an old Spanish proverb which, roughly translated, says 'you build bridges beneath the departing enemy'!

MARIANO DOPORTO

Before his departure, Nagle recommended to the Department that Dr Mariano Doporto should be his successor as Director. Doporto was a Basque who had fought against Franco in the Spanish Civil War. Towards the end of that war he escaped into France and was interned there. He had no passport — only an elaborate document like a folding road-map, issued by one of the refugee organizations, which contained all kinds of details such as side-face photos and finger-prints. He had not applied for Irish citizenship and was advised that, if he did so, it would improve his chances of being appointed Director. This he refused to do but indicated that, if he got the job, he would then apply. He got it and did apply. In his application, he was asked to name two Irish citizens who would vouch for him. He chose two of the most junior of the staff and when one of these suggested that he should pick citizens of greater substance he replied 'You are Irish citizen; that is good enough for me'. He got his Irish citizenship.

In contrast to Nagle, who displayed a touch of flamboyance at times, Doporto was timid though he had a warm temper when roused. He disliked the cut and thrust of Departmental discussions. On one occasion he came back from a discussion with a certain Mr S in the Department's headquarters in Kildare Street all limp and weary. He announced that 'S— he is son of beech',

Although Doporto could be hard at times he was always courteous and kind to the staff, especially the junior staff. There was a certain Mr K, a Clerical Officer in the Director's Office, who lorded it over more junior staff — typists, writing assistants and messengers. On one occasion Mr K bitterly complained to Doporto about the behaviour of one of these menials. The reply was 'but Mr K, we must not be too hard on the little people'. On another occasion there was a Meteorological Assistant, Mr H, who got into deep trouble, through drink. He had been transferred from Shannon to Headquarters and found that Dublin was a bad town. There were landladies calling in to the office looking for Mr H; Doporto called him in for a talk, and the account of the interview is as related by Mr H himself. Doporto was all sympathy, put him sitting in an armchair and got him talking about his problems. At the end, Doporto asked Mr H if he would like to be transferred back to Shannon. Mr H replied in the affirmative and, before he left the room, Doporto took out his wallet and handed Mr H a five-pound note saying 'This may be a help to you and don't worry about repaying me'. It is gratifying to report that Mr H did reform. Not only that; he became a pillar of society and saved several others who had taken or were taking a wrong turning, and Doporto did get his fiver back!

International meteorology

by Michael Connaughton

When one considers, on the one hand man's dependence on weather and climate and on the other, the fact that weather transcends all man-made boundaries, it is not surprising to find that meteorology — the science of the weather — represents one of the most fruitful areas of international cooperation. To quote John Ruskin, an amateur meteorologist and a famous English art critic speaking in 1839:

> 'The meteorologist is impotent if alone; his observations are useless for they are made upon a point while the speculations to be derived from them must be on space'.

From earliest times, students and observers of weather phenomena sought to exchange their findings with each other so that slowly, and often laboriously, the point was expanded to a space — from a single observation to a parish, to a country, to a continent and eventually to the globe and beyond. Until relatively recently on the historic time-scale such expansion was impeded on two fronts: lack of suitable instrumentation and poor communications.

Up to the beginning of the 17th century AD observations of weather parameters were necessarily subjective since no appropriate instruments were available to the observers. It was not possible therefore to compare validly observations taken at different points or to analyse objectively spatial variations in weather conditions. Then in the early 17th century the blossoming of the Renaissance in Europe and the impetus provided by demands for objective information on weather conditions affecting sea transport between Europe and the rest of the world led to the invention of scientific instruments for measuring the various weather elements. The air thermometer in 1600 was followed by the barometer in 1644 and later in the century by the anemometer and the hygrometer, so that by the beginning of the 18th century a sufficient range of instruments was available to permit the various weather parameters to be measured scientifically, and valid comparisons to be made between observations at different points. In addition, the availability of scientific instruments enabled scientists to make considerable advances towards the greater understanding of atmospheric proccesses: Boyle established the fundamental law relating pressure to volume, Hadley related the behaviour of the trade winds to the earth's rotation while Lavoisier, Dalton and others established the basic principles regarding the nature and composition of the air. At the same time, networks of weather-observing stations were gradually being established, notably in parts of Europe and the United States; the point was slowly expanding to a space. By the early 19th century, rudimentary weather maps were making their appearance: Brandes, from Leipzig, is generally credited with producing the first map in 1820 — based on data collected in 1783! While these maps were useful in providing insight into the structure and movement of weather systems such as depressions and anticyclones, they, clearly, because of the tardiness of their construction, were of no value in preparing weather forecasts. The timely dissemination of forecasts required rapid exchange of observational data from as wide an area as possible, and the rapid circulation of forecasts based on the analysis of these data; not until 1843 did such rapid exchange become possible.

In 1843 occurred the event that revolutionised the field of communications — the invention of the electric telegraph by Samuel Morse. For the meteorologists, the transmission of a short message between Washington D.C. and Baltimore in that year opened up a whole new vista of rapid data and information exchange. While at first the high cost of telegraphic equipment and transmission impeded development, the real-time exchange of meteorological data within the United States and Europe and between those continents steadily increased in volume. Weather maps based on telegraphic data were being prepared in both continents by the middle of the nineteenth century and there were growing demands for weather forecast services from the general public and from business and commercial interests. These demands were nowhere more pressing than from maritime interests, both military and civil. Navy and merchant fleets were being rapidly expanded and the potential value of weather forecasts and storm warnings to shipping was obvious. The provision of such a service required close international cooperation and it is not suprising that the first international meteorological conference was almost exclusively devoted to maritime meteorology.

FIRST INTERNATIONAL METEOROLOGICAL CONFERENCE (BRUSSELS, 1853)

The main organiser of the Brussels Conference was, significantly, a lieutenant in the United States Navy, Mathew Fontaine Maury. Delegates from 10 countries (Belgium, Denmark, France, Great Britain, Netherlands, Norway, Portugal, Russia, Sweden and USA) attended the conference and all, with the exception of a Belgian mathematician and a British military engineer, were naval officers.

The standardisation of meteorological observations at sea was the main preoccupation of the delegates at Brussels. A set of observing instructions was drawn up for use by ships of all nations and a standard form of reporting was adopted. This was the first step towards ensuring that maritime meteorological observations would be universally comparable whatever their provenance. In addition, a proposal was adopted calling for the voluntary cooperation of commercial and military fleets of all nations in a worldwide system of maritime weather reporting.

The basic framework established at Vienna consisted of Congress, which would establish general policy and procedures and a Permanent Committee consisting of a small number of Directors of Meteorological Services, elected by Congress, which would draw up and monitor programmes of international scope and which would advise Congress on all matters concerning the development of international meteorology. It was envisaged that Congress, at which Directors of Meteorological Services would represent their respective governments, would meet every few years while the Permanent Committee would meet more frequently, possibly annually, to ensure continuity between meetings of Congress.

The importance of the Brussels Conference lay not only in its success in establishing standards for weather observing at sea but also in the impetus which it gave to the development of international cooperation in meteorology in general. Encouraged by the outcome of the Conference, scientists and governments in many countries decided that the advent of scientific techniques of observing weather and of methods of quickly exchanging data and disseminating forecasts could only be fully exploited by an internationally coordinated effort. After numerous discussions at scientific level, the first international meteorological congress was held in Vienna in 1873.

THE FIRST AND SECOND INTERNATIONAL METEOROLOGICAL CONGRESSES (VIENNA 1873 AND ROME 1879)

The Vienna Congress of 1873 was truly a milestone in the history of international meteorology. While the Brussels Conference of 1853 was an important stepping-stone towards world-wide coordination of effort in the meteorological field, it was attended only by a group of individuals interested mainly in one narrow field of meteorology. Delegates at the Vienna Congress, on the other hand, represented 20 governments: their deliberations and decisions had therefore the full backing of the governments concerned. In addition, the agenda of the Congress covered the whole range of meteorology rather than one sector.

The significance of the Vienna Congress for international meteorology cannot be overemphasised. Not alone did it decide in a harmonious and constructive atmosphere on basic practical procedures for the calibration and checking of meteorological instruments, the timing and methods of observations and on the exchange of information but it also created a machinery through which the continuity of international cooperation in meteorology would be assured. This machinery, later to be known as the International Meteorological Organization up to 1951 and the World Meteorological Organization thereafter was to guide international meteorology through the successive stages of technological development and despite the traumatic interruptions of two world wars and several regional conflicts from that first Congress in 1873 to the present day.

The Permanent Committee, elected by the Vienna Congress, lost no time in getting to grips with the awesome task of coordinating meteorological activities on a world scale; it is recorded that it opened its first meeting in Vienna two hours and fifteen minutes after the Congress closed and by the end of a session lasting only seventy-five minutes had succeeded in establishing its rules of procedures, arranged for the circulation of the resolutions of Congress to governments and had commenced work on instructions for observers, on the standardisation of instruments, on a telegraphic code for the transmission of observations and on a variety of proposals to be submitted to Congess. During the subsequent five years or so the Permanent Committee maintained its momentum so that, by the time the Second Meteorological Congress met in Rome in early 1879, solid foundations had been laid for a broadly based work programme in international meteorology including participation in a international synchronised scientific programme associated with the First International Polar Year (1882–1883) during the course of which thirteen expeditions were sent to the Arctic and two to the Antarctic to study the meteorological and magnetic phenomena of those regions.

Eighteen countries were represented at the Second Congress at which formal approval was given to the programme methodically prepared by the Permanent Committee concerning a broad range of subjects including the continuance of the standardisation of instruments and methods of observations initiated in Vienna, the publication of scientific studies, reports and International Meteorological Tables, and the organising of conferences on specialised subjects. The Permanent Committee was re-established but with a new name, the International Meteorological Committee, which comprised nine Directors of Meteorological Services including the Director of the British Service, R.H. Scott, who deserves special mention. Scott, born in Dublin in 1833, a graduate of Trinity College, Dublin and first Director of the British Meteorological Office (1867–1877) was a key figure in the development of international cooperation in meteorology. He played a prominent role in the preparations for the Vienna Congress in 1873 and was a dynamic secretary to the Permanent Committee elected by that Congress and to the International Meteorological Committee elected by the Congress of Rome in 1879 up to his retirement in 1900. His qualities as a first-class organiser and administrator were invaluable on the international scene over a period of 28 years and he is rightly recognised as having been the driving force behind the development of international cooperation in meteorology. Most of Scott's library is held by the Irish Meteorological Service at Valentia Observatory, Co. Kerry.

THE INTERNATIONAL METEOROLOGICAL ORGANIZATION (1879–1951)

The International Meteorological Committee elected at Rome in 1879 performed its coordinating role with the same vigour and determination as had its predecessor, the Permanent Committee. Although the status of the organization, by then known as the International Meteorological Organization (IMO), was governmental, governments were, by and large, satisfied to leave the planning and implementation of programmes and even policy decisions in the hands of Directors of Meteorological Services. In fact, the Rome Congress was the last governmental meeting held until after the Second World War and the IMO became a non-governmental organization controlled by Directors of Meteorological Services.

While it could be argued that non-governmental control of an important international activity must necessarily be less than fully effective because of the possible lack of full governmental backing for decisions taken or plans made by a non-governmental body, it is evident in the particular case of the IMO, that such considerations did not hinder to any apparent degree the considerable strides that were made in international meteorology between 1879 and 1951. With guidance from Conferences of Directors of Meteorological Services which were held periodically (nine in all from 1879 to 1951), smaller groups of Directors who formed successive International Meteorological Committees organised and coordinated international meteorological activities with remarkable success. Agreements were reached on world-wide standardisation of instruments and observations, a numerical coding system for the transmission of observations was developed, arrangements were made for regular exchange of observations, specialist groups (Technical Commissions) were formed to study and promote activities in the various spheres of meteorology, e.g. agricultural meteorology, marine meteorology and climatology, while a system of regional associations was established to deal with meteorological problems specific to the different parts of the world.

In this present age, when ponderous bureaucratic mechanisms spawning a plethora of committees, groups, sub-groups and working parties and seemingly endless series of symposia, conferences and planning meetings are the order of the day, it is salutary to reflect that the quite extraordinary development of international meteorology in the late nineteenth and early twentieth century was achieved through the efforts of a relatively small number of dedicated scientists who for little or no material or personal reward pursued vigourously and selflessly the goal of international cooperation in meteorology.

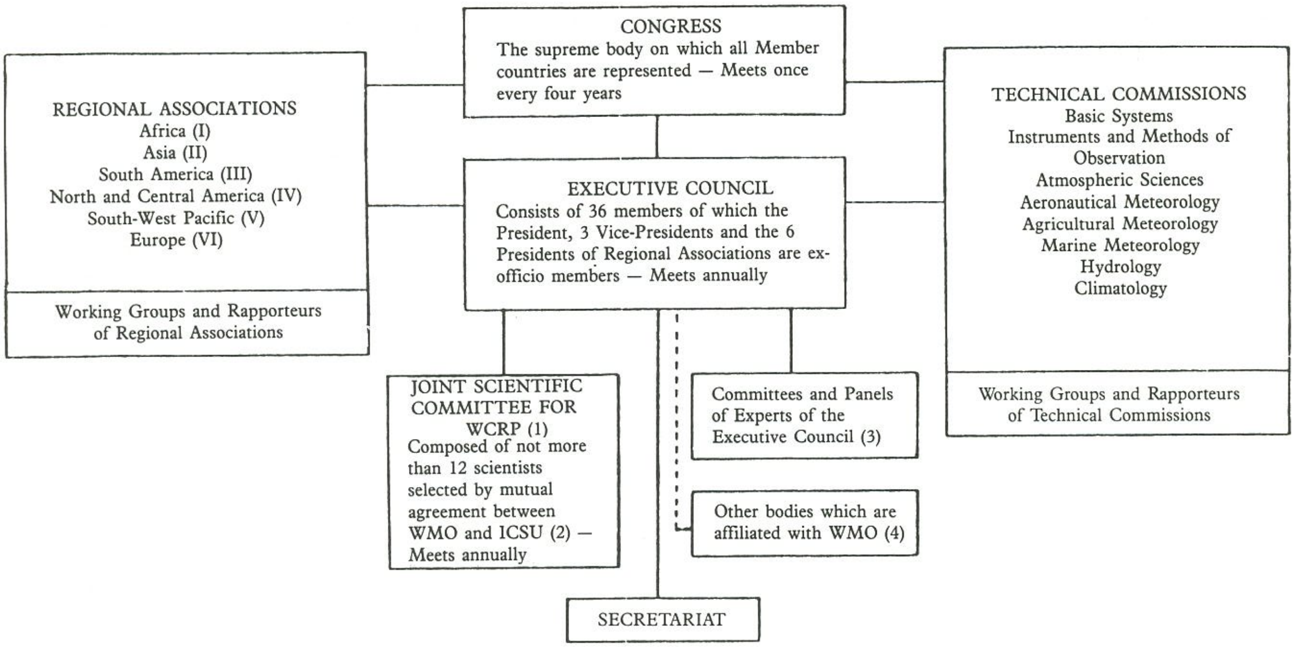
As the membership of the IMO grew and the volume of activity of the International Meteorological Committee and the Technical and Regional Commissions increased, the need for a permanent Secretariat became increasingly pressing. Successive Conferences of Directors recognised this need but governments were reluctant to provide the necessary funds. Eventually in 1926, it became possible to establish a small permanent Secretariat to service the various meetings, to publish reports and proceedings and to act as a documentation centre. It was agreed that the Secretariat would be located in one of the smaller European countries and pending a final decision on its location it was installed, on a temporary basis, at the headquarters of the Dutch Meteorological Service at De Bilt. At the outbreak of hostilities in 1939, the Secretariat was hastily transferred to Lausanne in neutral Switzerland where it continued to function throughout the war, mainly engaged in preparing a post-war plan for international meteorology. It is interesting to note that while the 1939-1945 war severely restricted international contacts, financial contributions from member countries continued to arrive in Lausanne and were only 10% less, on average, than during the last pre-war years.

When the Second World War came to an end in 1945, the meteorological community was faced with the task of picking up the threads of international cooperation which had been so rudely snapped in 1939. New technology developed or perfected during the wartime years e.g. radio, teleprinter and radar had to be adapted and fitted into the world meteorological mesh, Technical Commissions had to be re-formed and revitalised and the future constitutional status of world meteorology had to be studied and decided upon. This last subject was one which had been extensively debated at pre-war Conferences of Directors; opinions were clearly divided as to whether, in view of the considerable expansion in meteorological activities, international meteorology should remain essentially under the control of Directors of Meteorological Services or whether its status should be governmental with the full political and financial backing of governments. Discussions on this constitutional question were reopened with renewed vigour at the first post-war Conference of Directors, held in Washington D.C. in 1947. By this time, the United Nations Organization (UN) had been established and it was known that its founding fathers, the Great Powers victorious in the war, envisaged the establishment of governmental bodies which would be responsible for the coordination of international activities in the various fields of human endeavour except for political and security matters which would be dealt with by the UN itself. These bodies, called specialised agencies, would be in close relationship with, but independent of, the UN and would have full governmental status. Thus, for example, the World Health Organization (WHO), the Food and Agriculture Organization (FAO), the International Labour Organization (ILO) and the International Telecommunications Union (ITU) would coordinate international activities in the fields of health, agriculture, labour relations and telecommunications, respectively. After a long and often animated debate, the Washington Conference of Directors finally decided that it would be in the best interests of meteorology that it should be coordinated on a world scale by an international governmental organization affiliated to the UN family of organizations. Agreement was reached on the Convention of the new organization and after its ratification by the required number of governments, the new body, to be known as the World Meteorological Organization (WMO), was formally established on 23 March 1950 and the First Congress of WMO was held in Paris from 19 March to 28 April 1951.

THE WORLD METEOROLOGICAL ORGANIZATION

Fifty-nine countries were represented at the First Congress of WMO and observers were present from the UN and six specialised agencies. While the Congress was concerned largely with constitutional and administrative matters, it also adopted a four-year programme of scientific activities, decided on the establishment of a permanent Secretariat to be located in Geneva and appointed the first Secretary-General, Dr G. Swoboda who had acted as Chief of the IMO Secretariat. All participating countries were represented by the Directors of Meteorological Services; Ireland was represented by Dr. M. Doporto with Mr. S. Tierney as alternate. It is of interest to note that the representative of British East African territories and Indian Ocean Islands was Mr. D.A. (later Sir Arthur) Davies who had been for a period in 1938/39 a weather forecaster at Foynes and who was later to serve as Secretary-General of WMO from 1955 to 1979. Among the observers at the Congress was Mr. A. Nagle who had been the first Director of the Irish Meteorological Service from 1936 to 1948 when he left Ireland to join the U.S. Weather Service.

Having settled at First Congress the many constitutional and administrative questions arising out of its accession to governmental status and its affiliation to the UN, the new organization concentrated its efforts on the scientific aspects of international meteorology. The framework for such activities had been well established by its predecessor, the IMO and in fact the overall structure of WMO adopted by First Congress and which has remained practically unaltered up to the present day was esentially the same as that



(1) WCRP World Climate Research Programme
(2) ICSU International Council of Scientific Unions
(3) Committees and Panel of the Executive Council:
Panel of Experts on Education and Training
Panel of Experts on WMO Voluntary Co-operation Programme (VCP)
Panel of Experts on Environmental Pollution
Panel of Experts on Satellites
Panel of Experts on Weather Modification
Working Group on Antarctic Meteorology
Working Group on Long-Term Planning
Advisory Committee for the World Climate Applications and Data Programmes

(3) Committees and Panels of the Executive Council (contd.):
Selection Committee for the IMO Prize
Selection Committee for the WMO Research Award for Young Scientists
Staff Pension Committee
Joint IOC/WMO Working Committee for the Integrated Global Ocean Services System (IGOSS)
(4) Other bodies:
WMO/ESCAP Panel on Tropical Cyclones in the Bay of Bengal and the Arabian Sea
ESCAP/WMO Typhoon Committee

Figure 1. The structure of the World Meteorological Organization

established by the IMO in the 1890s with the addition of a permanent Secretariat (see Figure 1 — The structure of WMO). The system of Technical Commissions, initiated by the IMO, provided a base from which to promote coordinated international efforts in the various specialised fields — communications, agricultural and marine meteorology, instrumentation etc. One area which required particular attention especially in the early years of WMO was that of aviation meteorology since the rapidly expanding aviation industry was pressing for comprehensive weather services for national and international flights. The coordination of such services at international level was a major preoccupation of WMO in its early years and its Commission for Aeronautical Meteorology worked closely with the International Civil Aviation Organization, a sister agency in the UN system, to ensure that meteorological services to aviation were of the highest possible standard. From the beginning, the Technical Commissions of WMO proved to be of immense value in fostering cooperation and goodwill among meteorologists from all parts and in facilitating the exchange of information, ideas and techniques between Meteorological Services throughout the world. Working in close harmony with the Secretariat which provided scientific and secretarial support for their activities, they played a key role in the organization's efforts to further the state of knowledge of atmospheric processes and to achieve world-wide uniformity of meteorological practices. In addition, they provided the basic input to a series of Technical Notes and Guides designed to keep meteorologists everywhere abreast of scientific developments and to provide them with guidance on methodology and practices. From the Irish point of view, it should be noted that Irish meteorologists have made significant contributions to the scientific work of WMO, many of them actively participating in the work of the Technical Commissions and some having served with distinction as Presidents or Vice-Presidents of various Commissions.

While the detailed scientific activities in the various fields of meteorology are dealt with by the appropriate Technical Commissions and aspects peculiar to particular regions of the world by Regional Associations, the responsibility for the overall coordination and promotion of international meteorology rests with Congress, at meetings of which Directors of Meteorological Services attend as representatives of their governments. At the four-yearly meetings of Congress, all activities of the Organization are reviewed and plans adopted and finances allocated for the work of the Organization during the subsequent four years. During the periods between meetings of Congress, the activities of WMO are monitored and controlled by the Executive Council, comprising thirty-six Directors of Meteorological Services, which meets annually and whose responsibility it is to ensure that decisions of Congress are implemented.

INTERNATIONAL METEOROLOGY — A PERSPECTIVE

Looking back at the history of international meteorology over the past 100 years or so one cannot fail to be impressed by the manner in which the international meteorological community has adapted to the considerable technological, political and sociological changes which have occurred in the intervening period.

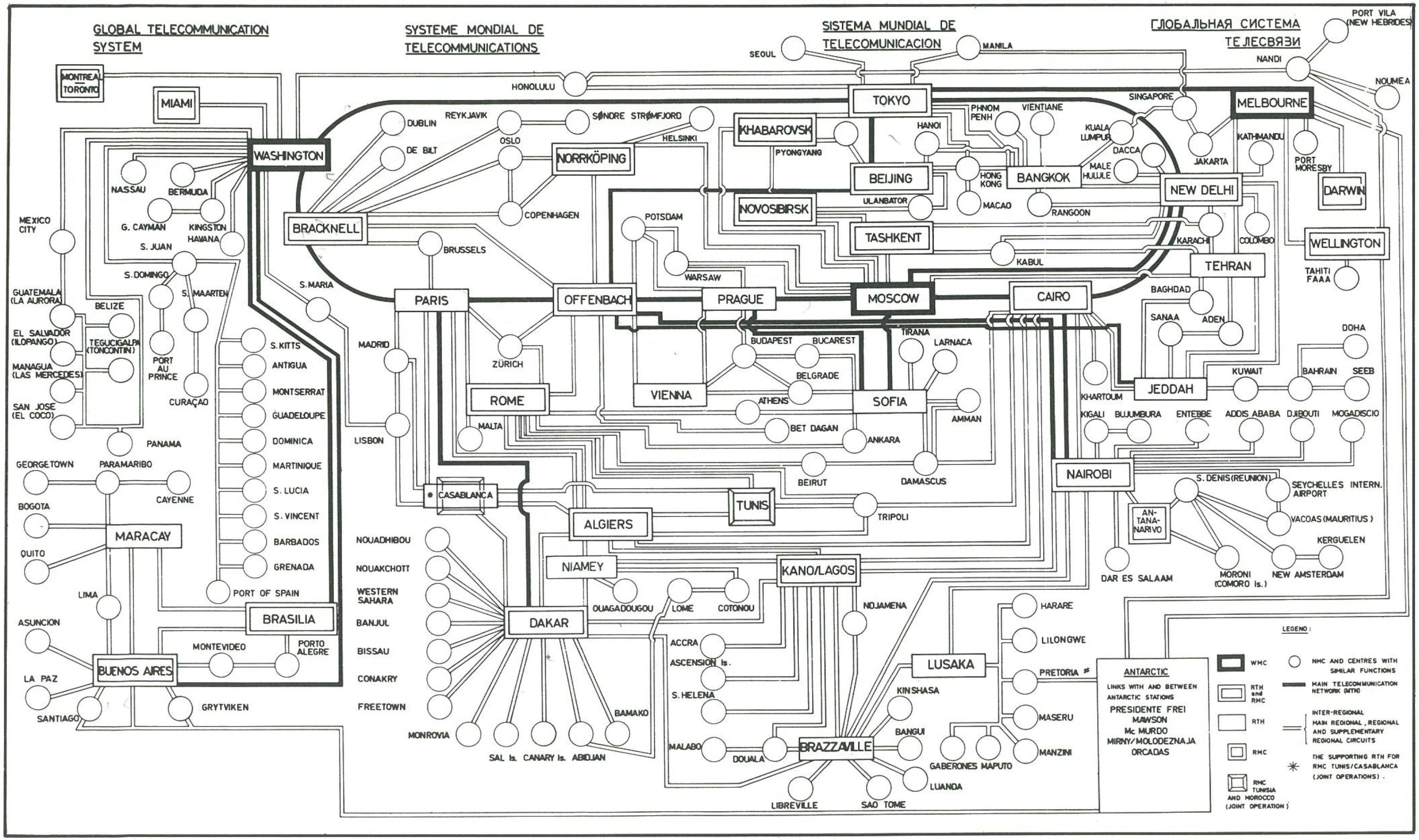


Figure 2. The WMO Global Telecommunications System

On the technological side, the means of communication, which are the life blood of meteorological exchange, have changed out of all recognition since Samuel Morse tapped out his first telegraphic message in 1843. As each new method of communication was developed, from the telephone, through the radio, teleprinter, telex, facsimile to the computer and satellite, meteorologists quickly seized on each new possibility to improve national and international exchange of data and information. Today, the international meteorological communication system is a model of its kind linking as it does national, sub-regional and regional meteorological centres throughout the world, thus permitting the rapid exchange of data on a global basis (see Figure 2 — the WMO Global Telecommunications System). The advent and development of the electronic computer opened up new horizons in meteorology in the fields of data-processing and numerical modelling and forecasting as well as in communications, while the use of radar and satellite photographs led to significant improvements in meteorological analysis and forecasting.

The membership of WMO has increased spectacularly since its establishment in 1950 when it counted 50 members: this membership had doubled by 1959 and at the end of 1985 there were 159 members. In large measure, this striking increase in membership was due to the accession to independence of a large number of former colonies, notably in Africa. In many cases, the meteorological infrastructure of these newly independent states had been seriously disrupted by the change in regime and large-scale efforts were required to rehabilitate their Meteorological Services. In this process WMO, with the collaboration and financial assistance of other agencies of the UN system and with the voluntary aid of WMO member states, coordinated a technical cooperation programme designed to assist developing countries in building up their meteorological services. Such assistance, in the form of fellowships for the training of personnel, instruments equipment and expert advice, has become a major feature of WMO activities: in 1985, for example, assistance to the value of US$20 million was provided to improve the Meteorological Services in developing countries.

Just as the international meteorological community responded to demands for weather services for shipping in the second half of the nineteenth century and for services to aviation in the post World War II era, it has actively participated in major international efforts in other fields. WMO, for example, played a significant part in the formulation and implementation of the plans developed at the UN Conference on the Environment held in Stockholm in 1972; today it has a key coordinating role in the research and monitoring aspects of environmental pollution. In the early 1970s when the focus of world attention was on the drought-stricken Sahelian zone of Africa and the general world stocks of food were giving rise to widespread concern, WMO responded to a call from the World Food Conference (Rome, 1974) for meteorological input to concerted actions for the improvement of food production, by initiating a programme of agrometeorological projects. These projects, planned and implemented in collaboration with the Food and Agricultural Organization (FAO) provide meteorological information and advice in the operation of Crop Monitoring and Early-Warning Systems in problem areas as well as expert advice on weather-related aspects of food production such as pests and diseases. Other international meteorological programmes deal with such diverse subjects as weather modification, building climatology, tropical cyclones, operational hydrology and atmospheric research.

While inevitably the history of international meteorology is largely concerned with the activities of the global organizations, IMO and its successor, WMO, it should also be noted that many advances in the science of meteorology and the more effective exchange of data and information have resulted from bilateral, multilateral and regional cooperative arrangements between countries. Of particular Irish interest in this area are two groups, the first of which cooperates in maintaining a number of permanent weather-observing ships at fixed stations in the North Atlantic (North Atlantic Ocean Stations) and the second which is responsible for the establishment of the European Centre for Medium Range Weather Forecasts at Reading, UK at which meteorologists from 17 European countries collaborate in producing weather forecasts for up to 10 days ahead, using advanced numerical models.

International meteorology has come a long way since Lientenant Maury convened the first international meteorological conference in Brussels in 1853. Advances in technology have certainly played a major part both in the development of the science of meteorology and in facilitating the global exchange of weather data and information but without considerable cooperative efforts from National Meteorological Services and the effective global coordination of IMO and WMO, it is doubtful whether international meteorology could have attained the status which it enjoys today. Much has been achieved in welding together an effective global meteorological system designed to provide comprehensive meteorological input to national and international weather-related activities, and in efforts to safeguard the atmospheric environment. The system is not perfect; there are still significant gaps in observational and communications networks; Meteorological Services in some developing countries are still inadequately equipped; the transfer of technology and meteorology from the developed to developing countries is in some cases painfully slow. With the goodwill and the spirit of cooperation which has characterised the development of international meteorology over the years, one can be reasonably confident that these inadequacies will be remedied and that Meteorological Services of all nations will be able to play their full role in the furtherance of social and economic well-being of their countries and of the world.

THE IRISH METEOROLOGICAL SERVICE AT WORK TODAY

Weather forecasting

by Paddy MacHugh

Almost two million telephone calls for weather forecasts were made in this country last year, despite the easy availability of the information through the media. This is not surprising when one remembers the dependence of agriculture on the weather; how many branches of industry are affected by it, and how the general public, in its day-to-day activities and especially in its leisure pastimes, can suffer when conditions are adverse.

THE DIFFICULTY OF FORECASTING IN IRELAND

Irish weather is notoriously difficult to forecast for two particular reasons. Firstly, because the country is situated in a region of the globe where the cold, relatively dry, polar air masses meet and mix with warm, moist tropical air masses, often vigorously and occasionally explosively. The principal characteristic of weather here is its changeability, and the forecaster is constantly faced with the problems of anticipating the changes correctly. Secondly, because of the earth's spin, the great atmospheric vortices, created in the mixing process, approach Ireland, broadly speaking, across a wide expanse of ocean, where surface weather observations are sparse. Consequently there are increased problems of precision in locating oncoming weather systems and in determining their speed and development. Happily, major advances in technology — such as the satellites which provide regular pictures of the earth's cloud cover, and immensely powerful computers — have revolutionised the science in the past few decades and go a long way towards counteracting the disadvantages associated with our geographical position.

MODERN METHODS OF FORECASTING

Standard forecasts

Regular forecasts prepared at the Central Analysis and Forecast Office (CAFO) for land areas of Ireland, surrounding coastal waters and the Irish Sea, cover a period of 24 hours ahead, and include an outlook covering 48 hours. They are produced by a composite man/machine method — traditional subjective extrapolation, strongly influenced by objective numerical guidance.

When making the forecast it is necessary to consider weather conditions prevailing over a wide area because weather systems are capable of moving long distances with great rapidity. In practice, observations from an area stretching from the Urals in Russia, westward across Europe, the North Atlantic and North America as far as the Rockies, bounded by 80° North and 30° North, are routinely taken into account. There are three distinct stages in the work.

ANALYSIS

An in-depth examination of the atmosphere is conducted at a particular time. All available data at surface level from land stations, ships, buoys, lighthouses etc. are plotted on a large map called a synoptic weather map. Each observation includes a pressure reading, and when lines of equal atmospheric pressure (isobars) are drawn on the map, the familiar 'HIGHS', 'LOWS', 'TROUGHS' and 'RIDGES' are thrown into prominence. Further consideration of temperature and humidity readings at both surface and higher levels, together with upper-air wind fields, identifies the limits of different air masses and, most importantly, their leading edges — bands of disturbed weather called FRONTS. These are designated 'WARM' or 'COLD' fronts depending on the nature of the advancing air mass, and 'OCCLUSION' when two fronts have coalesced.

They can usually be picked out clearly on satellite images, although there is a drawback in that cloud patterns as viewed from space do not always have a straightforward relationship with surface weather conditions.

A major analysis is conducted every six hours, with a limited one midway between. A local analysis over Ireland and Western Britain is performed hourly.

PROGNOSIS

Following study of their history through a series of analyses, the various weather features are projected forward in time. Preliminary estimates of future positions and intensities are modified by the forecaster in the light of the computer-predicted fields of the pressure, temperature, humidity and wind. Prognostic maps are then drawn showing the expected locations of existing systems and any new developments, after 24 and 48 hours.

INTERPRETATION

Finally the forecaster writes descriptive texts of the weather conditions implied by the prognostic charts he has produced, and transmits the information to user communities in many different ways.

PRESENTATION

The forecast is presented to the public by radio, TV, newspapers, recorded telephone message, videotex, telex and telefax.

Medium-range forecasts

Forecasts beyond two days ahead are outside the scope of even an experienced forecaster, and only sophisticated mathematical models can hope to handle the complexities of behaviour of the unruly atmosphere on this time scale.

Fortunately, Ireland has been actively involved in the planning and day-to-day work of the European Centre for Medium Range Weather Forecasts since its inception in the mid 1970s. This cooperative venture by seventeen countries has since led to ECMWF becoming the world leader in producing numerical forecasts for up to ten days ahead. Scientists at ECMWF continually improve their models of the atmosphere, simulating its physical and dynamical processes in an ever more realistic way. All the ECMWF products are automatically available to the Irish Meteorological Service and underpin the weekly forecasts, which can now be made with a high degree of confidence.

The Centre took delivery of an astonishingly powerful new computer at the end of 1985 which, operating at one thousand million calculations per second, can complete a global forecast for ten days ahead in two and a quarter hours.

Short-range forecasts

At the other end of the scale there is a requirement also for short-range forecasts of up to six hours or so ahead. Within the framework of the guidance provided by the prognostic chart, such requests are handled by reference to the regular hourly analyses. These are supplemented by satellite images displayed on a screen adjacent to the forecaster and, where possible, by radar echoes from weather radars located at Dublin and Shannon Airports. The radars permit subjective forecasts of precipitation in terms of both quantity and times of onset and cessation, and these forecasts remain valid over a period of a few hours. Techniques for objective use of digital radar in conjunction with geostationary satellite data have been developed internationally.

Long-range forecasts

So far, little useful progress has been made in producing forecasts beyond ten days, but it is fully recognised that monthly or seasonal forecasts could be of immense benefit. An ongoing study programme sponsored by the World Meteorological Organization is aimed at increasing the understanding of large-scale ocean-atmosphere phenomena which, it is felt, may provide the key to future advances in forecast range.

The Central Analysis and Forecast Office — a general view

A forecaster at his desk in CAFO


Analysing a chart

Weather forecasting by computer

by Peter Lynch

Before the computer era, all operational forecasts were made subjectively. The forecaster began with a synoptic chart showing the weather observations valid at a single time, and analysed the fields of pressure and other elements into weather systems. He then constructed a forecast chart, representing his estimate of the pattern of weather systems (say) one day later, and on this chart he based his forecast of the actual weather, winds, rainfall, etc. His forecasting skill derived from his years of experience in studying weather patterns and his knowledge of how weather systems typically behave.

The physical laws which govern atmospheric motions have been known for a long time: they are the universal principles of conservation of mass, energy and momentum. It was recognized early this century that these laws could, in principle, be used to make objective forecasts — but the amount of calculation required made this approach impracticable. The breakthrough came in the late 1940s with the invention of the electronic computer. The first computer forecasts were made in 1950, and they soon achieved an accuracy comparable to that of a skilled forecaster using subjective techniques. Thus dawned the age of Numerical Weather Prediction (NWP).

NUMERICAL WEATHER PREDICTION

The process of NWP can be broken into several steps. The observations of weather made world-wide are entered on the Global Telecommunications System (GTS) using special numerical codes and are transmitted to the National Meteorological Centres (NMCs). The communications computers at the Irish NMC in Dublin are linked directly to the GTS, and they automatically receive thousands of observations every day from all over the Northern Hemisphere. These are then decoded and checked for errors through a process called Automatic Data Extraction (ADE). The observational data valid at a given time are then used to derive a picture of the state of the atmosphere at that time — this is done by the Objective Analysis (OA) System. The analysis uses several hundred upper-air (radiosonde) observations and some thousands of surface and ship reports, as well as reports from commercial aircraft. Satellite observations are particularly important for us, as conventional observations are scarce over the Atlantic Ocean immediately upstream from Ireland. The objectively analysed fields are plotted on charts for use by the forecasters. They also serve as initial fields for making the computer forecast.

The computer forecasting model is a complex program which solves the mathematical equations corresponding to the physical laws (see box). These equations are solved by the method of finite differences: the initial fields are used to calculate the rate at which variables such as pressure, temperature and wind are changing, and the rates-of-change are used to extrapolate the fields forward in time. To maintain accuracy, the timesteps must be short and so a full forecast is made up of a sequence of many short steps in time. The continuous fields of pressure, temperature and wind are represented by their values at the points of a regular grid superimposed on the area of interest, and at a discrete set of atmospheric levels.

THE IRISH MODEL

Our forecast model has a grid of 2,100 points spaced 150 kilometres apart and covering Europe, the North Atlantic and Eastern North America (see Figure). There are five levels in the vertical. Our original model required about 37 minutes of computations to make a 24-hour forecast. Several innovations, developed within our Research Division, have enabled us to improve the efficiency of the model. The most recent version, introduced into operations on 1 July 1986, makes a 24-hour forecast in only 6 minutes. Many millions of calculations are required for each timestep. Our mainframe computer, a Digital DEC-2050, is capable of executing about one million instructions per second (1 MIPS).

(1) Conservation of momentum (zonal component)

$$\frac{du}{dt} - \left(f + \frac{u \tan\phi}{a}\right)v + \frac{1}{\rho}\frac{\partial p}{\partial x} = 0$$

(2) Conservation of momentum (meridional component)

$$\frac{dv}{dt} + \left(f + \frac{u \tan\phi}{a}\right)u + \frac{1}{\rho}\frac{\partial p}{\partial y} = 0$$

(3) Hydrostatic balance

$$\frac{\partial p}{\partial z} + g\rho = 0$$

(4) Conservation of mass (Continuity equation)

$$\frac{d\rho}{dt} + \rho\nabla\cdot\mathbf{V} = 0$$

(5) Conservation of energy (Thermodynamic equation)

$$\frac{dT}{dt} + (\gamma-1)T\nabla\cdot\mathbf{V} = \dot{Q}/c_v$$

(6) Boyle-Charles law of perfect gases

$$p = R\rho T$$

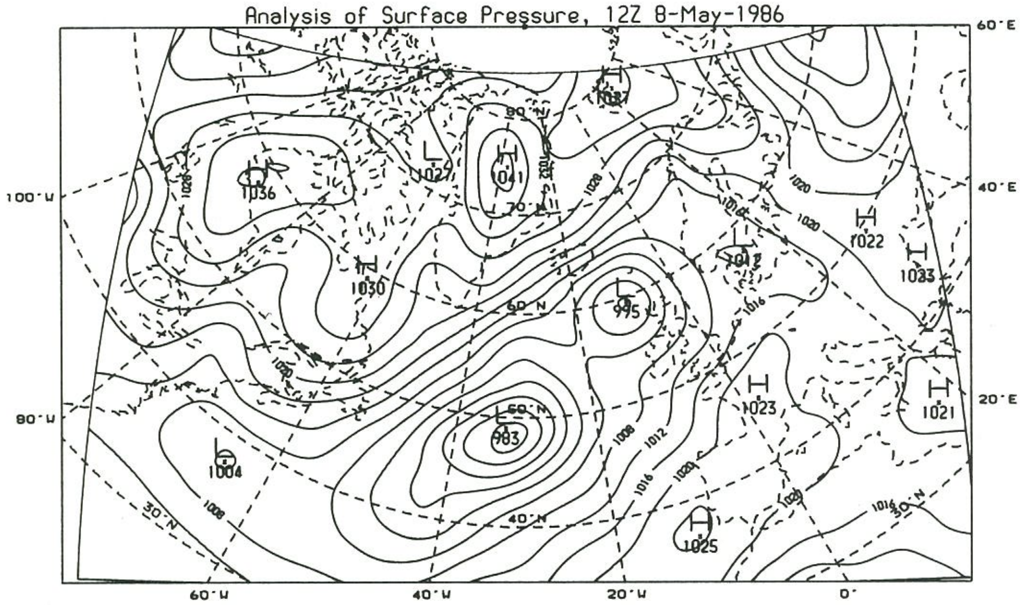
The physical principles governing atmospheric dynamics and their mathematical expression (the equations of motion)

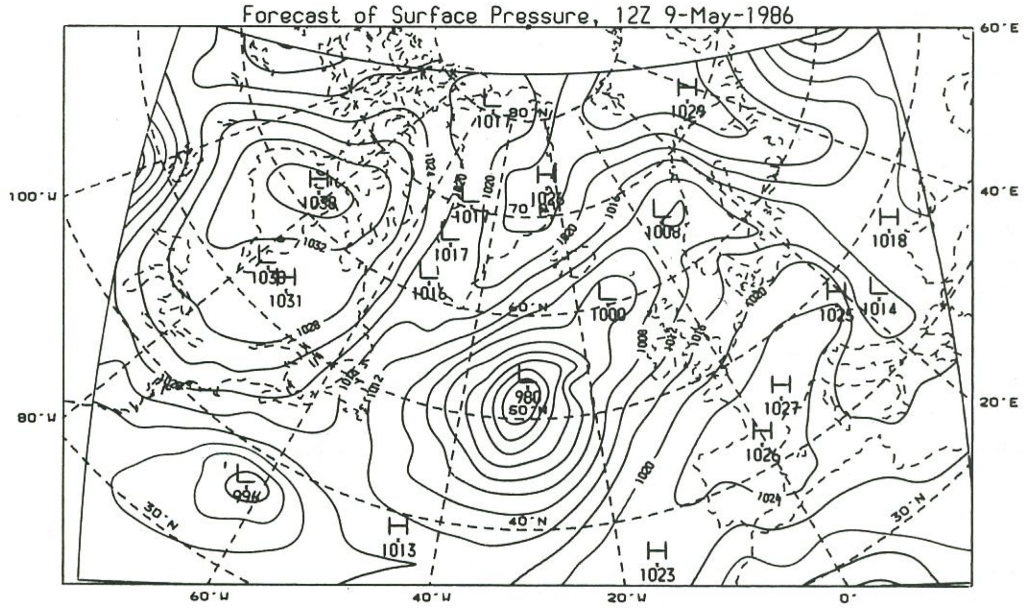
In the Figure we show an example of the objectively analysed surface pressure (above) and of the forecast pressure valid 24 hours later (below). A depression in mid-Atlantic is deepening and moving north-east, while the low-pressure area north of Ireland is filling and moving away. This forecast is the end-product of an intricate sequence of computer operations: The data have been received, decoded, checked and analysed, the numerical forecast made, and the results plotted automatically; and the forecast is ready within a few hours of the time the observations were made.

RESEARCH ACTIVITIES

The quality of computer forecasts depends crucially on the numerical schemes used. To improve this quality, the research team at the Irish Meteorological Service has concentrated upon developing new, accurate and efficient schemes for integrating the equations of motion. The main advance recently has been the introduction of a Lagrangian advection scheme. This scheme forecasts the flow by following the evolution of individual parcels of air, in contrast to the more common Eulerian approach of examining changes at a fixed point. The Lagrangian scheme has allowed us to speed up the numerical forecasts, saving more than one third of the computer time. Thus, the numerical guidance is available to the forecaster earlier than before — with the rapidly changing Irish weather, timeliness is of the essence. Another recent change has been the introduction of a semi-implicit scheme; this numerical method allows us to use a 90-minute timestep, and results in further computational efficiency without loss of accuracy.

At present, computer predictions of pressure patterns are more accurate than those produced by the human forecasters. However, the deduction from these patterns of the actual weather which we experience is still a task for the forecaster; here he can use his experience and knowledge of local conditions, and can take account of factors which are ignored by the numerical models. Thus, the best weather forecasts now available are the result of a man/machine mix, where subjective human experience and sheer number-crunching computational power work in harmony to produce a product which is superior in quality and accuracy to that which might be produced by either man or machine working alone.





Computers and communications

by Declan Murphy

A modern meteorological service relies heavily on computer technology in its operational work and the Irish Meteorological Service is no exception. Its computer installation at its headquarters in Glasnevin is in many respects the hub of the Service's day-to-day 'real-time' activities. Many aspects of meteorological work lend themselves readily to computer techniques — for example data communications, weather-chart production, numerical weather prediction, climatological data processing and archiving. Indeed some of these applications could not be carried out at all without access to computers.

The computer system is based on a DEC-2050 mainframe computer, installed in 1979, and two DEC PDP 11/40 machines installed in 1975. The latter are due to be replaced in the near future by two DEC VAX 11/780 computers. The strategy to be adopted with the introduction of the VAX computers is that as much as possible of the critical real-time work of the Service will be handled by the VAX system, with one machine backing up the other, while the DEC-2050 will be used for the very large jobs such as numerical weather prediction, and as the general purpose computer for the less time-critical activities. A total of 52 terminals are supported by the system, 39 in headquarters and 13 at other locations such as the airport meteorological offices, the School of Meteorology in Galway and Valentia Observatory.

Data communications, the 'lifeblood of meteorology', is one of the most important computer applications. The Meteorological Service computer system is linked to a variety of international computerised centres from which all the raw data upon which its forecasts are based are received. Among these links are :

- THE REGIONAL METEOROLOGICAL CENTRE, BRACKNELL: the distributor of basic meteorological reports from the Northern Hemisphere and of computer forecasts from British and American numerical weather-prediction systems. Among the reports received are surface reports from land-based and maritime stations; wind, temperature and humidity soundings of the atmosphere from equipment attached to weather balloons; aircraft reports and atmospheric soundings from satellite-based instruments. A total of 13,000 reports of various kinds are received each day.

- THE EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS, (Reading, Berkshire): forecasts for up to ten days ahead are received each day in digital form and are the basis of the Service's medium-range forecasts.

The DEC PDP 11/40 communications computers — soon to be replaced

- MOTNE (THE METEOROLOGICAL OPERATIONAL TELECOMMUNICATIONS NETWORK/EUROPE): reports, forecasts and warnings for airports throughout the Northern Hemisphere are received and used in flight documentation and briefing. Our link with this network is through London.

In addition a total of 15 circuits (some data lines, some teleprinter circuits) are used to disseminate data to the airport meteorological offices and to aviation agencies such as the Aviation and Marine Communciations Service and Aer Lingus. Irish data from the three civil airports and from twelve meteorological stations are collected each hour or half-hour by the computer for onward transmission on the international circuits.

Another, non-computer, communications technique much used in the Meteorological Service is analogue facsimile transmission, whereby pictorial data such as weather charts are relayed from centre to centre.

A large portion of the data processed by the computers is converted into weather charts of plotted reports, isobars, isotherms etc. for use by the forecasters. Automatic pen plotters and colour-graphics screens are used for this purpose.

Numerical weather analysis and prediction is an activity which places a heavy demand on computer power. It involves applying numerical techniques to the solution of the mathematical equations governing the atmosphere. Forecasts for up to 36 hours ahead are produced twice a day by this method.

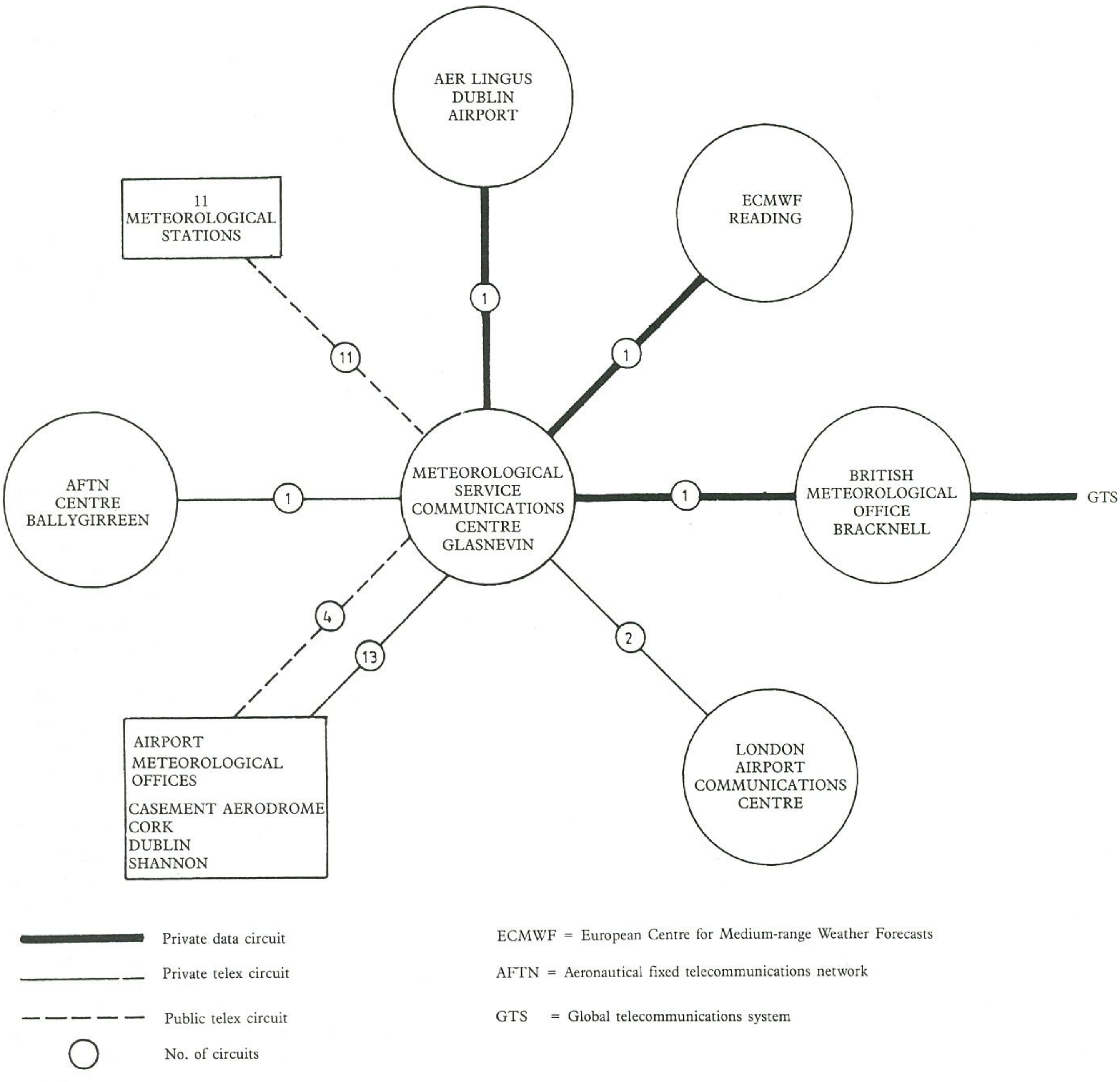
The oldest computer application in the Service is the processing and archiving of Irish climatological data, which was begun on the Revenue Commission's computers in 1965 and continues now on the DEC-2050. Reports from the Service's own stations, together with those from the voluntary rainfall and climatological stations, are subjected to rigorous computer quality control and archived on magnetic tape.

The computer also finds a role in the specialist areas of meteorology such as agricultural and marine meteorology and the processing of solar-radiation and earth-magnetism data, and is increasingly being used in administrative areas such as financial management, personnel records, instrument inventory and library catalogues.

Future developments are likely to focus on upgrading communications techniques linking the airports to the central computer, with computers at the airports handling automatic chart plotting and communications. On the international scene satellite communications are expected to become more widely used.

Removing a chart from the CALCOMP automatic plotter

METEOROLOGICAL SERVICE COMPUTER TELECOMMUNICATIONS NETWORK



ECMWF = European Centre for Medium-range Weather Forecasts

AFTN = Aeronautical fixed telecommunications network

GTS = Global telecommunications system

Meteorology for aviation

by Patrick A. Lyons

THE EARLY DAYS

It is not a coincidence that the National Airline — Aer Lingus — and the Irish Meteorological Service are both celebrating their 50th Anniversary around the same time. Meteorology and aviation have been of necessity closely linked and have developed side by side. As aeroplanes began to fly higher and higher and over longer distances it became obvious that a detailed knowledge of the atmosphere was required, not only in the interest of the comfort and safety of passengers and crew but for economic reasons as well. Studies of the atmosphere by meteorologists and information received from aircraft pilots confirmed that this was so. Winds could change quickly in speed and direction both in time and in space, huge variations in temperature were found both vertically and horizontally and there were areas of turbulence that could cause structural damage to an aeroplane; these were some of the phenomena which affected the safety and performance of aircraft.

INTERNATIONAL ORGANIZATIONS

At an early stage it was realised that aviation requirements would necessitate the international exchange of standardised meteorological information. Suitable fast and efficient communications networks would also have to be established. A special Commission for the Application of Meteorology to Air Navigation (later to be called the Commission for Aeronautical Meteorology) within what is now known as the World Meteorological Organization (WMO) was established in 1919 to deal specifically with the meteorological needs of aviation and about the same time the predecessor of the International Civil Aviation Organization (ICAO) was founded. These organizations set about drafting standard procedures with the primary objective of ensuring the maximum safety, regularity and efficiency of air navigation. Most countries in the world including Ireland are represented on these two bodies and side by side they work together to ensure that the meteorological requirements of the aviation community are continually under review.

SAFETY

Statistics show that a substantial percentage of aircraft accidents are weather related and most of these occur during take-off or landing. This is not to say that they are caused by weather alone as there is scarcely ever a single cause of an accident. However, it is not surprising that a detailed knowledge of the weather in the terminal area is required. Fog, low cloud, unfavourable winds, rain, icing, snow and wind shear are foremost among the meteorological phenomena which contribute to the accidents in this area.

In the en-route phase of flight the phenomena which contribute to the causes of accidents are low cloud base, rain, snow, icing, turbulence and thunderstorms. Again, as would be expected, the existing requirements for information for pre-flight briefing and documentation include those very important items.

REGULARITY AND EFFICIENCY

Knowledge of the actual and expected weather in the terminal area, for both the departing and arrival aerodrome, plays an important part also in minimising the number of delayed or diverted flights. Another important factor in the regularity and efficiency of an airline operation is a knowledge of upper-level winds and temperatures. A very high percentage of jet fuel is burned off just in carrying the fuel itself. It is important, therefore, with high fuel costs that the optimum amount of fuel for the journey is taken. Accurate forecasts of the upper winds and temperatures ensure that the best route and altitude are chosen so that the most economical and safe flight can be made. It is estimated that a large American airline could save millions of dollars per annum with the optimum use of accurate upper-air information.

SERVICES TO AVIATION

Nowadays, an efficient system has been established throughout most of the world which provides the necessary meteorological services to the aviation community. Here in Ireland the Irish Meteorological Service (IMS) through its offices at Dublin, Shannon and Cork international airports and at the military aerodrome at Baldonnel fulfils its own and international obligations to the aviation community. At our international airports detailed terminal weather information for airports in Europe, the Middle East, North Africa, North America and other parts of the world is available, with information on en-route weather conditions, upper winds and temperatures to various destinations. If difficult weather situations needing further clarification arise, consultation with a forecaster is also available. Detailed weather information for the general aviation community, mainly the pilots of the many light aircraft operating around the country or across to the mainland of Europe, can be made available at the meteorological offices at the airports or over the phone. It is now also possible to have access to a large variety of meteorological information stored in the IMS computer through Telex; this facility can provide immediate access to a substantial amount of pre-flight planning material. At the military aerodrome at Baldonnel, Irish Air Corps crews get detailed weather information for Ireland and Irish coastal waters which enables them to plan their rescue operations and helps them in their fishery patrol duties and other vital missions. At Shannon Airport, watch is maintained over meteorological conditions affecting flight operations over Irish airspace. When certain specified en-route phenomena, e.g. severe turbulence or active thunderstorms which may affect the safety of aircraft operations, are expected to occur, warnings are issued to other meteorological centres to be used for pre-flight briefing on the ground and through Air Traffic Control to aircraft pilots in the air.

Accurate forecasts of the upper winds and temperatures ensure that the best route and altitude are chosen so that the most economical and safe flight can be made. (Photo: Aer Lingus)

A personal briefing from a meteorologist before a flight (Photo: Aer Lingus)

COMMUNICATIONS AND AUTOMATION

Communications have always played a vital part in meteorology. The primary weather observations upon which the forecasts are based, reports from airports throughout the sphere of interest, aircraft reports, and all the other vital pieces of information that are required must be acquired with the minimum delay. Already very complex communications systems are in use. Weather reports from over 200 European airports are available in our offices within minutes of their making and are updated every half hour, and conversely information on the weather at our Irish airports is available in places as far away as Moscow or Cairo in similar time. Requests to European and American databanks for information concerning other airports can be made and replied to within minutes. However, at an International Conference of the American Meteorological Society on the Aviation Weather System held in Montreal in June 1985 it was stated that, while there was much weather information in the system, it was not always getting to the users as quickly as it should, and more use of automatic systems, particularly for pre-flight briefing and in-flight information, was needed. A step in this direction is currently being taken in the form of an automated pre-flight self-briefing system for pilots at Dublin Airport. A system is being developed which will ultimately allow aircrew to have a printout from the IMS computer of all the weather information relating to the flight in a matter of seconds merely by pressing a button. The IMS is also processing and providing upper-air wind and temperature information for the Northern Hemisphere for input to airline computers. This allows flight plans to be produced automatically with the minimum delay.

FUTURE DEVELOPMENTS

Even while aircraft are in the air the weather is constantly changing, and updated flight plans are needed to ensure that modern airliners can achieve optimum performance. Data links are now being developed which will allow for new meteorological information to be fed into flight-management computers on board so that flight plans are continuously updated and optimised. Plans are also being made to automate the weather information for the terminal area to such a degree as to allow for immediate reception on board aircraft without the need for human voice channels.

It is clear that much of the development in the years ahead will be in the field of communications but there are also many aspects of weather, and particularly the forecasting of weather, which will require more attention — the detection and prediction of low-level wind shear and severe turbulence, and the very short range forecasting of fog, visibility and runway visual range, are but a few.

Even while aircraft are in the air the weather is constantly changing. (Photo: Aer Lingus)

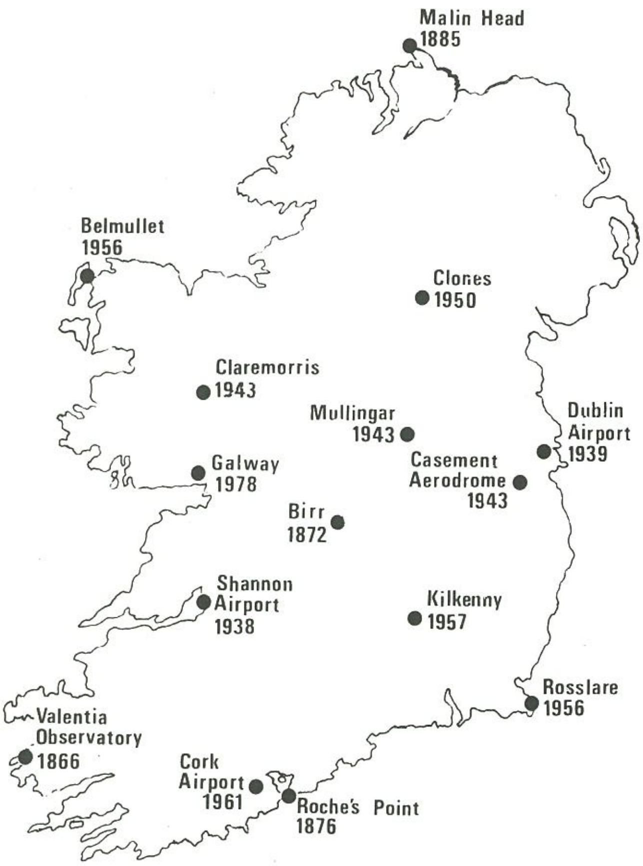
The weather observation network

by Marty Keane

As in the case of all meteorological services, the primary basis for all activities of the Irish Meteorological Service (IMS) is its network of weather observing stations. These stations may be divided into three categories : synoptic, climatological and upper-air.

SYNOPTIC STATIONS

The 15 synoptic stations are located as shown in Fig 1. They are manned on a 24-hour basis by IMS staff whose main function is to maintain continuous watch on weather conditions and to make detailed weather reports every hour, on the hour, in an internationally standardised coded form; additional reports are made when weather conditions change significantly. At synoptic stations located at airports, the frequency of standard reports is higher and special reports of a specialized nature are supplied to Air Traffic Control Services.



The synoptic observing stations and dates of their establishment

The elements included in synoptic weather reports are direction and speed of surface wind, visibility, air temperature, dew-point, amount, type and height of clouds, atmospheric pressure, pressure tendency and weather conditions e.g. rain, snow, mist, or hail with details of the nature of precipitation, if any, e.g. light, moderate, heavy, continuous, intermittent. In addition, for climatological purposes, all synoptic stations report rainfall amounts, temperature extremes, duration of bright sunshine, soil and earth temperatures and minimum gross temperatures; some synoptic stations also report daily values of solar radiation (global and diffuse). Nine synoptic stations participate in a programme for the chemical analysis of air and rain samples; air and rain samples are collected at these stations and forwarded to the IMS Laboratory for analysis. Six synoptic stations participate in a programme for the monitoring of radioactivity levels; samples of precipitation, tapwater and dust are collected and forwarded to the Nuclear Energy Board (NEB) for analysis.

The weather reports from synoptic stations are sent by telex to the Central Analysis and Forecasting Office (CAFO) in Dublin whence they are relayed nationally to the four airports and internationally through the Global Telecommunications System (GTS) of the World Meteorological Organization (WMO). They form, together with corresponding reports received through the GTS from other countries and from ships, the basic foundation for all forecasts produced and for all advice and information supplied to the general public and the various specicalized interests. They also constitute a vital body of information for use in such emergencies as would arise in the case of serious propagation of radioactive material or an outbreak of foot-and-mouth disease.

CLIMATOLOGICAL STATIONS

Climatological stations may be divided into two categories: rainfall stations (650) at which daily falls of precipitation (rain, hail, snow and dew) are measured and 'full' climatological stations (85), at which daily measurements are taken not only of precipitation but also of maximum and minimum air temperatures, duration of bright sunshine and, at some stations, wind speed, earth and soil temperatures, solar radiation and evaporation.

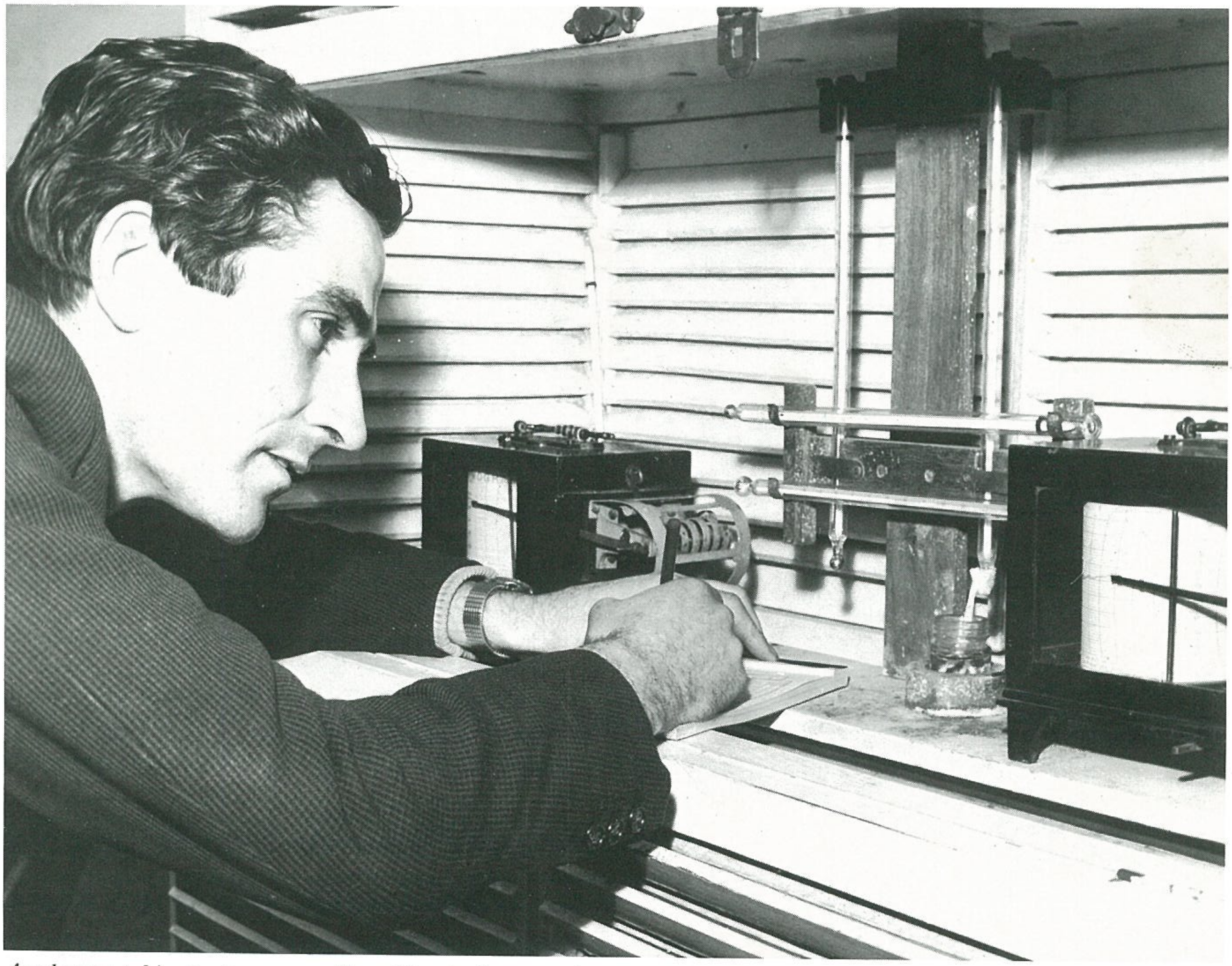
Measurements are carried out by voluntary observers, some being private individuals, others being attached to the staff of state or semi-state bodies or other institutions e.g. Forestry Service, Bord na Móna, An Foras Talúntais, the Electricity Supply Board and University College, Galway. The locations of 'full' climatological stations are shown in Fig 2; it may be seen that synoptic stations are included in the climatological network.

The data from climatological stations are quality controlled and archived on magnetic tape. They are extensively used to provide information to all branches of the Service, to industrial, commercial, agricultural, and legal interests and are used as a basis for routine climatological publications such as the *Monthly Weather Report* and the *Monthly Weather Summary* as well as many publications relating to long-term averages of the various weather elements and special investigations — see Appendix for list of publications.

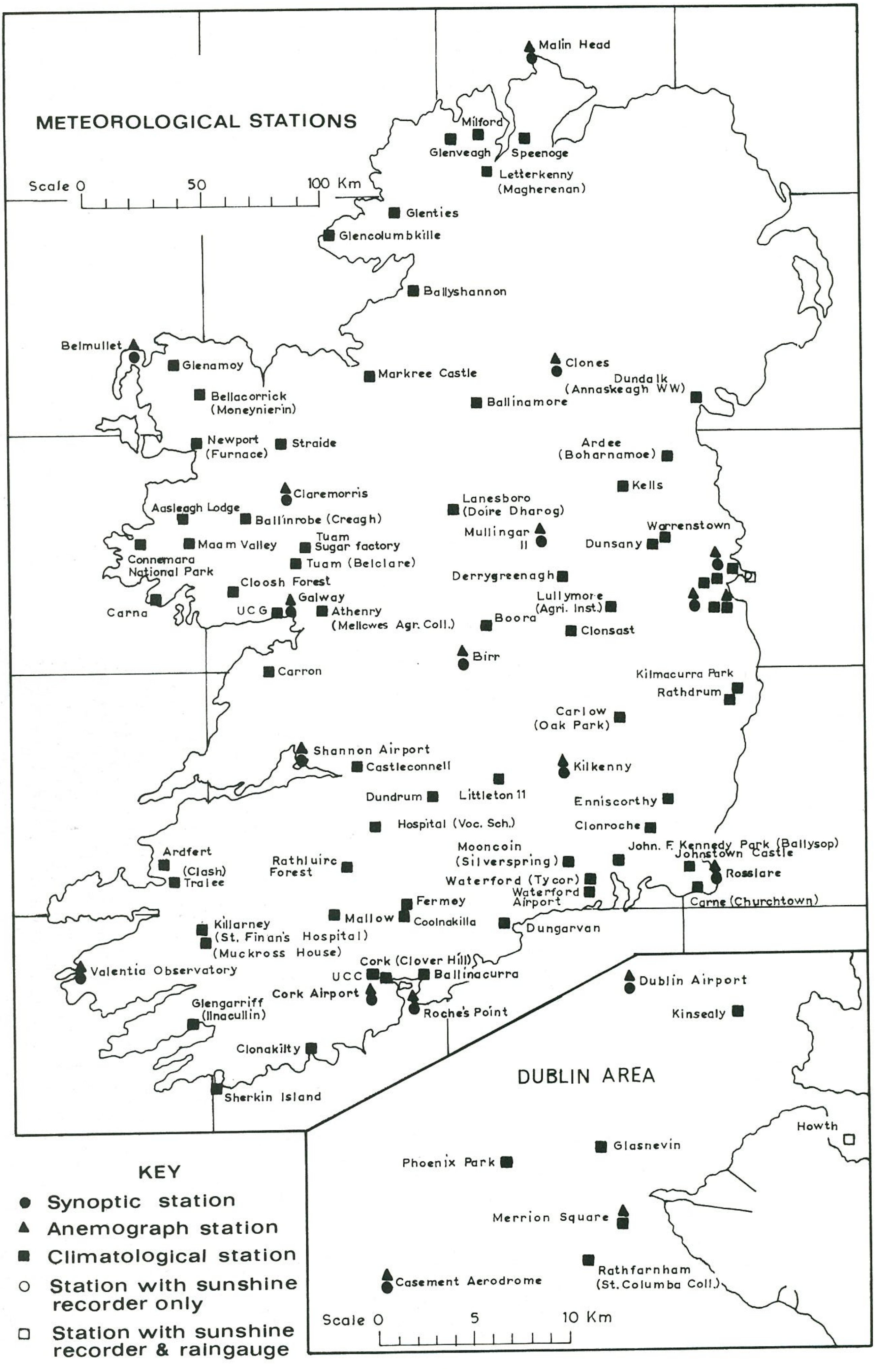
THE UPPER-AIR STATION

There is only one upper-air station in the state, at Valentia Observatory. Upper-air observations are normally made four times a day at 0000, 1200, 1800 and 2400 GMT. The observations consist of measurements of wind direction and speed, temperature and humidity at various levels of the atmosphere up to at least 100,000 feet. The measurements are made by means of sensors carried aloft by hydrogen-filled balloons to which are also attached radar targets. The balloons are tracked by radar and the radio signals activated by the sensors are received by radiosonde equipment at the station. The data thus received are processed and forwarded immediately in code form to CAFO and thence on the GTS world-wide.

Upper-air data form an invaluable complement to surface data in the preparation of forecasts since weather developments at surface level are influenced largely by atmospheric conditions aloft. Upper-air charts at various levels — 10,000, 18,000, 30,000 and 40,000 feet — are plotted and analysed and used, in most cases using numerical modelling techniques, to forecast conditions 24, 48, 72 and up to 240 hours ahead. The forecasting of winds and temperature and of significant weather (icing and turbulance) at the various flight levels for aviation are based on upper-air observations. It should be noted also that upper-air data are essential in pollution meteorology and in the tracking of radioactive material since they provide information not only on the lateral spread of contaminants but also on the vertical distribution of such material.



An observer taking temperature and humidity readings at a Stevenson screen. Instruments shown are: grass minimum thermometer (at left), wet and dry bulb thermometers (horizontal), bimetallic coil thermogram (at left) and hair hygrogram (relative humidity recorder). (Photo: Irish Times).


METEOROLOGICAL STATIONS
Scale 0 50 100 Km
Malin Head
Milford
Glenveagh
Speenoge
Letterkenny
(Magherenan)
Glenties
Glencolumbkille
Ballyshannon
Belmullet
Glenamoy
Markree Castle
Clones
Dundalk
(Annaskeagh WW)
Bellacorrick
(Moneynierin)
Ballinamore
Newport
(Furnace)
Straide
Ardee
(Boharnamoe)
Kells
Claremorris
Lanesboro
(Doire Dharog)
Aasleagh Lodge
Ballinrobe (Creagh)
Mullingar
II
Warrenstown
Maam Valley
Tuam
Sugar factory
Dunsany
Connemara
National Park
Tuam (Belclare)
Cloosh Forest
Derrygreenagh
Galway
Lullymore
(Agri. Inst.)
Carna
UCG
Athenry
(Mellows Agr. Coll.)
Boora
Clonsast
Birr
Carron
Kilmacurra Park
Rathdrum
Carlow
(Oak Park)
Shannon Airport
Castleconnell
Kilkenny
Dundrum
Littleton 11
Enniscorthy
Hospital (Voc. Sch.)
Clonroche
Ardfert
Rathluirc
Forest
Mooncoin
(Silverspring)
John. F. Kennedy Park (Ballysop)
Johnstown Castle
Rosslare
(Clash)
Tralee
Waterford (Tycor)
Waterford
Airport
Carne (Churchtown)
Fermoy
Mallow
Coolnakilla
Killarney
(St. Finan's Hospital)
(Muckross House)
Dungarvan
Valentia Observatory
Cork (Clover Hill)
UCC
Ballinacurra
Cork Airport
Roche's Point
Glengarriff
(Ilnacullin)
Clonakilty
Sherkin Island
DUBLIN AREA
Dublin Airport
Kinsealy
Howth
Glasnevin
Phoenix Park
Merrion Square
Rathfarnham
(St. Columba Coll.)
Casement Aerodrome
Scale 0 5 10 Km
KEY
Synoptic station
Anemograph station
Climatological station
Station with sunshine recorder only
Station with sunshine recorder & raingauge

The instrument enclosure at Valentia Observatory

The Climatological Division

by Denis Fitzgerald

The Meteorological Service is responsible for the collection, quality control, archiving and dissemination of weather information from both the land and sea areas of Ireland. In order to provide accurate values of the various elements a network of observing stations is maintained. These stations make regular returns which are examined for errors before being put into the climatological data bank, thereafter to be used in answering queries and in determining the summary statistics, such as averages, commonly used to describe the climate.

OBSERVATIONS ON LAND

The fifteen synoptic stations, which are manned full-time by Meteorological Service personnel, form the core of the observing network overland. From their records are extracted hourly values of all the usual weather elements. The synoptic station network is reinforced by some 85 climatological stations which usually take readings once daily at 0900 GMT. All climatological stations record air temperature and daily rainfall amount. Stations recording rainfall only are some 650 in number.

At present daily rainfall totals are read at a total of 750 stations of which 85 are additionally equipped with rain recorders. Air temperatures, including daily maxima and minima, are taken at 100 locations. Sunshine is recorded at 39 stations and solar radiation at 7 of the synoptic stations. Hourly wind data are available from 15 synoptic stations and there is a small amount of additional wind information. Evaporation from a shallow tank of water is read at 27 locations and the evaporative loss from grass (evapotranspiration) is measured at six sites and estimated at the 15 synoptic stations. At Valentia Observatory radiosonde balloons are released at 12-hourly intervals in order to provide information on the variation of temperature, humidity and wind in the vertical.

MARINE DATA

Observations are received from five light-houses, a light-ship, from oil rigs and wave-measuring buoys. The five coastal synoptic stations supplement these observations and additionally an archive of weather reports made by ships in the sea areas around Ireland is available. During the past few years estimates of wave heights generated by a computer model have been archived. Available in the library are marine atlases mapping parameters such as mean sea-surface temperature.

QUALITY CONTROL AND ARCHIVING OF DATA

Observing stations are inspected regularly to ensure that the sites, the instruments and their exposure conform to the standards set by the World Meteorological Organization.

The data received are scrutinised for inconsistencies and errors with the aid of sophisticated computer programs. Any readings flagged are examined by experienced staff, who decide whether to accept or reject the doubtful values. The data are stored in computer files, thus enabling the powerful computer methods of data handling to be used in their analysis.

PRESENTATION OF CLIMATOLOGICAL INFORMATION

The Meteorological Service regularly publishes tables and maps of the 30-year averages of air temperature, rainfall and sunshine. Specialist publications on extreme values of wind and rainfall, on topics in agricultural meteorology and on solar radiation are also produced (see Appendix). A full list of publications may be obtained from the Meteorological Service on request. Many data sheets and frequency tables are available to answer the wide range of queries received.

SERVICES TO THE PUBLIC

Climatological services, like forecast services, are available to the general public as well as to industry, commerce and the professions. The building industry is supplied with degree-day information which helps in determining heating needs. Records of rainfall, temperature and wind can be supplied where construction work has been hampered by bad weather. The legal and insurance professions and indeed members of the general public often require reports on weather conditions at a particular place and time when there has been an accident or storm damage. In the event of litigation expert opinion will be given in court, if required. Queries relating to agricultural and marine matters are passed on to meteorologists specialising in these applications. The correct use of climatological information during the planning and monitoring of weather-dependent projects can be of considerable economic benefit. The Meteorological Service will advise on the availability of useful weather data, and will consult with a customer on how best to present the information.

FUTURE DEVELOPMENTS

The recent rapid increase in the capacity of computers to store, manipulate and output data seems likely to continue. The Meteorological Service endeavours to take advantage of such advances to increase the range and improve the presentation of climatological data. Modern electronics has provided methods of sensing and logging data which present us with the opportunity of acquiring detailed weather data from remote areas. Radar and satellite sensing techniques are being developed which differ from traditional observations in that they sense areal rather than point values; they offer the hope of providing better estimates of quantities such as the key hydrological parameters of rainfall and evaporation over river catchments.

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

The success of harvesting may depend on an accurate weather forecast (Photo: Bord Bainne).

Agricultural meteorology in the Meteorological Service

by Tom Keane

Agriculture plays a most important part in the Irish economy. Gross agricultural output exceeds £ 2,500 million annually and the agricultural section contributes about 25% to our export earnings. It is also one of the sectors most vulnerable to the vagaries of weather; this fact has all too clearly been brought into sharp focus in recent years when a succession of unusually long cold springs and wet summers caused serious problems in agricultural production.

Even apart from such extreme cases, farming is one of the most weather-dependent activities and the Meteorological Service has always been acutely aware of the farmers' special needs for weather information. Although services to agriculture were high on the list of priorities of the Service right from its inception in 1936 it was not until 1965, when the staffing problems eased somewhat, that it was found possible to establish an Agrometeorological Unit within the Service to cater specially for the weather-related aspects of agriculture. It was clearly recognised that this special Unit could function effectively only if it operated in close collaboration with agricultural scientists and advisers working in the various branches of agriculture — soil science, horticulture, dairying, farm management, veterinary science etc. The Unit has always cooperated closely with ACOT (Advisory Services) An Foras Talúntais (the Agricultural Institute), the Department of Agriculture and university faculties of agriculture. The close liaison between these bodies and the Agrometeorological Unit is now effected through an AGMET Group which meets regularly to discuss joint projects and general coordination of effort in the agrometeorological field.

SERVICES TO AGRICULTURE

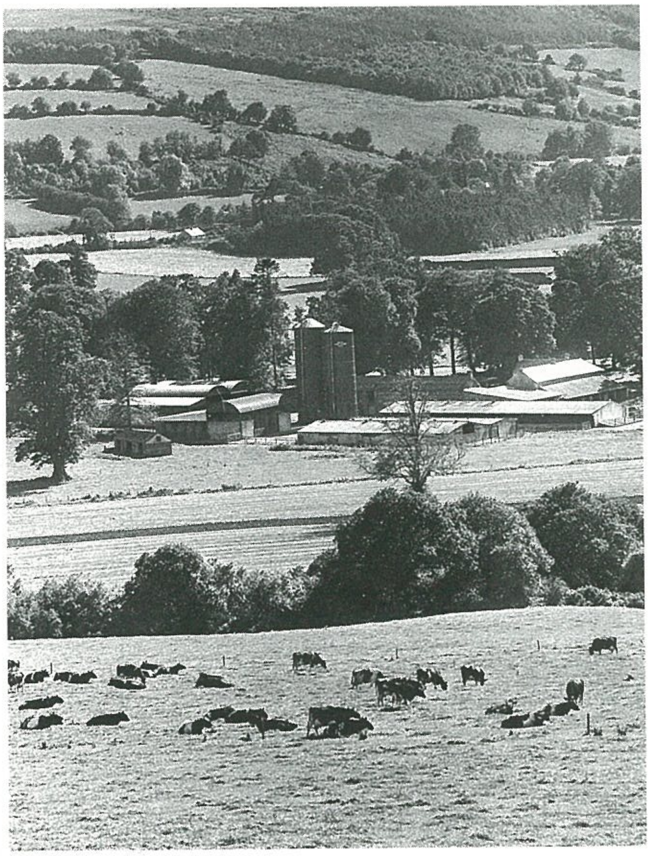
These services are of two kinds: weather forecasts and advisory services. While the weather-forecasting services are supplied directly to farmers, the advisory services are in the main supplied to agricultural scientists and advisers, who in turn incorporate them into more general agricultural advice to the farming community.

WEATHER FORECASTS

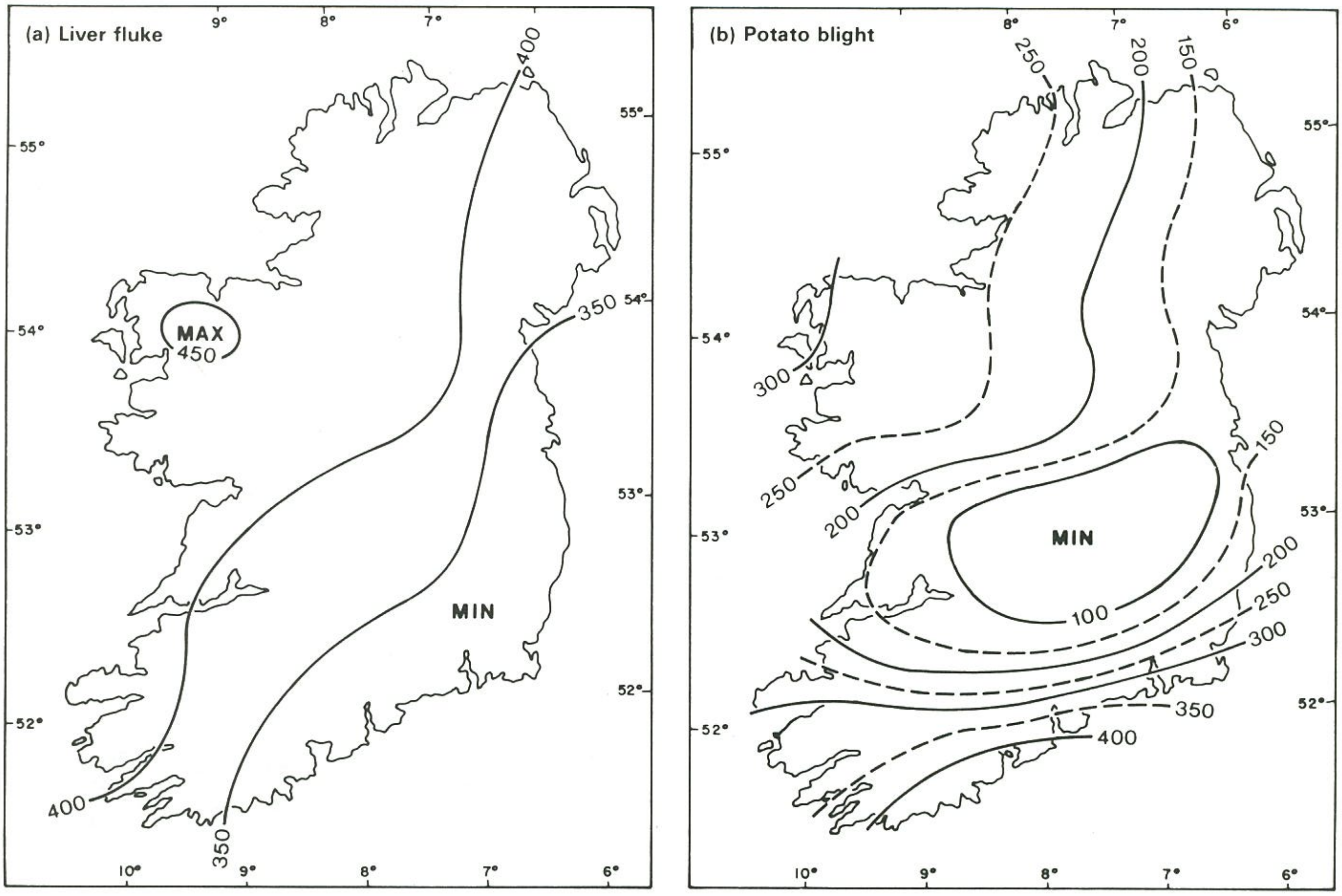
Farmers are, of course, keenly aware of the potential benefits to be derived from a reliable weather-forecasting service and indeed, after aviation interests, farmers constitute the largest group requiring such a service. Farmers' needs for weather forecasts extend right through all phases of farming operations, from the preparation of seed beds to harvesting, and it is significant that, according to a recent survey, almost 90% of the farmers who responded judged that they derived 'some or much' (as distinct from 'little or no') economic benefit from the use of weather forecasts.

SPECIAL BLIGHT AND DISEASE WARNINGS

Within the farming community, the most popular source of weather forecasts is the nightly TV presentation given after the main news, followed by forecasts on radio and on the automatic telephone weather service (ATWS). In spring and early summer, particular reference is made in the forecasts to the likely occurrence of frost which would be a hazard for soft fruit, while during the period May to September warnings are given when spells of weather conducive to the development and spread of potato blight are imminent. Weather forecasts specially directed to farmers are included in agricultural programmes on radio, and information on weather prospects for up to a week ahead are provided to and published in the farming press. In a recent development, the Meteorological Service provides an input into the AFT/ACOT Agriline videotex service for farmers which is available, through the telephone system, on home TV screens; this input comprises weather forecasts and agroclimatological statistics.



Agriculture — Ireland's most important and most weather-sensitive industry (Photo: Steve Treacy, Irish Farmers' Journal)



Distribution of climatic susceptibility to a) liver fluke, measured in terms of the mean Ollerenshaw index for May to October 1957–81, and b) potato blight, measured in terms of mean duration of effective 'blight weather' for May to September, 1957–81.

ADVISORY SERVICES

The advisory services provided by the Meteorological Service to agricultural interests range over the many aspects of agricultural production in which weather is perceived to play an important role. In the area of animal health, for example, some animal diseases are favoured by particular weather patterns which in many cases can be identified well before the event, thus enabling effective counter measures to be taken. In the case of diseases such as liver-fluke, nematodiriasis, parasitic pregnancy toxaemia, gastroenteritis and red-water, the Meteorological Service cooperates with the Veterinary Division of the Department of Agriculture in assessing and advising on the likely levels of disease.

The threat of foot-and-mouth disease requires constant vigilance. Since the spread of this dreaded disease can be related to meteorological conditions, the Meteorological Service is an important component in the Department of Agriculture's emergency plans to be implemented in the event of an outbreak in this country. Both bodies are currently cooperating in the acquisition of a special computer model to monitor more precisely the drift of the emitted virus, thus leading to a more rational deployment of veterinary resources.

Apart from potato blight, already referred to, the development and spread of many crop diseases are greatly influenced by weather conditions; this is particularly true in the case of many fungus and rust diseases. Based on careful monitoring of meteorological conditions at weather-reporting stations throughout the country, coupled with a prediction of weather for a week ahead, the Meteorological Service provides valuable input to the crop-disease and pest-report bulletin published weekly during the growing season by ACOT; this bulletin provides the basis for recommendations on disease-prevention measures to be taken by farmers.

GRASS GROWTH

In an agricultural economy such as ours, in which free-range stock-raising features prominently, it is clear that the rate of growth of grass is an important parameter in farm management. Irish agricultural scientists and meteorologists have collaborated closely in assessing weather effects on grass growth and consequent animal performance. Operationally, AFT produces a computer simulation of grass growth based on actual and forecast values of soil temperature and soil moisture supplied by the Meteorological Service; grass-growth rates are made available to farmers through the farming press.

FOREST FIRES

Although recent summers in Ireland do not particularly evoke thoughts of long, hot, dry periods which are associated with forest fires, these fires do periodically occur here, especially in spring, with disastrous effects on timber production; forest fires sometimes cause serious damage to non-forest property and can bring injury and even death in their wake. The Meteorological Service issues warnings to the Forest and Wildlife Services when weather conditions are likely to favour the start and spread of forest fires.

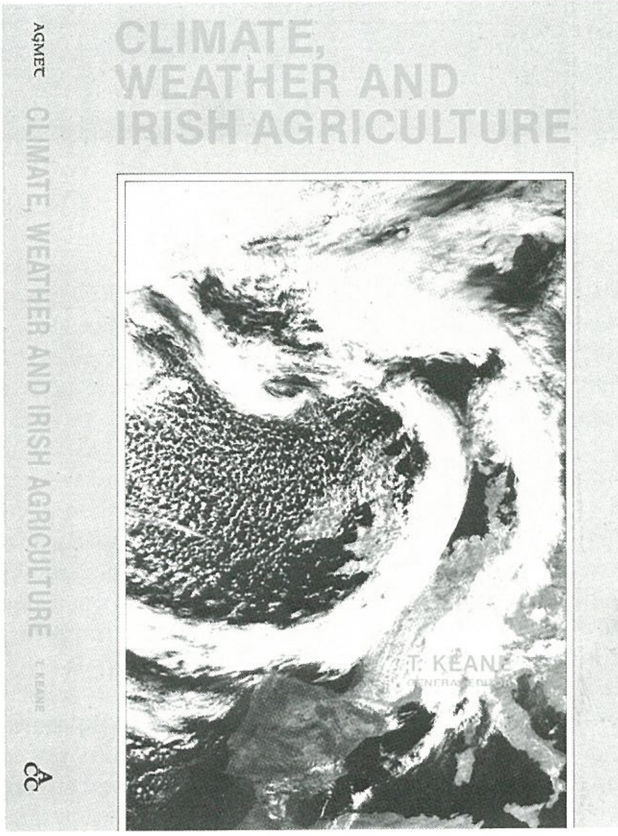
RESEARCH AND DEVELOPMENT

Apart from the provision of the services described above, the Agrometeorological Unit of the Meteorological Service collaborates closely with agricultural scientists in research and investigation into numerous weather-related facets of agriculture. Weather effects on the heating of greenhouses, on wheat yields, on sugar-beet production, on the growth of maize — these are some of the joint projects in which meteorologists and agriculturalists have been engaged. The results of such investigations are published in agricultural journals; in addition, the agrometeorological memoranda series of the Meteorological Service contains information on the agroclimatology of the country, for example the occurrence of air and ground frost, soil-moisture levels and potato-blight conditions.

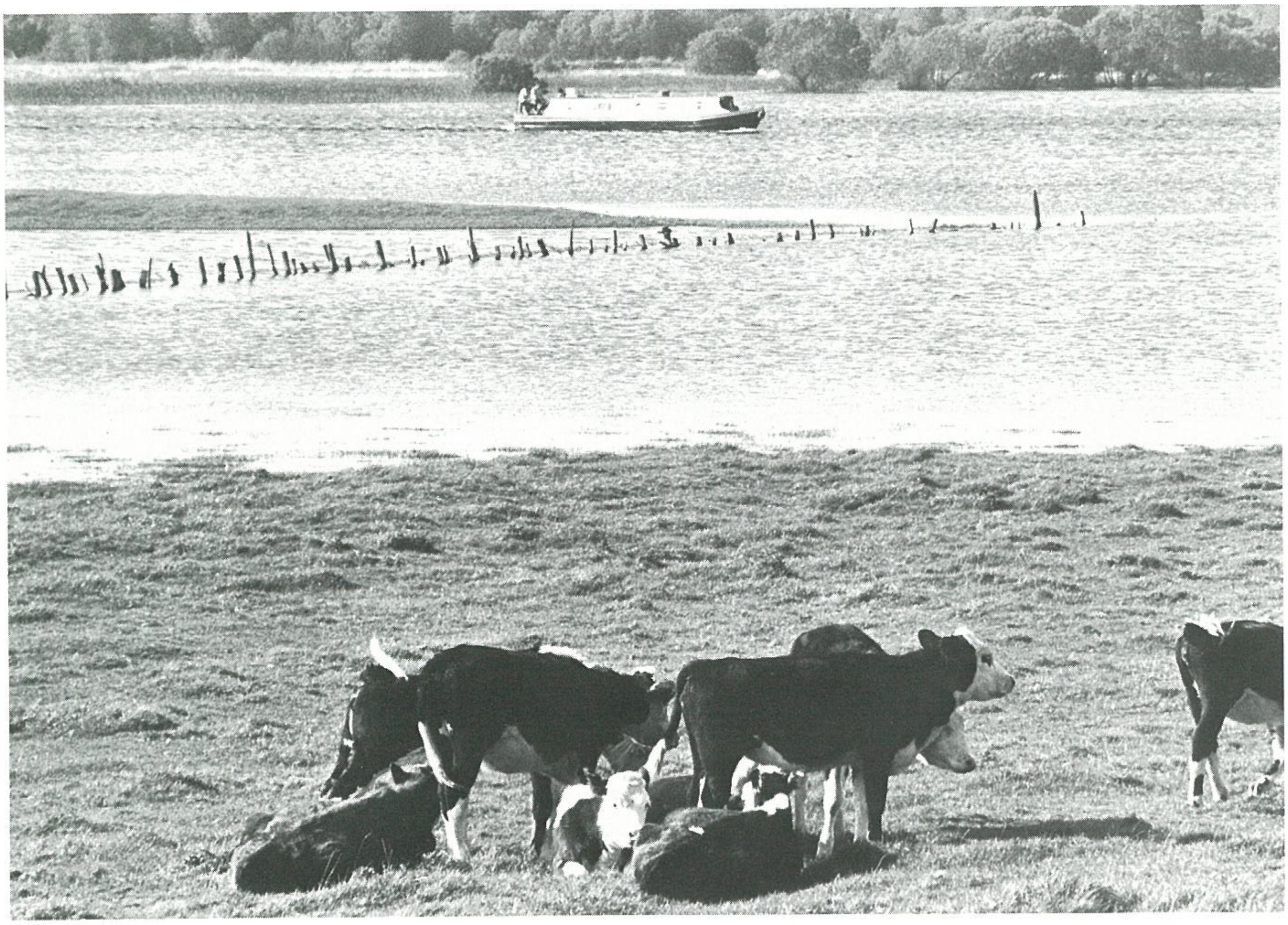
In the recently published book produced by the AGMET Group, entitled *Climate, weather and Irish agriculture*, meteorologists and agricultural scientists describe the effects of weather on agricultural production and the role of agrometeorology in aiding the farmers in planning and operational activities.

* * *

In general, it can be claimed that, as befits a predominantly agricultural country, agrometeorology is in a healthy state in Ireland. Through active cooperation between meteorologists and agricultural scientists, much progress has been made in providing a comprehensive service to the agricultural community; there is every reason to predict a continuation of such cooperation to the benefit of our most important industry.



Climate, weather and Irish agriculture, *edited by T. Keane, published by the AGMET group and distributed by the Agricultural Trust.*



Agricultural land is vulnerable to the effects of extreme weather conditions — the banks of the river Shannon overflowing after excessive rain (Photo: Steve Treacy, Irish Farmers' Journal).

Marine meteorology

by George Callaghan

The Marine Unit of the Meteorological Service came into existence in the early 1950s, when vessels of Irish Shipping Ltd. (ISL) were making regular voyages between Europe and North America. The Unit installed meteorological equipment on board five of the vessels and the ships' officers prepared and transmitted weather observations, generally four times daily. These reports proved very useful to forecasters at Shannon and Dublin Airports at a time when information about weather over oceans was often scarce. The Unit collected the ships' weather logbooks regularly and, after quality control, all reports were forwarded to the member states of the World Meteorological Organization (WMO) which have the responsibility for preparing climatological atlases of the oceans. In later years ISL left the Atlantic for routes in other oceans, but its vessels continued to make weather reports which were welcomed by forecasters in other countries. The Unit also placed equipment on board other Irish vessels operating between Ireland and the United Kingdom or mainland Europe and, during the 1970s, reports were being received from over a dozen vessels. While ISL has now gone, the vessels of B&I and Irish Continental Lines continue to provide reports along their routes, and a member of the Meteorological Service visits them regularly to ensure that the equipment remains in good condition. Recently the Unit obtained a copy of a computerised archive containing all the weather reports from ships in Irish offshore waters over the past 100 years which had been exchanged under the WMO scheme mentioned above.

During recent years oil exploration in Irish waters created a requirement for forecasts of wave height and period, elements additional to those already included in routine forecasts for shipping (wind, visibility, etc.). The Marine Unit, with the assistance of other meteorological services (principally Netherlands and Norway) developed techniques for wave forecasting, which are used in forecasts issued by the Central Analysis and Forecast Office (CAFO) to oil companies drilling in the Irish Economic Zone. At present the Unit gives advice to CAFO on forecasting wave conditions in coastal areas where construction work is in progress and forecasts are required. It also attends to enquiries from engineers and others who are planning coastal projects such as piers or fish farms. It prepares weather reports for insurance assessors and solicitors in connection with accidents at sea. It continues to monitor the reliability of observations made by Irish ships, including the patrol vessels of the Department of Defence, by Irish lighthouses and by the Kinsale gas platform. All such reports are archived for climatological purposes.

The Marathon oil platform at Kinsale (Photo: Marathon Petroleum Ireland)

The light-house at Fastnet Rock (Photo: M.P.L. Costeloe, Irish Lights)

The Laboratory of the Meteorological Service

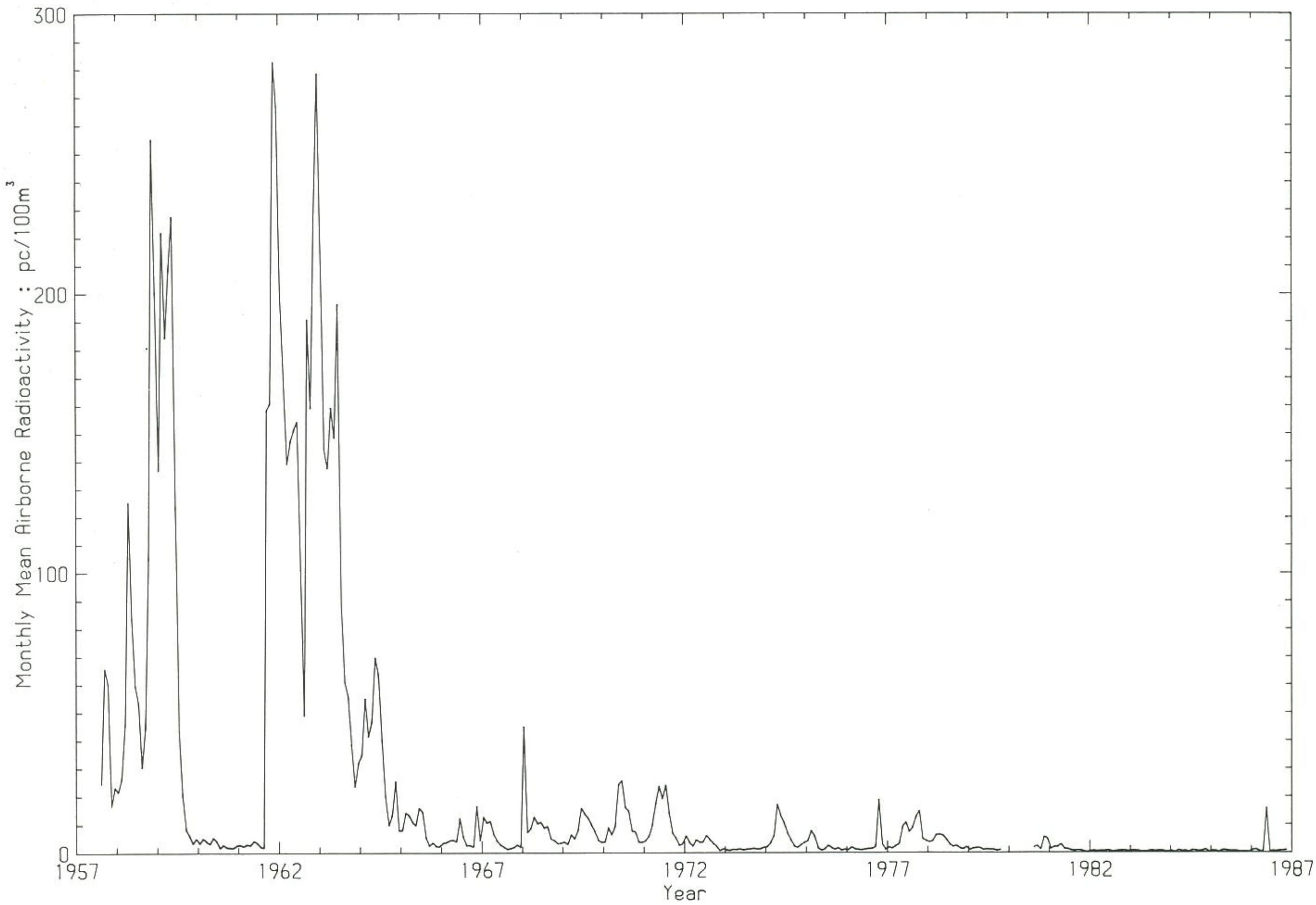
by George Callaghan

RADIOACTIVITY

The Laboratory was set up at a time when several countries were carrying out lengthy series of nuclear bomb tests in the atmosphere. Initially, our interest was to attempt to trace the flow of the airborne radioactive particles as they were carried around the world by the winds in the upper atmosphere, but later the monitoring of radioactivity was continued to assist health authorities concerned with its biological dangers. Daily samples of air and rain, collected at Valentia Observatory and Dublin City, were examined for their beta-activity content. Tap water from the Dublin area was also examined. Later, milk was analysed on behalf of the Department of Agriculture for its content of radioactive iodine (I 131) and strontium (Sr 90). With the curtailment of the nuclear bomb tests, external interest in radioactivity waned gradually but the Service continued to monitor samples of air and rain until this task was taken over by the newly formed Nuclear Energy Board (NEB). The Service still continues to collect samples at some of its stations and processes them in Headquarters but the analyses and publication of results are now performed by the NEB. It is likely that there will be an ongoing need for this sampling, as part of a national radioactivity-monitoring network being set up in the wake of the accident which occurred at the Chernobyl nuclear reactor in the USSR in April 1986.

ATMOSPHERIC CHEMISTRY

Around 1960 the Service also became involved in other fields of atmospheric chemistry. Equipment for the collection of air and rain samples for chemical analysis was installed at a number of our synoptic stations (nine at present) and regular sampling — monthly, weekly or daily — carried out. The samples are now 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 now contributes to three international programmes:

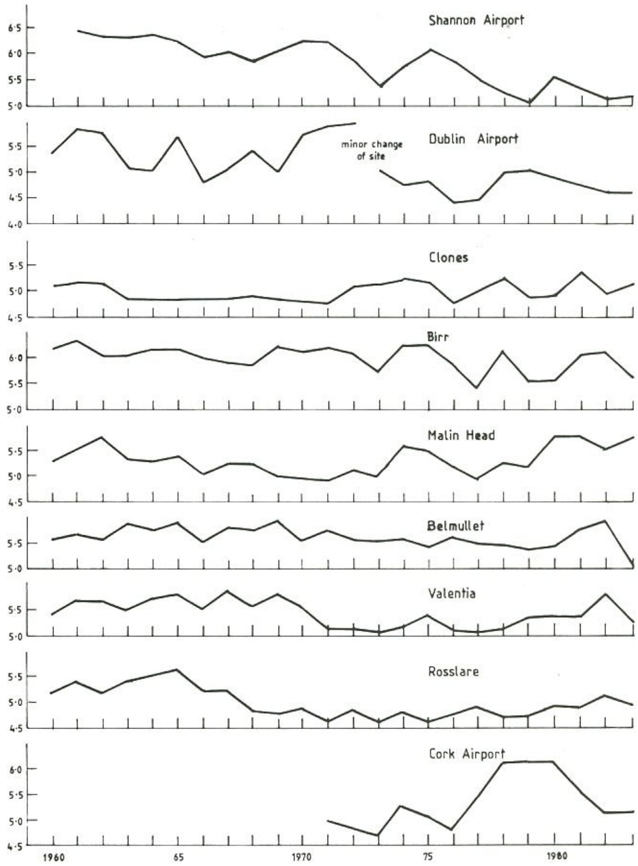


Airborne radioactivity in Dublin city, 1957-1986 (monthly mean values)

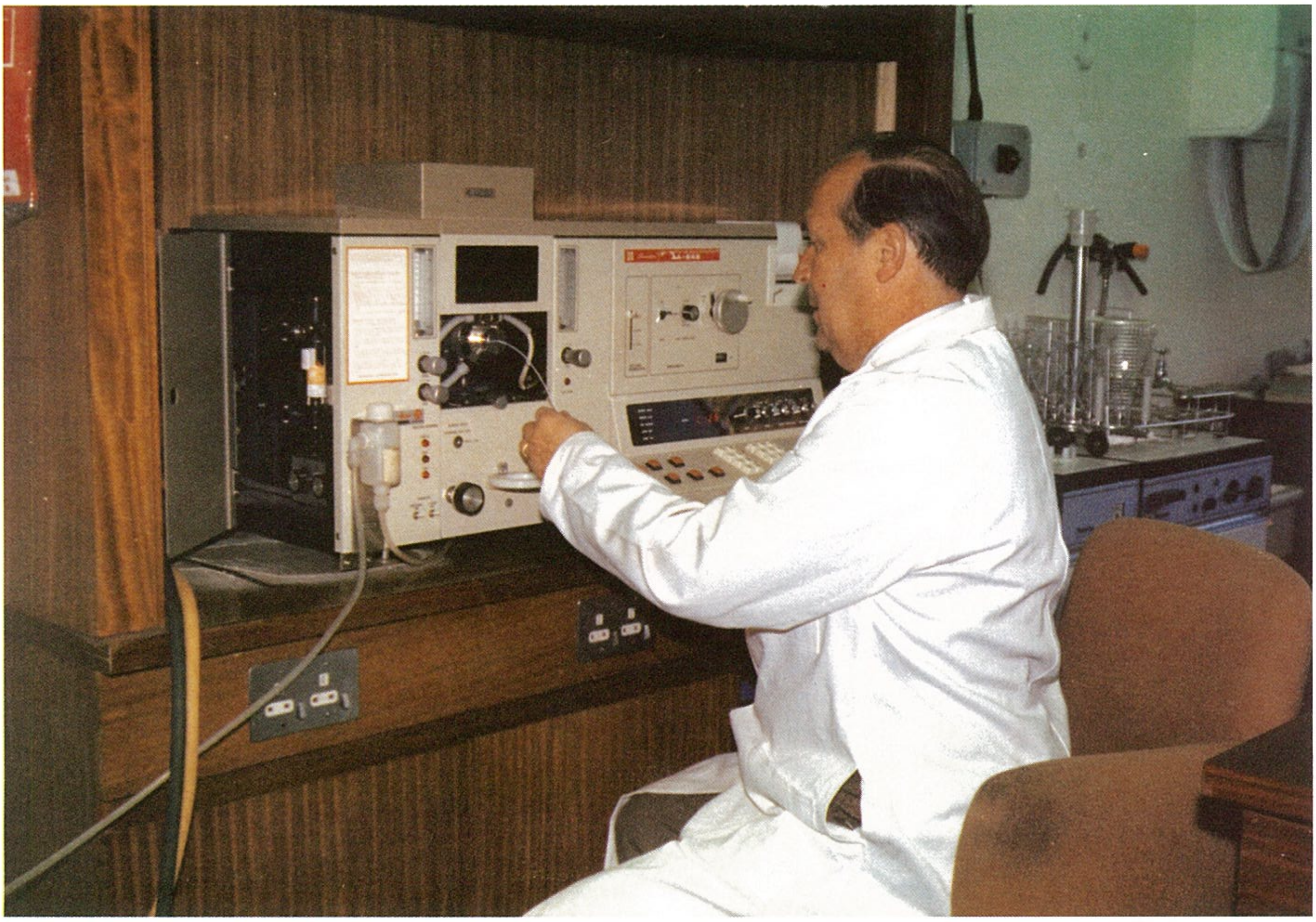
- the Background Air Pollution Monitoring Programme of the World Meteorological Organization (WMO): monthly and weekly data from Valentia Observatory;
- the European Air Chemistry Network: monthly data from nine stations;
- the European Monitoring and Evaluation Programme (EMEP): daily data from Valentia Observatory.

AIR POLLUTION AND ACID RAIN

The first two of these programmes are intended to monitor, on a global or continental scale, any increase in impurities in the atmosphere at background level. The aim of the programmes is to identify current levels of pollution and long-term trends in the concentration of significant constituents which may affect the environment and thus may induce climatic changes. The last-named programme (EMEP) is intended to determine the extent to which man-made pollution is carried by the wind from one country to another — 'trans-boundary pollution'. Values of the pH of rain samples, an indication of their acidity, are now viewed with alarm by many individuals and organizations concerned with the effect of 'acid rain' on buildings, trees and lakes. Measurements carried out in Ireland over the past 25 years show an irregular decrease in pH values (that is, an increase in acidity) over that period although the values indicate a generally lower level of acidity than in most other European countries.



Annual mean values of pH in monthly rain samples at 9 stations, 1960–1985

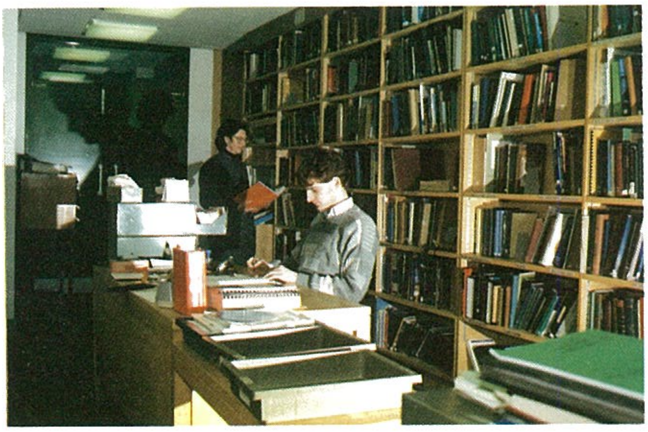


Frank McCaffrey analysing rain water for its sodium content on the atomic absorption spectrophotometer in the Laboratory.

Library Services

by Lisa Shields

The Meteorological Service Library is situated on the ground floor of the Headquarters building in Glasnevin, in a room measuring 35′ x 29′, with about 1270 foot of shelving. Because of space limitations some of the older Library stocks are stored elsewhere in the building or at other locations. The Library contains books, journals, reports and published weather data from all over the world and in many languages. In the administrative framework it forms part of the Research Division. It is in continuous use by staff members of all grades, but particularly by those engaged in research or investigational work. Arrangements can also be made to accommodate readers and researchers from outside the Service when the need arises.



Textbooks on meteorology and related subjects

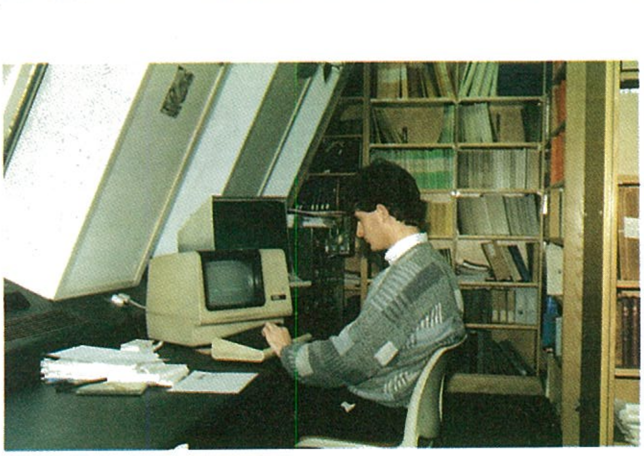
HISTORY

When the Irish Meteorological Service took over from the British Meteorological Office in 1936 it inherited technical books and weather records. It also retained the interesting library of early meteorological books that had been bequeathed to Valentia Observatory in 1916 by the founder of the Observatory, R.H. Scott. Since then the Library has built up a large specialized collection, mainly through gift/exchange arrangements with foreign meteorological services and by virtue of our membership of the World Meteorological Organization (WMO).

THE FUNCTION OF THE LIBRARY

The Library functions primarily as a technical library, serving the needs of staff at all levels, both at Headquarters and at outlying stations. It aims to keep staff abreast of the latest developments in meteorological research and technology, relying on its own resources supplemented by active participation in inter-library loan schemes at home and abroad.

At the same time it has a national function, as it is the only library in the country devoted entirely to meteorological subjects. Within its limitations it acts as a national resource centre for meteorology.



Computerised methods make catalogue retrieval easy.

HOLDINGS

If you want to exasperate librarians try asking them how many books they have. It is notoriously difficult to estimate the number of items held in a library. What is a book? When is a report not a report? If twelve reports are bound as one volume does that count as one or twelve? In all, we possibly have about 4,000 monographs, 10,000 reports, countless volumes of climatic data, as well as some non-book materials (slides, films, microfiches, microfilms, audio tapes, etc.).

The Library is kept up to date by the purchase of the best textbooks on meteorology and related subjects (climatology, atmospheric physics, oceanography, agriculture, mathematics, statistics, hydrology, computer science etc.). It receives about 100 current journals, and keeps bound sets of the most important ones, in some cases complete sets going back many years — for example the *Quarterly Journal of the Royal Meteorological Society* (1873 to the present).

There is also a small collection of early weather diaries, mainly on microfilm. Normally, original climatological registers are the responsibility of the Climatological Division, and are not housed in the Library. Three important series have, however, been transferred to the Library and have recently been rebound: the manuscript registers from Phoenix Park, Dublin (1855-1959), Birr Castle (1872-1951) and Markree Castle (1869-1968).

COMPUTERISATION

The existence of a mass of library material is of little use if the users do not know what it contains. The value of our library collection has been greatly enhanced by the introduction of swift and efficient computerised cataloguing and retrieval techniques, initiated in 1982. The system was made operational in 1984, and is now available on line to all staff members who have a terminal linked to the

Headquarters mainframe computer: this now includes staff at Shannon Airport, Dublin Airport and the Training Division in Galway. Users can request retrieval through any combination of keywords, authors' names and UDC (subject-classification) numbers; they can print out or retain files of the items retrieved. Loan records (over 1000 items on loan at one time to about 120 individuals or sections) have also been automated, and linked to the retrieval system. Periodic accessions lists are prepared, sorted and printed straight from the computer. All these systems have been designed and developed internally to suit our own requirements.

SERVICES PROVIDED

Part of the scientific literature received is in foreign languages. A translation service for staff from Russian, French and Spanish (all official languages of the WMO) is provided when necessary.

Staff at outlying stations receive selected periodicals on circulation, and may request material on loan from Headquarters. Most stations have a small collection of technical books and manuals on 'permanent loan', and larger sub-libraries of books on permanent loan are held at Valentia, the airports and Galway Training Division.

FUTURE DEVELOPMENTS

The efficient operation of libraries depends on adequate staffing, space and equipment being provided. Space presents a perennial problem. While it is not possible to retain all library materials permanently, it is important to ensure that useful and irreplaceable collections are not dispersed or eroded through pressures of space. This is a problem that can only increase with time. In the long term, perhaps the 'paper explosion' will be contained to some extent by technological advances in computer storage. Large quantities of climatic data, for instance, can be more conveniently stored on magnetic tape than on paper or even on microfilm.

An interesting development is the capability of tapping huge international data bases to retrieve and order bibliographic references. If the present high cost of such services can be reduced, and if future technology allows the retrieval of text as well as references, the needs of small libraries may well be revolutionised.

At present a great deal of duplication of effort takes place in the various meteorological libraries around the world (the cataloguing of identical material, for example, and the production of similar software). I can see rich rewards being gained through international cooperation and the sharing of bibliographic resources, perhaps organized and funded through the WMO.

New journals are displayed in the reading area of the Library.

Training in the Meteorological Service

by Séamus Ó Laoghóg

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 located at different places over the years; initially located at Valentia Observatory, it was moved to Dublin Airport in the 1940s, to Rosslare Harbour in 1957 and finally to Galway in 1979.

The Galway centre is located about 3 km east of the city on a site overlooking Galway Bay. This situation is ideal for the purposes of training since, on the one hand, it is sufficiently far from the city centre to give the wide view of the sky and surrounding countryside necessary for meteorological observations and, on the other, it is conveniently close to educational centres such as University College Galway and the Regional Technical College. The centre is housed in an attractive modern building and includes two classrooms, an instruments laboratory and a room designed for the plotting and analysis of weather charts. Other facilities include a dial-up terminal to the main computer in Glasnevin and, outdoors, a set of the instruments normally used at observing stations.

In addition to the training centre, the building accommodates a synoptic observing station. This has been the traditional arrangement in the Meteorological Service and is in recognition of the fundamental role of weather observations in meteorology and meteorological training. The synoptic station operates 24 hours per day and provides hourly weather reports for forecasting purposes as well as detailed climatological data for the developing Galway area. The total staff of the office number eight, of whom two are involved in training activities.

All new recruits to the Meteorological Service receive their initial meteorological training at the Galway Centre. The educational qualifications of recruits are quite high: Meteorological Officers (MOs) require a Leaving Certificate with honours mathematics while Meteorologists must have a good honours degree in mathematics or physics. In recent years many of those entering the MO grade have had some third-level education; this illustrates both the spread of educational opportunity and the keen competition for jobs.

The most important part of the MO course is training in the making of observations which includes the reading of instruments as well as the more difficult 'visual' part of the observation — the estimation of visibility and the classification of weather phenomena and of the constantly changing cloud types. Also included in the course are the plotting of observations on weather charts, instrument maintenance, lectures on theoretical meteorology and an introduction to the computer and telecommunications systems of the Service. The course lasts three months and, after leaving Galway, the newly-trained MOs receive a further period of on-the-job training in the particular posts to which they are assigned.

Trainee Meteorologists (i.e. the grade which includes forecasters) normally spend seven months in Galway. Like the MOs they receive a thorough grounding in weather observation and the use of instruments, but the bulk of their course consists of lectures in theoretical and practical meteorology. Modern weather forecasting is a rapidly developing and highly technological field. Mathematical models of the atmosphere and high-speed computers have extended the range of useful forecasts to several days while satellite pictures and weather radar also play prominent roles. For this reason, forecasters need to be highly qualified and well trained. One of the more traditional skills which remains an essential part of the forecaster's repertoire is the analysis of weather charts. This includes the drawing of isobars, the location of fronts and the identification of various weather systems. Meteorologists make their first acquaintance with weather charts in Galway and this part of their training continues after they have been transferred to an operational forecasting office on completion of their initial course. Since meteorologists are engaged in activities other than forecasting, the course must be sufficiently wide to accommodate those who will eventually work in research, climatology or applications such as agricultural or industrial meteorology.

A new development in the Training Division is the provision of courses for overseas students. As is indicated elsewhere in this publication meteorological services in many developing countries have a pressing need for the training of their personnel. The Irish Meteorological Service has agreed to provide training for meteorologists from such countries and, in collaboration with the Bilateral Aid Section of the Department of Foreign Affairs and the World Meteorological Organization, courses are arranged for meteorologists from developing countries. Currently, students from Zambia, Tanzania, Jordan, Oman and Lesotho are studying at the Training Centre in Galway and it is planned that training programmes for foreign students will become a permanent feature of the activities of the Centre.

Training class, November 1986. Meteorological Officer trainee Margaret Ryan shown with overseas students doing the 'Class I meteorologists' course' (from left) J.J. Al-Musa (Jordan), W.K. Sakala (Zambia), W.A. Chillambo (Tanzania), T. Ntoi (Lesotho) and S.A. Adthaly (Oman).

Cooperation with outside bodies

by Cormac O'Connor

The intimate relationship between the Irish Meteorological Service (IMS) and aviation is well known. Not so well known, perhaps, is the cooperation that has developed over the years between the Service and non-aviational bodies. This cooperation is considerable and impressive; it could hardly be otherwise considering the universal relevance of weather to all aspects of the nation's life. Can one think of harnessing the wind for energy, gauging the insulation requirements of buildings, planning the construction of roads and houses or considering the flooding of river valleys without seeking what the Meteorological Service can provide by way of weather information?

No section of the national economy is independent of weather, and both public and private bodies take into account the advice of weather experts when planning their undertakings. For this basic reason an excellent spirit of cooperation has developed between the IMS and bodies such as Bord na Móna, ESB, Bord Fáilte, county councils, city corporations, Garda Síochána, Irish Lights, the Department of Defence, Civil Defence, the Office of Public Works, the Irish Navy, to mention but some.

This cooperation has, in many instances, been two-way, especially where such bodies found themselves in a position to supply some basic observational data to the IMS in response for what they obtained. Thus Garda stations, technical schools, ESB and others supply rainfall and other measurements. Irish Lights supply observations from their manned lighthouses. Oil rigs supply weather and sea data from their sea locations. Agricultural Colleges and organizations have been similarly involved. Other liaisons have developed as needs arose with, for example, building contractors, especially where large construction works were in hand such as the building of airports, industrial plants etc.

Cooperation with educational institutions has also been increasing especially as meteorology and climatology are being given more importance as subjects for study and research.

Cooperation with umbrella bodies goes without saying as, for example, with the World Meteorological Organization (WMO), the global body that coordinates the work of all the meteorological services of the member nations. Meteorology would be in confusion indeed had the nations not united long since in a central cooperation aimed at the standardisation and universalisation of basic meteorological practices. In the aviation field the International Civil Aviation Organisation (ICAO) performs a similar function for aviation meteorology, and the IMS is deeply committed to this body.

Through such basic liaisons Ireland, for good reasons and through the IMS, takes part in what is undoubtedly the world's largest and most sophisticated scientific experiment, namely the monitoring of the global atmosphere on an ongoing daily basis. To this end several of our scientific staff take part in conferences, seminars and researches, organized around the world by these bodies, and our contribution there has been disproportionately large in relation to our size and our resources. Our work in agricultural meteorology, for example, pioneered in the forties, fifties and sixties by Dr P.M.A. Bourke, continues to advance apace. Similarly our team of theoretical meteorologists contributes greatly to internationally pooled research.

Ireland is a member of the European Centre for Medium Range Weather Forecasts (ECMWF) This link entitles us to all the scientific material produced by ECMWF which, in turn, gives our products an excellence that we can pass on the the consumer. It also provides a valuable channel of communication through which scientists can interact, and thereby further basic researches relevant to weather analysis and forecasting.

In the present, and certainly in the decades to come, meteorology, both as a pure and an applied science, can contribute to the nation and to the community of nations only on the basis of intelligent and wholehearted cooperation. The IMS, notable for its contribution to the growth of transatlantic aviation in its early days, has gained much prestige from its involvement with many international, European and national bodies. From this involvement it has derived an immense energy and strength and it now contributes substantially to the economy and, indeed, to the Irish culture as a whole. It may well double its value to the nation in the next decade.

Training class (see caption on opposite page)

SOME FACETS OF METEOROLOGY IN IRELAND

Reminiscences

by Fred E. Dixon

EARLY DAYS AT THE BRITISH METEOROLOGICAL OFFICE

My meteorological career began a little earlier than the Irish Meteorological Service, in January 1936. As part of its preparations for the expected war, Britain was recruiting for essential services, including meteorology. The British Meteorological Office had more than war on its mind and was developing its organization for transatlantic flights. So the new recruits were put to work quite soon. We were given the working charts of the previous year and bundles of ships' logs. Every relevant report was added to the charts, which were then re-drawn where necessary under the supervision of S.P. Peters. We next determined the geostrophic wind and, with the aid of course-and-distance calculators, estimated the flight time between Foynes and Botwood via the Great Circle and Rhumb Line routes, with assumed air speeds of 100, 150 and 200 knots. F. Entwistle was awarded a gold medal from the Royal Aeronautical Society for a paper summarising the results.

The training course was at Croydon aerodrome, in easy reach of London, which meant that we were able to attend meetings of the Royal Meteorological Society, and we were quickly recruited to the meteorological branch of the Institute of Professional Civil Servants by its zealous secretary and treasurer, A.H. Nagle.

As part of the training we had weekly seminars, each of us in turn introducing a topic. I chose sunspots and the solar cycle manifestations in geophysics. I think it was this which influenced my selection for transfer to the Edinburgh Meteorological Office to replace J.M. Stagg, who later played an important part in winning the war as leader of the British team of forecasters for the D-day landings. At Edinburgh my duties included editing the Lerwick and Eskdalemuir sections of the *Observatories' Year Book* and mainly climatological work, involving inspection tours of the Scottish stations. One important event during my Edinburgh stay was a major meeting of the International Union of Geodesy and Geophysics, where I was in charge of the typing and stencilling. On one memorable day I cut the stencil, in English, from minutes in French and had the results ready within an hour. One of my last tasks in Edinburgh was going through the library and selecting duplicate volumes which could be spared for the newly formed Irish Service, and parcelling them.

JOINING THE IRISH METEOROLOGICAL SERVICE

All the new appointments to the British Meteorological Office were at first only temporary, but after the first few months successive batches were made permanent. My establishment was delayed by my having appendicitis and in mid-1938 I was head of the list of temporaries but was still being passed over. So when the advertisement for the Irish Service appeared in *Nature*, I saw it as an opportunity of permanent employment and it had the additional attraction that I would return to the work on the transatlantic route. I was among the successful applicants and reported at Foynes on 3rd March 1939, later than the others because I had to give a month's notice. Mr Peters had been seconded from the British Meteorological Office, and was now in charge of the flying-boat station at Foynes.

My experience was ignored and I heard Peters's lectures on theoretical meteorology for a second time. We had to work extremely hard, observing and plotting and studying in

Meteorologists at Foynes in 1939. From left: Shane Tierney, John Doherty, Martin O'Herlihy, [Barrow?], Austin Bourke, Paul Browne, Jack Staunton, Sean McWilliams and Leslie Leech. (Photo: F.E. Dixon)

Walsh's hotel. I was luckier than most in that I lived in Jean Little's Ardanoir Hotel, formerly the home of Charlotte Grace O'Brien, more luxurious than the lodgings of my colleagues.

The first stay in Foynes was short. A special course had been devised for us at the Imperial College of Science in South Kensington where we had a well-balanced series of lectures from Brunt (theory), Bilham (climatology) and others. At Brunt's lectures a small foreigner sat at the back, and I got talking to him one day in the rooms of the Royal Meteorological Society. He was Leo Wenzel Pollak, destined to play an important part in the development of meteorology in Ireland. He had been a professor in Prague and was then a refugee in London, attending Brunt's lectures to improve his knowledge of English.

I well remember Derby Day 1939 when the trainees went to Epsom. As the Irish were the racing experts I consulted them before placing any bets. I wanted to bet on the favourite but they talked me out of it, the price being too short. It won. In the last race I suggested we all ought to have a gamble on a horse called Gaelic. Again they dissuaded me; at 20 to 1 it could not have a chance. It won! I have never since placed a bet with or without the experts' advice.

At the end of term we returned to Foynes where the flying season had begun and where Peters had the assistance of D.A. Davies and John Harding who had been with me in Croydon. Harding was Irish, and in his student days at Trinity College, Dublin, had been observer in the climatological station then in the Fellows' Garden. Davies became Director of the East African Meteorological Service and eventually Secretary General of the World Meteorological Organization.

Possibly the most important people in Foynes were the radio operators. All the synoptic data were received in Morse and the rate at which the men transcribed the thousands of figures was really impressive. Plotting the charts was tedious, with conversions of Celsius to Fahrenheit, inches of mercury to millibars, etc. Iceland had different codes from everyone else. Batches of data were sometimes missed through radio interferences. At one period there were several such interferences, eventually traced to American aircrews using their newly invented electric shavers. The electricity supply was also erratic, the source being a generator attached to the local saw mill, the ESB not yet having reached Foynes.

S.P. Peters — in charge of the flying-boat station at Foynes (Photo: F.E. Dixon)

L.W. Pollak cracked the British code during the First World War. (Photo: Pollak archives)

OUTBREAK OF WORLD WAR II

The commencement of World War II on 3rd September had many repercussions. The elaborate course of tuition in London was scrapped and we had yet more lectures from Peters assisted by Davies. Happily they were replaced by the refugee Pollak who succeeded, where others had failed, in getting the pupils interested in basic theoretical meteorology. When Peters and Pollak got talking they found that they had been on the same front in Austria on opposite sides, and it was revealed that Pollak had cracked the British code and was able to use Peters's weather and wind reports.

'FORECAST FOR OVERLORD'

As the war developed there were many problems. Foynes became an important terminal for civilian transatlantic flights and there was a deal between Ireland and the UK including the exchange (in cypher) of synoptic data. After the war was over J.M. Stagg revealed in his book *Forecast for Overlord* that it was a report from Blacksod in June 1944 which resolved the disagreement between American and British

Pollak on duty in his Austrian army uniform in 1916. (Photo: Pollak archives) forecasters. The report was not consistent with the Americans' analysis: so the British view was accepted, and the forecasts vital to the successful outcome of D-Day were based on it.

My position was peculiar. I felt that my Irish colleagues distrusted me as being an English spy, but the British also had doubts about my working in a foreign country: I learned later that my name was on a list of those whose correspondence had to be specially censored! However, Director Nagle cleared me with the British authorities, so that I was free to travel home on holiday without being conscripted. The first such holiday was in December 1939 and I was back in Foynes on Christmas Eve, scheduled for duty at 0600 on Christmas Day.

H.H. Lamb appeared during the winter. He had missed the advertisement of August 1938 through being on holiday in Iceland. He did not, however, stay long in Ireland. His later experiences included a journey to the Antarctic as meteorologist to a whaling expedition, and his current post is Emeritus Professor of Climatology at the University of East Anglia. It was Lamb who courageously took charge of the hydrogen generator, necessary because cylinders of hydrogen could not be obtained while the war was on.

TRANSFER TO DUBLIN

I said goodbye to Foynes in 1940 when the Director moved me to Dublin, primarily to organise the library, but also to help in the newly formed Climatological Division staffed by young ladies from the Irish Hospital Sweeps, laid off because of the effect of the war on the sweepstakes business. One of my first jobs was unwrapping parcels I had tied up in Edinburgh. My companion in the library was M.J. Finnegan, whose main asset was his flair for languages. He had learned many of them in the famous Ruhleben camp during World War I. An outstanding example of his range was when a man appeared in the office, with no English and showing us the name Doporto on a piece of paper. After a few unsuccessful attempts Finnegan tried Basque, the visitor's face lit up, and he was soon ushered into Dr Doporto's room.

Mention must be made of the offices at 14–15 St Andrew Street, rickety premises reputed to have been twice blown up. Solus Teoranta had the ground floors. The Service shared the upper ones with a tax collector and the Shannon Power Development Co. Here Mr Nagle organized everything with the help of John Keegan and Miss Whelan who later married Arthur Morgan.

Professor Pollak also moved from Foynes to Dublin and, assisted by Arthur Morgan, organized the Climatological Division. One very important person in this connection was S.G.G. Kelliher, whose meteorological career had been in Malaya. As an ex-colonial civil servant he was the ideal man to visit those country houses where some voluntary observers were reluctant to transfer their allegiance from the British Office to the Service of the Free State.

ORGANIZING THE LIBRARY

In 1943 the Service moved to 44 Upper O'Connell St, where Aer Lingus Teo. already had the ground floor. This led to a little confusion and I even heard an Aer Lingus porter refer to 'our Met. Service up the stairs'. Here Mr Finnegan and I were ordered to catalogue the library, and at once: Establishment needed a list urgently. We laboured at it, using our own classifications and incorporated everything from the Scott memorial library, in Valentia Observatory. Una Kinahan did the typing (seven copies) and, although superseded by proper indexes, the list is still found useful as a guide to the older library materials.

When the library was organized I was told to report to Dublin Airport to refamiliarise myself with forecasting. I then returned to O'Connell St. but was to be on call if one of the forecasters went sick. The call came in August: Austin Bourke was sick and I must take on his duties on the Bank Holiday Monday. The call reached me on holiday at my girl friend's home on Howth Head. She suspected that I had organized it to get away and it was only six years later that we were eventually married!

SECRET CODING OF WEATHER MESSAGES

Finnegan and I were involved together in a very hush-hush operation, the printing of the Syko coding cards. When war broke out there was speculation on how international messages and such things as reports to and from aircraft would be handled. I remember discussing the problem with Peters and mentioned that the safest system was sets of random numbers, changed at regular intervals. The numbers of a message would be subtracted from those of the set, and the recipient of the resultant numbers merely repeated the procedure. Peters gave me an odd look, and later I realised he must have known already that the responsible authorities had already adopted that very scheme. The Irish Meteorological Service was given the responsibility of preparing one set of cards, and Finnegan and I had to supervise their printing in the confidential section of a certain printing works, beginning at 8 am. One or other of us had to be present at all times and to ensure the destruction of trial prints etc. and at 5 pm I placed the printing plates in a safe to which I held the only key. Unfortunately during this period there was an international conference for which the Meteorological Service provided the secretariat, and after my nine hours at the printery I had to go to No. 44 and operate the Gestetner duplicator, which no-one else could handle. One night I did not get back to the boarding-house until after midnight.

DUBLIN AIRPORT

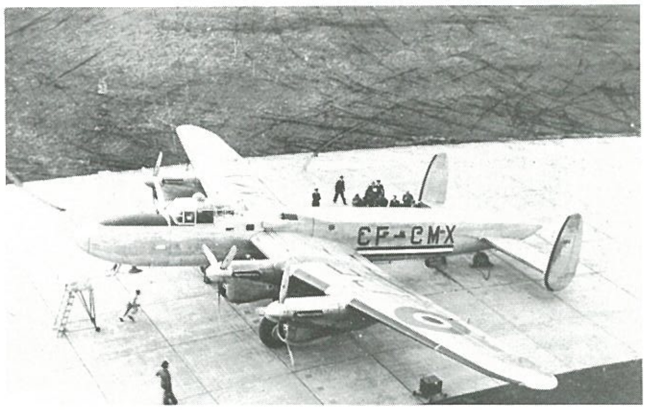
Work at Dublin Airport was easy then, with only one flight a day, but there were some problems with the telephone censor. We could exchange landing forecasts with Liverpool, in cypher, and could telephone direct, but if the man at Speke tried to tell us any details a loud buzz immediately jammed his message. However, if I asked 'Do the figures in your fourth group still apply?' he could answer 'Yes' or 'No'. Landing an aircraft in near-minimum conditions in those days could be quite prolonged. One of us would go to the control tower to help Capt. Comiskey. When we heard the aircraft's engines we would call to him inside the tower 'Engines north-east' and he would pass it to the pilot via the radio operator. A few minutes later it would be 'Engines north' as the pilot circled gradually lower until he could see some landmarks and effect his landing in part of the field away from the sheep. There was a shepherd and his dog who took those sheep into a corner when the aircraft was expected, and the sheepdog was still on the payroll after the sheep had gone. I think it was the shepherd who gathered the mushrooms. Some mornings he would bring in a whole sackful.

Rineanna training course 1945: Fred Dixon (front left) with staff and trainee forecasters (from left) [Tom] O'Callaghan, James McMonagle, Shane Tierney, John William O'Byrne, Ignatius Lambert and Declan Larkin. (Photo: F.E. Dixon)

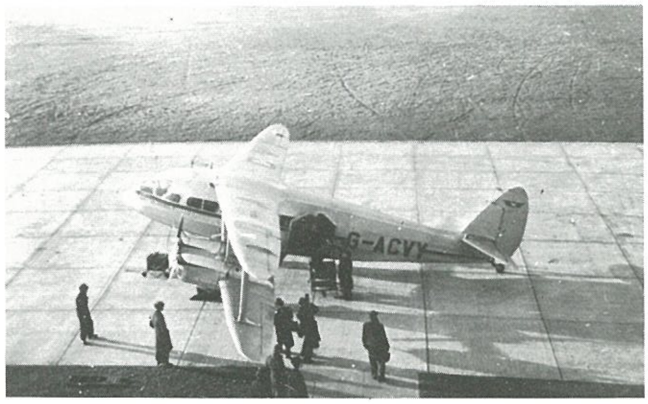
POST-WAR DEVELOPMENTS

When the war ended in 1945 we learned that Shannon Airport must be ready for land planes as well as flying-boats. Shane Tierney and I were sent to Rineanna, with two tasks — to prepare for the land planes' arrival and to train the next batch of forecasters, Messrs Lambert, Larkin, McMonagle, O'Byrne and O'Callaghan. The arrival of the first aircraft on 16th September was celebrated by a superb lunch at the expense of Pan American, memorable as the first occasion on which Irish coffee was served. Meanwhile at Dublin Airport Michael Morley was in charge, issuing forecasts phoned to him from Shannon. When the Christmas rush began Aer Lingus felt this wasn't enough and insisted on having a qualified forecaster on the spot. I was ordered back to Dublin at 24 hours' notice.

Early 1946 was hectic for me. I had strict instructions to be on duty an hour before the first flight and to remain until the last flight was in each day, and I accumulated nearly 200 hours' overtime for which I received no payment or even time off in lieu. When I eventually collapsed with exhaustion I asked that I should be given the time off in lieu but no: the absence had to be classified as sick leave. There were not many flights to handle, but there were some important ones. On 15th January there were the first regular airmails between Dublin and England and on 2nd March a Lancastrian effected the first transatlantic flight direct to Dublin. I still have souvenirs of the airmail flights — envelopes carried each way signed by the pilots, Hanley and Greenhaugh.



The Lancastrian's first transatlantic flight to Dublin airport on 2nd March 1946. (Photo: F.E. Dixon)



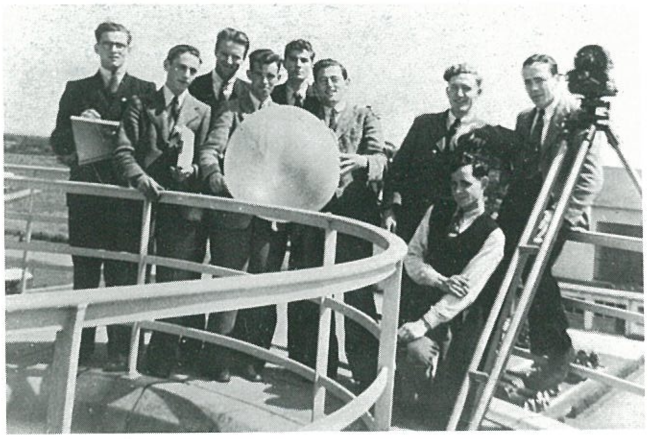
The first regular airmail flight to England (1,500 items carried), Dublin Airport 15th January 1946. (Photo: F.E. Dixon)

Eventually other forecasters were found and, although I was kept at Dublin Airport, my job was to train new recruits, mainly Meteorological Assistants. Many were needed because the system was changing; part-timers at Malin Head, Blacksod etc. were being replaced by full-time professionals. The Analysis Room became the classroom. The pupils were not all for the Meteorological Service; I also trained some Air-Corps personnel for Baldonnel (not yet Casement). I cannot claim all the credit for the tuition, as Dick Mathews arrived as my deputy.

What I still believe to be a remarkable achievement was the pilot-balloon ascent of 12th July 1955 when Liam Ellis, assisted by Michael Connaughton, followed the balloon for 160 minutes: It should probably be in the *Guinness book of records*!

SOJOURN IN ROSSLARE

Mr Nagle left in 1948 but some of his schemes continued in preparation. One was that training should be done far from city distractions, somewhere where there was nothing to do but work. I disagreed, urging that there should be contact with universities. However, he had persuaded the Government that a large building well away from Dublin was desirable as a place of refuge if Dublin were invaded by enemy forces, and the peculiar choice of Rosslare Harbour was made; if Ireland were to be invaded, Rosslare could well be the first port seized. It was also a poor environment for young men, who soon discovered that both Customs officers and CIE personnel regarded Rosslare Harbour as a penal settlement. My protests were in vain and in 1957 I went there with another group of trainee Assistants, and soon



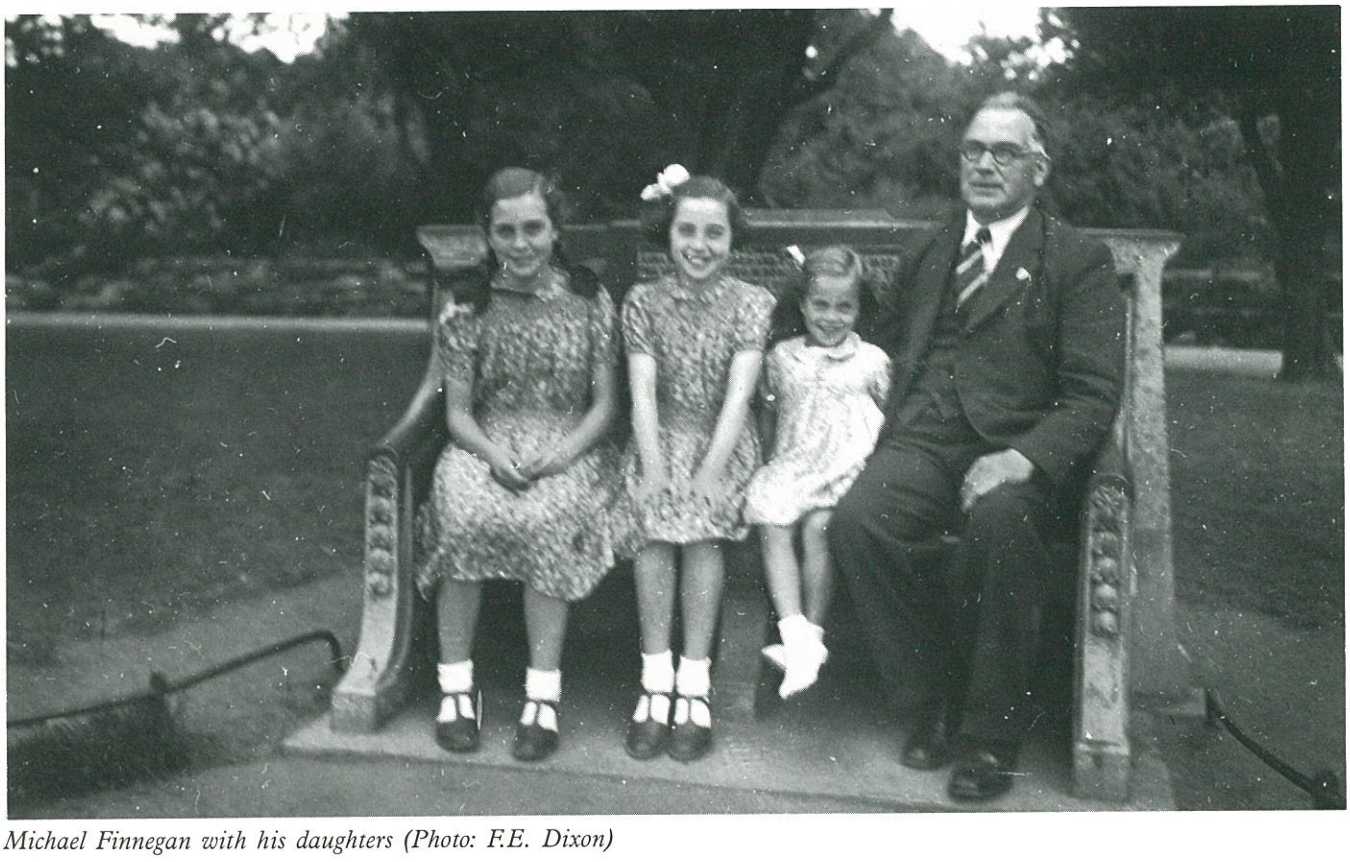
Meteorological Assistants in training at Dublin Airport in 1947. (From left) Fintan Crean, Tony O'Dwyer, Ned Chambers, Sean McAuliffe, Phil Ryan, Paddy Flaherty, Fergus O'Halloran, Gerry Brazil and Frank Greene. (Photo: F.E. Dixon and P.A. O'Dwyer)

found that Tommy Reynolds was a congenial and hard-working companion in the uncongenial surroundings. The only consolation was that it brought me promotion to Senior Meteorological Officer. That joy was somewhat dampened when my continued protests led to an increment being withheld. Good evidence of the unsuitability of the place was provided by the number of trainees who resigned before ending their courses — a far higher proportion than had been the case in Dublin.

I got away from Rosslare Harbour a few times when there was nobody to train. I had failed to find suitable accommodation for my wife and daughter and they remained in Dublin seeing me only for occasional weekends. So I was transferred temporarily to Dublin and such tasks were devised for me as writing out in full my lectures on theoretical meteorology, based on what I'd learned from Peters, Brunt and Pollak, supplemented by more modern textbooks (notably that of Haurwitz), and tactfully including references to the papers of the Director, Dr Doporto. The typescript probably survives, of no use to anyone. Every teacher likes to prepare his own lectures.

MY LAST YEARS IN THE SERVICE

Eventually I did get away permanently, in 1963, to take charge of the Meteorological Office in Dublin Airport. Later I moved to the Forecast Office in Dublin and finally to the Climatological Division. I found aspects of my work stressful, and my health was deteriorating. So on medical advice I retired in 1977, at the age of 64. My retirement present was an electric typewriter, which has been in regular use for philatelic and numismatic articles, letters to the newspapers, letters to friends — and these paragraphs.



Michael Finnegan with his daughters (Photo: F.E. Dixon)

Two remarkable characters

by Dermot O'Connor

MICHAEL FINNEGAN

Finnegan was a Monaghan man. After school he studied for a year in an agricultural college. Then he joined the (Capuchin) Franciscans. After some time in the Novitiate he was sent to University College, Cork, where he obtained his First Arts. He was then sent to a Franciscan College in Rome and studied there sufficiently long to acquire fluency in Italian. Then his Superior in Rome called him one day and told him he had doubts about his (Finnegan's) vocation. Finnegan agreed and was released from the order. He returned to Ireland and, on the strength of his knowledge of Italian, got a job with one of the international language institutes. A vacancy for a teacher of English occurred in one of the institute's schools in Germany, and Finnegan was given the job.

WARTIME EXPERIENCES

By the time the first World War broke out, Finnegan had acquired fluency in German. So much so that the war was on for more than six months before he was picked up as an 'enemy alien'. He was interned in Ruhleben Camp for the remainder of the war. While there, he studied accountancy by correspondence with the London School of Economics. This course was organized by the Red Cross in cooperation with the German authorities. At the end of the course he underwent an examination set by the London School and strictly supervised by the German authorities. He passed and received a diploma. During his internment, he also managed to steal a ham from the German Officers Mess and was not detected.

At the end of the war the internees awoke one morning to find that all their German guards had vanished. Finnegan made his way back to London. He got a job on Lord Curzon's Commission which was concerned with the delineation of the 'Polish Corridor'. When that finished, he got a job paying off demobbed RAF men. When that finished he was demobbed himself.

A ROLLING STONE

One day he noticed an advertisement by a Yorkshire woollen firm seeking an accountant for their factory in Bradford. The firm had a London office and Finnegan applied there. He was told that the London office had nothing to do with the selection of applicants and that he should go to the office in Bradford. He did, and managed to convince the Bradford people that he had been taken on by the London Office. They set him to work.

In a very short time he realised that his book knowledge of accountancy was very little use in practice, at least in a Bradford woollen mill. He ignored the counting house and spent most of his time watching the wool being sorted and processed. He became quite proficient at this, so much so that when the firm found him out and fired him at the end of a year he was able to get a job as a sorter in another mill. The other mill had a representative in Italy who absconded and Finnegan, with his good knowledge of Italian, applied for the job and got it. He was stationed in Monza. Very quickly he realised that the material his firm was sending out was not suitable for the Italian market. He made numerous representations to them but all were ignored. He was not too worried because he was on a salary. However he decided to contact yet another Bradford firm who agreed to send him the material he wanted. Business boomed and as the second firm paid him on a commission basis he was in clover. He still continued to receive a salary from the first firm, spending week-ends on the Riviera and so forth.

After a few years Finnegan married a girl he had met in Bradford. He had the neck to write to the first firm announcing his marriage and asking for a rise. They replied telling him he was fired. That did not worry Finnegan because business continued to prosper — that is until the Abyssinian War and the application of sanctions against Italy. Almost overnight Finnegan's business collapsed completely. The Finnegans held on hoping for an end to the war. At this stage they had two little girls and he recalled bringing them out to the park at weekends hoping to meet friends who would give money to the children!

LIBRARIAN/TRANSLATOR

Eventually the family got back to Dublin with financial assistance from Mrs Finnegan's family in Bradford. He was one of the first two employees of Aer Lingus, and was in attendance at the inaugural flight from Baldonnel. However, Aer Lingus was moving too fast for him and he got a job in a Labour Exchange. There, he one day noticed an announcement about the setting up of a Meteorological Service in Ireland and it occurred to him that such a Service might have a use for somebody with a knowledge of languages.

Finnegan called to the office of the Service in St Andrew Street and was received by Austen Nagle. He obviously made a very good impression on Nagle because when the vacancy for a Translator was announced, it specified an upper age limit of 50 years, which barely allowed Finnegan in under the wire.

For quite some time he served as Librarian as well as Translator. He was very good as Translator but he was as bad as Librarian as he was as Accountant. He worked on the journal system, and if a borrower could not tell him when he took out a book it might take half an hour to trace the entry.

At times Mr Finnegan worried about the small pension he would qualify for when he retired. He need not have worried. The kindly gentle soul departed this life before he qualified.

CHRISTY PLUMMER

Christy Plummer's service to the State commenced in 1934 when he was 28 years of age. He started as a coal carrier in the Model Schools in Marlboro Street. In November 1936 he was promoted to Male Cleaner in Dublin Castle at a salary of seventeen shillings and six (old) pence a week. Early in 1940 he was promoted to the grade of Messenger, salary two pounds and ten shillings a week. Following these rapid promotions he was assigned to the new Meteorological Service as Messenger in mid-1940. Sad to relate, Christy received no further promotion, although he gave the Meteorological Service dedicated and diligent service for the ensuing forty-two and a half years.

In 1940, the Headquarters of the Meteorological Service consisted of only five rooms in 14/15 St Andrew Street. There was no central heating and Christy was called on to keep five fires going — lighting, stoking (often with damp turf), removing ashes, clearing the rooms and anything else that needed doing — all these in addition to his Messenger duties.

A CLOSE SHAVE

The St Andrew Street premises also housed an organization known as the 'Shannon Office'. What it did nobody seemed to know but Christy did errands for staff in that office also. Its staff included two characters — a Mr McM (HEO), a careful man and a Mr O'B (CO), a spendthrift. Mr McM, the careful one, had a weakness for the horses and, before making his daily investment, he usually consulted Christy who had an undeserved reputation for picking winners.

On one of the occasions when, a day or two before pay-day, Mr O'B was on the rocks, he propositioned Christy to give Mr McM two 'stiffs' for that day's bet which they would hold between them. Mr McM obliged with a five-shilling double on the two 'stiffs' Christy gave him. Every time Christy went out that afternoon he had a look-in at the bookies in Trinity Street. Imagine his consternation when he found the first leg of the double had come up. Imagine his horror when he found the second leg had also come up! But there was a steward's inquiry and, providentially, the second 'winner' was disqualified. To this day, the sweat glistens on Christy's forehead as he relates that story. At that time the five shillings which he and his accomplice 'earned' the hard way would buy (and, no doubt, did buy) seven pints.

BOYHOOD DAYS

Christy was born in Cork. His father, a soldier, was stationed at Victoria (now Collins) Barracks. He started school there, but the family moved to Dublin when he was six or seven years old and lived in a flat in Church Street. He remembers the 1916 Rising, the Black-and-Tan war and the Civil War. His mother suffered from rheumatism and Christy once overheard a friend advising the mother that celery was good for rheumatism. One day or two later, Christy and a younger brother were scutting around the Smithfield Market and spotted celery in a stall there. They had no money but that did not stop them nicking two heads which they triumphantly brought back to the mother. When they told her how they got it she ordered them to bring it back to the stallholder. The brother baulked but Christy brought the celery back on his own. When the stallholder heard his story he sent back the celery as a gift to the mother!

VARIED DUTIES

One day in the O'Connell Street days Christy came to this writer to say that had found three hundred pounds in banknotes in one of the toilets. I advised him to keep silent until someone squealed. Christy did not take my advice. He went around seeking the owner and, of course, found him very quickly. Later, I asked Christy how much he had received as reward. He replied 'nothing, but why should I expect any reward?'

In addition to his official duties, Christy was continually doing private errands for the staff. On one occasion a certain Miss M gave Christy a package to bring to a Miss X in Brown Thomas's to exchange it for the next larger size. Christy did not know that the package contained an intimate item of ladies' underwear. When he was ushered in to Miss X he found himself in a salon peopled by women in various stages of undress. As the package was opened and the message read out, there was hilarious glee at Christy's expense. He came back frothing at the mouth 'Do you know' he said, 'what that b— M did to me?'

In all the changes of accommodation of headquarters staff, Christy was always there to take reams of papers off shelves, pack them in cases, unpack the cases in new locations, clean up rooms and, in short, act as general dogsbody. In addition he acted as relief telephonist, drains cleaner or anything else that was required. In his 42-plus years with the Meteorological Service he did not have 42 days sick leave. It is nice to record that he got a good send off when he retired in December, 1982 and that he is still hale and hearty approaching his 80th birthday on 19th December next (1986).

Christy did not know how to say 'No' and he never heard of demarcation. When Cardinal Newman drew up his specification for a gentleman, he must have had someone like Christy in mind.

Christy Plummer at the 50-year anniversary party at Glasnevin, January 1987 (Photo: Peter O'Shea)

Half a lifetime with potato blight

by Austin Bourke

In a preface to his classic book, *The history and social influences of the potato*, Dr Redcliffe Salaman felt it necessary to explain how his preoccupation with 'the otherwise inoffensive vegetable' had come about. Many of his friends regarded his studies with a pitying shake of the head and an indulgent smile, indicating that nothing, short of mental instability, could excuse a lifelong obsession with so banal a subject.

I have met a very similar reaction to my own association over some forty years with an even narrower speciality, the course and history of potato blight, so I happily seize this opportunity to explain the chain of chance events which induced me to devote so much time to the pursuit of something which to other eyes might seem petty, if not downright potty.

INTRODUCTION TO A LIFE-LONG INTEREST

As Assistant Director of the Meteorological Service it was part of my assigned duties, in the late 1940s, to encourage research and development in meteorology. This was far from easy, since my colleagues' noses were kept firmly pressed to the routine grindstone of transatlantic aviation meteorology; the best that one could hope to do was to link spare-time research projects with the hobbies and enthusiasms of individual meteorologists. For instance, the time of the rise of the mayfly in Irish lakes and the rivers — and of the consequent stampede of fishermen to the local hotels — varies appreciably from season to season; an officer with an interest in angling might be willing to investigate whether the date could not be usefully forecast from environmental factors. Similarly a fan of radio and television might be induced to sacrifice part of his leisure to linking the quality of reception to the varying structure of the lower atmosphere. So, from year to year, a list of possible subjects for research was compiled and dangled before the staff, with the hooks so baited as to tempt persons of different temperaments.

Inevitably, tucked in among dozens of other potential ideas, there was listed a project for forecasting the seasonal onset and course of potato blight. It is a disease of major economic impact in Ireland; that there is a broad relationship between its ravages and the seasonal weather has long been recognised. If one could establish a rational basis for forecasting the development of blight, growers could be advised on when and how often to apply fungicides, so as to contain the disease with the greatest efficiency and the least cost. The project was particularly promising since some progress on similar lines had been reported from the Netherlands and England. Nevertheless none of my colleagues took up the theme.

Meanwhile my Director, Dr Doporto, gave one of his rare interviews to a newspaper reporter who, for one reason or another, got hold of the wrong end of the stick and announced in his article that the Meteorological Service would shortly begin a warning service on potato blight for Irish farmers. Faced with this development, Dr Doporto was adamant: 'You started this business, Mr Bourke. Now you must finish it'. I had been pitchforked into agricultural meteorology.

The task proved unexpectedly absorbing. The methods for forecasting the disease which had been empirically derived elsewhere were found to be less successful when transported to the Irish climate, and there was not available an adequate body of quantitative data on blight in past years to enable a domestic empirical model to be constructed. The only promising approach was to study the life cycle of the fungus and the results of laboratory research on the effects of temperature, humidity, etc. on different stages of its growth, and from the complex relationship between environment and disease to attempt to build up a simplified picture of the essential factors involved. By a lucky chance, I came early upon E.C. Large's fascinating book, *The advance of the fungi*, which proved to be a ready gateway to the rich pastures of nineteenth-century literature on plant diseases. With the guidance of Large and his forerunners, and with the help of the recent laboratory results of Crosier and others, it proved possible to establish a numerical model which permitted the use of routine meteorological observations to forecast the date of appearance each year of potato blight and the annual variations in its intensity. The new service of blight forecasts for Irish farmers was successfully launched, and the publication of several Technical Notes on the subject brought me into the position of being a domestic specialist on meteorological aspects of plant pathology. One of the great advantages of working in a very restricted field is that competition is reduced: in the kingdom of the blind, the one-eyed man is king.

The successful establishment of an Irish service of potato blight forecasts should have been the end of the matter, but it proved to be only the beginning. In 1953, the World Meteorological Organization, through its Commission for Agricultural Meteorology, decided to prepare a report on the forecasting from weather data of potato blight and other plant diseases and pests. In view of my recent activity in this field, I was appointed chairman of the international Working Group charged with preparing this review. As much of the relevant literature had already been surveyed here, it did not take unduly long to draft the required report, which was published by WMO over my name in 1955. From being a domestic specialist, I had been cast overnight in the role of international expert whose services, as luck would have it, were soon to be called upon.

ASSIGNMENT IN CHILE

The potato had always been an important crop in Chile, and luckily one that long remained free from blight even though the disease was prevalent in most of its South American neighbours. Late in 1950 the first appearance of potato blight in the Chilean crop was confirmed in the laboratory. In the following year the disease caused disastrous damage to the crop and brought real distress to Southern Chile. The distinguished German plant pathologist, Dr K.O. Mueller, was called in as an FAO expert; in his report to the government of Chile he suggested an investigation into the effect of climatic variations in different parts of the country, and of weather conditions in different years, on the appearance and spread of blight. This might bring to light, he thought, clues as to the reasons for the severe attack of 1951, and could provide a basis on which to forecast the probable frequency of future attacks, and on which to make a rational choice of seed-producing areas. Coincidentally the government of Chile approached the UN for the services of an expert on the meteorological aspects of potato blight at the very moment when the report of the WMO Working Group was being published.

I went to Chile on a twelve-month assignment more as a conscript than as a volunteer. Indeed in the absence of external pressure I was highly unlikely to have been granted leave of absence from a Meteorological Service which was suffering from severe staff shortage: a later application to undertake a short-term mission in Turkey was rejected. When I arrived in Chile in October 1955, the disease had become quiescent, and my main concern, viewing the assignment as basically a piece of detective work, was that, after five years, the trail might be too cold to reveal the vital clues. The records were indeed sketchy in parts but, helped by a fresh outbreak of disease in 1956, it proved possible to piece the story together bit by bit, until at the least the main lines were made clear.

What was of particular interest to an Irishman in Chile was the striking similarity with the Ireland of more than a hundred years earlier. The slight impact of blight when it first appeared in Chile in the late season of 1950 and the savage attack in the following year were an exact parallel to the course of the disease in Ireland in the successive years 1845-6. The survival of the feudal system in South America provided a living example of social conditions broadly similar to those of Ireland in the 1840s, even in the matter of absentee landlords; a master who spent his time in Santiago was normally farther removed from his estates than an Irish landlord in London or Paris. As regards climate and human temperament, Darwin had already noted a hundred years ago the analogy of the large island of Chiloé to Ireland, and conditions there had scarcely changed in the interim. As one stood by a blighted potato patch near Ancud and heard the cries of a distressed mother faced with the destruction of the main food of her large family, one had the eerie feeling of being transported through time and space to the Ireland of August 1846.

Equally striking were the differences. There was great distress in Chile when the potato crop failed, and much hunger and even local starvation, but nothing remotely resembling the Irish disaster of 1846-7. The Chileans were curious as to why the whole Irish nation had once been so dependent on a single crop, and one, in particular, of which the surplus in a good season could not be stored and carried over as reserve against later shortage; long familiarity with the facts had not dulled their astonishment at a historically unprecedented dependence on a non-cereal food crop. And why had so many died when blight came? I gave the traditional answers but, far from home, they did not seem entirely convincing.

BACK IN IRELAND

Back in Ireland, these questions continued to nag. There were additional puzzling aspects the closer one looked into the matter. Potatoes to feed eight million people surely required an enormous acreage. How was this fitted, together with the ground needed for pasture and cereal crops, into the limited tillage land of Ireland? How was this vast acreage manured? What happened to the abandoned potato land after the famine? Why had potato blight wiped out the 1846 crop in Ireland while nowhere else, then or later, had it ever led to more than about a 50% loss? Was the weather in fact unique in the years of the Great Famine? Possibly the answers were buried in the rubble of time, but the satisfaction of following successfully a cold trail in Chile gave birth to the idea of picking up a still colder trail in Ireland.

There followed years of sparetime burrowing in Dublin libraries, the British Museum, the Colindale newspaper library, the French National Library, the Belgian Royal Library and indeed everywhere where clues to the first great European epidemic of potato blight might be found. The Royal Meteorological Society helped with a grant from its Scientific Activities Fund, the Rockefeller Foundation contributed towards travel and subsistence costs, several (foreign!) airlines provided familiarisation flights and the Civil Service, thanks to Dr Thekla Beere, provided a short spell of special leave at a critical stage of the work. The picture finally took shape, first in an article published in *Nature* in 1964 and, a year later, in a Ph.D. thesis submitted to the National University of Ireland. (My investigations over the years into the potato disease played some part in the award of a second doctorate in 1973, an honorary D.Sc. also from N.U.I.).

THE DISEASE IN ICELAND

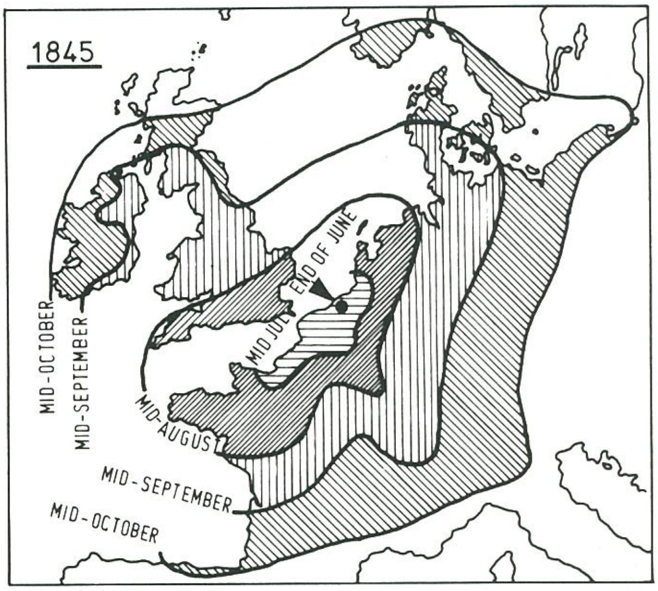
Retirement from the Meterological Service in 1978 brought leisure to travel and to ponder further meteorological aspects of plant pathology. A complication in assessing the effects of climatic change on agriculture is that one needs to take into consideration not just the direct consequences on growth and yield, but also the changes in the impact of diseases and pests. A visit to Iceland highlighted the effect of temperature fluctuations on the local potato crop. A distinct rise of air temperature in Iceland during the growing season in the 1930s and 1940s improved conditions on the one hand by lengthening the growing season, but also led to a series of severe blight attacks because conditions had become more favourable to the fungus. The plateau of warmth in these decades in Iceland was followed by the onset of cooling, gradual at first but sharper since 1960, to a level in the 1970s characterised by lower mean temperatures than any recorded for the earlier decades of this century. Simultaneously with the temperature fall, the impact of blight in Iceland gradually died down, so that in recent years the disease has been hard to detect.

FUNGAL SPREAD — A RE-APPRAISAL

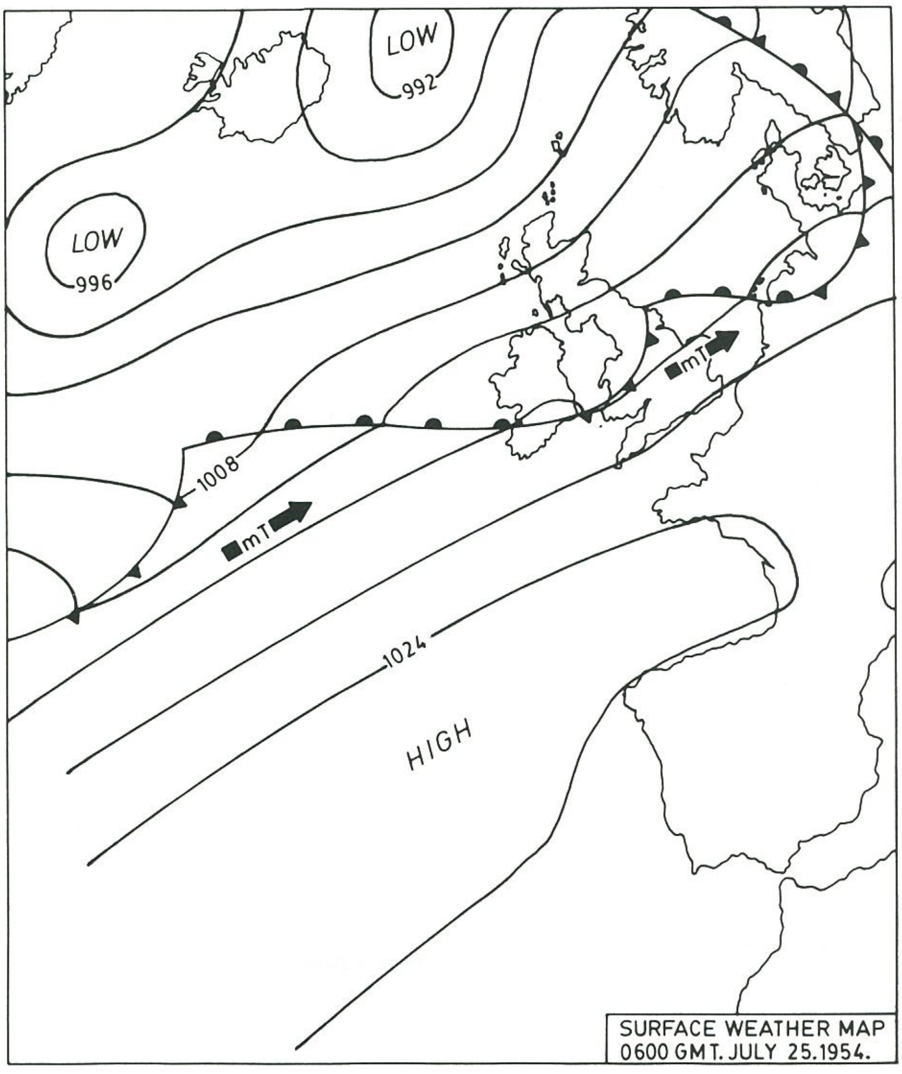
A return visit to South America threw fresh light on the importance of wind dispersion in the spread of plant diseases. Coffee leaf rust is a major disease of the coffee crop which has been known for more than a hundred years and is prevalent in India, Kenya and in other coffee-growing parts of Asia, Africa and Oceania. The coffee crops of the Americas, where the varieties in widest use are known to be highly vulnerable to the causal fungus, had been happily immune until 1970 when the disease was discovered in Brazil, borne there apparently by the wind across the South Atlantic from western Africa. The theory of transport of the infection by the prevailing winds was reinforced by the subsequent rapid spread of the disease from Bahia, where it first appeared, in the direction of Paraguay and Argentina.

This raised again a question which had arisen some twenty years earlier when the spread of potato blight in Europe in the epidemic year of 1845 had first been mapped. The spread of the disease from the initial infection in Flanders towards the northeast could readily be explained in terms of the usual prevailing winds; but were the wind patterns in that summer of 1845 consistent with a quite rapid spread also to the west and northwest? This problem was taken up in an EEC research project on 'The spread of potato blight in Europe in 1845-6 and the accompanying wind and weather patterns' undertaken by Professor H.H. Lamb of the University of East Anglia and myself. It was established that there were frequent occasions when weather leading to sporulation of the fungus in July and August 1845 was accompanied by easterly or southeasterly winds.

The study also concerned itself with broader issues, such as the phytosanitary dangers of devoting great areas of land to a single crop (monoculture) and to the identification of the inherent vulnerability of the population as the prime cause of the disaster. It is hoped that the detailed analysis of the 1845-6 analogue, with its devastating social and economic consequences, may prove useful in interpreting and countering the threat of future plant disease epidemics, particularly in the Third World.



The spread of potato blight in 1845.



Synoptic weather situation (mT = maritime tropical air) favourable to potato blight in NW Europe)

Some Irish meteorologists and their work

by Fred E. Dixon

Meteorology as a modern science began with the invention of the barometer and the thermometer. The Irish-born **Robert Boyle (1617–1691)** was important in the development of both, and it was he who first used the word 'barometer' and invented the siphon type. Probably more important is Boyle's Law, the first step in quantifying the changes in the atmosphere. One memorial to him is a statue on the facade of the Royal College of Science buildings in Merrion Street, Dublin.

One of my favourite quotations is

> 'Let rash, gloomy and ungrateful mortals forebear to murmur at this climate, since it is evident that bounty of providence causeth the sun to shine upon us in far greater degree than we commonly imagine or deserve'.

That appears in John Rutty's *Natural history of the county of Dublin* (1772). This book reprints the weather summaries from his earlier (1770) *Weather and seasons and diseases in Dublin* which had two main objectives — to disprove astrological influences, and to establish connections between weather and diseases. **John Rutty (1697–1775)** was an English-born Quaker physician and tutor to the children of William Penn. He settled in Ireland in 1724, but his weather summaries cover 1716 to 1766, using data from other diaries as well as his own. Another quotation from his works is

> 'Beware of blaspheming in relation to the weather; a vulgar impious practice'.

Hugh Hamilton (1729–1805) was Professor of Natural Philosophy at TCD and his *Philosophical essays* (1766) showed clear understanding of evaporation and condensation and cloud formation. He suspected that aurora was the result of electrical discharge. He was the first man to suggest adjusting the scale of a barometer to allow for the change of mercury level in the cistern.

James Archibald Hamilton (1747–1815) was first Director of Armagh Observatory and among the many men devising improvements to barometers, and it was in a letter to him that Hugh made the revolutionary suggestion of contracting the scale.

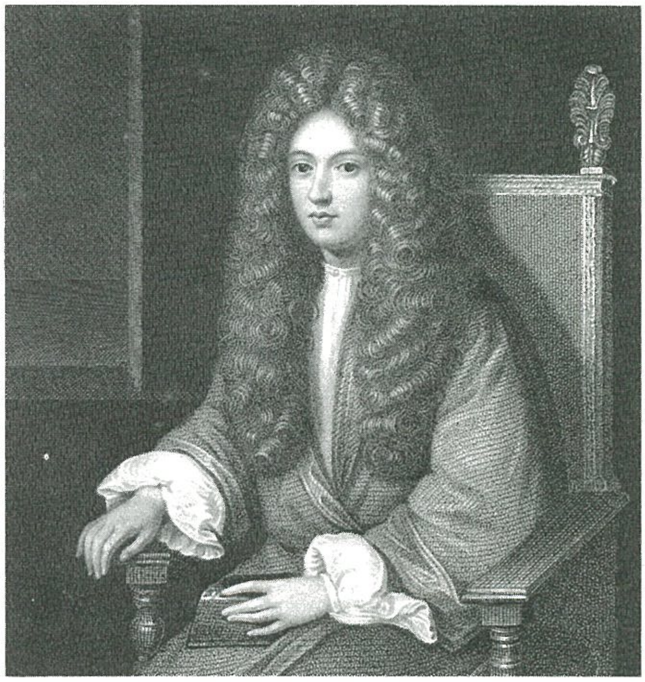
Richard Kirwan (1733–1812) was not only the greatest Irish meteorologist to date, but was eminent in chemistry, mineralogy and other sciences. He used Rutty's data to derive regression equations for predicting seasonal weather with great success. Unfortunately the rhythms have changed and neither his equations nor attempts at modern ones have yielded good results. Many of his ideas, published in the *Transactions of the Royal Irish Academy*, anticipated 20th-century concepts, such as the air-mass idea, with air masses classified as polar, extra-tropical, intra-tropical, supra-terrene and supra-marine. He believed in a general circulation but thought that when air from the equator reached the poles it was combusted and this caused the Aurora! One of his handicaps was his fervent belief in phlogiston.

Kirwan's first meteorological publication was *An estimate of temperature of different latitudes*, London 1787, collecting data from 42 places, from Lapland to the Falkland Islands, and Pekin to Philadelphia. He decried the diversity of temperature scales and advocated a scale of 250° from the freezing point of mercury to the boiling point of water.

Admiral Sir Francis Beaufort (1774–1857), born at Collon with French ancestry and most famed as hydrographer, was much influenced by his brother-in-law (later his father-in-law) Richard Lovell Edgeworth, whose interests included meteorology. The Beaufort scale of wind force, and Beaufort's system of weather letters are both widely used.

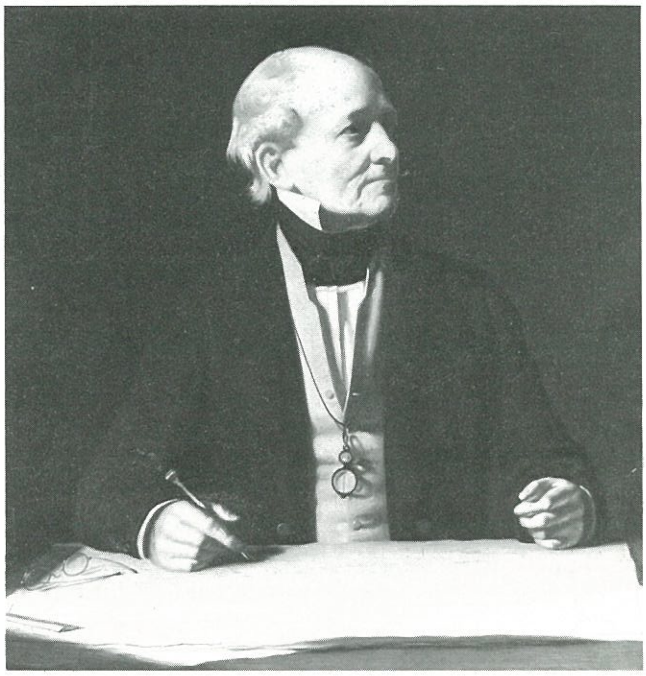
Thomas Romney Robinson (1792–1882), Director of Armagh Observatory, married another of Edgeworth's daughters and it was Edgeworth who suggested the design of the cup anemometer which Robinson perfected after many years of experimenting. He was born in Dublin, entered TCD when only 12, was Scholar at 14, B.A. at 16 and Fellow at 21.

Dr James Apjohn (1796–1886), born in Granard, was first Professor of Chemistry in the Royal College of Surgeons, Dublin, where he began regular meteorological observations. Although his development of the wet-bulb equation was not the first, his treatment was the most thorough and his form $e = e_{sw} - Ap(t-t^1)$ is still used. It was not derived for meteorologists but to help the determination of the specific heats of gases.



Robert Boyle (1617-1691)

Richard Kirwan, 1733-1812 (from a drawing by Brocas in the Dublin Magazine *for December, 1812)*



Sir Francis Beaufort, 1774-1857. (The painting by S. Pearce in the National Portrait Gallery, London)

Sir George Gabriel Stokes (1819–1905), born at Skreen, was most noted for his hydrodynamics and made several other contributions to meteorology. He was a member of the Meteorological Council, for which he developed the theory of the constriction in barometer tubes. He also made Campbell's sunshine recorder into the now familiar form, probably assisted by his father-in-law Robinson.

General Sir Edward Sabine (1788–1883), born in Dublin, was President o f the Royal Society, arctic explorer, geophysicist, and largely responsible for the chain of observatories at Toronto, St Helena, Cape of Good Hope, India and Tasmania, for which the observers were trained at TCD.

Humphrey Lloyd (1800–1881), Dublin-born Provost of Trinity College, was more concerned with geomagnetism than meteorology. He established the special building (now at University College) on the Fellows' Garden, first used as the training centre for the observers at Sabine's chain of observatories. His contributions to meteorology included analysis of the diurnal temperature changes to decide the best combinations of hours if restricted to two, three or four measurements each day.

Yeates & Son originated about 1790 and from the 1830s to 1970s occupied the shop at the corner of Grafton Street and Nassau Street, Dublin, as opticians and makers of scientific instruments. (The optical end of their business still flourishes in the Grafton Arcade, off Grafton Street.) In 1876 they exhibited an electrical self-registering rain gauge which would record on a dial at any distance, and in 1882 they produced a distant-reading anemometer. Their most important contribution was their technique for manufacturing sheathed thermometers. The idea had been suggested by several, and in his *Meteorological Magazine* Symons stated that it was not possible to fuse a sheath leaving the bulb exposed. However A.M. Festing wrote from Aldborough Barracks, Dublin, reporting that he was using such thermometers made by the Yeates firm.

John Tyndall (1820–1895), born at Leighlin Bridge, was invited to apply for the chair of meteorology in Toronto but declined. His principal contribution to the subject was studying the dependence of scattering on wavelength, and hence explaining the blueness of the sky and of distant hills.

Robert Henry Scott (1833–1916), born in Dublin, was first Director of the Meteorological Office, and prominent in the foundation of the International Meteorological Organization He wrote numerous papers and some good elementary text books. His library was presented to Valentia Observatory which he had founded.

John Joly (1857–1933) claimed to have Irish, French, German, Italian and Greek blood. He was Professor of Geology at TCD, and was a pioneer in colour photography. His principal meteorological innovation was a system of recording the principal elements at a distance from the instruments. He also invented a fractionating raingauge to separate the catch at different periods of a storm, to facilitate the determination of changes in the proportions of suspended matter.

Space does not permit discussion of 20th-century workers, but I am sure that when the Centenary volume is compiled that Mariano Doporto and Leo Wenzel Pollak will find a place.

Robert Henry Scott (1833-1916), the founder of Valentia Observatory and first Director of the British Meteorological Office (Photo supplied by F.E. Dixon)

Popular weather lore in Ireland

by Lisa Shields

Reliable scientific weather forecasting for the general public is a recent phenomenon, but country people have always needed forecasts. The fisherman's life can depend on his knowing if a light wind will suddenly blow up into a dangerous gale; the farmer's livelihood hangs on his ability to balance the seasons against his crops and make full use of short spells of favourable weather.

Before official forecasts ever were disseminated there already existed a rough-and-ready system for foretelling the weather, and it is against this background that the scientific product is seen and evaluated, improved upon, or perhaps found wanting. The individual is limited by his surroundings: he cannot see over the horizon. Scientific forecasts use global information, supercomputers and powerful communication networks, and they have access to satellite pictures showing approaching weather systems. Yet their useful range is only six or seven days, and it is unlikely that this can be increased beyond ten to fourteen days in the foreseeable future. Unfortunately farmers, dependent on the course of the seasons, have a strong desire for a forecast of not only weeks but months ahead. It is not too surprising if, looking out with dismay at their parched or rainsodden fields, some of them are inclined to switch off their television and reach for their almanacs to consult the phases of the moon or the month-by-month printed forecast for the year. And it is seldom that a year passes without the popular press seizing upon someone's prediction that this year, at least, we are in for a sizzling summer.

Country people have always needed weather forecasts. (Photo: Steve Treacy, Irish Farmers' Journal)

The store of weather knowledge which was once the common stock of countrymen and women has not been forgotten, but it has certainly dwindled. The local specialist, with a superior store of sure signs, keener powers of observation and perhaps secret methods of his own, is now a rarity. The lore itself, part of a greater European tradition, has doubtless been influenced by popular printed sources (almanacs, *Ireland's Own*, newspapers, even school primers). It would be a hard job to isolate the uniquely Irish, or even the exclusively traditional, aspects of this orally transmitted heritage. It is in the Irish-language material that we are more likely to find expression in pithy proverbial or metrical form. This form (found so freely and strikingly, for example, in French weather lore) probably aids the preservation of the material; unfortunately here the native language is itself part of a waning tradition. Whether expressed in English or Irish the same content and themes recur with variations all over the country.

I do not propose here to make an exhaustive list of weather beliefs and forecasting rules or to attempt to assess their validity. A few examples will suffice to convey their flavour, often lively, entertaining and full of the poetry of traditional speech.

Broadly speaking they fall into the following categories:

- pseudo-scientific astrological and astronomical rules;
- magical divination of seasons from the weather of special days;
- empirical rules based on the observation of animals and birds, and of sky, wind, visibility, audibility etc.;
- climatological observations and recurrent phenomena;
- folk memories of unusual seasons and extreme weather events;
- local weather signs, based on the application of empirical rules to features of local topography.

All these may coexist, and be regarded with varying degrees of respect or scepticism. They may survive in a corrupt or distorted form, or find expression in a confused manner, so that a perfectly intelligent notion may come out as apparently absurd.

ASTROLOGICAL FORECASTING

This type of forecasting is very reminiscent of the techniques of the disciples of Aristotle and his intellectual descendants, whose influence held sway until the seventeenth century, and who left their mark on almanacs and learned treatises alike. Pride of place is given to the moon, its phases and divisions, its appearance and position in the sky.

> They had to see the moon first, the first or the second or the third night, its hold on the sky. And once they would spend a while looking at that moon they were fit to walk into the kitchen and they would be fit to tell then how that moon was going to work . .. by the appearance of the moon hanging on the sky, by the

> colour of the moon. If it was right North on the sky that was all the better. If it's any way stooped, it's a bad sign, it's going to let the drop down, and if it's lying on the broad of its back it's going to let the drop down. It must be standing up straight. For that's how they were fit to calendar the moon. And they calendared the weather as long as that moon was on the sky. Well you see if that moon then was in the beginning of the quarter of the year that weather was going to carry on for three moons one after the other.
> (Andy McDevitt, Co. Donegal, 1985)

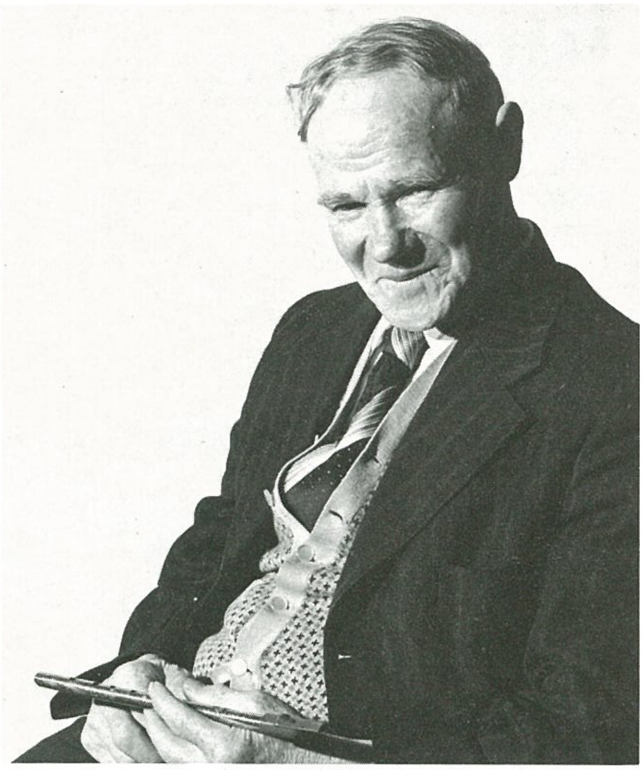
There could be considerable variation in different localities:

> The harvest moon would be early in September. Well they knew with the position it was set in whether it would be a good harvest or a bad one. I only knew a few of the rules and regulations, too. If it was set on its back with the two tails standing up, that kept off the rain for that harvest. If it was set sideway, if it was what you'd call you could hang the kettle on it, that was middling weather. If it was set on its back, the two forks down — downpour, a very bad harvest, for the corn and the digging and the spuds.
> (Frank Browne, Co. Roscommon, 1983)

The stars, special stars and constellations or the milky way, were also interpreted as weather signs.

DIVINATION

Certain periods of the year and special days were used to predict the coming months or seasons: the 12 days of Christmas as predictors for the coming 12 months, the four seasons of the coming year from the appearance of the stars on the first four days of January, the course of the three winter months from the first three days of November, the forty days after St Swithin's day, and so on.



Frank Browne, retired county Roscommon farmer: 'My father's father knew all about it, and he was able to record how the four seasons would go from the weather and the stars on the first four days of January,' (Photo: Brendan Dempsey, CLCS, Trinity College, Dublin)

EMPIRICAL OBSERVATIONS

Some of the best-attested beliefs refer to the changes in visibility and appearance of objects seen through altered atmospheric conditions — the apparent nearness of distant objects for example, or the presence of high ice clouds visible as a lunar halo, or changes in sky colour caused by the scattering of light through fine dust.

One of the most commonly found weather beliefs in this country is that if the cat sits with its back to the fire it is a bad sign. Domestic animals are closely watched and their behaviour related to oncoming weather. The colour of frogs, the activity of snails or midges, the behaviour of dogs, goats etc. are all of interest, but it is birds with their knowledge of other horizons and great heights that excite the greatest attention.

> If the crane [i.e. heron] goes to the hill we are going to get stormy weather, but if she makes for the sea we are going to get good weather.
> (Joe McCafferty, Co. Donegal, 1980)

> Nearly every second man or woman you met round the West knew all about the curlew. She went to the bog in the morning on the upland, and if the day was going to be wet she'd not leave the land, but if the day was going to be fine, at 9 o'clock in the morning UP she'd go and straight off to the bog. In fine weather she only gave two calls, KWAI KWAI .. but when the rain was coming, KWAI KWAI KWAI, KWAI KWAI KWAI, she gave the three. The swallow was the next best thing. You'd only get warning an hour before the rain would come with the swallow. When the rain was coming the air changed. The air was higher up when it was fine, but when it was coming near rain the air was nearer to the earth, and the swallow was following the flies. If the day was going to be fine the swallow was up a hundred yards up in the air but if it was going to be wet he'd be down skimming the ground.
> (Frank Browne, Co. Roscommon, 1983)

CLIMATOLOGICAL OBSERVATIONS

Each month has its expected or desired characteristics.

> Old Moore was for death and the son went to the room to the bed till him and he asked him, says he, 'Father, what'll I put in the almanac when you've gone?' Says he, 'Plenty of wind and rain and an odd shower of snow or two and plenty of lies and truth'.
> (The late Eddie Butcher, Co. Derry, 1979)

> 'Put anything you like in it', says he, 'But put no frost in July and no snow in June!'

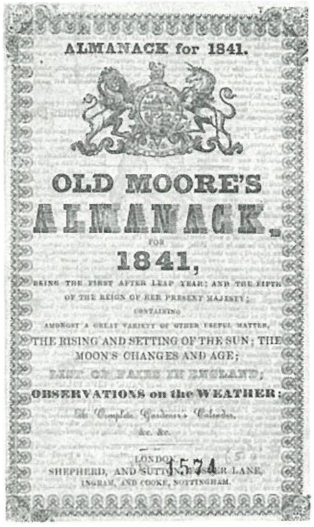
The Co. Kilkenny schoolmaster, Humphrey O'Sullivan, was an exuberently poetic describer of the changing weather scene. In his diary for 1827, he quotes Gaelic proverbs neatly summing up the typical characteristics of the months:

> Gionbhar gruama dorcha duairc;
> Faoilidh fliuch leat lae neamshuairc;
> Marta meisgeach gaothmhar cruadh;
> Abraon baraonach meighilleach nuadh.

> (January glum, dark, surly;
> February, wet half the day, disagreeable;
> March angry, windy, hard;
> April dripping, bleating, new.)

Climatological maxims are often in rhyme:

> A wet and windy May
> Fills the haggard with oats and hay.



Sioc soineann an earraigh
Is é a líonas fearrantaí le stór;
B'fhearr cith cloch shneachta i dtús an Aibreáin
Ná leathadh an aigéin de ór.

(A frosty calm spring
Fills the farmlands with wealth;
Better a shower of hail at the beginning of April
Than half an ocean of gold.)

Recurrent weather disturbances were labelled, or dramatised — the 'barnacle storm' at the beginning of winter, around November, or the 'cuckoo storm' at the very beginning of May, or the three harsh days at the beginning of April that 'killed the old cow':

> April got three days from March because there was a cow one time — they called her the *réabhóg* . . . well she got March over her, and she thought she was all right once she got March over her. She lifted her back end and ran through the field. But what did March done but she got three days from April as a gift and they skinned this *réabhóg* on one side — they took the skin off her, flesh and all and whenever they had that done she turned round her other side till she took the skin and beef and all from the other side and all and that's why they call them the '*trí lá na réabhóige*'.
> (Joe McCafferty, Co. Donegal, 1980)

These three harsh days that March borrows from April are also widely known as the 'borrowing days'.

WEATHER MEMORIES

These may stretch back for the last century and a half. Stories are told about unusually harsh seasons or extreme weather events, and how they affected local people: the Night of the Big Wind on the 6th–7th January 1839 and unusually severe storms since then; particularly severe winters and long frosts, unusually hot or wet summers, crop failures related to the weather and so on.

LOCAL WEATHER SIGNS

Perhaps this is the most vigorous branch of the lore, and likely to be seen as the most useful, as weather can vary considerably between nearby localities and be greatly influenced by geographical features.

> Or if you were going up that mountain brae there in the morning and the wind on your face, you might as well turn because you'll have to come home anyway, for the rain'll be on you before you're right up. The old folk used to say — you see when you're going to the bog you aye took your lunch with you in a bag on your shoulder — and they would have said 'We'll no be long in the mountain the day because the wind's in the mouth of the bag.'
> (Eddie Butcher, Co. Derry, 1979)

> When you hear the sea noising from the direction of the cliffs of Moher it's a sign of good weather. We didn't hear that for a long time!
> (Christy O'Connell, Milltown Malbay, Co. Clare, 1986)

The cap of cloud or mist on a prominent mountain is widely regarded as a sure weather sign by people in the surrounding counties. As early as 1652 the Dutch writer Gerard Boate reported an example of this in his *Irlands naturall history*:

> And in many places it is found by experience that the like Fogs upon the tops of the mountaines is a fore-runner of rain in the next country: whereas all those who have lived any time at Dublin, may have good knowledge. For seldom a mist appeareth upon the top of the Wickloe-mountains, situated some five or six miles to the South of Dublin, or of the head of both [corrected in the 1726 edition to 'or of the head of Hoath'], without being followed with rain at Dublin within 24 houres: wherein is observable, that a Fog quite covering those mountaines all over is not so sure a signe of Rain, as when it is only upon the top: and that those generall Mists upon the mountains are often seen without any following Rain, the which very seldom or never happeneth in the others.

Intelligent users of local lore will of course test these signs for themselves:

> West of us here it was a lough until the Famine. In the summer time the mud in the bog would dry out and crack with the sun. One day you would go out and there'd be three, maybe four, inches of lovely clear water, and it wouldn't have rained — it just sprung up out of the ground, and that was a sure sign that you were going to have rain. And I did see that again and the blooming weather came lovely after it, so it's hard to know!
> (Jack Devereux, Co. Wexford, 1982)

Whether or not popular lore has anything to add to the scientifically derived weather forecast, it is interesting and attractive in itself; the practice of do-it-yourself prediction, involving a careful scrutiny of the clouds and the skies, of birds, animals and small creatures, adds variety to everyday life and contributes to its enjoyment.

Scrutinizing the skies: Mackerel sky (cirrocumulus) is thought to be a sign of rain to come, especially after a beautiful sunset. (Photo: a view from Foynes, by F.E. Dixon)

Early Irish weather records

by Fred E. Dixon

There are four schools of thought about climatic change. One finds evidence that we are entering the next Ice Age: another is as confident that the earth is getting warmer; a third believes that there has been no significant change in historical times, and the fourth is agnostic in such matters. Similarly there are always some who believe in cycles and others who do not. One of my pet ideas is that the best-marked 35-year cycle is that of belief in meteorological cycles. Whatever your feeling in these matters the test for your theory is in the study of the weather records, and Ireland is well served in this field.

The oldest records are of climate rather than weather, the testimony of glaciation and the pollen and plant debris in peat deposits. About 2000 BC, after a warm and wet period, there was a change to drier conditions and the bogs were replaced by forests.

A SEARCH OF THE ANNALS

The annals written in Irish monasteries provide the oldest written records for Europe, but the earliest events were already ancient before they were written down and there is considerable doubt as to the dating. According to the annals, Lakes Con and Techet overflowed about 2668 BC, nine lakes 'erupted' in 1629 BC. Such eruptions were probably due to bog-slides blocking lake outlets, but bog-slides do not necessarily indicate a wet season. A dry spring can encourage people to start cutting turf too early, and this can lead to the undermining of the front of a bog. Mentions of exceptional floods, droughts, gales, thunderstorms, frosts and snow continue through the mediaeval period. However, the fact that they were recorded is evidence that they were exceptional and tell nothing of the weather generally occurring.

The annals have been scrutinised by many scholars studying the Irish climate, the first being Joseph McSweeny (1829) whose essay won a £40 prize offered by the Royal Irish Academy. More comprehensive was the compilation by Sir William Wilde (1856) in Vol. I of Part V of the 1851 Census report. Best is C.E. Britton (1937) *A meteorological chronology to AD 1450*, Meteorological Office Geophysical Memoir 70. At present Professor Susan McKenna-Lawlor of Maynooth University is conducting a computer-based study, funded by the EEC, of the climatic evidence contained in the Irish annals from 536 AD to 1577.

EARLY IRISH WEATHER DIARIES

The earliest known Irish weather diary is for a few months of 1682-83, written at Kilkenny for the Duke of Ormond by John Kevan, and preserved in the National Library of Ireland. From 1684 to 1686 William Molyneux and St George Ashe were observing in or near Trinity College for the Dublin Philosophical Society and they included barometer readings in their records, but only one small extract survives. These observations were resumed in 1707 to 1708 by William Molyneux's son Samuel, who measured rainfall and temperature as well as pressure. The first surviving Irish diary with thermometer readings was kept by George Rye near Cork for a year 1721-22 in connection with his assessment of perspiration. (He weighed everything he ingested and excreted.) Thomas Neve at Ballyneilmore on the shore of Lough Neagh devised a raingauge which he used first in 1711. He later had a barometer and thermometer. A copy of his diary for 1711-25 was made in 1726 and is still preserved by the Royal Society.

Best of the 18th-century weather diaries is the series covering 1716-66, surviving in three manuscripts, which formed the basis of John Rutty's works on the climate of Dublin. Also important is the record of 1753-55 by James Simon, printed by the Royal Society. The first station to be well equipped with instruments was Richard Kirwan's at his house in Cavendish Row, Dublin, where he observed from 1787 to 1808, having a pressure-plate anemometer of his own design.

Mention must be made of almanac diaries. From early in the 18th century some of the almanacs were supplied with blank interleaving, and many owners used these for diaries dealing mostly or entirely with the weather. The earliest of these surviving is for 1734. One exceptional series was written by Maximilian Favière, mainly in Dublin, from 1781 to 1811.

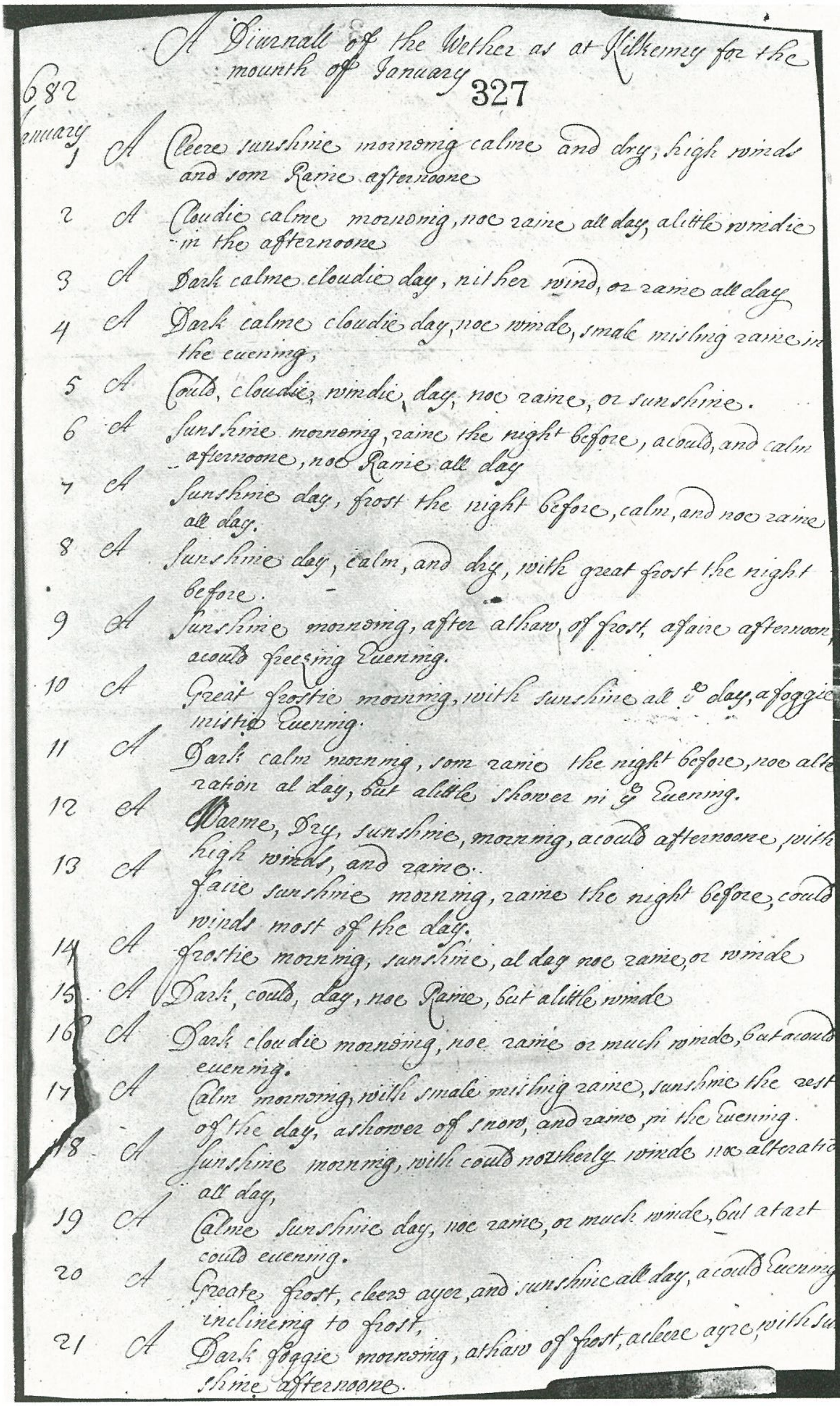
EARLY ORGANIZED WEATHER RECORDING

Four astronomical observatories are worth mentioning for their weather records — Dunsink (1788), Armagh (1790), Markree (1824) and Birr (1845). Armagh still continues and the synoptic station at Birr is a direct successor to Lord Rosse's. Meteorologically Dunsink was replaced by the geophysical observatory at Trinity College, Dublin, (1838) with the delightful building now on the campus of University College.

What are now the National Botanic Gardens, only a stone's throw from the Meteorological Service Headquarters, were founded by the Dublin Society (not yet Royal) in 1797 and by 1800 were keeping weather records. There was a break in the 1830s (when the alcoholic gardener was retired on pension) but the station is important as the oldest surviving, next to Armagh.

When the Irish Ordnance Survey commenced in 1825, sporadic meteorological measurements were made at the principal triangulation points and in 1829 a permanent observatory was established at the Dublin headquarters in Phoenix Park, as fully equipped as any in the world at the time.

In 1851 the Royal Irish Academy organised a year-long meteorological survey of Ireland with 16 stations, mainly coastguard stations or lighthouses. Some results were summarised by Humphrey Lloyd, including straight-line isotherms derived by the least-squares technique! The original observations are still preserved in the Academy.



A Diurnall of the Wether as at Kilkenny for the mounth of January 327

1682 January

1 A Cleere sunshine morning calme and dry, high winds and som Raine afternoone

2 A Cloudie calme morning, noe raine all day, alittle windie in the afternoone

3 A Dark calme cloudie day, nither wind, or raine all day

4 A Dark calme cloudie day, noe winde, smale misling raine in the euening,

5 A Could, cloudie, windie, day, noe raine, or sunshine.

6 A Sunshine morning, raine the night before, acould, and calm afternoone, noe Raine all day

7 A Sunshine day, frost the night before, calm, and noe raine all day.

8 A Sunshine day, calm, and dry, with great frost the night before.

9 A Sunshine morning, after athaw of frost, afaire afternoon, acould freesing Euening.

10 A Great frostie morning, with sunshine all ye day, afoggie mistie Euening.

11 A Dark calm morning, som raine the night before, noe alteration al day, but alittle shower in ye Euening.

12 A Warme, Dry, sunshine, morning, acould afternoone, with high winds, and raine.

13 A Faire sunshine morning, raine the night before, could winds most of the day.

14 A frostie morning, sunshine, al day noe raine, or winde

15 A Dark, could, day, noe Raine, but alittle winde

16 A Dark cloudie morning, noe raine or much winde, but acould euening.

17 A Calm morning, with smale misling raine, sunshine the rest of the day, ashower of snow, and raine, in the Euening.

18 A Sunshine morning, with could northerly winde noe alteratio all day,

19 A Calme Sunshine day, noe raine, or much winde, but at last could euening.

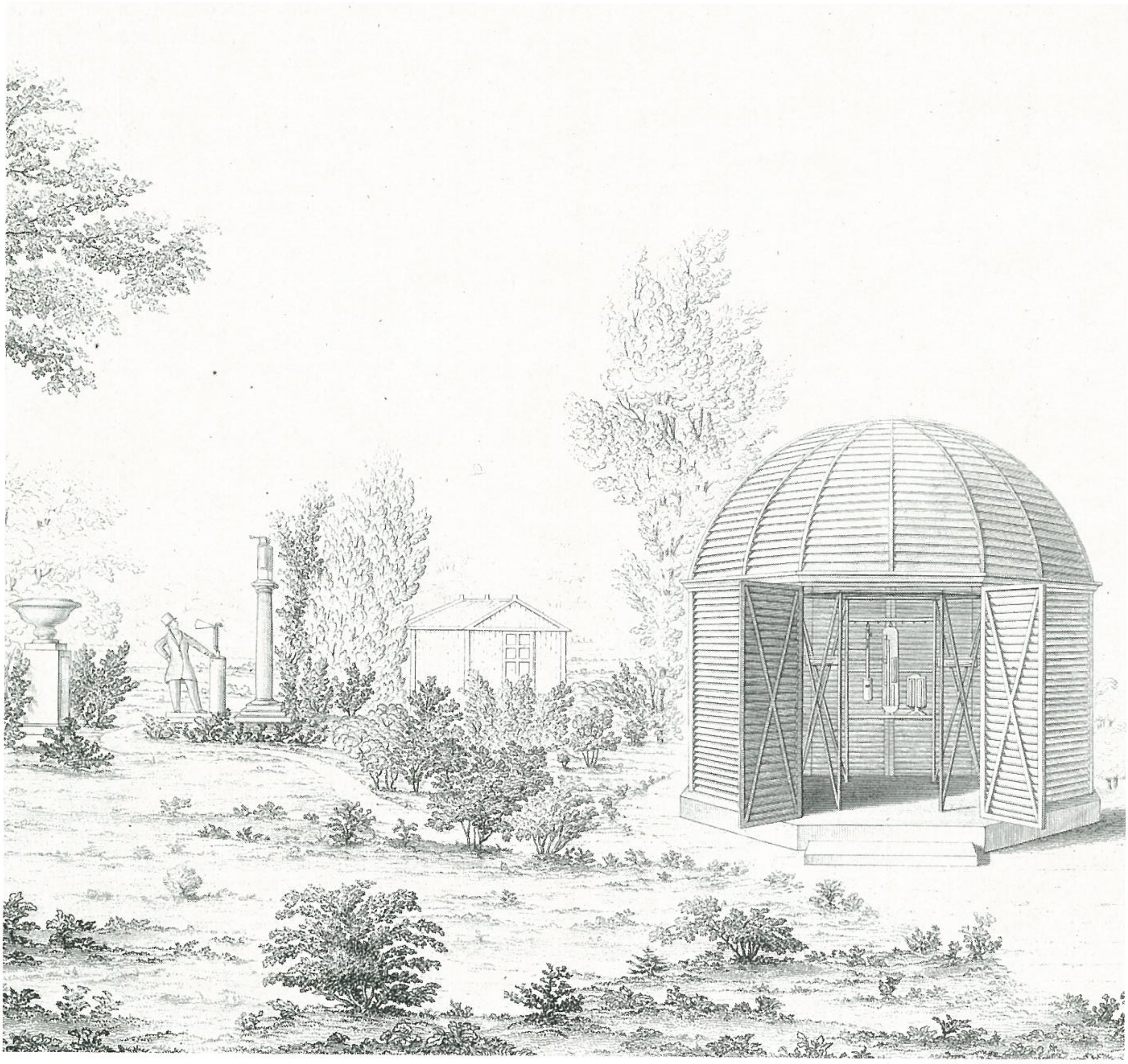
20 A Greate frost, cleere ayer, and sunshine all day, acould Euening inclineing to frost,

21 A Dark foggie morning, athaw of frost, acleere ayre, with sunshine afternoone.

The oldest known Irish weather diary. The page for January 1682/83 from the diary made by John Kevan of Kilkenny for the Duke of Ormonde. (Photo of National Library of Ireland MS 2428, p. 327)

One more recent weather record is noteworthy, that of Sir John Moore, whose station, most of the time in Fitzwilliam Square, Dublin, supplied continuous records from 1865 until his death in 1937.

Modern data accumulate so rapidly that, even with the most sophisticated equipment, meteorologists find it difficult to make full use of them. Meteorological services cannot be expected to find time to analyse all ancient records, some only qualitative, and others based on instruments of doubtful accuracy with non-standard exposure. Nevertheless the pioneers deserve to be remembered, and their records must be consulted by all believers and non-believers in climatic change.



The observing station established in 1829 by the Ordnance Survey in Phoenix Park, Dublin.

Our voluntary observers: the background to the climatological network

by Brendan Smith

While the prime objective of the Irish Meteorological Service on its establishment was the institution of a forecasting service for aviation, it also took over other responsibilities from its predecessor, the British Meteorological Office. Ancillary to the forecasting service were the Telegraphic Reporting Stations at Roche's Point, Blacksod Point, Malin Head and Birr. These stations, staffed by part-time observers, along with the officially staffed Valentia Observatory, Cahirciveen, had for many years made detailed weather reports at regular intervals daily, sending them in international code by telegraph to London, and through London to all the main European forecasting centres.

THE CLIMATOLOGICAL OBSERVER

There was also a network of weather observers with no immediate connection with weather forecasting: the climatological observers. Climatology is, in brief, the study of weather change over the country. The climatologist is concerned with assessing the mean and extreme values of the weather elements and the changes, if any, that occur in these elements in the long term. The basic data required in the study are reliable weather observations made regularly over a long period at as many places as possible throughout the country; more precisely, measurements of the various weather elements made at a fixed hour daily by a competent observer using reliable standard instruments which are so installed that the readings furnished are representative of the locality.

Climatology is possibly unique in science in that its data base has been assembled for the most part by non-professionals. It appears that there have always been individuals prepared to take a scientific rather than cursory interest in their environment, and to undertake the initial step essential in any science: measurement — measurement in this case of the amount of rain and of the rate at which it falls, of the changes in temperature, of the duration of sunshine, of the changes in strength and direction of the wind. Centuries before their work received official recognition these amateurs were comparing their observations and improving their methods by correspondence and through learned societies. They combined in organisations such as the British Rainfall Organisation, but eventually the various meteorological services, prompted by the growing demand for climatological information from administration, science and industry, took over the collection, collation and publication of data, and also standardised observational practice and instruments.

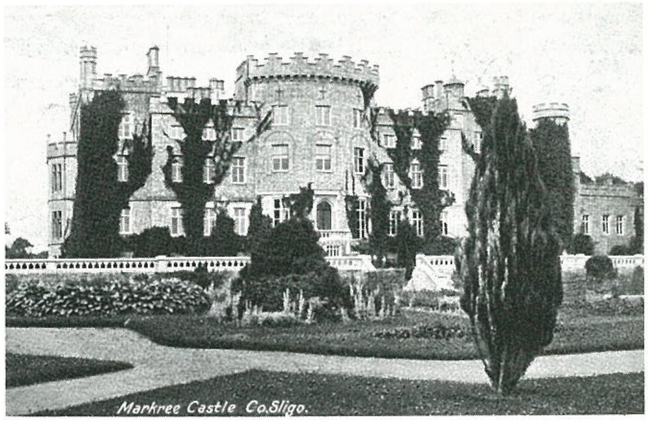
THE CLIMATOLOGICAL NETWORK REORGANIZED

There have been such observers in Ireland for over two hundred years, but it was only in the latter half of the last century that they were drawn together into the climatological network administered from London by the Meteorological Office. When the Irish Service took over in 1936, the network comprised 230 stations, some measuring rainfall only, others furnishing a full set of readings of rainfall, temperature, wind and sunshine. The stations were unevenly distributed, with few stations in the extreme west and north. There was, at that time, a fairly sudden upsurge in demand for data, particularly in connection with water supply, hydroelectric generation and land-drainage projects, and the new Service had to start immediately on the reorganization and expansion of the network. It was fortunate in being able to secure for the work the services of Stephen Kelliher, who in 1937 was retiring from the Civil Service of the Federated Malay States. He had left his native Co. Louth at an early age to join the British Navy, and after the First World War had gone to Malaya to join its newly established meteorological service. In London on retirement leave he met the then Director of the Meteorological Office, Sir George Clarke Simpson, who suggested to him that the new Service in Ireland could do with his help. He agreed to join it for five years, stayed for fifteen, and when in 1952 he retired for the second time he had built the climatological network up to about 800 stations, this despite all the wartime difficulties of travel and of equipment procurement. In addition he had improved many of the old stations as regards exposure and observing practice. To the observers, many of whom were seeing an inspector for the first time, he explained the importance of their work to the whole community and the value attached to it by the new Service.

He incidentally brought about some changes in accepted thinking regarding Irish climate, mainly by improving instrument exposure. He showed, for instance, that the Shannon 'dry belt' depicted on the rainfall maps was non-existent; the siting of many of the Shannon raingauges had been seriously at fault, and they were receiving well below the actual areal rainfall, a fact he proved by installing comparison gauges in better positions. He also installed many mountain raingauges, at levels of up to 808 metres, and so obtained valuable new data on upland rainfall.

Kelliher's first concern was to ensure the continuation of records from long-established stations. For a weather record to be of full value it must have been maintained over a very considerable period. When, for instance, reference is made to mean values of meteorological elements for a particular area the mean is an average calculated over a period of thirty years, and for the study of climatic change successive means for successive thirty-year periods are required. These historic stations are also the 'bench marks' to which newer records can be referred.

Ireland is fortunate in having a number of such long-term stations. Some of these had an official status, attached to state or semi-state establishments — the Ordnance Survey Office at the Phoenix Park in Dublin, for example, which in 1936 had already been keeping records for 100 years; the National Botanic Gardens and Valentia Observatory in Cahirciveen.



Markree Castle, c. 1907 (Postcard courtesy of F.E. Dixon)

THE VOLUNTARY OBSERVERS

But there were also private individuals prepared to undertake this demanding and, at first glance, unrewarding task. They rarely came to public notice and, if they did, received scant respect. In literature they appear as harmless comic eccentrics. In Thomas Peacock's *Crochet Castle* there is Mr Firedamp who preaches the dangers of living near water from which 'the sun sucks up infection . . . wherever it exists on the face of the earth', and in his *Ingoldsby Legends* Robert Barham has Mr Simkinson whose essay delivered 'at the meeting of Sçavans . . . in the City of Dublin . . . demonstrating that the globe is a great custard, whipped into coagulation by whirlwinds and cooked by electricity, a little too much baked in the Isle of Portland, a thought underdone about the Bog of Allen, was highly spoken of.' Even in recent times the late Arthur Koestler, who could write so brilliantly on scientific subjects, for some reason digresses from the story line in one of his best novels to be heavily satirical about climatologists, divided by him into two schools, 'Apocalyptists . . . whose one ambition in life was to be able to announce the 15th July with the heaviest snowfalls on record' and their hated rivals the 'Normalists passionately searching for the 15th July nearest to the statistical average' and who 'were able to prove that by taking the last Winter Equinox as a starting point the amount of rainfall and the mean temperature in the shade came closer to the ideal average than any other year since 1903.'

In fact amateur meteorologists, at least in Ireland, tended to be very normal and practical individuals, extraordinarily varied as to occupation and station in life. In the published climatological summaries the Stationmaster at Mallaranny ranks equally with the Earl of Granard, with a maltster in Cork and a schoolteacher in Tralee. As to the reasons for their interest in weather the Earl was interested in the improvement of farming and horticulture, the Stationmaster — or rather his Directors — wished to give a factual background to their claims regarding the mild climate of West Mayo, where they had a hotel, and the maltster was interested in the breeding of new species of malting barley suited to the climate of the southern counties.

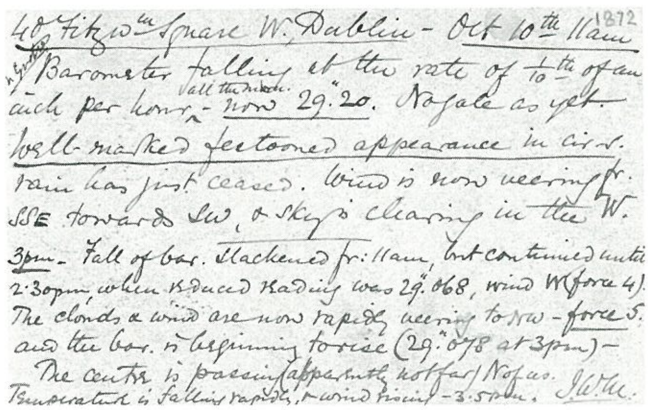
NOTABLE FAMILIES

In Co. Sligo, near Collooney, weather records have been kept at Markree Castle for over 100 years. Cornet Cooper had received the Markree lands in the seventeenth century as a reward for military service in Ireland. His nineteenth-century descendants were progressive farmers, improving landlords and, like many of their class at that period, amateur scientists. Joshua Cooper had in the 1830s established at Markree one of the best-equipped astronomical observatories in Europe and, ancillary to it, a weather station. The observatory is gone, its instruments now museum pieces in Hong Kong and Manila, but the weather observations continue.

In the midlands and the south several long observational series are due to some of the Quaker families who have contributed so greatly to agricultural and commercial progress in Ireland. Records were kept by the Grubbs in Carrick-on-Suir and Clonmel, by Pims and Jacobs in Mountmellick, by Malcomsons in Portlaw. The weather diaries kept in some cases by these observers to supplement the instrumental readings give interesting insights into the life and commerce of the period.

WEATHER AND PUBLIC HEALTH : THE WORK OF SIR JOHN MOORE

But if anyone belies the image of the eccentric meteorologist it is John William Moore, Knight, physician and public health expert. He lived near the heart of Dublin and no doubt it was the succession of epidemics which in his youth swept that overcrowded insanitary city, especially in summer, that led him to study the relationships between climate and public health, and the importance of environment in the treatment of disease — especially of tuberculosis, so prevalent in his day. The results of his research are included in his *Meteorology practical and applied* in the section entitled 'The influence of season and weather on disease', one of the most valuable of the early publications on climate and health. His establishment of a sanatorium well away to the south of


40 Fitzwm Square W. Dublin - Oct 10th 11am 1872
Barometer falling at the rate of 1/10th of an inch per hour all the morning - now 29.20. No gale as yet.
Well-marked festooned appearance in cirri.
Rain has just ceased. Wind is now veering fr. SSE towards SW, & sky is clearing in the W.
3pm - Fall of bar. slackened fr. 11am, but continued until 2.30pm, when reduced reading was 29.068, wind W (force 4). The clouds & wind are now rapidly veering to NW - force 5. and the bar. is beginning to rise (29.078 at 3pm) -
The centre is passing (apparently not far) N of us. J.W.M.
Temperature is falling rapidly, & wind rising - 3.5 pm.

Postcard with a special weather report from J.W. Moore to R.H. Scott, the Meteorological Office, London, 10th October 1872

Dublin, between the Wicklow Hills and the sea, was a new step in treatment, and weather observations made there in later years proved that he had chosen the ideal site for the purpose, mild, dry and sunny. He himself kept records at his residences in and near Dublin for over 71 years until his death in 1937 at the age of 92, an observing record unequalled in these islands.

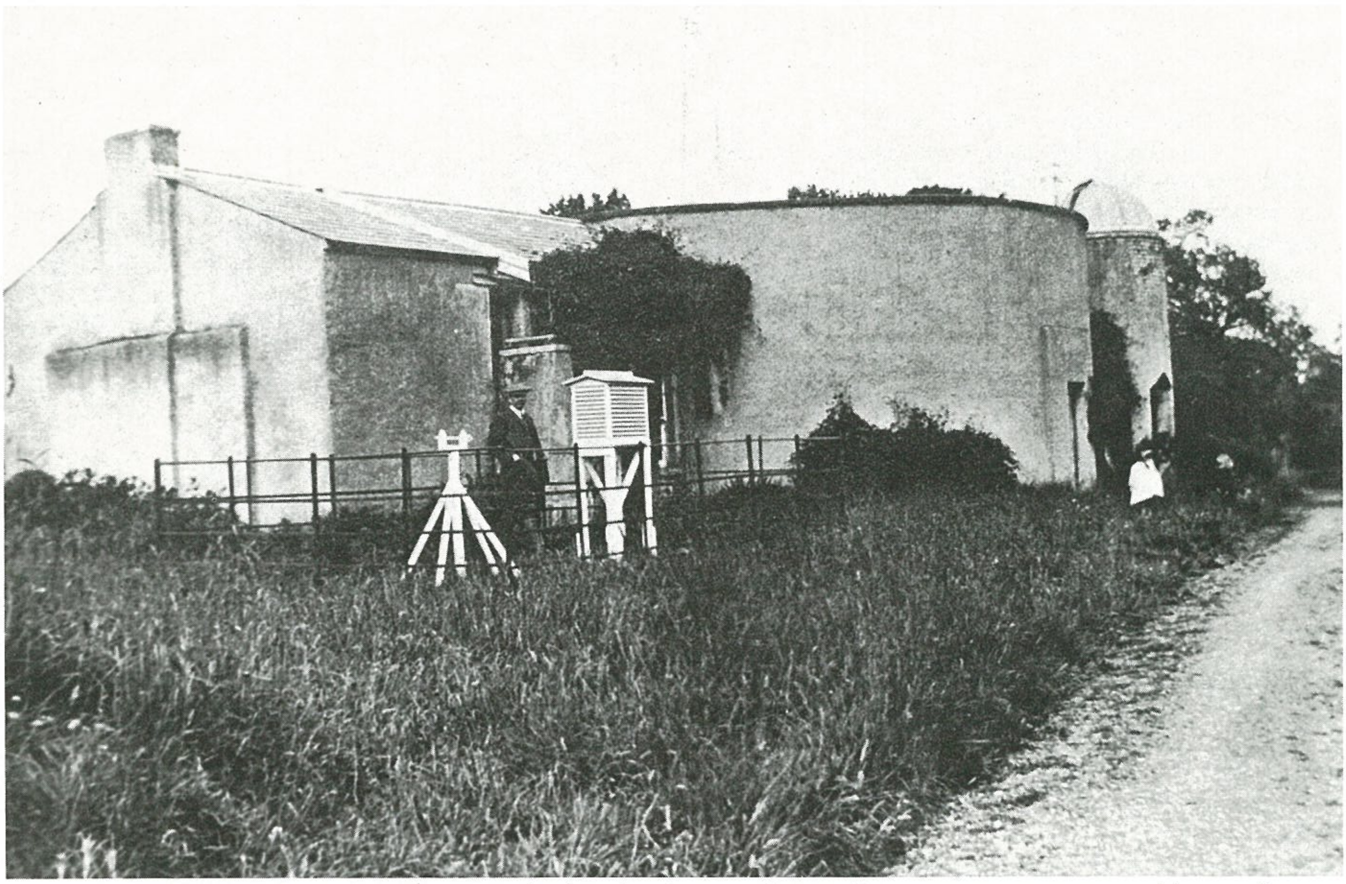
VALUABLE SERVICE

The Service is fortunate that in its jubilee year so many of the historic records are still maintained. The era of wealthy amateur scientists with their private observatories has passed but there are still enthusiasts following in the steps of Moore and Cooper. An observer in Howth, Co. Dublin, now in her eighties and still an enthusiastic gardener, continues to this day the observations she began early in the 1930s. A farmer in the Suir Valley has been returning readings for over a quarter of a century and there are several others who from habit, interest, or a sense of duty continue to take readings.

In the first fifty years of the Service many new series have been begun. Though the majority have been of very short duration a useful number have continued, and every year new observers come forward to undertake the daily routine perhaps in furtherance of another interest, but in many cases, like their predecessors, just to learn a little more of their environment and to add a little to human knowledge.

The use of the data obtained from the network merits a separate study. New uses are continually being found for it, necessitating continual processing and re-processing. Only with the advent of the electronic computer has it been possible to realise the full value of the vast amount of material stored and continually supplemented, and to accomplish its processing into the many and varied forms required in modern times. The existence of this unique data bank is now known almost universally and demands on it are ever increasing.

The work of Mr Firedamp and of Mr Simkinson is at last appreciated!



Instrument enclosure at Markree castle 1912, showing the observer, solar maximum-temperature screen, sunshine recorder, and wind vane. (Photo: Meteorological Office climatological inspector's file)

The Irish Rainfall Association

by Louis Power

People of intense zeal and dedication have always fascinated me; I like to know what motivates them to start with and what sustains them in overcoming the frustrations and setbacks that so discourage others.

One such person was E.W. Montagu Murphy who lived at Ballinamona, Cashel, Co Tipperary and, while little is known of his background or personality, he proved himself to be one of the outstanding weathermen of this century in Ireland.

Rainfall readings had commenced at Ballinamona in 1904 and diaries for those early years show that Montagu Murphy at that time was keenly interested in all aspects of weather recordings, whether they were rainfall amounts, temperature or pressure readings or simply weather conditions, both at his home and elsewhere. It is not known how he contacted others with a similar interest but somehow he did and, in 1918, he formed the Munster Rainfall Association. He suffered from epilepsy, and this infirmity prevented him from taking up any active profession. Thus the Association, soon to become in 1920 the Irish Rainfall Association (embracing all of Ireland), became his life interest.

The original list of rainfall observers included in the annual reports reads like a 'Who's who' of the aristocracy and landed gentry of that period: names like the Earl of Rosse (Birr), the Earl of Courtown, Sir John Moore of Fitzwilliam Square, Dublin (another dedicated weatherman), the Pack-Beresfords of Fenagh, Carlow, the Hodsons of Athlone, Lord Clonbrock of Ahascragh, the Earl of Dartery (Cootehill), the Earl of Antrim and many others at rectories, colleges, schools and private houses throughout the 32 counties. The diaries and note-books, all neatly handwritten, reveal an amount of detail that must have entailed considerable effort and correspondence on Montagu Murphy's part.

There was a nominal 'voluntary' subscription of five shillings (present 25p) per annum for members of the association but it is clear from correspondence that it did not pay its way and Montagu Murphy had to make good any deficit from his own pocket. In addition to the expenses detailed in the annual pamphlets, Mr Murphy expended much of his own money travelling the country inspecting raingauge sites and encouraging people to start rainfall stations. Many of those encouraged by him still survive today and have made very useful additions to our knowledge of the climate of Ireland.

Each year Montagu Murphy published a pamphlet showing for each station its name, its height, the person responsible, the amount of rainfall for the year in inches and the number of days of rainfall. In addition, he sent copies of all his records to the Meteorological Office in London and these were included in the British publication, *British Rainfall*, up to 1939. The pamphlet reached its heyday in the early 1930s, and in 1932 the records for a total of 269 rainfall stations were included; after that, the numbers steadily decreased until in 1946 there were only 37 entries, and publication of the pamphlet ceased (at this stage, the Irish Meteorological Service was in the process of establishing its own network).

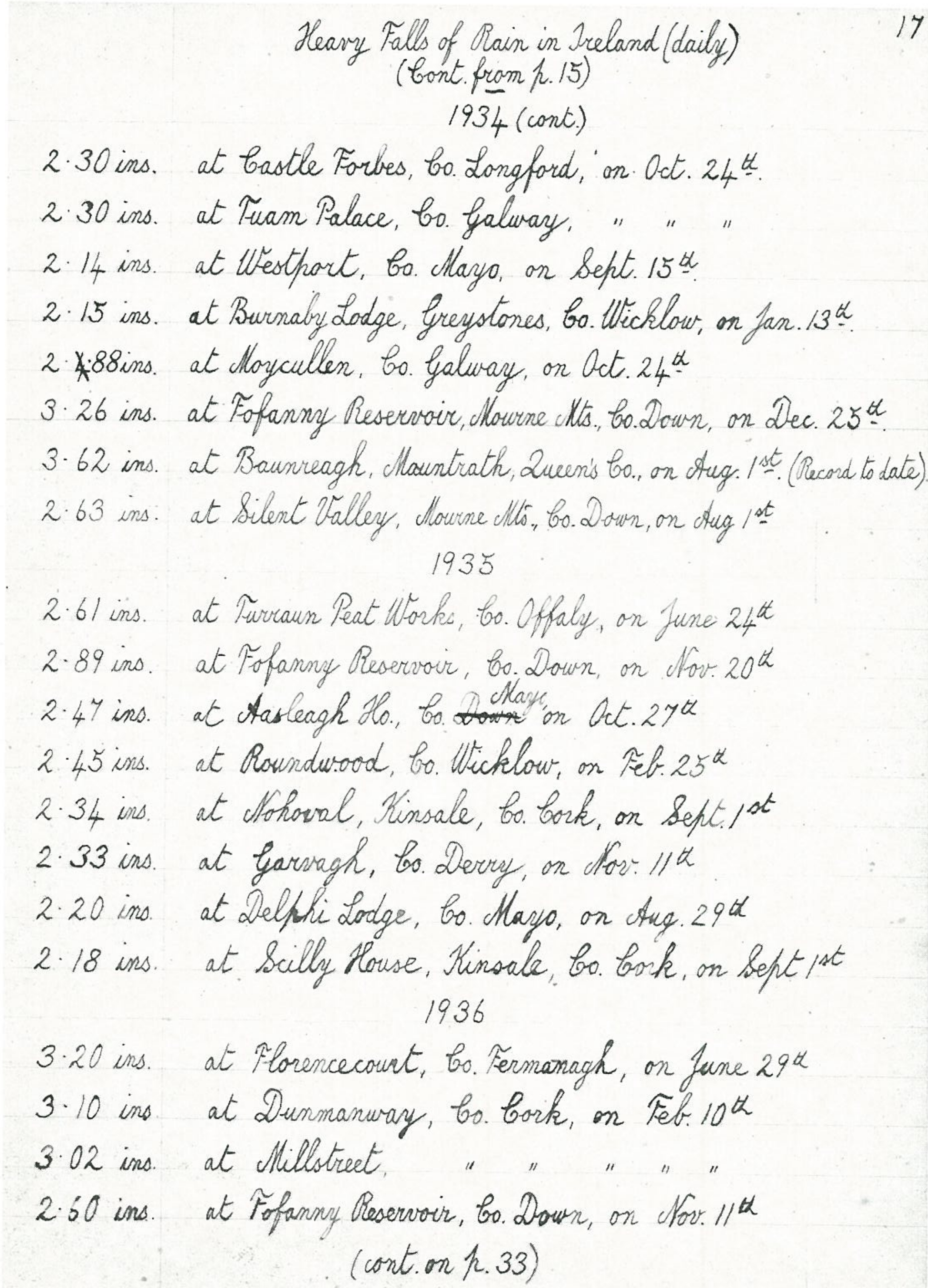
From 1931 onwards, Mr Murphy made continual references to his failing health, both in the annual pamphlets and in correspondence with the Irish and British Meteorological Services. (A member of the staff of the Meteorological Service, who comes from that area of Co. Tipperary, remembers the frequent epileptic fits suffered by Montagu Murphy while attending Mass in Cashel on Sundays). Nevertheless he kept up his interest in the recordings of rainfall for the next 34 years until his death in 1965.

The diaries and notebooks, so painstakingly compiled by Mr Murphy during his lifetime (see illustration), were handed over to the Meteorological Service in 1966. Miss Kathleen Murphy (his sister) continued to take readings until her death in 1975, since when the manager of the estate has continued to the present day.

Following Mr Murphy's death, the then Director of the Meteorological Service, Dr Austin Bourke, wrote a letter to Miss Murphy and this serves as a fitting epitaph for a dedicated and zealous weatherman.

'. . . we are very grateful especially for the notebooks of your late brother. They will be preserved as a lasting reminder of Mr Murphy's pioneer work for Irish Meteorology and some of the contents of these notebooks will be able to inspire further researches by the growing generation of Irish Meteorologists.

I did not have the privilege of meeting Mr Murphy but appreciate fully the value of his efforts in establishing the Irish Rainfall Association and, through that today, in helping the rainfall division of the Meteorological Service.'



Heavy Falls of Rain in Ireland (daily) 17
(Cont. from p. 15)

1934 (cont.)

2·30 ins.	at Castle Forbes, Co. Longford, on Oct. 24th.
2·30 ins.	at Tuam Palace, Co. Galway, " " "
2·14 ins.	at Westport, Co. Mayo, on Sept. 15th.
2·15 ins.	at Burnaby Lodge, Greystones, Co. Wicklow, on Jan. 13th.
2·88 ins.	at Moycullen, Co. Galway, on Oct. 24th.
3·26 ins.	at Fofanny Reservoir, Mourne Mts., Co. Down, on Dec. 25th.
3·62 ins.	at Baunreagh, Mountrath, Queen's Co., on Aug. 1st. (Record to date)
2·63 ins.	at Silent Valley, Mourne Mts., Co. Down, on Aug 1st

1935

2·61 ins.	at Turraun Peat Works, Co. Offaly, on June 24th
2·89 ins.	at Fofanny Reservoir, Co. Down, on Nov. 20th
2·47 ins.	at Aasleagh Ho., Co. ~~Down~~ Mayo on Oct. 27th
2·45 ins.	at Roundwood, Co. Wicklow, on Feb. 25th
2·34 ins.	at Nohoval, Kinsale, Co. Cork, on Sept. 1st
2·33 ins.	at Garvagh, Co. Derry, on Nov. 11th
2·20 ins.	at Delphi Lodge, Co. Mayo, on Aug. 29th
2·18 ins.	at Scilly House, Kinsale, Co. Cork, on Sept 1st

1936

3·20 ins.	at Florencecourt, Co. Fermanagh, on June 29th
3·10 ins.	at Dunmanway, Co. Cork, on Feb. 10th
3·02 ins.	at Millstreet, " " " " "
2·60 ins.	at Fofanny Reservoir, Co. Down, on Nov. 11th

(cont. on p. 33)

A page from Montagu Murphy's notebooks.

Extreme values of some meteorological elements

by Denis Fitzgerald

What's rare is not always wonderful but is usually interesting. Extremes of the different meteorological elements are of particular importance in applied climatology since they provide limiting values to be kept in mind when designing weather-sensitive systems whose failure may be dangerous or expensive or both.

Because of Ireland's maritime climate the extremes of some elements fall within a relatively narrow range. The air temperature seldom exceeds 30°C, seldom drops more than 10°C below freezing point and rarely remains below 0°C for more than 24 hours. Rainfall rarely results in either destructive flooding or severe water shortage. Strong winds are not unusual but even gales are not invariably accompanied by extensive damage.

EXTREMES OF TEMPERATURE

In the period 1881 to 1985 the highest air temperature reported from a standard site was 33.3°C. This value was observed at Kilkenny Castle on 26th June 1887. A very low value of −19.4°C was observed at Omagh (Edenfel) Co. Tyrone on 23rd January 1881. While it is probable that more extreme temperatures have occurred here, the range of air temperature in Ireland in the past century is indicated to within perhaps one degree Celsius by the values given above.

EXTREMES OF RAINFALL

At Ballaghbeama Gap in the Kerry mountains 3965 mm of rainfall was measured in the year 1960. Over 640 mm of the total fell in November. The station is at an altitude of 308 m above sea level. In the Cummeragh River area of south Kerry (Gauge No. 3, altitude 540 m) 686 mm was recorded in the month of December 1959. This was more than the total for the year 1959 at each of a number of stations near the east coast of Ireland. Although these are extreme values of measured yearly and monthly rainfall, it is virtually certain that greater amounts could have been recorded at other locations in the mountains of Kerry and Mayo if a greater density of gauges had been installed. The gauges which are in Ballaghbeama Gap, the Cummeragh River catchment and other mountain areas are read monthly. Until 1986 none of our daily gauges had recorded a 24-hour fall in excess of 200 mm. On 5th August, in the mountainous Caragh River area of Co. Kerry the Glenvickee station (altitude 128 m) had a fall of 206.5 mm. On 25th August 1986, the lowland station at Kilcoole, Co. Wicklow recorded 200.2 mm, while at Kippure, Co. Wicklow (754 m above sea level) the 24-hour fall was some 270 mm. After a thunderstorm on 11th June 1963 at a site in Mount Merrion, a south Dublin suburb, 184 mm was measured in the 24-hour period ending 2300 GMT. Of this amount nearly 83 mm fell between 1350 and 1455 GMT (1 hour and 5 minutes).

For periods of less than an hour only a limited amount of data has been tabulated. At Orra Beg, north Antrim, there was a truly remarkable fall of 97 mm in only 45 minutes on 1st August 1980. On 26th August 1949 at Waterford (Tycor) 38 mm was recorded in a 12-minute interval.

In 1887 at Dublin (Glasnevin) measured rainfall was only 356.6 mm (14.04 in). This is the lowest annual total that has come to notice since comparable values for different locations have been available. In that very dry year it is remarkable that at all stations in Ireland some measurable rainfall was reported every month.

No rain fell at some observing stations in Ireland during a calendar month in at least five years. In August 1801 no rain was recorded at Dublin (Cavendish Row). In June 1921 no rain fell at Midleton (Ballinacurra) and Dripsey (Woollen Mills) Co. Cork and at Monaghan (Workhouse). In April 1938 a large area in the south and east had no rain. Nil returns came from Clonakilty, Kinsale and Mallow, Co. Cork, from Clonmel and Tipperary, Co. Tipperary, from Waterford (Gortmore) and from Rathdrum (Avondale) and Newcastle, Co. Wicklow. The same year gave us the longest absolute drought of recent times in Ireland. At Limerick (Mulgrave Street) no day from 3rd April to 10th May had as much as 0.25 mm of rain. In February 1965 no rain was reported at Kilronan on the Aran Islands. By October, the year 1986 had the unique distinction of having had two months, February and September, in which no rain was recorded at a number of stations.

A street if Little Bray, Co. Wicklow after the flood of 25th August 1905. (Note the 'tidemark' on the wall of the houses). Similar severe flooding occurred on the same day of August 1986. (Photo: R.M. Barrington, from British Rainfall, *1905)*

Lightning at Ballymun, Dublin at 2 am on 29th June 1986 (Photo: Joseph Duff of Santry, Dublin)

Too much rain in too short a period (Photo: scene after a cloudburst in Drumcondra, Dublin, 26th April 1975, by S. McCarthy)

Flooding is rare, but can have a devastating effect. (Photo: Steve Treacy, Irish Farmers' Journal*)*

The exceptional snow of January 1982 (Photo: scene at Rathfarnham, county Dublin, by P.A. O'Dwyer)

OUTSTANDING SNOWSTORMS

Because of its infrequent and irregular occurrence, snow in large quantities causes serious disruption in Ireland. Major falls are remembered long after their occurrence.

On 19th and 20th November 1807 a disastrous blizzard swept the country and many people were killed. Two transport ships were wrecked on the east coast. Heavy snow prevented the crews from realising how close to land they were.

In a violent snowstorm on 14th February 1853 a ship, the 'Queen Victoria', struck Howth Head with a loss of 55 lives. In 1886 a great blizzard struck northern Ireland and the northern part of Great Britain with snow to a depth of up to 0.6 m. Traffic was disrupted between 28th February and 2nd March. Further noteworthy falls occurred in the winters of 1891–92, 1894–95, 1909–10 (when counties Kerry, Clare and Cork were covered to a great depth for several days), and 1916–1917. In 1917 the most severe snows of the present century occurred. On 25th and 26th January the south and west of Ireland experienced a severe storm which paralysed these areas. Snow to a depth of 0.6 m and drifts to 4.5 m were observed in Co. Mayo. At Carrick-on-Suir (Seskin), the daily snowfalls on 25th, 26th and 27th January were equivalent to 25 mm, 22 mm and 10 mm of water respectively. Low temperatures in the following week delayed the thaw and many roads were impassable for days after the snowfall had ceased. An even more severe storm struck on 1st April 1917 and many places were cut off for several days. Snow lay to an estimated depth of 1.3 m with drifts of 3.0 m.

On 23rd and 24th February 1933 a snowstorm made roads impassable for a period of up to three days and many villages were isolated for periods of up to a week. The snow was associated with a small depression of polar origin and the heaviest falls were in the south and midlands. Snowstorms in the early months of 1947 affected most areas and caused serious hardship, particularly because good-quality fuel for heating was scarce in the years immediately following the Second World War.

The winter of 1962–63 was very severe; between 25th and 31st December snow fell over most of the country and was particularly heavy on 30th and 31st. A depth of 45 cm was measured at Casement Aerodrome on the morning of 31st. Appreciable snow fell again on 15th January. January was exceptionally cold and snow lay in places until after 5th February when snow fell for the last time in that cold spell. Then rain and a general rise in temperature cleared the snow.

Appreciable falls of snow between 28th and 31st December 1978 were followed by frosts of unusual severity on 1st and 2nd January 1979. This cold spell ended on January 6th but there were further snowfalls later in the month.

On 8th January 1982 there was widespread snow, heaviest in eastern areas where there was considerable drifting due to strong easterly winds. A severe cold spell followed and snow remained on the ground until January 15th.

EXTREMES OF SUNSHINE

The southeast corner is the sunniest area of Ireland. The greatest annual duration of bright sunshine was the 1996.4 hr recorded at Rosslare in 1959. Sunshine measurements have been made at Rosslare only since December 1956.

The years 1979, 1980, 1981 and 1983 were extremely dull, with records being made and then broken even at long-term stations and the lowest total at an open unobstructed site was the 889.9 hours recorded at Claremorris in 1983.

A monthly total of 250 hr or more of bright sunshine is unusual but in July 1955 a total of 308.2 hr was recorded at Valentia Observatory.

At the other extreme, in the very dull January of 1974 the monthly total at Glencolumbkille, Co. Donegal was a mere 6.4 hr.

EXTREMES OF ATMOSPHERIC PRESSURE

The highest atmospheric pressure, reduced to mean sea level (MSL), observed in Ireland was 1051.9 hectopascals (hPa) at Valentia Observatory on 20th January 1905 (1 hPa = 1 millibar). The lowest reported MSL pressure in Ireland, 927.2 hPa was recorded at Belfast on 8th December 1886. Examination of the pressures read on the hour shows the extreme three-hour pressure fall to be 23.5 hPa and the highest pressure rise over three hours to be 21.1 hPa. Values somewhat greater than these may have occurred in three-hour periods not commencing exactly on the hour.

EXTREMES OF WIND

The direct reading of actual extreme velocities in Ireland dates from the early years of the twentieth century. However, wind force can be assessed with some accuracy by noting the effect of the wind on the sea and on trees or other suitable objects on land.

The storm on the night of 6th–7th January 1839 probably caused more widespread damage in Ireland than any storm in recent centuries.

This night has become legendary as 'The Night of the Big Wind'. Pressure had fallen rapidly in the west of Ireland on the morning of 6th. Rain and strong winds which built up to hurricane force spread eastwards over the country. Winds reached gale force on the east coast by 2100 GMT. The gale continued till the evening of 7th. The register of observations taken at Dublin (Phoenix Park) records gale-force winds from 2100 GMT on 6th January to 1800 GMT on 7th January inclusive. The 0900 GMT observation on 7th January 1839 is worth giving in full:

> 'Clear, and blowing a gale. A hurricane from about two to four in the morning. Upwards of 160 trees along the pathways in the Park from Dublin Gate to Mountjoy torn up.
>
> Pressure 28.721 inches, [972.6 hPa], Temperature 40°F [4.4°C]. Rain Gauge read at Noon [for past 24 hours] 0.115 inches [only 2.94 mm];
>
> It was estimated that over 2,500 valuable trees were blown down in the Dublin area and some 5,000 houses (20% to 25% of total) had damage ranging from complete destruction to broken windows. Reports from other parts of Ireland and Great Britain show comparable damage in many places. It is reasonable to assume that wind speed exceeded 52 m/s (100 kt) in gusts in many parts of Ireland during that storm.'

The storm of the night of 26th/27th February 1903 was probably the most severe to have affected Ireland since 'The Night of the Big Wind'. In parts of the country it was reported that whole woods were laid low. Damage to roofs, chimneys and buildings was correspondingly great.

The year 1974 began with a very stormy period over Ireland, gales or gale gusts being reported on most days in

January. A storm which passed to the northwest of the country on the night of 11th–12th gave widespread gales, and record speeds were reported from a number of locations. This storm probably did more material damage than any previous one in the present century. Electricity supply to some 150,000 subscribers was temporarily interrupted and damage to telephone lines was correspondingly great. Trees were blown down and buildings damaged. At Kilkeel in Co. Down winds reached a speed of 55.6 m/s (108 kt) in gusts, the highest recorded for a station near sea level in Ireland. A storm on the night of 27th–28th also did widespread damage particularly in the west of the country.

In a series of observations the breaking of the existing record occurs more frequently early than late in the sequence. Nonetheless, publications on extremes require updating from time to time. After the record-breaking rains of August 1986, September was extremely dry and at Dublin (Phoenix Park) it was the driest month in well over 100 years of recording. With the weather gods in such a fickle mood who knows what the future may bring?

Sheep sheltering at the Sally Gap, Co. Wicklow. (Photo: Matt Kavanagh, Irish Times)

Changes in Climatological Data Processing

by Andy McManus

In the Climatological Division (abbreviated to Climat from now on) the period from 1936 to 1986 saw dramatic changes in data handling, from simple office procedures to current methods which rely on a sophisticated computer system. This article charts the sequence of major innovations in the archiving, retrieval and presentation of data which occurred in these fifty years.

In the early years the main work consisted in compiling daily and monthly statistics for our Irish network of synoptic, climatological and rainfall stations. The work was done by a small number of clerical staff, with the aid of mechanical manually-operated adding machines. All data were in manuscript form.

Young clerical staff in the Climatological Division in the early 1940s (Photo: F.E. Dixon)

REGULAR PUBLICATION OF CLIMATOLOGICAL DATA

In 1948, the first edition of the Monthly Weather Report (MWR) and Annual Weather Summary (AWS) was issued. Generally speaking, the tables were modelled on those published by the British Meteorological Office and the aim was to make available to interested parties a range of summary statistics of the data from the observational network. A great drive had been made in the early forties to improve the network of rainfall and climatological stations. At the time of first publication of the MWR four full-time observing synoptic stations (Valentia Observatory, Shannon Airport, Dublin Airport and Midleton), about 25 climatological stations and over 600 rainfall stations were in operation. Observed and tabulated values of weather elements were entered on manuscripts which were then typed on chemically treated paper which could be used on the printing machine for producing multiple copies. The typed tables were carefully checked for errors against the original manuscripts before passing to the print room for reproduction and collation.

Apart from the Monthly and Annual Weather Reports there were very few 'hand-out' sheets to answer public enquiries. Enquiries from the public were relatively few (by modern standards) but many of them involved painstaking research.

EXPANSION OF THE OBSERVATIONAL NETWORK

As the demand for weather information increased steadily in the fifties additional synoptic, climatological and rainfall stations were opened; this increased the volume of data which had to be processed for the MWR but, fortunately, the standard of office equipment had improved and electric calculating machines were acquired.

THE PUNCH CARD ERA

Upper-air observations had been punched on cards at Valentia for use by the British Meteorological Office, and some ships' observations had been punched at Headquarters for transmission to many centres in Europe. But it was not until the late fifties that the use of punch cards and associated equipment was mooted for general use in the Meteorological Service. In the early sixties sets of instructions for the transfer of all synoptic and climatological station data were issued. By this time there were 12 synoptic full-time weather stations, over 50 climatological stations and over 800 rainfall stations. In October 1961 punching of weather data for all synoptic stations commenced. Some of the data were punched at outstations, some at Climat in Dublin. The key punches used were of an old mechanical type, some of which were manufactured as far back as 1919. For checking purposes, in general, it was necessary to punch all data in duplicate; electrically assisted verifiers were used in some areas but were not entirely satisfactory. In November 1963, Climat got its first key punch operator and a second joined the Service in January 1964. One electronic key punch and one electronic verifier were installed in Climat; machine verification removed the need for duplicate punching. With the use of sorters and tabulator in the Office of the Revenue Commissioners, the punch cards were used for computation of some of the Monthly Weather Report statistics, but it was not until time was made available to us on an ICT 1300 series computer belonging to the Revenue Commissioners that the full potential of punch cards was realised. Programs were written to produce tables for the MWR by computer. With the opening of Casement Aerodrome as a full-time station on 1st January 1964, the number of synoptic stations had increased to fourteen. On a 31-day month the data for the synoptic stations for the MWR were held on 21,700 cards.

As there were no back-up peripherals such as magnetic tapes, it was essential that the data be correct and that cards be in good condition before being processed by the computer. To enable Climat to achieve this accuracy and quality, a sorter, tabulator and reproducer were installed. At this stage most of the noisy mechanical and 'electrically assisted' calculating machines had been replaced by small silent electronic calculators.

The next major step forward came when a computer became available which had the advantage of having a quarter-inch magnetic tape, where tabular data could be stored until print time. Then updating data files was considerably easier and it was possible to bring the magnetic tape on which the tables were held to other computer installations for printing. High quality printing on the chemically treated stationery was not always easy to achieve on the printer which produced 600 lines a minute.The print quality was better on slower printers and so time was bought on computer systems with printers which produced 300 lines a minute.

By 1966, with all work for monthly and annual publications running smoothly, there was time in hand to key in pre-1962, synoptic-station data with a view to the production of tables and statistical analyses of the long-term figures. The volume and variety of tables available to answer enquiries were dramatically increased.

Data-processing capabilities expanded further with the acquisition by the Revenue Commissioners in 1968 of a Honeywell 2200 series (two computers) machine. This new computer was a big improvement on the old; lack of memory space was no longer a problem, speeds were faster, there were eight magnetic tape drives and two printers with each computer. However, running several programs at the same time was not possible, although a 'print only' job could be run simultaneously with another program.

The punching of 'back data' both in Climat and outstations continued steadily. Until the advent of computers, the checking of data for accuracy and consistency was very tedious and time-consuming. Computers made possible more extensive and more rapid checking of each station's data for internal consistency, and comparisons with neighbouring stations could be made much more comprehensive.

THE IRISH METEOROLOGICAL SERVICE COMPUTER — STORAGE OF DATA ON DISC

Two DEC-1140 computers were acquired in the Meteorological Office in Upper O'Connell Street in 1975. They were used primarily for communications and were only used occasionally to do 'once off' jobs for Climat. Most of the staff of Climat moved from Marlborough Street to the new building in Glasnevin in 1979. A few staff remained to process the last of the back data and to put it on tape for retransfer to the new mainframe DEC-20 computer which was then installed in Glasnevin.

In 1980 all synoptic weather stations began sending in their observations directly to the computer via telex. A Mohawk system was installed so that the data now received from climatological and rainfall stations were keyed in on floppy disk for transfer to the mainframe computer via the DEC-1140. Programs were written in the Climatological and Computer Divisions for more efficient computerisation of all the climatological work. The punch-card era had ended.

The task of transferring all data from the 7-track tapes of the Honeywell system to the 9-track tapes of the DEC-20 was completed and all data from synoptic stations from the time of opening, rainfall stations back to 1941 and climatological stations back to 1966 are now available for processing. Much work has yet to be done in the transfer of pre-1941 rainfall data and climatological station data for the pre-1966 period.

USING THE COMPUTER TO PRODUCE PUBLICATIONS

One of the most popular publications of the Climatological Division is the Monthly Bulletin issued on the first working day of each month since November 1956. It originally consisted of a written description of the main features of the month's weather (mainly as recorded at the synoptic stations), a table of their rainfall, air-temperature and sunshine statistics and a map of rainfall totals. The format of this bulletin remained almost unchanged for many years. In recent times there has been a major change in format. The work has been almost completely computerised and the methods of computer graphics are to the fore in the new, expanded bulletin. This is typical of the changes made possible by advances in computer science.

The main functions of Climat are now exactly what they were in 1936: to quality-control and archive weather data, to produce weather statistics of benefit to the nation and to weather organizations worldwide. To enable it to fulfil this task it must maintain a network of reliable stations. Modern technology has enabled it to produce statistics and information of a volume and range impossible in the 'pen and ink' era. However, it would be a mistake to forget the painstaking effort of the pioneers in Climat who set a standard of which they can be justifiably proud. Our aim today is to add to the great resource we now possess in the climatological data bank and to keep up the standards of care and accuracy which were always a central concern of our predecessors.

Data entry and verification are much easier now using the Mohawk terminals

Valentia Observatory

by Eamon Murphy

Valentia Observatory is about 1 km south-west of the town of Cahirciveen on the well-known tourist route, the 'Ring of Kerry'. The Observatory derives its name from the fact that it was originally established on nearby Valentia Island. Meteorological observations began on the island as far back as 1860 when the system of weather telegraphy was introduced by Admiral Fitzroy. The work was undertaken by R.J. Lecky, manager of the telegraphic station, and the first report issued was for 8 am on 8th October 1860. These reports continued until 1867 when the Meteorological Committee of the Royal Society decided to establish an observatory on the island. Accordingly, a dwelling-house was rented and prepared for the installation of instruments etc. This house was situated on the shore of the strait separating Valentia Island from the mainland at Latitude 51° 54′ N, Longitude 10° 18′ W. Here, the Observatory routine was maintained until March 1892 when the Observatory was transferred to its present site on the mainland, then known as Westwood House, at Latitude 51° 56′ N, Longitude 10° 15′ W.

EARLY MANAGEMENT

The Rev. T. Kerr entered into residence as the first Director of the Observatory on 15th June 1868 and continued in office until his death on 21st August 1875. J.E. Cullum took over the reins on 22nd August 1875 and was appointed Superintendent the following November; he was at the helm for almost 40 years until his retirement on 20th April 1915. During 1890/1891 it was planned to expand the Observatory work programme, and the Meteorological Council came to the conclusion that 'it is very desirable to take advantage of an opportunity that has now presented itself of securing, for what may be practically regarded as a permanency, a building much more conveniently situated and otherwise more suitable than the house now occupied for this purpose'. The Meteorological Council had 'at their command a sufficient sum to purchase the lease, viz., £1,400, and they can without any difficulty meet all other charges that may arise in connexion with the transaction'. The building in question was Westwood House, which had been occupied by a Captain Needham. Needham was the agent for Trinity College, which had major land holdings in the area. The purchase of Westwood House by the Royal Society, from the funds of the Meteorological Council, was completed in the month of March 1892 and the change of the Observatory to its new location was completed on the 28th of that month.

At that time, and indeed until 1971, transport from Valentia Island to the mainland was effected by boat. A wooden hut, which was used to house magnetic instruments, was secured to a raft and towed to the mainland for relocation on the new Observatory site while the instruments were transported by ferry.

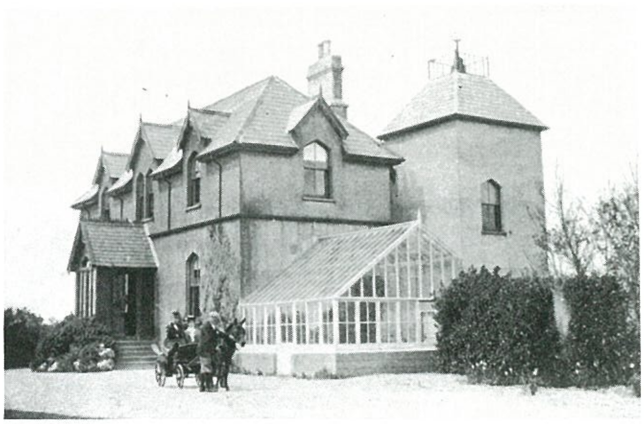
On 1st May 1915 L.H.G. Dines, Senior Professional Assistant at Eskdalemuir Observatory, took up his appointment as Superintendent at Valentia Observatory. There are a number of instruments, well known to the meteorological community, which are associated with the Dines family e.g. the Dines pressure-tube anemometer, the Dines tilting-siphon rain recorder and the Dines float barograph. The inventor of these instruments was W.H. Dines, father of L.H.G. Dines.

C.D. Stewart succeeded L.H.G. Dines on 1st July 1922. It is noteworthy that, during the troubled period 1915 to October 1921, Mr Dines and his family only managed to have one holiday together away from Westwood House. Transport was difficult and expensive and there were, undoubtedly, inherent dangers involved. The Stewart family departed on 1st November 1927 and, while Mr Stewart retained overall responsibility for the Observatory, a Cahirciveen man, Michael J. Morley, was the senior man at the station until the arrival of the incoming Superintendent M.T. Spence on 21st April 1928. Spence was succeeded by H.F. Jackson on 3rd January 1934.

TRANSFER TO THE NEW IRISH METEOROLOGICAL SERVICE

Responsibility for the staffing and operation of the Observatory and other meteorological stations had remained with the British Meteorological Office since the foundation of the Irish Free State. On 1st April 1937 the transfer of control to the newly formed Irish Meteorological Service took place. However, in the case of the Observatory, it was agreed that, pending the appointment of a full complement of Irish Free State staff, the Observatory would be operated by the Meteorological Office, London, on an agency basis.

Mr Jackson returned to Great Britain on 2nd October 1937. The newly appointed Officer-in-Charge S.G.G. Kelliher had assumed duty on the previous day. I. Lambert took charge in mid-October 1940 and was succeeded on 1st December 1944 by S. McWilliams who remained in charge until 5th November 1979.



Valentia Observatory in the 1920s (Photo: Meteorological Office, The Observatories' Yearbook 1922*)*

Valentia Observatory has played, and continues to play, a very important role in the world of meteorology. Because of its strategic location on the western edge of Europe, all its surface and upper-air observations are of great interest to weather forecasters, especially in Europe. With its long history and tradition, the Observatory is well known to many members of the scientific community world-wide.

During the years since 1892 there has been a steady and gradual expansion in the activities undertaken at Valentia. At the time of the transfer from Valentia Island, other instruments were added to those already in use so that the Observatory at Westwood House started off with equipment which was the latest available at that time. These instruments included a Robinson cup anemograph, a Fortin barometer, a Beckley automatic raingauge and a photographic barograph and thermograph (wet and dry bulb) which were the first of their kind and provided continuous records of pressure, temperature and humidity.

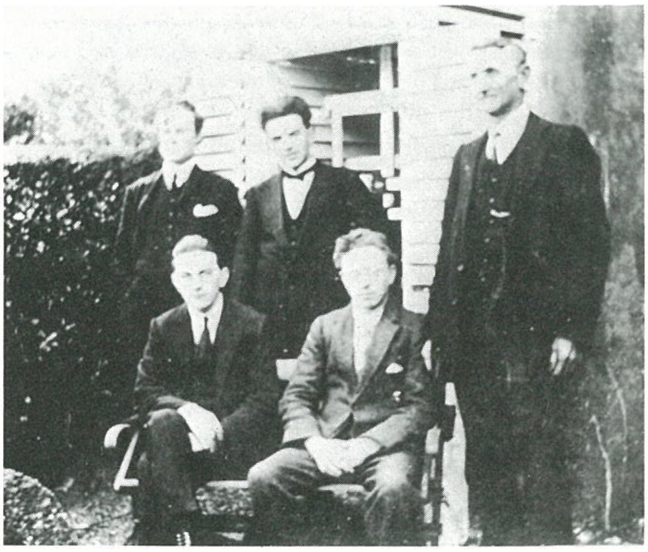
Until 1937, the Observatory was maintained by the British Meteorological Office and was provided with the best equipment available. It was often used as a testing site for newly developed equipment. A new type of barograph (Dines float barograph) was introduced in 1921. In 1924 a prototype of a new wind-measuring instrument — the Dines pressure-tube anemograph (PTA) — was installed for field tests. In 1931 an improved version of this PTA replaced the Robinson cup anemograph as the official station instrument. In 1934 the Jardi rate-of-rainfall recorder was installed and is still maintained as the official recorder for this purpose.

STRATEGIC IMPORTANCE FOR TRANSATLANTIC FLIGHTS

The first transatlantic flights to and from Foynes took place in the summer of 1939. The outbreak of World War II in September of that year curtailed the amount of meteorological information available for analysis and forecasting. In order to improve the situation resulting from the reduced number of reports, it was decided to increase the frequency of observations, and hourly synoptic observations were introduced as from 3rd September 1939. With greater demands from forecasters for upper-air data, because of the increased emphasis on aviation requirements, radio-sonde measurements of pressure, temperature and humidity were introduced twice daily in September 1943. Upper-wind measurements were made by tracking the balloon with a theodolite. An American-type radio theodolite was introduced for upper-wind observations in 1946 and this was replaced in 1948 by a converted British Air Ministry anti-aircraft radar which was maintained in service until 1968 when it, in turn, was replaced by a more modern Cossor-type wind-finding radar. This equipment is still in use. In 1961, an electrolytic hydrogen plant was installed to provide, on site, the hydrogen required for the upper-air balloons and this facilitated the introduction of radar wind ascents four times daily as recommended by the World Meteorological Organization.

THE VARIED FUNCTIONS OF THE OBSERVATORY

The scope of the geophysical activities was also being extended. In 1953 a set of variometers and recorders was installed to provide continuous records of the variations in declination, horizontal force and vertical force of the earth's magnetic field and in 1977 a proton vector magnetometer was installed for the absolute or baseline control measurements.



Staff at Valentia Observatory c. 1920: (from left) L.H.G. Dines (Superintendent), Michael and John Morley (Boy Clerks), P.I. Mulholland (Professional Assistant) and M. Sugrue (Supernumerary Clerk) (Photo from F.E. Dixon)

Global solar radiation observations were begun at Valentia in 1954 and the observational programme has expanded since then to include diffuse sky, direct sun and infra-red radiation together with observations of the net radiation balance, atmospheric turbidity and observations of the radiation received on a vertical south-facing surface.

Air and precipitation samples have been collected and processed during the last 30 years for chemical analysis and for radioactivity monitoring. Twice-daily observations of the concentration of atmospheric nuclei were begun in 1950, and since 1976 there has been continuous recording of this concentration using samples taken from the atmosphere every half-hour. In 1962 the Meteorological Service was invited to participate in the 'World-wide standard seismograph network' organised by the United States Coast and Geodetic Survey. The equipment, supplied by the survey, was installed at Valentia Observatory in a specially prepared semi-underground vault and consists of short-period and long-period vertical and horizontal seismometers and recorders, together with associated monitoring consoles.

Staff and trainee meteorologists at Valentia, c. 1940: From left (back), Jack Staunton (Observer), Gerry Granville, Barney McNamee, Kilian Rohan, Barney Doherty; (front) Gerry O'Sullivan (Observer), Hubert Lamb (Officer-in-Charge), Tom Morley (Senior Observer), Con Gillman (Photo: C.J. Gillman)

In cooperation with the German Meteorological Service an International Phenological Garden is maintained at the Observatory, as part of a network of such gardens in Europe, in order to study and compare the growth of plants in different climatic conditions. Evaporation measurements, which were begun in 1921, have continued and in 1952 a Thornthwaite evapotranspirometer was brought into use.

The Observatory facilities include well-equipped workshops for woodworking, metal-work, instrument making, radar and electronics which are staffed by qualified technicians. Much of the station equipment and some of that used in the Meteorological Service is manufactured at the Observatory.

Over the past 120 years the observational programme and range of activities at Valentia Observatory has been considerably developed and expanded to meet the current needs of the meteorological community. These needs continued to increase as more and more people become aware of the important role of meteorology in their lives on planet Earth, and of its social, environmental and economic aspects.

Radiosonde balloons are released at 12-hourly intervals at Valentia

Visitors are welcome to Valentia Observatory any Thursday morning during the summer season when a tour of the establishment may be arranged commencing at 1115 am and ending with the launch of the hydrogen-filled balloon at 1230 pm (1130 GMT).

Valentia Observatory, the main building as it is now

Aviation meteorology in Ireland — from flying-boats to jet aircraft

by Kilian Rohan and Con Gillman

Prior to World War II, large aircraft developed on two separate lines: land planes and flying-boats. The land plane, used for overland flights, required aerodromes but, as practically all these were grass-covered, aircraft weight was inhibited. There were also technical reasons which made for faster development of the flying-boat. One was related to structural engineering, and another was the advantage of using the perfect universal landing surface — water, both at the destination and in emergency. In addition, for administrative reasons the flying-boat was more attractive; to the USA for rapid communication with the Caribbean and South America; to Britain for its colonies; to France and Germany for their spheres of influence.

By the early 1930s enough confidence had been gained to plan a regular flying-boat service across the Atlantic. At a conference in Ottawa in 1935, the governments of Ireland, Great Britain, Canada and the USA agreed on the administrative framework and the provision of the necessary back-up services. These included landing facilities, and radio, air traffic control and meteorological services.

EARLY DAYS IN FOYNES

When the Irish Meteorological Service was established in December 1936, commercial flights were already operating between Ireland and Britain, and Foynes had been selected as the base for experimental flights by flying-boat expected to begin in 1937. One of the first priorities of the Service was the establishment of an observing station and a forecasting office at Foynes to provide a service for these flights.

Thanks to the availability of a small group of very competent professional staff, seconded on loan by the Meteorological Office in London, the forecasting office in Foynes was in operation temporarily from 15th February to 17th March 1937. The office was located in the back of the upper storey of the former Monteagle Arms Hotel. An observing station was set up in a level field near the office, and a pilot-balloon enclosure and a hydrogen store were erected near the pier by the Foynes Harbour Trustees.

The office was reopened on 15th April 1937 when a small staff began providing a meteorological service to flights and arranging for special weather observations for landing and take-off to be made by trained observers aboard the air traffic control launch. Then, as now, a good communications service was essential for a forecasting office. This service was provided by Shannon Aeradio, then located within the Department of Posts and Telegraphs, and synoptic data from Europe, the North Atlantic and North America enabled the forecasters to produce weather charts and forecasts. A full meteorological organization was in operation in time for the first survey flights on 5th July 1937 when the Imperial Airways 'Caledonia' operated the first westbound flight from Foynes to Botwood, Newfoundland, and the Pan American Airways 'Clipper III' completed the west-to-east crossing to Foynes on the following morning.

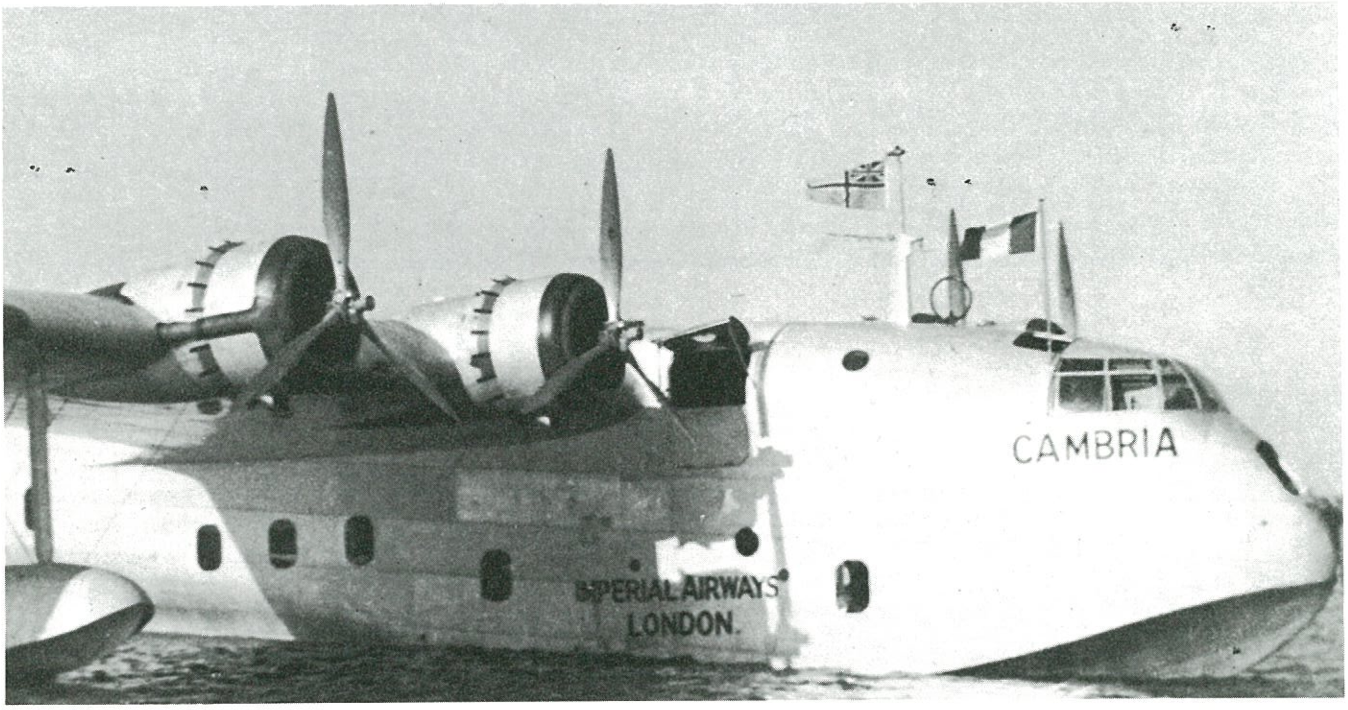
Further proving flights were carried out in 1937 and 1938 with flight times westward up to 17h 18 min, and eastbound as low as 10h 33 min. (This last record was set by the 'Cambria' on the final survey flight when she returned to Foynes from Botwood on 28 September.) On the basis of the experience gained during the proving flights an Air Conference, held in Dublin in March 1938, laid down procedures for Atlantic flights; these procedures were little changed in the immediate post-war period.

THE FIRST PASSENGER FLIGHTS FROM FOYNES

When the first scheduled passenger flight arrived at Foynes on 28th June 1939, the meteorologists at Foynes had already considerable experience of Atlantic weather, and the meteorological office had developed into a smoothly functioning unit. Weather reports were being received on

The flying-boat base at Foynes (Photo: P.K. Rohan)

View of Foynes, facing East, in 1941 (Photo: C.J. Gillman)



Imperial Airways flying-boat 'Cambria', which flew between Foynes and Newfoundland in 1937 (Photo: C.J. Gillman)

a continuous basis, charts plotted and analysed and forecasts prepared. Although the forecast chart was produced by subjective means, it was the basis for forecasting numerical values of wind speed, wind direction and temperature for a number of flight levels for each 5-degree zone of longitude, along the anticipated track.

The flight documentation supplied to flights consisted of 12 to 18 typewritten pages of very detailed forecast information for the route — a general statement of the meteorological situation, forecasts of surface and upper-level conditions at intervals of 5° longitude, forecasts of conditions at the aerodrome of destination and alternates, together with actual and forecast charts of conditions at surface level. Advisory information supplied by the destination aerodrome for the second half of the route was also available for consideration. An adaptation of the format was used for the flights from Foynes to Lisbon and to locations further south when these began during the war years.

PRE-FLIGHT BRIEFING

At the pre-flight weather briefing the forecaster stood on his own, with his charts and weather reports — rather like an expert witness in court. The audience included the aircraft commander, co-pilot, navigator and radio operator, frequently a double crew, as was necessary with flights possibly lasting twenty hours. Also present was the company flight operations officer (dispatcher), and frequently the company station manager and air traffic controller. The questions were searching; possible deviations from the forecast were discussed and assessed by the commander, co-pilot and navigator.

Finally, when all concerned were satisfied, the last documents were signed, crew and passengers embarked and the aircraft proceeded to the take-off point. After the take-off the tension continued at the meteorological office, as the weather along the track of the aircraft was kept under close surveillance. Major position reports were received from the aircraft each hour, together with a full report of wind, temperature and clouds, with a simpler report each half-hour. These reports were carefully studied by the meteorologists, and updated information and, if necessary, amendments were radioed to the aircraft.

WARTIME FLYING

By late 1940, because of the war, data were no longer available from the continent of Europe with the exceptions of Spain and Portugal, there were no weather reports for the Atlantic and only a small selection was available for Great Britain, Iceland, North America and later Greenland. Aircraft weather reports (received for the transatlantic flights by special codes) and debriefing reports for incoming crews made it possible to provide an acceptable level of service to transatlantic aviation during this time. It might be appropriate to mention that in the five years of the war, despite such scarcity of data and with aircraft of limited range, relatively few civil flights had to return to Foynes because of weather conditions and there were no fatal accidents on the direct westbound route.

The 'Mercury' at Foynes, c. 1938/9. The 'Mercury' was the upper component of the 'Short-Mayo composite' — a 'pick-a-back' device consisting of two aircraft locked together for take-off. The lower aircraft, the 'Maia', provided the power needed for take-off up to a suitable height, when the 'Mercury' was released. The 'Maia' was destroyed in a bombing raid in 1941, and the 'Mercury' was broken up two months later. (Photo: F.E. Dixon)

Weather data were largely exchanged in cypher, and clerical staff were posted to Foynes to code and decode confidential meteorological and operational information. A military guard was placed on the building for some time and tight security was maintained during most of the wartime period.

By 1942, the volume of aviation traffic had grown considerably with a corresponding increase in personnel from airline companies, Customs, Intelligence and other staff posted to Foynes, and the local people made a great effort to accommodate the extra staff. As staff numbers grew it became impossible to house them all locally and, in spite of wartime scarcity of transport, a bus service between Limerick and Foynes had to be provided to cater for some workers who lived in Limerick.

At the start of the war the state staff rented a small house for a club for off-duty recreation. It had card tables, billiards and table tennis and a small lending library. Later, thanks to the generosity of a local farmer, it was possible to set up a grass tennis court. Towards the end of the war years a new club premises was provided which included a dance area.

LAND PLANES — OPENING OF SHANNON (RINEANNA)

Work on the provision of land-plane facilities at Rineanna had begun before the outbreak of the war. Runways, a terminal building, an Air Traffic Control tower and other facilities were available when in October 1945 all operational staff and all but a few meteorological staff were transferred overnight to Shannon. The first land planes were Douglas DC4 Skymasters which normally flew unpressurised at 8,000 or 9,000 feet, against the 2,000 feet used by the flying-boats, while their air speed was about 75% greater. They had an excellent de-icing system, and could operate over the North Atlantic in both directions in winter.

When on 26th November 1945 a Constellation L-049 owned by TWA landed at Shannon, a new era of pressurised flight was ushered in. The Constellation had a ceiling of 18,000 ft, and a speed roughly 20% greater than the DC4.

The requirements for meteorological service for land planes differed considerably from those for flying-boats. They operated most efficiently at higher levels and consequently needed forecasts of wind, temperature and weather at those levels. The range of the early transatlantic land planes was not much greater than that of flying-boats. It was such that westbound flights were often not able to fly non-stop to New York, Boston or Montreal in winter. They could land at any of a number of airports in Newfoundland, the Maritimes and Labrador. In addition, they had the alternative routeing through Iceland and the Azores. Forecasts had to include forecast charts at 700 hPa (3 km) and later 500 hPa (6 km) levels as well as at surface level (1 hPa = 1 millibar). Information on temperatures and winds at flight levels was critical and the risk of icing and turbulence had to be indicated on an area basis. Pictorial route forecasts, supplemented by tabular winds, showed areas of precipitation, cloud distribution, turbulence and icing. The volume of air traffic increased rapidly and the number of operating companies grew. As a result meteorological service was required by ground operational staff at an increased number of local offices. In the autumn, when westbound passenger traffic was at its peak, strong headwinds often caused a curtailment of pay load and the passenger terminal became overcrowded with delayed passengers.

The Meteorological Service was unable to recruit and train enough Irish meteorologists to meet the increased demands. This problem was temporarily solved by employing foreign meteorologists supplied by the US Weather Bureau, American transatlantic airline operators and some European meteorological services. At one time in the early 1950s there were staff in the meteorological office at Shannon employed under thirteen different conditions of service. These meteorologists, who made a very good contribution to the work of the office, were gradually replaced in the mid 1950s.

As Superconstellation and DC6/DC7 aeroplanes came into use, there was an increase in the range and capacity of the aircraft. As 'pressure-pattern' and 'minimum-time track' flight-planning techniques were extended, a multiplicity of routes and flight levels began to be used. It was no longer possible to provide individual forecasts for each track and so the concept of the 'area forecast' was introduced. In particular, a significant weather chart depicting the route weather for the whole of the North Atlantic could be prepared and given to all aircraft on selected routes.

The year 1958 was the busiest pre-jet traffic year at Shannon, and the demand for meteorological service reached its peak. The introduction of new aircraft such as the DC7C and the Superconstellation with increased fuel capacity and range resulted in an increase in the number of direct routine flights from the mainland of Europe to North America, and this caused a lull in flight operations at Shannon after 1958. However, with the growth of the national airlines and with some foreign airlines maintaining their flight operations offices locally, a new requirement to provide information on polar routes between such places as Paris and Los Angeles emerged.

JET AIRCRAFT

The feasibility of civil jet air transport had been established during the 1950s by the Comet flights which normally did not operate through Shannon but, to cater for a later need, charts at 300 and 200 hPa levels were prepared on a regular basis. When the American large civil jet aircraft (Boeing 720, 707, DC8 and larger aircraft) commenced operations in the late fifties and early sixties it was necessary to provide information up to 200 hPa level (c.12 km). To avoid the need for a multiplicity of charts, information above the 300 hPa level was given in a single chart depicting the location of the tropopause and the vertical structure of the wind and temperature field. This in turn helped to highlight the areas of risk of clear-air turbulence, which is a phenomenon of special concern to these high-speed aircraft.

In the mid 1960s, when long-range jet aircraft were operating out of numerous airports in Europe, it was agreed internationally that, with improved computer support, communication facilities and good copying equipment readily available, it was wasteful of resources to expect each departure airport or even each national meteorological service to provide planning and in-flight documentation for long-distance flights of jet aircraft. Responsibility for preparing documentation for all transatlantic flights was eventually allocated to London, and for long flights over Europe to Frankfurt-am-Main. The Irish airports were connected to these centres by facsimile circuits to allow for the reception of the required charts, and this relieved Shannon of the need to prepare forecasts for long-distance jet flights. Briefing and

A Boeing 314 in flight over the Puget Sound. Eleven of these aircraft maintained a regular Transatlantic Service to Foynes from May 1941 to October 1945 (Photo: Boeing Company)

display facilities are still needed there as well as in-flight weather watch for all aircraft in the Shannon Flight Information Region. This latter service now has the support of a weather surveillance radar installation at Shannon.

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While it is inevitable that the history of meteorological services to aviation in Ireland is closely linked with developments at Foynes and Shannon, it must not be forgotten that the opening of state airports at Dublin (1940) and Cork (1961) necessitated the establishment of meteorological offices at these airports, from which comprehensive services are provided for aviation, both commercial and private: these services are described elsewhere in this book.

A modern jet plane in flight (Photo: Aer Lingus)

The war years in the Meteorological Office, Dublin Airport

by Wally Kavanagh

My introduction to the Meteorological Service was back in 1941 when the Controller of the Central Telegraph Office, GPO, informed me that I was to instruct the Radio Officers in the Operation of teleprinters.

In those days, because of petrol rationing, the common mode of transport was the bicycle. Travelling out along the Swords Road and up along the old Airport Road (now closed) I arrived at an old one-storey red-brick building which displayed a plate 'Dept. of Industry and Commerce Meteorological Service'. This is where the Collinstown Airport Meteorological Office was located. The old building was understood to have been used as a hospital unit by the RAF during the First World War. It consisted of a concrete floored hallway with two rooms on either side: on one side the Meteorological Office and the other side the Morse and teleprinter rooms.

The teleprinter had just been installed and the transmission of the first message gave rise to some excitement in the office. The first message was a lengthy one of five-figure code groups and it was transmitted to 'somewhere in England'. I was ably assisted in the transmission of the message by the then Officer-in-Charge, Austin Bourke.

The Morse code was used for the transmission and reception of weather data to Foynes. In those days we received hourly reports from Malinhead Radio, Belmullet, Valentia Radio, and Whitegate (Cork). These came from the GPO Dublin by telegram. Foynes supplied other reports over the Morse circuit. All these reports were then put into a code and transmitted by teleprinter to 'somewhere in England' (in fact to AMMET, the Air Ministry, Dunstable).

As far as I can recollect the airport meteorological service operated from the old red-brick building until March 1942 when we moved to the terminal building of the airport. The Service was allocated rooms on the third floor of the terminal building directly under the control tower. Morse working to Foynes ceased and a teleprinter circuit was established to Shannon Airport. Our duty roster covered 24 hours of the clock and attending for night duty gave rise to anxiety as we were frequently challenged by Military Guards.

Recently, when searching through some old documents I was delighted to come across a teleprinter message which arrived when I was on night duty at Dublin Airport in 1943 — a New Year's greeting, a copy of which is shown below.

In an effort to recall all my friends in the Meteorological Office in those years the following names come to mind:

- Meteorological staff : Messrs Bourke, Gillman, Twomey, McNamee, Molloy, O'Brien, Roche, Brennan, McCrum, Cass, Smith;
- Radio staff: Messrs Thorpe, Hughes, McCarthy, Leonard, Molloy, Ferguson, Duggan, Millar.

My service with the Airport Meteorological Office terminated in 1945 when three other colleagues and myself were recalled to the GPO. Working under 'Emergency conditions' in the Dublin Airport Meteorological Office from 1941 to 1945 gave me the most memorable years of my career in the Civil Service.

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ODD ODE
HERES HOPING THAT THE YEAR FOUR THREE
THE FINAL END OF WAR WILL SEE
WHEN BACK FROM OBS AND PLOBS WE'LLL BE
LISTENING TO THE B B C
WHERE FRANK OR JOSEPH QUITE UNNETTLED
ANNOUNCE AN OUTLOOK MOST UNSETTLED
NO ICELAND LOW WILL DRIVE US FRANTIC
NOR ANY FRONTS THAT CROSS THE ATLANTIC
AS WE SIT BACK AND TAKE OUR EASE
DOING WHAT WE DARN WELL PLEASE
INSTEAD OF PLOTTING ALL NIGHT LONG
LET US SING THIS JOYFUL SONG
'NO MORE THUNDER, HAIL OR RAIN
 NO MORE PORTUGAL, AZORES OR SPAIN'
WHAT CARE WE THOUGH THE BAR MAY FALL
A GUID NEW YEAR TO ONE AND ALL
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Teleprinter message received at Dublin Airport on New Year's Day, 1943

The Air Corps

by Andy Roche

One must go right back to the early days at Foynes and Rineanna to record the start of half a century of cooperation between the Air Corps and the Meteorological Service. It was, in fact, with the Air Traffic Controllers rather than with the pilots of the Air Corps that our Service began its association.

Only those who have witnessed the early days of the transatlantic flying-boats can fully appreciate the rapid growth of Irish Air Traffic Control (ATC) from its origins in the hands of Air Corps officers to its present international status. Pioneers of the infant service were Captain Ned Stapleton and Lt Joe Kearney. Their efforts were supplemented later by other Air Corps pilots including Jim Liddy, Larry O'Toole, Jim O'Brien, Tom Cregg, Jim Devoy, P.J. Flanagan and Sean Kelleher.

Across the Shannon from Foynes a detachment of four Ansons and two Walrus Amphibians began patrols around the south and west coasts from Rineanna. These squadrons were under the command of Captain W.J. Keane. All the officers already named were, along with many others, to play a vital part in the later development of the strong bond of friendship and cooperation that exists to this day between the Air Corps and our own Service.

HISTORY

A local meteorological forecast centre existed at Baldonnel in 1919. This catered for the meteorological needs of the British Army and Royal Air Force. It was closed in 1922 and its functions transferred to Collinstown, but later that same year, with the establishment of the Irish Free State, the facility was discontinued for the time being. Subsequently, meteorological forecasts and reports were directly available only from London. The British Meteorological Office provided detailed route and landing forecasts for the first successful westbound flight — that of the German monoplane 'Bremen' from Baldonnel to Newfoundland in 1928. This was an aviation event of world-wide importance which brought great honour to the Air Corps and to the newly independent State. Captain Kohl and Baron von Huenfeld were joined by Comdt J.C. Fitzmaurice of the Air Corps for this historic flight; the 'Bremen' and its crew of three took off from Baldonnel on 12 April 1928 and made a forced landing in Newfoundland on the following day.

In November 1935, the Department of Industry and Commerce arranged a conference, comprising representatives of the Departments of Finance, Defence, Post and Telegraphs, Agriculture and Education, to discuss the provision of meteorological services in Ireland. Since 1922 these services had been provided from Britain. It was decided to look into the possibility of establishing an agency to provide these facilities and also to take over the observational network, which until then had been under the control of the British Meteorological Office. The Irish Meteorological Service was formally established with the appointment of Austen Nagle as Director in December 1936, and arrangements for the recruitment of staff began shortly afterwards.

The Air Corps lost no time in advancing their needs for meteorological services. At the request of the Department of Defence, A.H. Nagle and S.P. Peters met Col. P.A. Mulcahy (O/C Air Corps) and Capt. W.J. Keane at Baldonnel on 13 October 1939. The conference discussed the provision of meteorological information for the Air Corps and the Defence Command and the training of Air Corps personnel in meteorology. At that time the Air Corps had approximately 50 aircraft in operation including 4 Gloster Gladiators, 15 Miles Magisters, 3 Walrus Amphibians, 6 Lysanders, 9 Ansons and a de Havilland Dragon. It was decided to relay routine daily flight forecasts from the Meteorological Office at Foynes to Rineanna and Baldonnel by priority telephone and telegram. The Air Corps, for its part, would make one of its aircraft available for a daily flight at 1200 GMT to record upper-air values of wind, temperature, humidity and pressure. It was also agreed that an officer of the Meteorological Service would attend regularly at Baldonnel to give lectures and arrange examinations in meteorology for Air Corps pilots. Hubert H. Lamb (now Emeritus Professor of Climatology at the University of East Anglia) began giving these lectures in October 1939. Prior to this, Father Bill O'Riordan (mathematician, and Chaplain at Baldonnel from 1922–1957) gave informal lectures in meteorology to the trainee pilots.

During the Second World War, information on both the Meteorological Service and the Air Corps was restricted for security reasons, but the following areas of cooperation are known to have existed in the 1939–1945 period:

- regular transmission of forecasts from Foynes to Baldonnel and Rineanna;
- provision of training in meteorology to Air Corps personnel;
- provision of meteorological equipment;
- supply of photographs of all identifiable cloud types for inclusion in an Air Corps booklet to assist military personnel in estimating the flying height of foreign aircraft;
- daily upper air ascents at Baldonnel and, from January 1942, at Rineanna.

During the war years the Service experienced severe staffing difficulties. The demand for forecasts for aviation and domestic needs was increasing at such a rate that the intake of both professional and sub-professional staff was totally inadequate. As a consequence, the personnel originally envisaged for assignment to Air Corps installations — a Meteorologist and a Senior Meteorological Officer (SMO) for Baldonnel and an SMO for Gormanston — could not be spared. The best that could be done was to train Air Corps personnel to make hourly weather observations and to provide them with training and technical back-up from very limited resources.

In 1948, a report on the required network of Irish Meteorological Reporting Stations was prepared. At that time, a reporting station of sorts existed at Baldonnel. An instruments enclosure had been prepared, with instruments supplied by the Meteorological Service, and Air Corps personnel attached to the Control Tower at Baldonnel had been trained in weather-observing techniques. Coded reports were sent to the Meteorological Office at Dublin Airport. The 1948 plan proposed that four categories of meteorological observing stations be established :

- Class A: coastal stations staffed by Meteorological Officers (MOs) with an SMO in charge;
- Class B: inland stations staffed by Assistant Meteorological Officers (AMOs) with an MO in charge;
- Class C: lighthouse stations staffed by Irish Lights staff;
- Class D: military stations staffed by Air Corps personnel supplemented by Meteorological Service staff.

Throughout the period 1948-1958, the air Corps continued to urge the posting of the sanctioned meteorological personnel to Baldonnel and Gormanston, but shortage of staff in the Meteorological Service made it impossible to comply. The demand for forecast services was increasing at an unforeseen rate, particularly on the North Atlantic, and recruitment difficulties, unexpected resignations and the lengthy in-service training made it necessary to postpone the Air Corps appointments, much to the frustration of the senior staff of the Air Corps. The deficiency was made more apparent by the appearance of more sophisticated aircraft on the tarmacs at Baldonnel and Gormanston — de Havilland Chipmunks in 1952, a de Havilland 10-seater Dove in 1953, Provosts in 1954, and finally the Vampire Jets in 1956. Apart from cross-country training flights, the Dove was used for aerial photography on behalf of various Government departments, and for VIP flights to various parts of Ireland, Britain and Europe, while the jets required forecasts of winds and temperatures at levels up to 40,000 feet.

It was understandable that the Air Corps felt the pressing need for a resident meteorologist. A further strain on the situation arose in the mid-fifties when it became increasingly difficult for the Air Corps to make personnel available for training and subsequent duty as weather observers. In early 1958, the Air Corps notified the Service that after May of that year it would not be possible to provide weather observations from Baldonnel. As it would be impossible to provide landing forecasts for the aerodrome without surface observations, it was decided to assign one full-time SMO and one part-time MO to provide half-hourly observations 0745-1645 GMT (Mondays/Fridays) and 0745-1300 GMT (Saturdays). These officers would also be responsible for the reception from the Meteorological Office at Dublin Airport of all Air Corps forecast needs, and for their distribution to the various sections of the Air Corps. Night-time observations and forecasts were required for night-flying exercises and, to provide these, temporary assignments from the Meteorological Service HQ were required to supplement existing staff during these exercises.

ACCOMMODATION PROBLEMS

Major problems arose from the beginning in regard to accommodation for meteorological staff and instruments at Baldonnel. As it was necessary for meteorological personnel to be located close to the instruments enclosure, the only suitable place was in the Air Traffic Control Tower building. Unfortunately this building was extremely cramped, and the little space available was almost fully committed to Air Corps needs. The best that could be achieved was to clear out a small store (about 80 square feet with one tiny window) which became the Meteorological Office at Baldonnel Aerodrome in June 1958.

The space allocated to the Meteorological Service increased in two stages. In the first instance, the Air Corps Air Traffic Control (ATC) office and lecture room was 'taken over' by a combination of 'squatter's rights' and the 'blind-eye' benevolence of the late Jim Liddy, then Officer-in-Charge of Air Corps ATC. The present building located beside the Control Tower, measuring 2500 square feet and including an excellent lecture room, was made available some years later, and is a lasting monument to the cooperation between the Services.

Early difficulties also arose in regard to the meteorological instruments available at the time of 'take-over'. A distant-reading cup anemometer had outlived its usefulness and was found to be very unreliable in certain wind conditions. A Dines pressure-tube system, comprising direct-reading and distant-reading units linked to display positions in ATC, the radar room and the Meteorological Office, was installed in 1964. The instruments in the enclosure were replaced by modern equipment, soil and earth thermometers were introduced, and Tonnelot and precision aneroid barometers were installed. In this way the Class D station was quickly transformed into a Class A synoptic station. Around the same time Muirhead facsimile receivers and a telex unit were installed to facilitate the provision of forecast information to Air Corps personnel.

HELICOPTER RESCUE SERVICE

In 1962, the Government decided to establish a helicopter rescue service to be operated by the Air Corps out of Baldonnel. As a result, three Alouette III helicopters were purchased in November 1963. As this service would be on call throughout the dawn-to-dusk period all the year round, meteorological observations and forecasts would be required on a 24-hour basis. Accordingly, in November 1963, four additional MOs were assigned to Baldonnel and the observational routine extended to 24 hours a day. One MO was assigned to Gormanston Aerodrome at the same time to provide meteorological back-up for the helicopter service in that area. In 1965 the aerodrome at Baldonnel was renamed Casement Aerodrome in memory of Roger Casement, a leading figure in events associated with the 1916 Rising.

Throughout this period, senior personnel of the Air Corps in the persons of successive Commanding Officers (Keane, Curran and Swan) kept up pressure for the assignment of a meteorologist for permanent duty at Baldonnel. A relaxation of demand on the North Atlantic route made it possible to assign a meteorologist to Casement in 1973 to provide direct weather briefing and formal and informal instruction in meteorology.

In the period since 1973, Air Corps flying activities have steadily increased as a result of the increase in both the number and type of aircraft available. Aviation activities now include search and rescue missions, air ambulance, national security cooperation, sea-fishery protection and national and international flights involving transport of Government ministers and officials. In addition, basic and advanced training of pilots on both helicopter and fixed-wing aircraft, involving trainee pilots on cross-country and night-time exercises, demands the most detailed attention of forecasters and observers at Dublin Airport, Casement and Gormanston. With the arrival of the new Dauphine helicopters, with the capability of flying in much poorer weather conditions, a further increase in meteorological requirements is inevitable. Precision approach radar is now operational at Casement and the installation of runway visual range equipment (IRVR) is mooted.

* * *

The Meteorological Service over the years has maintained a high level of cooperation with the Air Corps in the provision and up-dating of technical equipment, and today Casement is on a par with the civil airports as far as meteorological forecasts and observations are concerned. The transformation of Casement from a military flying field into an international aerodrome is almost complete, and the Meteorological Service in its 50th anniversary year is proud of its role in this achievement. The facilities available today reflect the close bond of cooperation between the two Services, which can be traced back to Foynes and Rineanna in the nineteen-thirties.

One of the first three 'Alouette' helicopters at Baldonnel, 1968 (Photo: P.A. O'Dwyer)

The last of the 'Vampires' at Baldonnel, in the mid-sixties (Photo: P.A. O'Dwyer)

Miriam Lyons, Meteorological Officer, boarding the Fouga Magister No. 220 in May 1979. Miriam, the first woman to work operationally in the MO grade, established another 'first' with this adventurous flight. Permission to fly in Department of Defence aircraft had just been extended to the meteorological staff at Casement. (Photo: Air Corps)

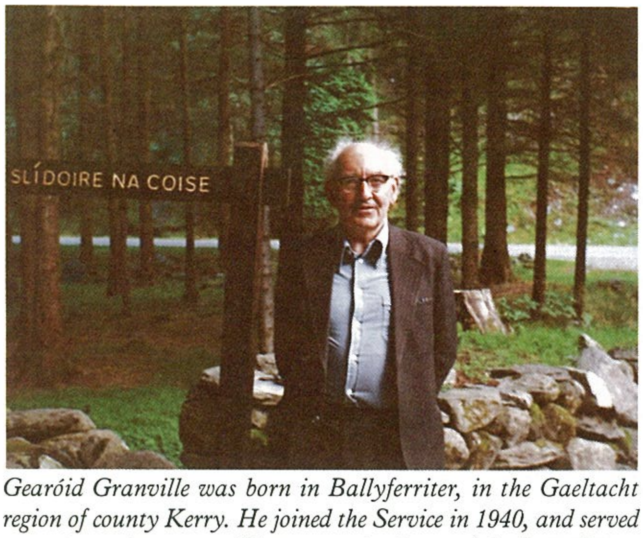
Réamhaisnéis fhadtréimhseach sa tSeirbhís Mheitéareolaíochta sna seascaidí

le Gearóid Grainbhil

Ná creid sionnach agus ná creid fiach
agus ná creid comhráite mná;
Pé moch déanach a éiríonn an ghrian
Is mar is toil le Dia a bheidh an lá.

Tá breis mhór eolais faighte ar an aimsir ó chum file éigin an rann seo thuas na céadta éigin bliain ó shin, agus ní gá feasta a bheith ag braith ar thuara aimsire mar iad siúd a luann sé chun réamhaisnéis fhónta trí nó ceathair de laethanta a thabhairt. Ach ní féidir a bheith ró-mhuiníneach as aon réamhaisnéis aimsire thairis sin. Go deimhin is é is dóiche ná beifear choíche in ann réamhaisnéis chruinn laethúil a thabhairt thar seachtain nó deich lá. Tá dóchas ann áfach gur féidir ar a laghad tuairim mhaith a thabhairt ar ghnéithe áirithe den aimsir, ar nós na meánteochta agus an mheánfhliuchrais, mí nó breis roimh ré.

Nuair a thóg an tSeirbhís Mheitéareolaíochta ar láimh réamhaisnéis fhadtréimhseach den saghas deireanach seo a chur ar fáil i 1963 bhí modhanna creidiúnacha éagsúla chun a dhéanta á gcleachtadh nó á dtriail i dtíortha eile. Orthusan bhí, mar shampla, modh á úsáid ag Oifig Mheitéareólaíochta na Breataine Móire a bhí bunaithe ar an dtuairim go leanann an sórt céanna aimsire na dálaí ginearálta céanna meitéareolaíochta. Mar sin más cosúil na dálaí ginearálta meitéareolaíochta i rith míosa ar bith leo siúd a tharla an mhí chéanna i mbliain éigin roimhe sin, bheadh súil go mbeadh cosúlacht dá réir idir an aimsir a leanann an dá mhí. Bhí modh sionoptach-staitisiúil, a bhí gaolmhar leis sin, á chleachtadh sa Ghearmáin ag an meitéareolaí cáiliúil Franz Baur.



Gearóid Granville was born in Ballyferriter, in the Gaeltacht region of county Kerry. He joined the Service in 1940, and served at various airports until he was put in charge of the Long-Range Forecasting Unit at Headquarters in 1963. He was appointed Assistant Director in 1978 and retired in 1980.

Roghnaigh an tSeirbhís seo modh a bhí bunaithe ar siúd a bhí á chleachtadh an uair sin ag Bureau Aimsire Stáit Aontaithe Mheiriceá agus a bhí ag braith ar chairt réamhaisnéise a dhéanamh i dtosach de mheánchúrsaíocht mhíosúil an atmaisféir agus uaithi sin éanormalachtaí teochta agus fliuchrais na míosa a mheas. Bhí a leithéid de mhodh triailte roimhe sin ar ndóigh, ach ní ró-mhaith a d'éirigh riamh leis. Níorbh ionadh sin mar nach raibh dóthain eolais ar chúrsaíocht an atmaisféir chun a leithéid a dhéanamh le haon chruinneas ná fiú dóthain faisnéise chun an t-eolas sin a fháil. Ach bhí athrú mór ag teacht ar na cúrsaí sin ón mbliain 1949 i leith agus bhí an uair sin, den chéad uair, faisnéisí aimsire tríthoiseacha iontaofa den atmaisféar sa leathsféar thuaidh á gcur ar fáil agus a líon ag dul i méad ó bhliain go bliain. Bhí breis mhór eolais á chur ar an gcúrsaíocht ghinearálta trí chumas na ríomhairí nua-aimseartha. Lena gcois sin bhí na meánluacha brúairde ar fud an leathsféir thuaidh, i.e. na faisnéisí aimsire ba ghá chun cairteanna na cúrsaíochta a líniú, á gcur ar fáil ar an gcóras cumarsáide. (Ní raibh an fearas ná an fhoireann ag an Seirbhís an uair úd chun a leithéidí a dhéanamh sa tír seo.)

Cinneadh ar an meánchúrsaíocht brúdhromchla 500 milleabar (i .e. 500 hPa) a úsáid mar bhonn don réamhaisnéis. Sochraíodh amhlaidh de bharr an dromchla sin a beith i gcóngar lár an atmaisféir agus go háirithe i dtaobh go raibh éirithe chómh maith sin leis an réamhaisnéis uimhriúil baratrópach aontoiseach a raibh an dromchla sin mar bhonn aici blianta beaga roimhe sin.

Tá an modh bunaithe ar an dlúth-bhaint atá ag an meánchúrsaíocht agus a héanormalachtaí leis an aeráid agus a héanormalachtaíse (Is í an mheánchúrsaíocht normalach an mhéanchúrsaíocht fhadtéarmach a ghabhann leis an aeráid normalach.)

CAIRT DE ÉANORMALACHTAÍ

Taispeánann cairt de éanormalachtaí airde ag brúdhromchla 500 mb patrúin atá cosúil leis na claiseanna agus na hiomairí, na cioclóin agus na frithchioclóin a fheictear ar na cairteacha aimsire ag leibhéal na farraige. Is féidir na patrúin seo a rianú agus a leanúint ó chairt go cairt, agus athraíonn siad ó mhí go mí do réir mar a athraíonn an chúrsaíocht normalach agus an chúrsaíocht mhíosúil. Samhlaítear iad le suaiteachtaí lena gcuireann an mheánchúrsaíocht mhíosúil an chúrsaíocht normalach as a riocht, agus nuair a bhítear ag líniú na cairte réamhaisnéise aistrítear iad faoi mar a dhéantar leis na córais brúnna ag leibhéal na farraige. Tugtar tuairim faoi a luacha uimhriúla ina n-ionaid nua le áird a thabhairt ar claonadh na luachsan chun méadaithe nó chun laghdaithe do réir mar a léiríonn an dá chairt nó trí dheireanacha). Is minic gur cabhair breise chun é seo do mheas féachaint a thabhairt ar chlaonadh an mheánairde le linn na 10 nó 15 lá dheireanacha den mhí díreach caite.

Nuair a suimítear na luacha nua seo le luacha normalacha na míosa atá le teacht faightear an chéad éachtaint ar leagan amach cairte meánchúrsaíochta na míosa sin. Ceartaítear agus cuirtear feabhas ar an gcairt seo le, mar shampla, suíomh na gclaiseanna agus na n-iomairí uirthi a chur i gcomparáid le gnáth-shuíomh na bpatrún míosúil, le féachaint ar fhoinsí fuachta agus teasa agus a n-éifeacht a mheas, agus le ceann a thógaint de thorthaí Rossby ina shaothar ar thonnta fada sna haershruthanna aniar. Thaispeáin na trialacha a rinneadh gur féidir le meitéareolaí go mbeadh taithí mhaith aige ar mhodhanna sionoptacha, cairt réamhaisnéise fhiúntach ag leibhéal 500 mb (500 hPa) a dhéanamh ar an gcuma seo.

AN TEOCHT AGUS AN FLIUCHRAS

Chun an teocht agus an fliuchras a mheas is fearr teacht níos congaraí ná dromchla 500 mb (500 hPa) do leibhéal na talún. Déantar sin trí chairt réamhaisnéise neamhspleách a dhéanamh ar an modh céanna thuas, cairt de mheánraimhre mhíosúil na sraithe aeir idir 1000 mb (1000 hPa) agus 500 mb. Tagtar ar an mbrúairde ag 1000 mb ach an mheánraimhre a dhealú ón airde ag 500 mb. Chun an teocht a mheas féachtar ar threo na gaoithe faoi mar a léiríonn na himlínte comhairde ag 1000 mb é, agus go mór-mhór ar threo agus ar neart an tsrutha éanormalaigh ar an gcairt réamhaisnéise, faoi mar a léiríonn an chúrsaíocht éanormalach é ag an leibhéal sin. Mar shampla más aniar gnáth-threo na gaoithe mar a léiríonn an mheánchúrsaíocht normalach é, agus gur aneas treo an tsrutha éanormalaigh, is iondúil go mbíonn an teocht ós cionn an mheáin. Dá mba aduaidh a bheadh an sruth sin bheadh súil leis an teocht a bheith faoi bhun an mheáin. Cuirtear san áireamh leis méad na héanormalachta agus neart an tsrutha, tráth na bliana agus tréithe na n-aermhaiseanna áitiúla.

DEACRACHTAÍ SPEISIALTA AG BAINT LE RÉAMHAISNÉIS AN FHLIUCHRAIS

Maidir leis an bhfliuchras tá deacrachtaí ar leith ag gabháil le réamhaisnéis a thabhairt air. Feiniméan an-áitiúil sea é. Is léir íosluach bheith aige, i.e. gan aon bháisteach a bheith ann, ach níl aon uasluach cinnte aige. Is féidir tuairim a thabhairt faoi le féachaint ar chuaire na n-imlínte comhairde agus ar mhéid éanormalach an airde; ach tá cuid mhaith taighde le déanamh fós sular féidir réamhaisnéis réasúnta maith a thabhairt ar an bhfliuchras.

Ní féidir a rá mar sin go raibh an modh réamhaisnéise fhadtréimseach seo thar a bheith sásúil. Tá lochtaí áirithe air atá soiléir go leor agus go bhféadfaí a leigheas. Mar shampla, chun brí cheart fhisiciúil a bheith ag an raimhre 1000/500 mb níor mhór dromchla na talún a bheith mar bhonn in áit 1000 mb. Tuigtear leis anois go mbíonn tionchar ag an gcúrsaíocht sa leathsféar theas ar siúd sa leathsféar thuaidh taobh istigh de sheachtain agus is gá é sin a chur san áireamh. Thar aon ní eile teastaíonn tuiscint níos fearr a bheith ar an ngaol idir an chúrsaíocht agus an aeráid.

Sé is dóiche áfach go bfuil ré na modhanna eimpíreacha dá leithéid seo ag druidim chun deiridh agus go mbeifear ag braith feasta ar mhodhanna uimhriúla chun réamhaisnéisí fhadtréimhseacha a thabhairt.

LONG-RANGE WEATHER FORECASTING IN THE 1960s

When long-range weather forecasting was undertaken in the Irish Meteorological Service in 1963 the method selected for the project was based on that then in use in the United States Weather Bureau. It entailed a forecast of the monthly mean circulation of the atmosphere in the northern hemisphere at 500 mb (500 hPa) and the deduction therefrom of the mean monthly temperature and rainfall anomalies (1 millibar = 1 hectopascal).

A chart of the height anomalies of the mean circulation contours at 500 mb (hPa) shows patterns of positive and negative deviations from normal which are analogous to the pressure patterns, i.e. depressions, anticyclones, troughs etc., at sea level.

These patterns may be regarded as disturbances imposed on the normal circulation by the monthly mean circulation. They move with continuity from month to month, changing as the normal and the mean circulations change. In the preparation of the monthly mean circulation forecast charts they are treated in the same way as their surface counterparts are in the preparation of the sea-level forecast charts. Their values for the coming month are estimated by assuming that their current tendencies to increase or decrease will continue at the same rate. The estimated values are added to the normal values, and the resulting chart gives a first indication of the forecast mean circulation. This chart is rectified and improved by consideration of such factors as the favoured position of troughs and ridges, the positions and effect of cold and heat sources, and wavelength considerations.

The forecast of the temperature anomaly is facilitated by using the same methods to produce a forecast of the mean monthly 1000/500 mb thickness and so deriving the 1000 mb (hPa) surface. The wind direction as shown by the contour lines and the strength of the anomalous flow at this surface, together with consideration of the air mass involved, are the principal means of deducing the temperature anomaly.

The rainfall forecast presents a more intractable problem. Rainfall is very much a local phenomenon. It may be estimated by considering the curvature of the contour lines and the magnitude of the circulation anomaly, but much research is still required before a reasonably accurate forecast can be expected.

The method was found to be moderately successful; some improvement could possibly be made by using the earth's surface as a base for the thickness to 500 mb, and by inclusion of southern hemisphere data. Most importantly, a greater understanding of the relationship between the circulation and the climate is required.

It is now clear, however, that future progress in the field of long-range forecasting will be through numerical methods rather than by empirical methods of the type described.

The quality of weather forecasts

by Ray McGrath

Over the past twenty years considerable progress has been made in the field of weather prediction. The result is that the weatherman today can probe harder and further into the future than ever before and now has the capacity to predict the weather for a week ahead. The Meteorological Service is understandably proud of its achievements, which are due in no small measure to the phenomenal developments in computer technology over the same period.

Weather forecasting is a profession in which successful forecasts are usually taken for granted; failure of a forecast is much more likely to draw a quick response from the public. The production of a forecast requires enormous effort in terms of international cooperation and raw computer power but this is of little interest to a farmer if, for example, expected dry weather fails to materialize for some critical event. This is to be expected; but on the other hand it is not always appreciated or understood by the public that the nature of weather imposes its own limitations.

WHY THE WEATHER IS INHERENTLY UNRELIABLE

Next time you go out on a showery day, take a look at the clouds in the sky. You will notice that there is no discernible pattern in the cloud cover; the sky is constantly changing in a haphazard fashion. The observation is important because it emphasises that certain aspects of the weather are completely random in nature and therefore unpredictable. For this reason a forecaster may predict showers for tomorrow but he cannot state, for example, that a shower will occur at a particular time and location; he may sharpen his forecast by specifying that certain areas are more likely to have showers than others, or that showers are more probable in the afternoon, but an element of uncertainty is always assumed: by analogy, one can confidently say that bubbles will appear at the surface of a boiling liquid but to predict that a bubble will appear at a particular spot at a given time is not feasible. It is also important to realise that we can never be rid of this uncertainty; future developments will undoubtedly lead to further improvement in the quality of forecasts but absolutely perfect knowledge of the atmosphere is not attainable.

RELIABLITY, FORECAST DETAIL AND FORECAST SPAN

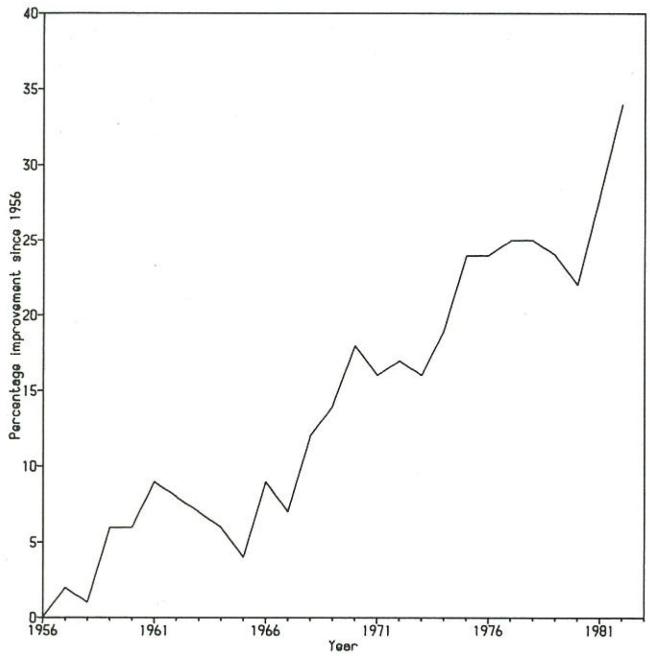
Certain features of the weather are so dependable that for all practical purposes they may be taken as representing meteorological truth. A good example is provided by our observation that mean temperatures are higher in summer than in winter. This type of information is important in climatology, but for forecasting purposes it is quite useless because of the lack of detail. As soon as we try to be more specific about the future weather an element of uncertainty begins to creep in; mean temperatures are usually higher in July than in June but we cannot guarantee that this will be the case for next year. The point is that in general the more detail we request in our forecast, and the more we try to pin down the weather with respect to position and time, the less likely the details will be accurately forecast. Weather is predictable but only up to a point. In a sense it is similar to enlarging a photograph in the hope of obtaining more detail and ultimately being frustrated by the fuzziness of the image. For similar reasons the forecasts become more unreliable the further they are projected into the future. Small random disturbances in the atmosphere, which may be unimportant initially, have a habit of growing with time and developing into major weather features after several days. The crucial details will be too small to be picked up in the description of the initial state of the atmosphere, and in consequence the forecasts will gradually get out of step with the real world. We could improve the situation by providing the computer with a more detailed description of the weather (by setting up a more dense network of observing stations, for instance), but even if we ignored the practical and financial considerations that this entails we would still find ourselves limited by observational errors; meteorological instruments are not perfect. Leaving aside these problems we also need to bear in mind that our mathematical model of the atmosphere is only a good approximation to reality and introduces its own errors into the forecasts.

HOW ACCURATE ARE THE FORECASTS?

Before we address this question we must decide on how we should measure accuracy. It is not as easy as it seems; forecasts which are found to be completely true or completely false can be disposed of fairly easily but how, for example, should we rate a forecast which specifies sleet when snow would have been more appropriate? Additionally, the forecaster will usually mention several weather elements (wind, cloud, etc.) the relative importance of each one depending on the listener; drying conditions may be of little interest to a city dweller but to a farmer they may be crucial. Ideally, in checking the accuracy of the forecasts we should devise a scheme for each weather element and weigh the scores relative to the interests of the community. In practice this is rarely done and instead attempts are made to measure the skill of the forecaster in predicting a single element such as precipitation. The skill is measured by comparing the forecast against some standard which displays no predictive skill (e.g. climatology or a 'persistence' forecast, where the weather is assumed to remain unchanged).

In the case of precipitation the forecasts are usually evaluated on a 'yes/no' basis, ignoring factors such as duration or intensity; 'it will rain tomorrow morning' is chalked up as a success if it rains continuously or if a single light shower occurs. This is clearly a very crude measure but it does allow us to check the performance of the forecasts over a period of time. On this basis the success rate of the 24-hour forecasts at present issued to the public is about 80% averaged over the country with slight regional variations.

The accompanying graph shows the relative change in skill in forecasting precipitation over Ireland since 1956 (24-hour forecast; average skill score for the four provinces). The



Changes in the level of skill in forecasting precipitation in Ireland since 1956. The graph is based on a five-year running mean of the average skill scores of four representative stations (one in each province).

upward trend since the 1950s is quite marked and coincides with the introduction and development of computer technology during the period. Not only is the quality of weather forecasts improving but the weatherman is now able to look further into the future. Twenty years ago forecasts beyond 24/48 hours displayed little skill. Since then, and particularly in the last ten years, the horizon has been pushed back so that forecasts up to ten days ahead are now available. True, the skill of these so called medium-range forecasts drops off beyond five days but even at the upper limit the products display a certain sense of realism to assure us that at least we are heading in the right direction.

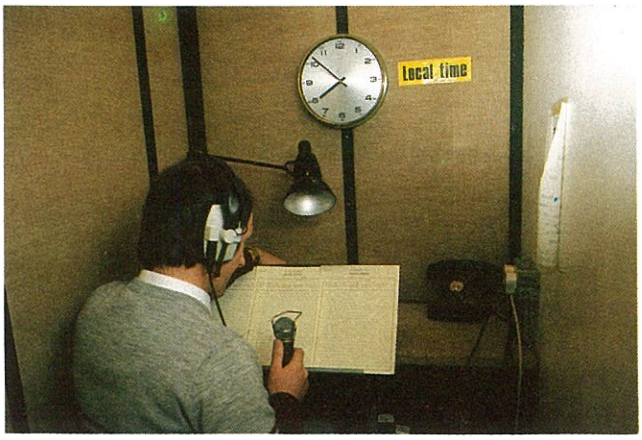
THE FUTURE

In a sense we are unfortunate in that the weather elements we are most interested in (cloud, precipitation) are least reliably forecast; weather forecasting would be a lot easier if we only had to predict the atmospheric-pressure values for instance. In the early days of computer guidance, direct prediction of cloud and precipitation amounts was avoided because of the complexities of the problem. Instead, output was restricted to forecast pressure patterns and other more obscure weather charts which characterize the large scale features of the atmospheric flow; it was left to the forecaster with his experience and judgement to interpret what the 'real' weather would be like. This gap has been bridged in recent years with the development of more complex models of the atmosphere and while human experience is still invaluable, particularly for unusual events, the quality of forecasts is linked quite firmly to atmospheric research and computer technology. Will we be able to push the limit of useful forecasts beyond ten days? Not if we are expecting detailed forecasts; because of the random nature of weather there are fundamental reasons for believing that the cut-off point is in the region of ten to fourteen days. However, if we are prepared to sacrifice detail for an extension of the forecast period then it may be possible to produce generalized forecasts for up to a month ahead (e.g. 'July will be wetter and cooler than normal'). Such forecasts are already produced by some forecast centres but the reliability of the products is not proven.

'Take a look at the clouds in the sky' (Photo: P.A. O'Dwyer)

Weather forecasts and the public

by Liam Burke



'The duty forecaster in Glasnevin broadcasts to the nation on radio while facing a blank wall. Who listens?'

Four times a day, the duty forecaster in Glasnevin broadcasts to the nation on radio while facing a blank wall. Who listens? Why do they listen? In order to find out the answers to such questions, the Meteorological Service recently carried out a postal survey of many sections of the community. About 1000 questionnaires were returned. The nation-wide random samples included 500 names, taken from the Voters' Register, together with 200 farmers, as well as building contractors, engineers, fishermen and others. The views of sportsmen were obtained by sampling clubs (sailing, mountaineering, golf, football etc.). Managers of the main race courses were also contacted.

The respondents ranged from those who obtain substantial benefits from our forecasting services, or are simply satisfied, to those who never use forecasts. A substantial minority, while generally satisfied, made criticisms or suggestions about specific matters. On the contents of forecasts, favourable comments outnumbered unfavourable ones by a factor of 9 to 1. Dissatisfaction was mostly confined to the presentation of forecasts on RTE TV, where the static set-up and poor graphics were criticised.

THE RESPONSE OF THE GENERAL PUBLIC

There appears to be a wide variation in the extent to which members of the general public react to weather forecasts, as typified by these comments from Wexford women:

> 'Weather forecasts make little difference to my lifestyle . . .'
>
> 'We realise the value of forecasts very much here . . .'

Eighty-five per cent of the general public respondents make decisions based on weather forecasts, at least occasionally.

> 'My work schedules are re-arranged because of imminent bad weather or to take particular advantage of predicted fine or windless spells.'
>
> 'I work extra hard to finish my task if the weather is to get wet.'
>
> 'I put things off until a better day.'

Members of the general public were asked to specify the activity in which they are most affected by the weather. 'Work' tops the list everywhere, followed by 'domestic'; in Dublin 'leisure/holidays' also has a high rating. These results are consistent with the differences to be expected between rural and urban lifestyles. The ranking of 'sport' is low everywhere. A West Cork woman commented:

> 'I alter the pattern of activities to suit the weather conditions, i.e. fishing, gardening, housework.'

The perceived impact of weather forecasts on human safety and on damage to property is less in Dublin than in the provinces. Despite complaints about forecasts being biased towards Dublin or not being valid for the West, there are no major differences between the regions in the assessment by the general public of the reliability of forecasts. Dublin rates them marginally higher and the South marginally lower. A Kerry woman commented:

> 'Only on All-Ireland day should priority be given to the weather in Dublin.!'

THE IMPORTANT WEATHER ELEMENTS

Drying conditions, sun and rain are the weather elements of most importance to both the general public and farmers. Frost ranks highly with market gardeners, building contractors and county engineers. It also affects racecourses and golf clubs. At sea, wind and fog are the most important weather elements. Wind is of great importance also at fish farms and on mountains.

First preferences do not give the whole picture. People may have special requirements when they are engaged in specific tasks; for example, wind affects the spraying of crops and the operation of tall cranes. According to respondents in all categories, precautions are taken when gales or harsh winter conditions are predicted. Travelling on potentially icy roads is a case in point. Prior to a gale doors and loose objects are made secure, especially on farms and building sites. Water pipes are protected from frost in all sorts of premises, from domestic homes to factory farms.

The respondents were asked 'for what periods ahead are weather forecasts most useful to you ?' 24-hour and 12-hour forecasts are the most important for almost all interests, the former having a slight edge. However the 2–5 day forecast has top priority for farmers. The 4-hour forecast is required for lifeboat rescues and is significant for yachtsmen and tarmacadam contractors. Some farmers and fishermen would like a 7-day forecast, to be broadcast on Sundays.

TV AND RADIO BROADCASTS

TV is the main source of weather forecasts for two thirds of the general public and farmers. Among the general public, forecasts on RTE are preferred to those on the BBC as a source by a factor of 5 to 1 in Dublin, 6 to 1 in south

Munster and 11 to 1 in Leinster, Cavan and Monaghan. Among farmers the corresponding nationwide ratio is 5 to 1.

Radio is the first preference of about 80% of commercial marine users. All of the inshore fishermen and lifeboatmen who replied prefer the sea-area forecasts broadcast on RTE to those on the BBC. Only about a third of ship captains prefer the latter, even though many of them often operate outside Irish coastal waters and the Irish Sea.

> 'I have always found the Meteorological Service forecasts to be better than the BBC, mainly because they concentrate on smaller coastal areas.',

commented a ship's captain.

Generally in the other interest groups, radio is as important a source of forecasts as TV. A small minority gives first preference to newspaper forecasts.

TELEPHONE FORECASTS

In 1985 almost two million calls were made to the pre-recorded telephone forecast system, an increase of 74% on 1984. Yet, according to our survey, one out of three members of the general public and one out of five farmers are unaware of the existence of this system, which covers the entire country except for North Connaught and Donegal. At present 75% of the general public and 53% of farmers never obtain weather forecasts by phone. The system is widely used by the construction industry and by recreational interests, including horse racing. Some people with special requirements, e.g. local-authority engineers, prefer to phone a forecast office for a personal weather briefing. A ship's captain commented:

> 'I have always had excellent co-operation when I have phoned up to ask for specific local forecasts.'

Comments on the pre-recorded telephone forecasts were generally favourable except for a suspicion that such forecasts are not amended promptly when they prove to be wrong. The following are typical comments from building contractors on pre-recorded telephone forecasts:

> 'Good idea, allows frequent calls by site managers which eliminates frustration on both sides.'

> 'usually not detailed enough for the particular query.'

Some special groups made a convincing case that the financial consequences of their weather-sensitive decisions require a personal weather briefing from a forecaster.

CONCLUSION

The problem facing weather forecasters is how to disseminate information to a wide range of individuals with different requirements and capacities for comprehension. The information itself varies with time and space, as in the case of a frontal system moving across the country. The single matter which was raised most often by respondents was a request for local or regional forecasts. This need may be best fulfilled by local radio or pre-recorded telephone forecasts.

'The fishing industry depends on accurate weather forecasts.'

The commercial usefulness of weather forecasts

by Liam Burke

The postal survey undertaken recently by the Meteorological Service polled many commercial interests throughout the country. The random samples included:

100 building contractors and 50 tarmacadam contractors;

200 farmers, 50 market gardeners, 44 stud farm managers and 10 fish farm managers;

75 consulting engineers and all 31 county and city engineers.

A response rate of at least 45%, but usually much higher, was obtained for each of these groups.

Marine interests also were polled by distributing questionnaires to the masters of vessels through shipping companies and fishing ports. Fully representative samples were achieved for some groups, such as local-authority engineers, lifeboatmen and racecourse managers.

The survey was based on the principle that weather forecasts are of no value unless they are used in making decisions. Therefore the questionnaires were aimed at the people who make decisions on the spot, for example ships' captains rather than HQ management.

The aims of the survey were to determine :

- who uses weather forecasts, under what circumstances ?
- what value does this information have for the users?

The perception of the reliability and explicitness of weather forecasts puts an upper limit on the extent to which forecasts are actually used in decision-making and hence on the economic and other benefits. Of course the weather is only one of the factors involved in commercial decisions.

QUALITATIVE ASSESSMENTS

Forecasts are used in decision-making only if they are perceived to be reliable. The percentages of the samples which considered that 24-hour forecasts are at least 80% reliable are:

ships' captains	90%
inshore fishermen	69%
building contractors	65%
farmers and market gardeners	60%
local-authority engineers	80%

To be of use in making a decision, the forecast must contain certain specific information. The respondents were asked if the information contained in weather forecasts is sufficiently explicit to enable them to make decisions. The percentages of the samples which replied 'always' or 'frequently' are:

ships' captains	92%
inshore fishermen	90%
building contractors	77%
farmers and market gardeners	62%
local-authority engineers	89%

Then the respondents were asked how often they made commercial decisions which are influenced by weather forecasts. The percentages of the marine samples which replied 'often' are:

ships' captains	75%
inshore fishermen	86%

The percentages of the commercial samples which replied 'often' or 'sometimes' are:

building contractors	63%
farmers	79%
market gardeners	90%
local-authority engineers	85%

The percentages of the samples which estimated the nett economic benefit of weather forecasts as 'much' or 'some', as opposed to 'little' or 'none' are:

ships' captains	88%
inshore fishermen	95%
building contractors	73%
farmers	89%
market gardeners	81%
local-authority engineers	93%

Few respondents made a quantitative estimate of the economic benefits of weather forecasts. To do so, it is necessary to determine the potential loss due to bad weather and the cost of taking preventive measures, taking into account that some forecasts prove to be wrong.

ENGINEERING AND CONSTRUCTION SECTORS

There were two estimates by local authority engineers of the annual nett economic benefit of weather forecasts:

(1) £100,000 for a rural county
(2) £20,000 for a provincial city

The cost of gritting roads is high.

> 'One abortive run for the protection of frost costs approximately £6,000.'

Another engineer stated:

> 'If we over-react we could lose up to £50,000 for the county.'

The penalty to others for a failure to grit icy roads may be enormous, taking into account the costs of accidents and disrupted traffic.

During surface dressing operations on roads, an outbreak of very heavy rain can result in a total loss. There were five estimates by local authority engineers of the loss of one day's surface dressing:

£12,000 £15,000 £18,000 £24,000 up to £60,000.

Two medium-sized construction companies assessed their potential loss at £50,000.

> 'The potential loss could be as much as £50,000 per annum, if certain work is planned without consideration of weather forecasts.'

In the construction industry, weather forecasts are normally consulted before making a decision on pouring concrete in winter. One contractor estimated the cost of the man-hours wasted on one aborted concrete job at £160. A county engineer estimated the potential loss from frost at £400 per house.

Various precautions are taken in advance on building sites when very strong winds are predicted, for example tower cranes are tied down. One contractor commented:

> 'Since the costs of these preventive measures are negligible and the potential losses run to thousands of pounds, the nett benefit is of this order also.'

AGRICULTURAL, MARINE AND OTHER SECTORS

The manager of a stud farm estimated that

> 'potential losses could be as high as £20,000 at any one time with the cost of preventive measures about £100.'

Similarly a market gardener quoted figures of £1,250 and £20, in protecting 1,000 plants against frost.

When asked about the economic benefits of weather forecasts, the farming activities most frequently mentioned by respondents are: haymaking, cutting silage, spraying and harvesting. Certain sprays should not be used if rain is expected. In such circumstances the expenditure can be a complete write-off. One market gardener estimated the cost of spraying at £150 per acre. Another put it at £500 per day. High temperatures can be fatal to poultry.

> 'On a single day, I lost £4,000 worth of broiler chickens because of excess heat. It is vital that I have accurate temperature forecasts.'

High temperatures can also adversely affect fish farms.

The greatest meteorological need of those engaged in such specialist operations is timely warning of potentially destructive conditions, especially if they do not usually occur at that time of year. Such warnings can result in major savings. Many inshore fishermen leave nets anchored at sea overnight. They can be retrieved in daylight only.

> 'If we are caught . . . by a sudden deterioration in the weather overnight, I stand to have my nets completely destroyed.'

Estimates of the cost of such a loss varied from £1,000 to £7,200.

Accurate weather forecasts are important for the success of silage-cutting. (Photo: Bord Bainne)

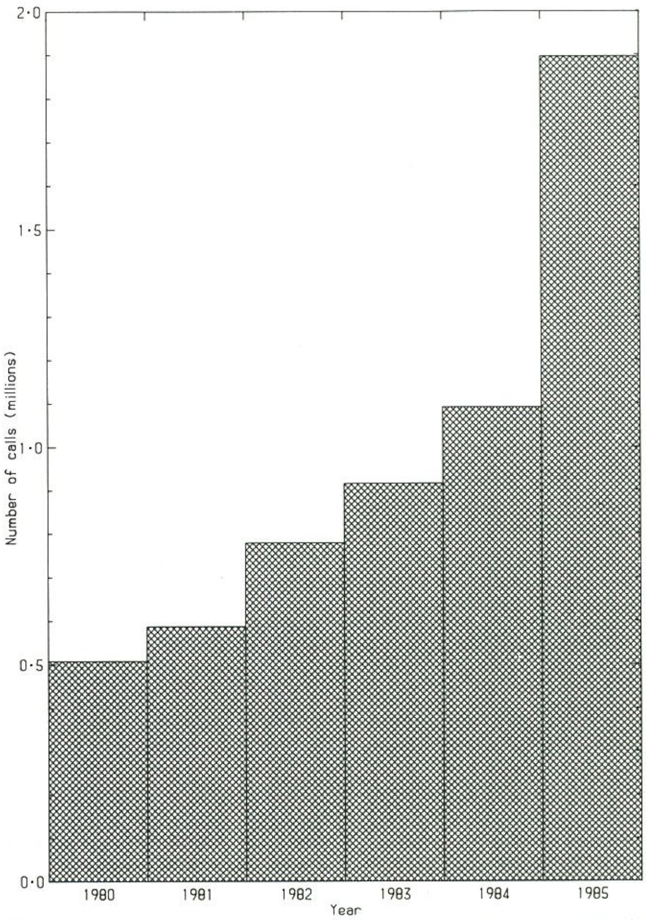
Spraying at the right time — meteorological advice is vital for this costly activity. (Photo: Irish Farmers' Journal*)*

In the Sport of Kings,

> 'the question of whether or not to irrigate the course is vital for an important course . . . where horses with a potential stud-value of up to £40 million may be racing.'

* * *

Weather forecasting is as much concerned with human safety as with economic benefits. National weather services have made enormous, if unquantifiable, contributions to aviation, off-shore drilling and other marine activities especially.



Total number of calls (in millions) received by the ATWS (automatic telephone weather service) over the period 1980 to 1985.

The automatic telephone weather service (ATWS)

by Sean Connolly

Answering a personal phone enquiry at the forecaster's desk

In past years telephoned weather enquiries from the general public to the forecast offices have been quite frequent. Such requests mostly came from farmers, sportsmen, holiday-makers or just the ordinary 'man-in-the-street', who might or might not have access to newspaper or radio weather forecasts, but in any event wanted to 'have a word with' the forecaster. For very many years these enquiries were invariably answered personally by the meteorologist on duty. In 1967 a recorded weather service was introduced for the Dublin area. Essentially this is a recorded 8-hour weather forecast, prepared by the Central Analysis and Forecast Office (CAFO) but provided by Bord Telecom, which can be received by dialling 1199. This forecast covers Dublin and parts of Kildare, Wicklow and Meath, basically the area covered by the telephone prefix (01), and includes a wind forecast for Dublin Bay.

At the Meteorological Office at Shannon Airport, as long as the number of direct enquiries remained small they were answered personally. For instance in 1968 the yearly total of such requests received at Shannon Airport was only 813. However, the number of requests increased steadily over the following years, until a point was reached when it became disruptive of the office routine to attempt to answer all such enquiries individually. The situation with regard to direct requests became critical around the year 1978 when the yearly total at Shannon Airport alone had grown to 20,101.

In considering possible solutions it appeared that a service like the one operating in the Dublin area might suit. Accordingly it was decided to provide a similar-type forecast on a regional basis as a solution to the problem of non-aviation enquiries. Such a scheme was introduced at Shannon Airport on the 24th July 1979 to cover north Munster. The region catered for comprised counties Clare and Limerick and adjacent parts of Kerry and Tipperary. The forecast is prepared by the meteorologist concerned and recorded onto a tape cassette of about 60 seconds' duration. It refers to a period of about 24 hours to 48 hours from the time of issue, together with a further outlook for up to 7 days. It includes reference to all the weather features of interest to the general public such as sunshine, wind, precipitation, temperature, drying conditions, fog, haze, thunderstorms etc. and their variation in space and time.

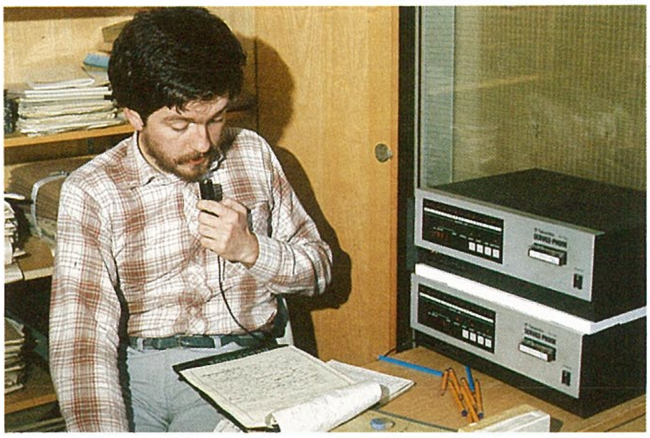
The recorded forecast when completed is placed in an automatic answering machine which can handle up to 26 incoming lines. The great advantage of this system is that there is generally no delay in getting through because of the large number of lines into the tape-machine. Also, as the tape is of the continuous-loop variety, it repeats the message as often as the caller requires. In view of the successful introduction of the north Munster ATWS forecast, the Irish Meteorological Service in 1981 initiated a regional forecast from CAFO for Leinster and counties Cavan and Monaghan, on the same basis. This was followed in 1982 by the introduction of an ATWS for south Munster prepared at Cork Airport. Later on in 1984 the south Connacht region (taking in county Galway and south Roscommon) was included in the ATWS issued from Shannon Airport. All these services became extremely popular and successful within a very short time.

The success of the system from the public's point of view can be gauged by the tremendous increase in the number of callers using the system each year since its introduction (see graph on opposite page).

Although the system is the basic one now for dealing with enquiries from the general public, requests from some groups with a particular interest in weather, such as local authorities and certain national utilities, must still be handled directly by the forecaster. Tailored forecasts for industrial, commercial and agribusiness interests etc. are provided also on a fee-paying basis.

The overall effect of the ATWS system has been to reduce greatly the time meteorologists need spend in dealing with non-aviation enquiries.

It is hoped that eventually the ATWS service can be extended to the remaining areas not already covered to provide a convenient and efficient service to the whole country.



Forecaster recording an ATWS forecast

Meteorological satellites

by Evelyn Cusack and Aidan Nulty

INTRODUCTION

Since they first began to feature in TV weather forecasts, satellite pictures have achieved a high degree of public awareness and acceptance and in recent years have been given much attention and publicity by the media in general. While modern weather satellites have a range of capabilities, they are most widely known for the impressive and sometimes beautiful visual images of cloud patterns and land masses they now relay back to earth on an almost continual basis. These images depict the scene much as it would appear to the human eye. Not so well known, but of equal importance to the meteorologist, are the 'infra-red' images which are transmitted simultaneously. An infra-red image is essentially a representation of temperature within the field of view of the satellite: it highlights warm areas as dark and cold areas as bright. The obvious, but not the only, advantage of such images is that they can be recorded both by day and by night and thus enable the meteorologist to watch the weather from space round the clock.

WEATHER SATELLITES — PAST AND PRESENT

Weather satellites are a product of the space age. The first artificial earth satellite, SPUTNIK-1, was launched in October 1957 by the USSR. Meteorologists were among the first to exploit this new space technology and in April 1960 the first meteorological satellite, TIROS-1, was launched by the USA. Thus a new era in meteorology was born. The Irish Meteorological Service was one of the first to avail of this exciting new facility and assisted NASA in the early years by arranging for the Air Corps to take high-level photographs of the cloud cover over Ireland simultaneously with the passage of the satellite overhead. A major breakthrough came near the end of 1963 with the launch of TIROS-8. Unlike the earlier transmissions, which were in the form of coded messages received hours later, actual cloud pictures were now produced in real time. This APT system (Automatic Picture Transmission) is still in use today.

Because in practice weather satellites have a limited operational lifetime, many more have been launched since the TIROS series. These consist of the NIMBUS, ESSA, ITOS, GOES and NOAA series of the USA, the COSMOS and METEOR series of the USSR, the METEOSAT series of Europe and the GMS series of Japan. Figure 1 shows the meteorological satellites currently in operation. They include

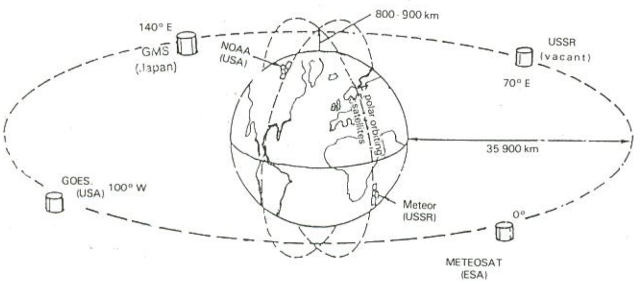


Figure 1. Meteorological satellites currently in operation

two different groups distinguished by their type of orbit — namely, polar-orbiting and geostationary. The orbital characteristics of polar and geostationary satellites offer different advantages to the meteorologist. In particular, polar orbiters provide complete global coverage every 12 hours as the earth rotates beneath the orbit, while geostationary satellites monitor the hemisphere within the field of view almost continuouisly. Examples of images received from each type are given in Figure 2.

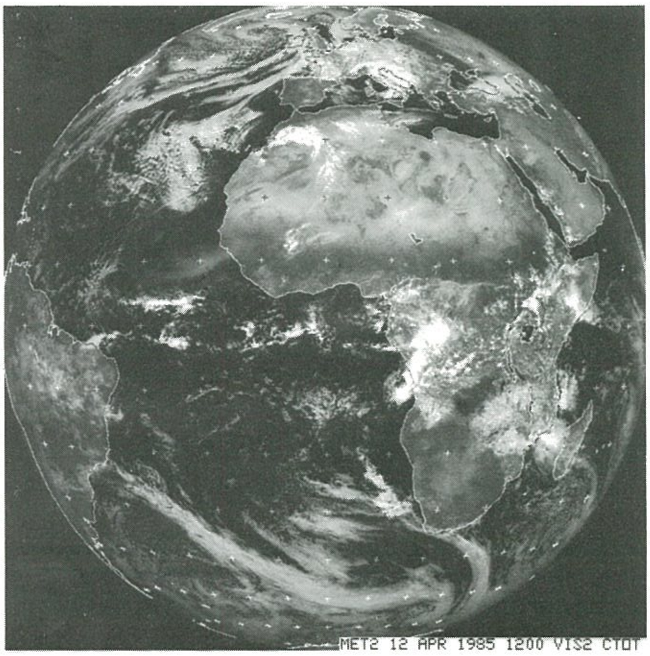


Figure 2(a). Example of an image received from the METEOSAT geostationary satellite.

The polar orbiters are typically 800–900 km above the earth's surface and pass near both the north and south poles in a single orbit which takes about 100 minutes. Because of the earth's rotation from west to east, successive orbits view different but overlapping sections of the earth's surface. At Ireland's latitude the area covered by each picture is about five million square kilometres. Each of the NOAA satellites currently in operation provides up to six of these pictures per day. At the Central Analysis and Forecast Office in Dublin and at Shannon Airport a grid of longitude and latitude is computed from the known orbital track of the satellite and superimposed on each image.

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. Hence the satellite appears at a fixed point in the sky above a pre-selected meridian of longitude. The geostationary satellite of most use to the Irish Meteorological Service is the European Space Agency's METEOSAT, located above the Greenwich meridian. METEOSAT provides half-hourly images of the area over and around Ireland in both visible

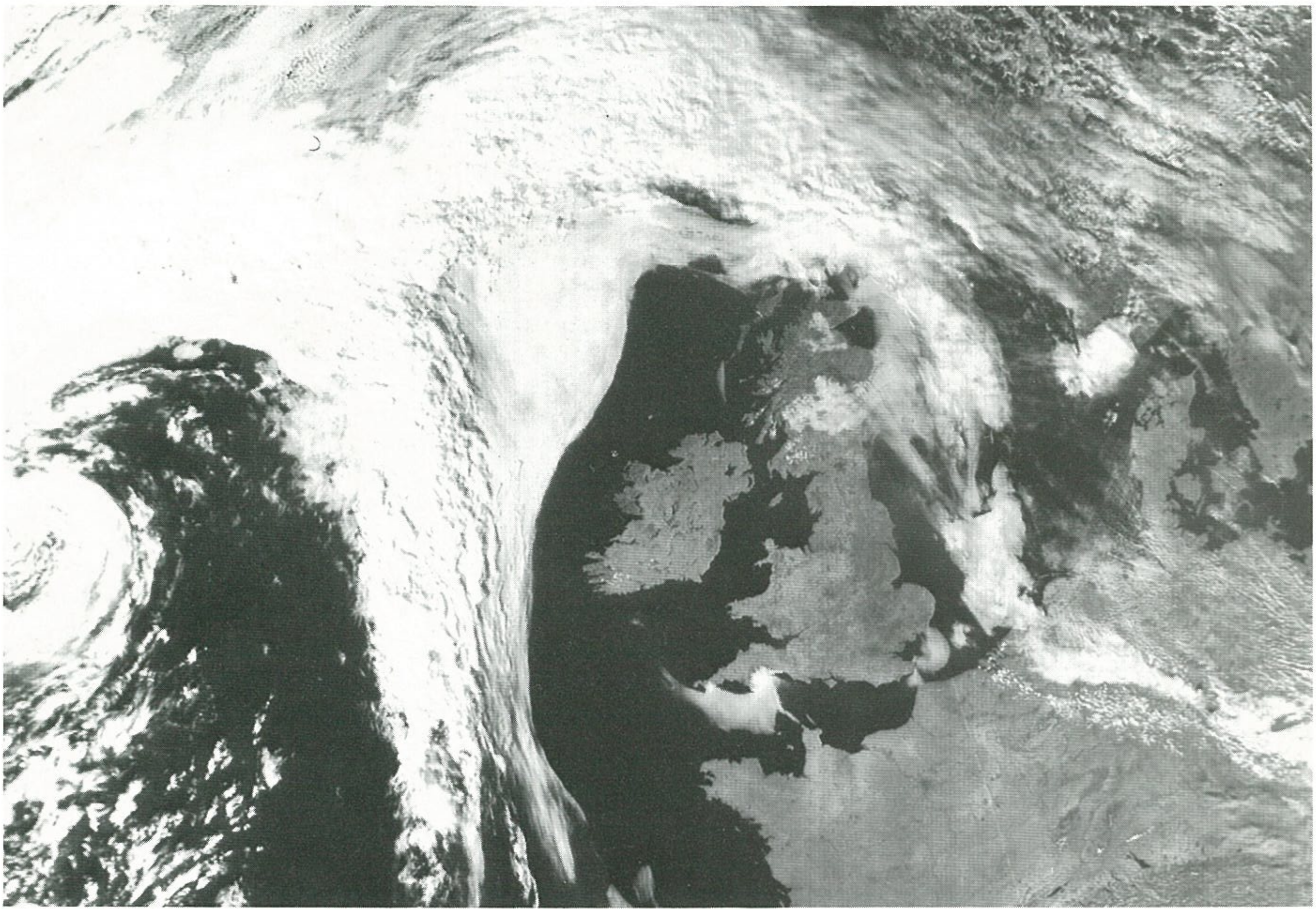


Figure 2(b). Example of image received from the NOAA-9 polar-orbiting satellite at 3.20 p.m. on 28 September 1985. (Photo: University of Dundee)

and infra-red formats, with a grid of longitude and latitude, in addition to an outline of land masses, pre-imposed on each image before transmission.

USES OF SATELLITES IN WEATHER FORECASTING

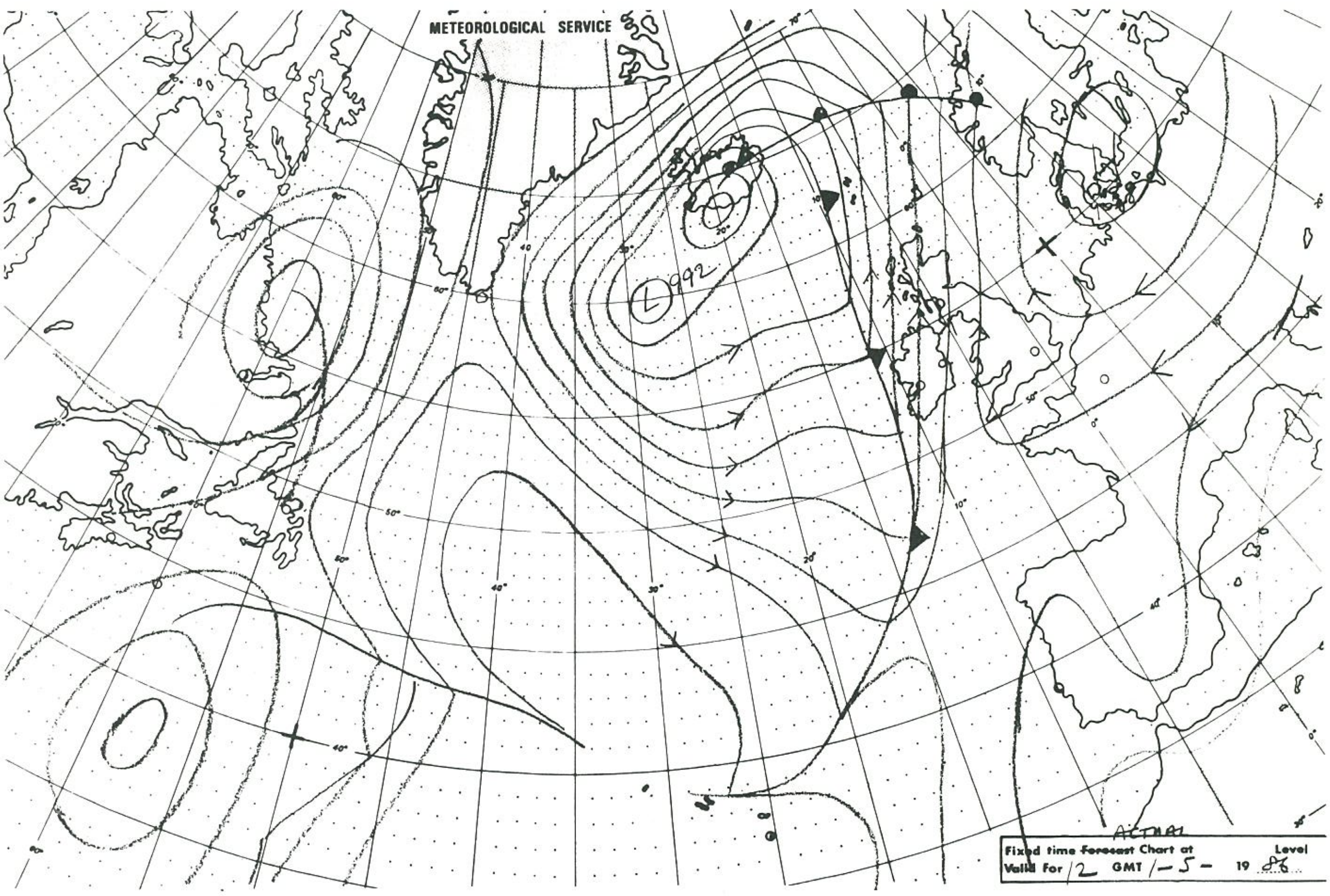
To make a weather forecast, it is essential as a starting point to have as complete and accurate a picture as possible of existing conditions over and around the area of interest. Much of the information is provided by observations from land-based weather stations, lighthouses, ships at sea and unmanned ocean buoys but, unfortunately, coverage on a global basis is still very uneven. It is adequate in well-populated regions but either sparse or non-existent in the more remote and inaccessible parts of the continents and over large areas of the oceans. Thus, weather forecasting in Ireland has always presented a special challange since our weather is for the most part influenced by conditions over the North Atlantic.

Over such a large area as the North Atlantic, the character and movements of weather systems have to be determined very much in jigsaw fashion by piecing together information provided by an often insufficient number of surface observations from ships and buoys and, to a lesser extent, land-based stations. So, from Ireland's point of view, satellites play an indispensable role in weather watching because of their ability to observe large-scale weather systems in a single view, thereby helping to fill in the gaps between conventional observations. Another major advantage of weather satellites is that the data they provide are usually available to the forecaster much sooner than those from other sources. Weather information is a highly perishable commodity.

Satellite images primarily give information about clouds — their distribution, extent, alignment and in some cases their structure as well. Each image covers an area large enough to include major weather systems, and at the same time contains enough detail to resolve individual features like shower clouds. It is well known that large-scale weather systems such as depressions, anticyclones, warm and cold air masses and frontal zones exhibit different but recognisable cloud patterns. Thus by studying the images the meteorologist can infer quite a lot about the location and intensity of these systems. The images also provide information about relatively localised events such as thunderstorms, squall lines and mountain waves, from which deductions can be made about vertical motions and turbulence in the atmosphere which, meteorologically, are as important as the more familiar horizontal motions. Furthermore, by studying sequences of images covering the same area it is possible to observe the movement, growth and decay of weather phenomena on many scales. Geostationary satellites are particularly useful in this context.

INTERPRETATION OF SATELLITE IMAGES

Both visual and infra-red images contribute to our knowledge of the state of the atmosphere. As an example, we show the images received from the American NOAA9 satellite on the afternoon of May 1st 1986 (Figure 3). Also shown is the surface pressure-field and frontal analysis at 1200 GMT on that day. The large area of clear weather over mainland Europe, Britain and most of Ireland is associated with an intense anticyclone (high pressure area) centred near



Surface pressure-field and frontal anlaysis at 1200 GMT on 1 May 1986

Denmark. Immediately west of Ireland and stretching from the Faeroes to the Azores is a well-defined band of cloud and rain due to a cold front. The corresponding warm front shows up as a more diffuse band of cloud extending from an area east of Iceland to northern Scandinavia. Shower activity generated by a flow of cold polar air is evident from the pattern of speckled cloud over the North Atlantic, while in the vicinity of Iceland it is just possible to make out the characteristic spiral of cloud associated with a major depression (low-pressure area).

Although the broad-scale features described above are evident on both visual and infra-red images, a closer study of the latter yields much additional information. As mentioned earlier, infra-red images depict temperatures within the field of view of the satellite in such a way that the warmest areas appear darkest and the coldest areas brightest. Thus we see, for example, the sharp contrast between the relatively warm land masses, cooler seas and much colder cloud tops over western Europe and the North Atlantic. Since temperature falls with increasing height through the atmosphere, the brightness of cloud systems on the infra-red image gives an indication of the height of their uppermost layer (which is all the satellite actually 'sees') and hence of their vertical extent or thickness. It becomes clear, therefore, that the leading edge of the cold front affecting some western parts of Ireland consists of relatively thin low-level cloud which, normally, would not be associated with heavy rainfall. Surface observations at the time confirm this to be the case. On the other hand, the main body of cloud to the west of Ireland clearly extends to very high levels in the atmosphere and would, therefore, be expected to contain a more substantial amount of rain. By using a similar approach, the infra-red image makes it possible to estimate the severity of those showers in the North Atlantic.

These images highlight a number of other, more localised, features of meteorological significance, of which two are worth a mention. Over the extreme northwest of Scotland and, to a lesser extent, over western and southern parts of Ireland the cloud appears in striated form with regularly alternating bands of clear and cloudy weather. These features are called mountain waves and occur when relatively strong winds blow over mountain barriers, being forced upwards on the windward side and downwards on the lee side. As a consequence a vertical oscillation is set up in the atmosphere, which continues for long distances after the original mountain barrier has been crossed. The striated cloud pattern results from the fact that cloud is formed in the updraughts and disperses again in the downdraughts. Mountain waves usually indicate strong turbulence in the atmosphere and are a particular hazard to aviation. A hazard of a different kind, more relevant to maritime operations, is sea fog which occurs in mild humid weather and may be of a patchy nature or may cover large areas of the oceans. The satellite picture in the present example shows a fairly extensive area of fog in the seas to the northeast of Denmark. On the visual image this fog is hardly distinguishable from cloud cover, being no more than cloud which extends right down to sea level. For this reason, however, its temperature is almost the same as that of the surrounding sea and as such it hardly shows up at all on the infra-red image.

Surface observations around the time these pictures were received show a relatively mild south to southwesterly airflow over Ireland and Britain, while a limited number of ship reports from the north Atlantic indicate much colder weather with predominantly west to northwest winds. The band of cloud and rain to the west of Ireland thus forms the boundary between two distinctly different air masses and these images provide a striking example of the contrasting cloud patterns and associated weather conditions to be found in different airmasses and along the line where they converge. This boundary, or frontal zone, marks the leading edge of a cold air mass and is therefore called a cold front. Conversely, the warm front extending westwards from northern Scandinavia corresponds to the leading edge of a warm air mass and separates the relatively warm air in the North Sea from the much colder air in the Arctic Ocean.

VALUE OF SATELLITE DATA

At Ireland's latitude, warm and cold air masses are in continuous conflict, sometimes the one and sometimes the other gaining supremacy. As a result, our weather is characterised by an ever-changing sequence of warm and cold spells which are not confined to particular seasons, but can last for periods ranging from mere hours to days or even weeks at any time of the year. Furthermore, since most of our rainfall occurs at the frontal zones which separate these warm and cold airmasses, the duration of the intervening dry periods can be just as variable. In general, the severity or otherwise of weather conditions in Ireland is more closely related to the nearness of low-pressure or high-pressure systems than to seasonal variations; at opposite ends of our changeable spectrum of weather we have, on the one hand, the storms and heavy rain due to vigorous Atlantic depressions and, on the other, the dry calm settled weather associated with anticyclones. Predicting the frequent changes which are the hallmark of Irish weather depends on knowing the location of weather systems, anticyclones and airmasses and how they are moving and evolving. Formerly the information was inferred from conventional earth-bound observations and, because of Ireland's geographical position, was rarely complete. Weather satellites have gone a long way towards compensating for this drawback and nowadays provide a comprehensive overview of cloud systems over the North Atlantic where surface data are often sparse.

The more recent generation of weather satellites also provides quantitative measurements of parameters like temperature, water vapour and carbon-dioxide concentrations at various levels in the atmosphere, as well as other weather-related entities which arise in the field of oceanography, such as sea temperature, wave heights and ice formation.

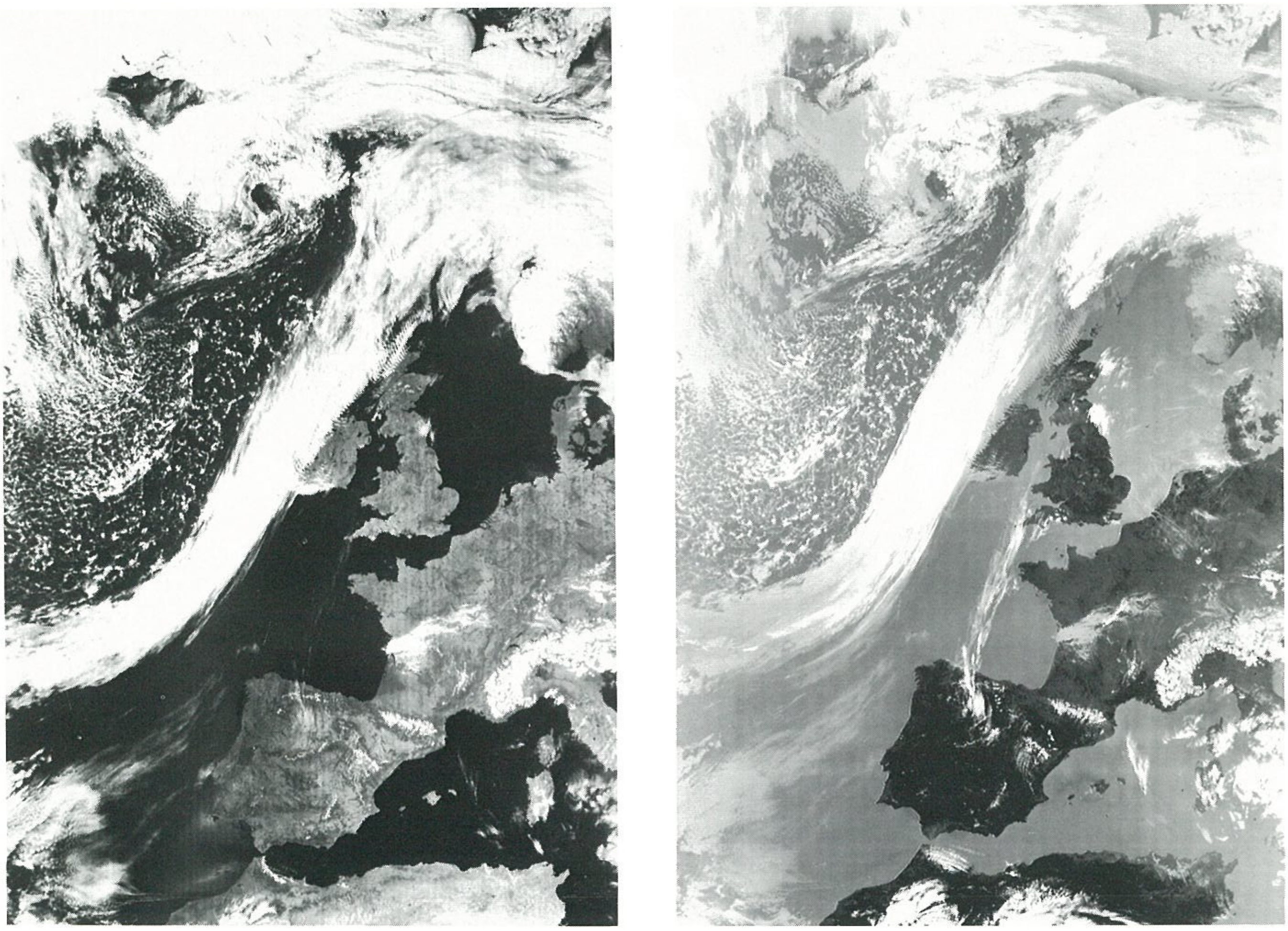


Figure 3. Visual and infra-red images from the NOAA-9 satellite on the afternoon of 1 May 1986 (Photo: University of Dundee)

Radar in the Meteorological Service

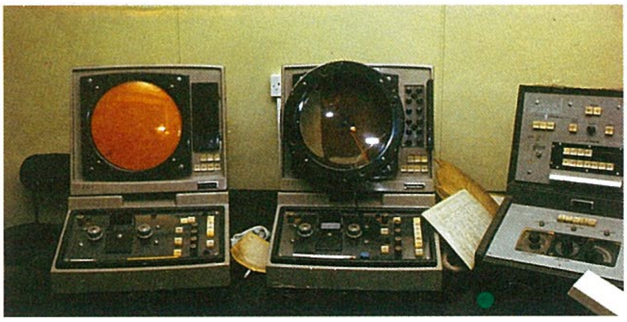
by Thaddeus Kelly

Radar, a word derived from the initial letters of the phrase 'Radio, Detection And Ranging', was the name given to a system for the detection and location of objects using radio waves. It was developed during World War II for the detection of enemy craft but it soon became apparent that it could be used for other purposes. Interest in the use of radar for meteorological purposes stemmed from the fact that it could detect the presence of water droplets in the atmosphere. In the years following the World War a number of manufacturers marketed radar equipment designed purely for meteorological use.

Since the purchase of our first meteorological radar in the early sixties the Meteorological Service has made considerable use of radar for the detection and forecasting of rain, hail and snow. Early meteorological radars were comparatively simple devices and limited in their capabilities, but with the advances in electronic and computer technology in the sixties and seventies they have now become considerably more complex and useful to weather forecasters. The present radar installation at Shannon is capable of displaying rainfall intensities within a range of about 125 miles, over an area of some 50,000 square miles, and of preparing this information in digital form for transmission to other users. The display uses a colour television monitor which can be viewed in daylight and uses its colour range to indicate the intensity of the rainfall.

EARLY RADAR INSTALLATIONS

The first radar purchased by the service was a Decca 41 installed at Shannon in the early sixties. Although this was a very simple radar it proved to be an extremely useful tool for the detection of rain, assessment of shower activity and the timing of approaching rain belts. It also proved invaluable in providing our forecasters with experience in the interpretation of radar images. Because of the Earth's curvature the range of any radar is limited and the Shannon radar could not provide adequate coverage of the East coast. The usefulness of weather radar experienced at Shannon led to the installation of a Selenia at Dublin Airport which considerably improved our coverage in this part of the country. This radar was considerably more complex and could provide much more detailed information on weather than was possible with the Shannon installation, particularly with regard to the vertical development of weather systems.



Radar receivers

DIGITISED RADAR IMAGES

The rapid advances made in radar technology in the sixties rendered the Decca 41 at Shannon obsolete and it was replaced in the early seventies by the Plessey 43S. This radar operated on a longer wavelength than any of our earlier radars and enabled our weather forecasters to make much more accurate assessments of the amount of rain falling. The complexity of this radar was such that full use of its capabilities was not realised until a computerised system for the continuous monitoring and assessing of the radar information became available. At present a computer is used in conjunction with the radar to 'digitise' the weather signals being returned. This has two advantages which were absent from our radars up to this time; the monitor, being in colour, can now be used to present, locally, information on both the location and on the variation in rainfall intensity simultaneously, and for users at a distance the same digital information can be passed along a telephone line to give a display identical to that at the originating site.

EUROPEAN NETWORK

The Shannon radar information is now transmitted to our Central Forecasting Office in Glasnevin and although its range is still limited the information has proved extremely useful in the preparation of the daily weather forecasts issued on Radio and Television. It is hoped that in the future it will be possible to acquire other modern radars, suitably located, to give weather radar coverage of the whole of Ireland. Shannon weather radar information is also disseminated internationally to form part of a European network of weather radars, the information from which is being combined to try to develop a composite picture of the whole of Europe, and thus overcome, to some extent, the limitations caused by the curvature of the Earth. The network is not yet complete but the information being received from it indicates that it is likely to be an important contribution to the provision of short term forecasts in the future. Plans are also in hand to display, at Irish Stations, the output from the United Kingdom network of radars which currently provides coverage of England, Wales and part of the Irish Sea.

Precipitation off the south-east coast of Ireland shows up as a digitised radar image on a monitor screen at Shannon Airport.

Computer graphics in the Meteorological Service

by James Hamilton

Computer graphics allows us to use a computer to draw maps, diagrams and figures directly from the information stored in its memory. The computer drives a plotter which produces pictures either by using motors to move a pen around on a sheet of paper (pen plotter) or by controlling the image on a TV monitor (graphics VDU). Both types of device are used in the Meteorological Service.

The involvement of the Irish Meteorological Service (IMS) in computer graphics began in March 1980 with the delivery of two Calcomp 960 pen plotters which were installed in the headquarters building in Glasnevin, Dublin. The use of computer graphics was expanded in 1982 with the purchase of three DEC full-colour graphics VDUs. Three more of these computer terminals were acquired in 1985. The first three are now installed in the central forecasting office (CAFO), at Dublin Airport and at Shannon Airport, while the others are used by the Research and Computer Divisions.

The computer-graphics equipment is used, first of all, to plot maps of symbols representing weather observations of wind, pressure, temperature etc. (weather maps). Secondly, it is used to draw contour lines of computer-produced forecasts of pressure, wind, temperature etc., obtained from our own numerical model and from the models of other centres (such as the European Centre for Medium Range Weather Forecasts). Thirdly, it is used by the Climatological Division to plot maps of the distribution of rainfall and temperature over Ireland. Lastly, it is used to provide a general plotting facility which is used by most sections of the office. In addition the graphics system has been integrated into a 'user-friendly' data-base interrogation system that allows the forecasters to access computer-generated forecasts from a number of models and a number of forecasting centres.

We will discuss these various applications of the computer graphics system in the following sections.

PLOTTING OF OBSERVATIONS

Traditionally, charts of surface and of upper-air observations were plotted by hand (and are still produced in that manner at the airports). However, machine plotting is faster (30 minutes per chart as opposed to about two hours when done manually) and the charts produced by the machine are easier to read since they are printed rather than handwritten.

Meteorological symbols are displayed using a set of standard, internationally recognised, weather symbols. Figure 1 shows a selection of these symbols. Thus, for example, snow is represented by an asterisk, rain by a full stop, drizzle by a comma etc.. In fact there are over 150 symbols in common use.

The first stage in writing a program to plot observations was to design a set of meteorological symbols (based on the recommendations of the World Meteorological Organization). A pen plotter works by drawing each symbol as a series of (short) straight lines, and curves are represented by a succession of such lines. Hence, we designed our symbol set by making a freehand drawing of each symbol on graph paper (using straight lines) and reading off the end coordinates of the lines. We put these coordinates into our program and then wrote a set of subroutines to shrink, expand, reposition or rotate the symbols so that each symbol could be displayed at any position, at any scale and at any orientation on the page.

A weather observation is plotted as a combination of numerical values (e.g. temperature, pressure, pressure rise or fall) combined with a number of the special weather symbols (e.g. for type of weather, type of cloud). The numbers and the symbols are displayed in a standard layout. The forecaster can tell immediately from the position of a number whether it represents a temperature or a pressure or some other element, and from the position of a symbol whether it refers to conditions at the time of the observation or to conditions during the previous hour. Figure 2 shows such a full station plot. Hence, the next stage in the design of a plotting program was to combine the weather symbols to produce such a plot. A complication was the wind arrow — as the wind direction changes, the elements in the station plot must be displaced slightly to prevent the wind arrow cutting through any of the symbols.

The normal chart used by the forecasters covers the Eastern USA, the Atlantic and most of Europe. It is drawn at a scale of 1/15,000,000 and is approximately three feet by two feet in size. Such a chart usually contains about 350 plotted stations and Figure 3 shows the positions of the stations on a typical chart. The plotting of such a chart, at full size and with each station plotted using the station model shown in Figure 2 takes about 30 minutes.

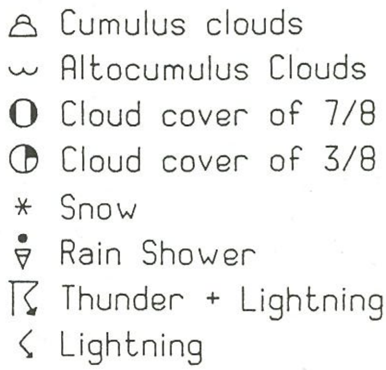
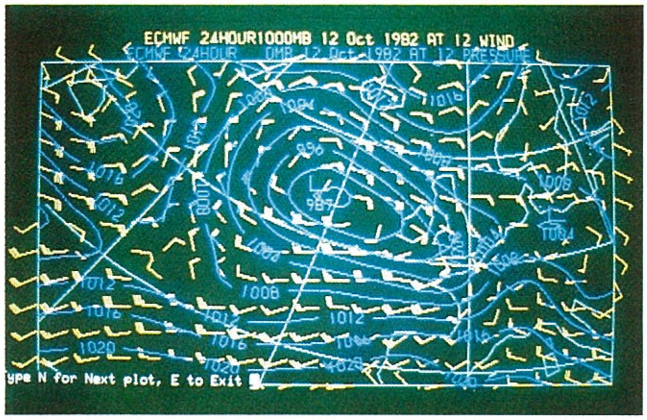


Figure 1. This diagram shows a selection of the international set of meteorological symbols. There are over 150 such symbols, and they are used for plotting weather observations.

Figure 2. Sample station plot with plotting model. The left-hand plot shows a weather observation for Dublin Airport as it would be plotted on a weather chart; the right-hand plot shows the meanings of the various symbols. Thus, moving clockwise around the station plot (starting at the top right-hand corner) the symbols have the following meanings: 965 is the pressure (PPP); 02 the pressure change in the past 3 hours (pp) and the symbol beside this number indicates a fall in pressure followed by a rise (a); the full stop (rain) and the comma (drizzle) are codes for the weather during the six hours preceding the observation (W_1, W_2); the horizontal line to the left of the past weather is the symbol for stratus cloud (C_l); the wind arrow indicates a wind speed of 10 knots coming from the south-west (230°) with the figure 3 indicating the second-last digit of the wind direction; 09 is the dew point (T_dT_d); 66 a code for the visibility (VV); the full-stop to the right of the visibility is the present weather — rain (ww); 10 is the temperature (TT); and finally the station circle, at the centre of the plot, is shaded to indicate a cloud cover of 8/8 (N).

CONTOURING OF NUMERICAL FORECASTS

There is an increasing trend towards the use of computer models for forecasting. The IMS runs such a numerical model and it also has access to the output from the computer models of the European Centre for Medium Range Weather Forecasts (ECMWF) and the UK Meteorological Office. Each model produces forecasts of the pressure pattern over Europe and the Atlantic in the form of a regular (rectangular) array of numbers, viz. the pressure values at various latitude and longitude points. A typical forecast consists of pressure values at approximately 2,000 such points.



GIGI interactive graphics terminal showing ECMWF forecasts of 1000 mb wind and surface pressure.

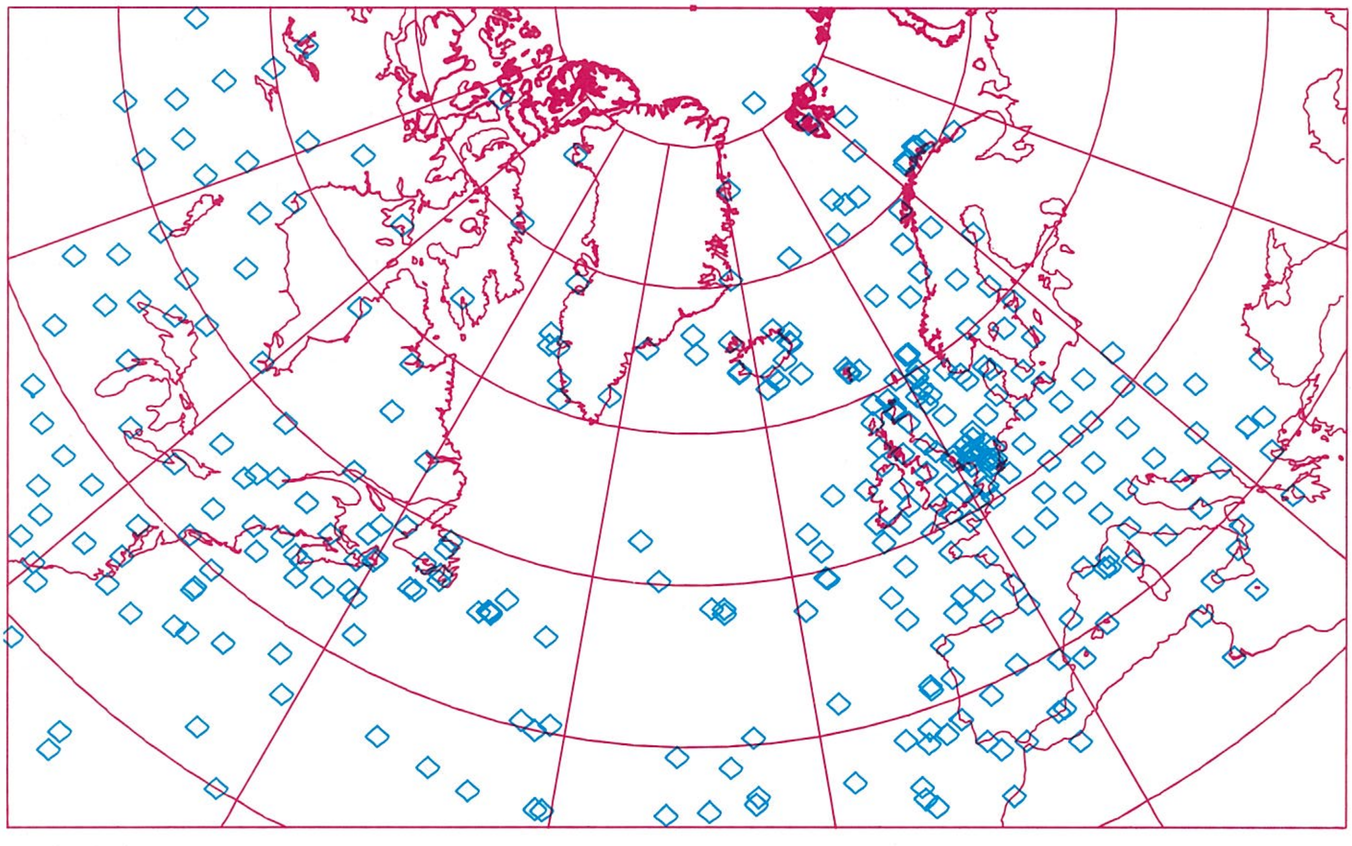
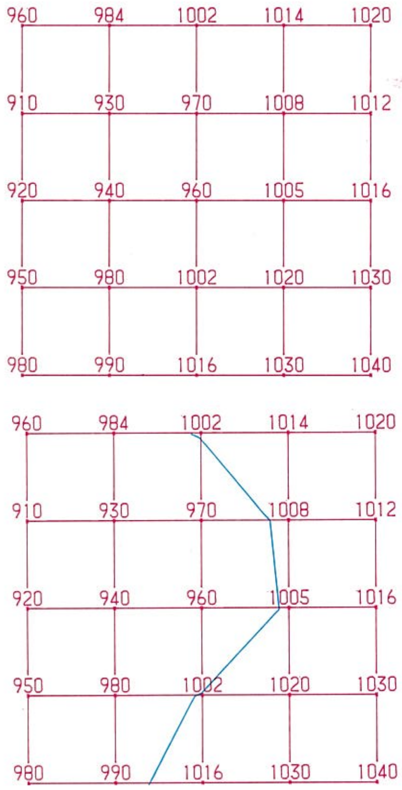
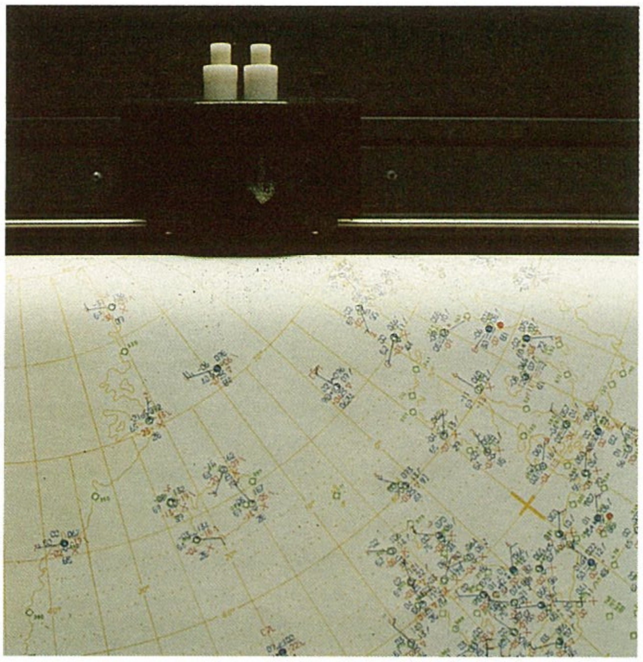


Figure 3. This plot shows the positions of 400 weather observations. Each weather station is marked with a small diamond. On a real weather chart each observation is plotted using the station model illustrated in Figure 2.



This diagram shows the basic ideas of contouring. The upper diagram shows an array of grid-point values (viz. pressures). The contouring package draws the 1000 hPa (i.e. 1000 mb) line by interpolating (linearly) along each cell boundary (using the values at each end to find the points where the field value is 1000 hPa) The lower diagram shows how the contour plot is produced by joining up the intersections.



Calcomp plotter with plot of weather observations. The pen-holders (white) can be seen at the top of the photo.

Figure 4 shows the basic ideas involved in contouring such data. The contouring package draws isobars (i.e. lines of constant pressure) by interpolating between the grid-point values produced by the model. Figure 5 shows a typical forecast from the IMS model. (Note that the background coastline map was drawn using a computer package obtained from ECMWF and modified extensively by the Meteorological Service).

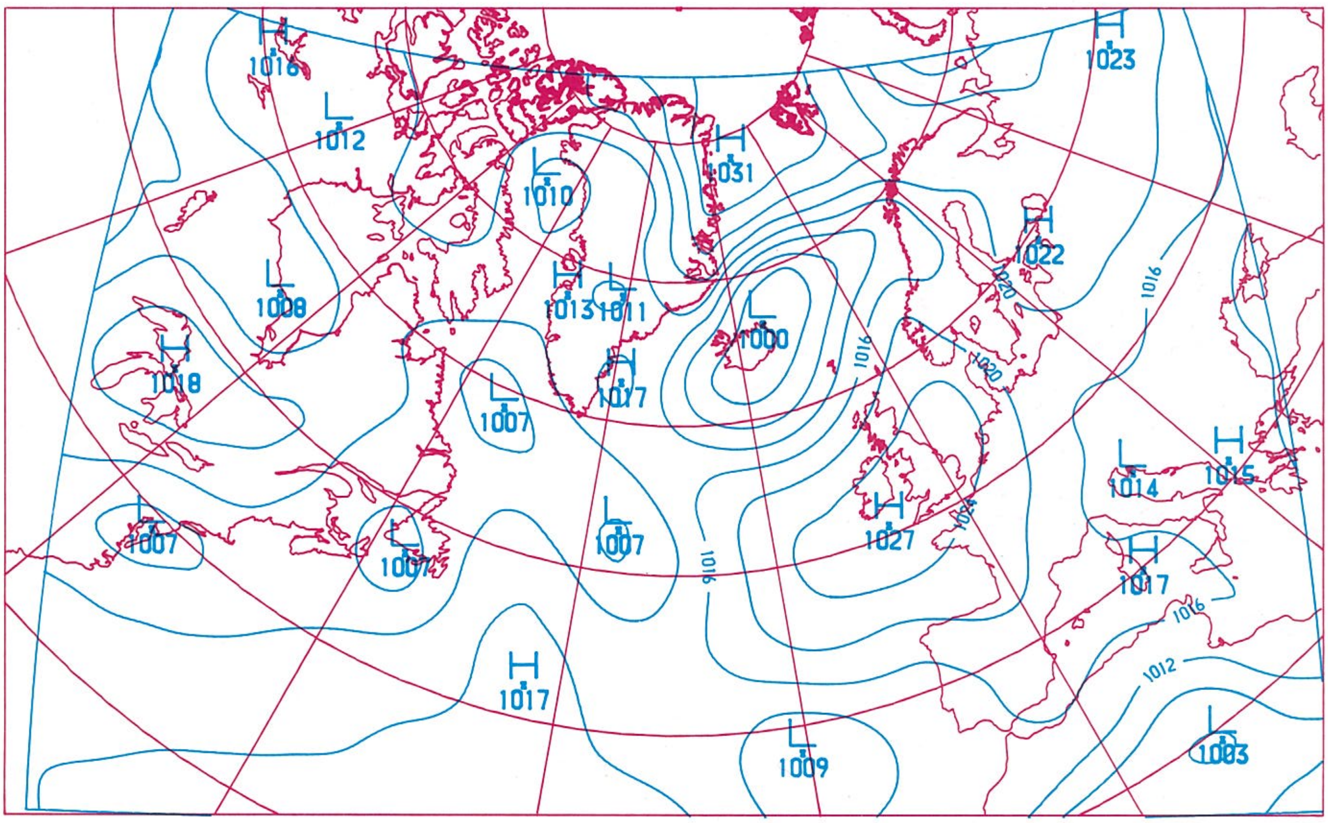


Figure 5. A plot of a typical forecast (of surface pressure) produced by the IMS model. The geographical background is drawn using a computer package obtained from ECMWF.

USER ACCESS TO NUMERICAL FORECASTS

The IMS model produces almost 100 forecast products per day, and about 300 products are available from the ECMWF model. Each product consists of a parameter (such as temperature, pressure, amount of rainfall) verifying at a particular time (e.g. a 24-hour forecast, a 2-day forecast) and (where appropriate) at a particular level in the atmosphere. It is quite impracticable to produce plots of all these products as a routine. Instead, a small number of products are plotted operationally every day and the forecaster can request other products by running a special data-base interrogation programme called CHARTS.

CHARTS was developed at the IMS and has been described in detail elsewhere (see J. Hamilton, 'The design of an interactive graphics system for the display of meteorological fields', *Software Practice and Experience*, Vol. 14, No. 6, pp 587-600, 1984). Basically it is 'user-friendly' command language which allows the forecaster to specify requests in an easy-to-use format. The program provides as much help as possible to the user by using meaningful names for parameters, allowing the use of abbreviations and printing helpful error messages when the forecaster types an erroneous or ambiguous command.

The format of the commands is best illustrated by an example. If the user types the following :

PLOT 3DAY IMS SURFACE PRESSURE

then the system will display a three-day forecast of surface pressure (as produced by the IMS model). The experienced user can reduce the amount of typing required to enter the command by abbreviating many of the key words in the above example to just one or two letters.

This CHARTS program produces a display of the chart requested by the user on a graphics VDU (in a format quite similar to Figure 4). The forecaster can get a hard copy (i.e. a copy on paper) of any chart displayed in this manner. The system has been operational since May 1982 and is in use at the Central Analysis and Forecasting Office (CAFO) and also at Shannon and Dublin Airports.

Dot matrix printer displaying IMS computer-generated forecast.

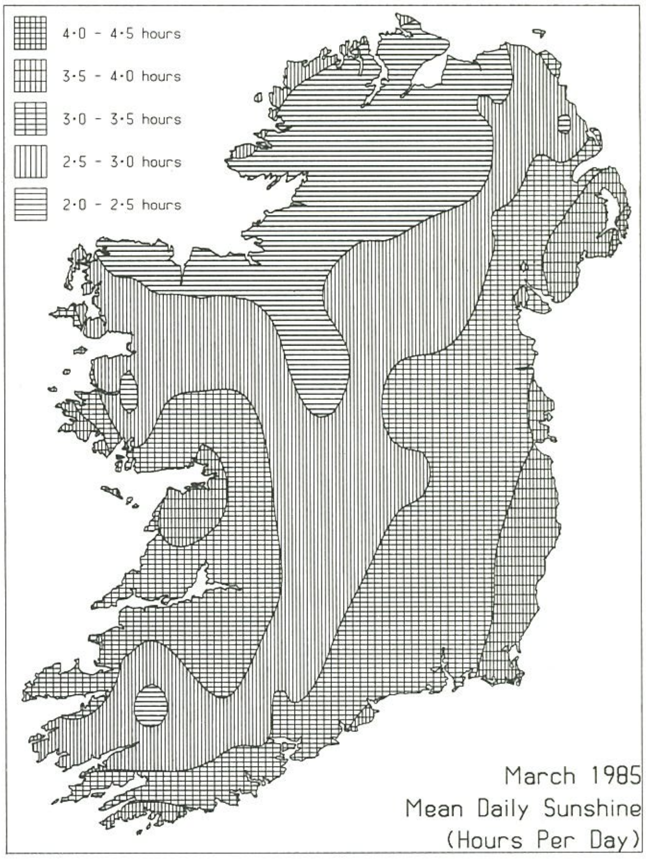


Figure 6. Sample plot produced by the Climatological Division. Data from 50 sunshine stations are converted on to a (regular) grid, and then contoured (and shaded) using the contouring package. Note how the shading lines are clipped at the land/sea boundary.

OTHER USES OF COMPUTER GRAPHICS

The use of computer graphics is becoming more widespread in the Service. A package has been written to draw graphs and histograms and this package is in much demand, especially by the Research section. The graphs on pages 38, 88 and 92 of this book have been produced by this package.

The Climatological Division has recently begun using the computer to produce contour maps of mean monthly temperature and monthly sunshine directly from the observations, and Figure 6 shows such a map.

INTERNATIONAL COOPERATION

Many of the graphics programs developed in the IMS are being made available through the World Meteorological Organization's Voluntary Cooperation Programme (VCP) as part of Ireland's aid to the developing nations. The graphics system was installed at the headquarters of the Instituto Nacional de Meteorologia in Brasilia, Brazil in August 1986. Turkey is scheduled to receive the system in March 1987, and at least three other countries are interested in the VCP scheme. In addition, graphics programs have been given to Iceland, Korea, Greece and Argentina.

The Irish Meteorological Society

by Ray Bates

The founding of the Irish Meteorological Society was rather late in coming, following the establishment of the Meteorological Service by almost half a century and the founding of the Royal Meteorological Society by over a hundred and thirty years. Nevertheless, its birth coincided with the establishment of similar societies in countries of similar size; just before coming to Ireland to deliver our first annual guest lecture Professor Joseph Smagorinsky had given a similar lecture to the newly-formed New Zealand Meteorological Society.

The Society had its origin in a meeting held in the Meteorological Service in late 1981 and was formally established in March 1982 when its first annual general meeting was held and its constitution and rules were adopted. A committee of twelve were elected, the first President being Mr Shane L. Tierney, a former Assistant Director of the Meteorological Service. From the beginning, the founding members wished the Society to attract people from all walks of life who had an interest in meteorology, and this wish is reflected in the present composition of the Society. In addition to present and former Meteorological Service staff, who form a majority, the membership includes physicists, agricultural scientists, astronomers, geographers, airline pilots and seamen. The total membership numbers about 120, representing a wide geographical coverage throughout Ireland and including some members from abroad.

The main aim of the Society being the promotion of an interest in meteorology, its principal activity has been in organizing lectures, meetings and outings to places of meteorological interest. Among the one-day meetings held was one devoted to 'Problems of weather forecasting in Ireland', where forecasters from North and South came together to share their experience. In the early days, most of the meetings were held in Dublin hotels, but more recently the Society has been fortunate in having lecture halls provided free of charge by Trinity College. Lectures have been organized on topics as diverse as 'The production of aerosols in the marine atmosphere' to 'Golfing in a wind'.

Following Professor Smagorinsky, the Society's annual guest lecturers have been Sir John Mason, who spoke on 'The effects of increased carbon dioxide on global climate', Professor John Latham, who described the physics of 'Thunder and lightning', Professor James Dooge, whose topic was 'Studying the fresh waters of Planet Earth', and Professor Bernard Vonnegut whose lecture dealt with cloud-seeding techniques, of which he was a pioneer.

Shane Tierney, the first President of the Irish Meteorological Society. A native of Derry, Mr Tierney joined the Meteorological Service in 1939, and served as a trainee meteorologist at the flying-boat station at Foynes. He was in charge of the Central Analysis and Forecast Office on its establishment, and was appointed Assistant Director in 1964. During the next ten years he was very active in the field of international marine meteorology and served as President of the Commission for Maritime Meteorology of the WMO from 1968 to 1972. He retired from the Service in 1975.

The Society has, since its founding, enjoyed cordial relations with the Royal Meteorological Society, and these relations were further strengthened in July 1986 when the Societies held their Joint Summer Meeting on 'Advances in weather forecasting' in Trinity College, Dublin.

A group of UK and Irish forecasters attending the joint Irish Meteorological Society/Royal Meteorological Society seminar in July 1986, with Alderman Bertie Ahern (Lord Mayor of Dublin). Seated (from left): Aidan Nulty, Francis Wilson, the Lord Mayor, Bill Giles; standing (from left): John Stone, Gerry Fleming, John Doyle and Michael Cleary. (Photo: Bord Fáilte)

Delegates at the Irish Meteorological Society/Royal Meteorological Society seminar at Trinity College Dublin, (Photo: Ian James, Royal Meteorological Society)

Contributors to this book

Ray Bates is an Assistant Director of the Service and previously served as head of the Research Division.

Austin Bourke joined the Service in 1939 and retired as Director in 1978. He served for some time as President of the WMO Commission for Agricultural Meteorology.

Liam Burke is in charge of the Marine Unit. Previously he served as a forecaster in the Central Analysis and Forecast Office (CAFO).

George Callaghan is head of the Applications Division (supervising the work of the Agricultural, Marine and Instrument Units, and of the Laboratory).

Michael Connaughton recently returned to the Meteorological Service after serving in the agricultural, training and administrative areas in the WMO Secretariat in Geneva.

Sean Connolly is a meteorologist at Shannon Airport.

Evelyn Cusack is a forecaster in CAFO.

Fred E. Dixon joined the Service in 1939 and at the time of his retirement in 1977 was head of the Climatological Division.

Denis Fitzgerald is head of the Climatological Division.

Con Gillman joined the Service in 1940 and at the time of his retirement in 1979 was in charge of the Training Division at Rosslare.

Gearóid Granville joined the Service in 1940 and was Assistant Director when he retired in 1980. For some years he had been in charge of the Long-range Forecasting Unit.

James Hamilton is a meteorologist in the Research Division, and the creator of a large number of computer-graphics programs in use in the Service and in many services abroad.

'Wally' (Robert Walter) Kavanagh is the only contributor who has not been a member of the Meteorological Service. He joined the Post Office in 1936 and during the war years was seconded to the Radio Service. He retired from the Post Office in 1983.

Marty Keane is a Principal Meteorological Officer in the Services Division. He spent many years working in the Climatological Division and has been an inspector of climatological stations.

Tom Keane is head of the Agricultural Meteorology Unit.

Thaddeus Kelly is a meteorologist at Shannon Airport.

Donal Linehan is the present Director of the Meteorological Service .

Séamus Ó Laoghóg is head of the Training Division in Galway.

Peter Lynch is acting head of the Research Division.

Patrick Lyons is Senior Meteorologist in charge of the Meteorological Office at Shannon Airport.

Paddy MacHugh is head of the Central Analysis and Forecast Office (CAFO).

Ray McGrath is a meteorologist in the Computer Division. For some years previously he served as a forecaster in CAFO.

Andy McManus is a Senior Meteorological Officer in the Computer Division. He has spent many years in the Climatological Division working on data processing.

Declan Murphy is head of the Computer Division.

Eamon Murphy is Senior Meteorologist in charge of Valentia Observatory at Cahirciveen, County Kerry.

Aidan Nulty is a forecaster in CAFO.

Cormac O'Connor is Senior Meteorologist in charge of the Meteorological Office at Cork Airport.

Dermot O'Connor joined the Service in 1941 and spent most of his career at Headquarters. He was Senior Meteorologist in charge of the Services Division when he retired in 1982.

Louis Power joined the Service in 1948. He worked for some years in CAFO. At the time of his retirement in 1986 he was a Senior Meteorological Officer in the Climatological Division and responsible for the inspection of climatological stations.

Andy Roche joined the Service in 1939 and at the time of his retirement in 1984 was Principal Meteorological Officer in charge of the Outstations Unit at Headquarters. Previously he had been in charge of the Meteorological Office at Casement Aerodrome, Baldonnel.

Kilian Rohan joined the Service in 1940. During his career he was in charge of the Meteorological Office at Shannon Airport and later head of the Climatological Division. He was appointed Director of the Service in 1978 and retired in 1981.

Lisa Shields is Librarian/Translator in charge of the Meteorological Service Library.

Brendan Smith joined the Service in 1940. At the time of his retirement in 1981 he was a Principal Meteorological Officer in the Climatological Division and responsible for the inspection of climatological stations.

Appendix
Selected publications of the Irish Meteorological Service

(Prices do not include postage and handling)

MONTHLY WEATHER REPORT 1985

Part 1 (General), £2.35 each monthly issue or annual summary
Part 2 (Rainfall), £3.10 for annual summary only
Part 3 (Selected data for synoptic stations), £3.50 each monthly issue, £6.50 for the annual summary.
(Back issues, including full sets of Part 2, 1981–1984 available at varying prices)

MONTHLY WEATHER BULLETIN

Annual subscription (including postage) £16

MISCELLANEOUS PUBLICATIONS

Averages of rainfall for stations in Ireland 1916–1950, £0.25 *Mean and extreme values of air temperature for stations in Ireland, (1921–1950)*, £0.25

Monthly, seasonal and annual mean and extreme values of duration of bright sunshine in Ireland 1931–1960, £0.25

Rainfall in Ireland 1931–1960, £0.35

The climate of North Munster, by P.K. Rohan (1968), £0.55

The secular variation of magnetic field (horizontal force, vertical force and total force) over Ireland, by J. McWilliams (1971), £0.25

Aeronautical climatological summaries, Shannon Airport 1961–1970 and descriptive meteorological memorandum, £1.25

Meteorological satellites, by D.L. Linehan (1972), unpriced

The secular variation of the magnetic elements at Valentia Observatory 1899–1972, by J. McWilliams, £0.25

Weather satellites and cloud pictures, by W.G. Callaghan (1974), unpriced

Analysis of solar radiation measurements at Valentia Observatory for the 11-year period 1964–1974, by J. McWilliams, £0.45

Aeronautical climatological summaries, Dublin Airport 1961–1970 and descriptive meteorological memorandum, £1.75

Some aspects of the weather behaviour at Dublin Airport particularly as regards poor landing conditions, by K. Breivik (1978), £0.55

Solar observations 1982 (Valentia Observatory, Kilkenny, Birr, Dublin Airport, Malin Head, Clones and Belmullet), £1.75 (back issues for the years 1981, 7 stations, and 1976–80, 4 stations, also available)

Magnetic observations at Valentia Observatory 1983–1984 (combined), £5.70 (back issues of single years from 1978 available at varying prices)

Meteorological Service annual report 1984, £1.75 (back issues for 1976 and 1978–83 also available at varying prices)

Aeronautical climatological summaries, Cork Airport 1962–1976 and descriptive meteorological memorandum, £2.00

A look at some aspects of the weather at Cork Airport, by F.J. Fitzgerald (1980), £0.45

The secular variation of magnetic declination in Ireland, by J. McWilliams (1980), £0.40

The climate of Dublin (1983), £6.00

AGMET — Joint Working Group on Applied Agricultural Meteorology — 1st report (March 1985), unpriced

The AGMET index — Irish scientists concerned with agricultural meteorology, (March 1986), unpriced

Request/reply facility for operational meteorological information for general aviation — user manual, by Ciaran Mac Gabhann (1986), £5.00

The secular variation of magnetic declination in Ireland (1985), by K.G. Commins, £2.00

The climate of Ireland, by P.K. Rohan, 2nd edition, Dublin, Stationery Office, 1986.

This is an enlarged and updated version of the 1975 edition. Available from any bookseller, or directly from the Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2. Price £4.45

AGROMETEOROLOGICAL MEMORANDA

1 : *Soil moisture deficit in Ireland in summer 1968*, by M.J. Connaughton (1969), £0.25

2: *Air frosts in late spring and early summer*, by M.J. Connaughton (1969), £0.25

3: *Soil temperatures in Ireland*, by M.J. Connaughton (1970), £0.25

4: *Air frost in late autumn and early winter*, by M.J. Connaughton (1973), £0.25

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6: *The first and last occurrences of ground frost*, by M.J. Connaughton (1975), £0.85

7: *Earth temperatures in Ireland*, by D.L. Fitzgerald (1977), £0.85

8: *Weather and potato blight*, by T. Keane (1982), £1.20

CLIMATOLOGICAL NOTES

1. *Records of extreme temperature in Ireland*, by M. Ó Cathain and G. O'Sullivan (1972), £0.25

2: *Surface winds over Ireland*, by P. Butler and B.C. Farley (1973), £0.40

3: *Distribution of driving rain in Ireland*, by E.J. Murphy (1973), out of print

4: *Sea water temperatures at Malin Head (1959–74)*, by M. Ó Cathain, D. O'Regan and F.E. Dixon (1976), £0.25

5: *Monthly and annual averages of rainfall for Ireland 1941–1970*, by H.B. Doherty and J.J. Logue (1977), £0.45

6: *Sea water temperatures at Malin Head (1959–1980)*, by D. O'Regan and M. Ó Cathain (1981), £0.40

7: *Monthly and annual averages of rainfall for Ireland 1951–1980*, by D. Fitzgerald (1984), £3.40

8: *Air temperature in Ireland 1951–1980. Monthly, seasonal and annual mean and extreme values*, by D. Keane (1985), £3.80

9: *Monthly, seasonal and annual mean and extreme values of duration of bright sunshine in Ireland 1951–1980*, by D. Keane (1985), £3.20

TECHNICAL NOTES

10: *Note on the occurrence of non-frontal fog or mist at Dublin Airport during the period October to February*, by S.L. Tierney (1949), (unpriced)

11: *The utilisation of aircraft weather reports at the Meteorological Office, Shannon Airport*, by P.K. Rohan (1952), £0.25

12: *Potato blight and the weather: a fresh approach*, by P.M.A. Bourke (1953, reprinted 1976), £1.00

13: *The potato blight weather warning service in Ireland in 1952*, by P.M.A. Bourke (1953), £0.25

14: *Evaporation and transpiration in the Irish climate*, by V.H. Guerrini (1953), £0.25

15: *Potato blight and the weather in Ireland in 1953*, by P.M.A. Bourke (1953), out of print

16: *On the objective determination of minimum density and frequency of upper air observations to meet stated requirements*, by M. Doporto (1954), £0.25

17: *An analysis of wind components at the 700 and 500 mb. levels along the great circle track between Shannon Airport, Ireland and Gander Airport, Newfoundland*, by C.J. Gillman and P.K. Rohan (1954), £0.25

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20: *Investigation into the accuracy of wind forecasts prepared at Shannon Airport for the great circle route Shannon-Gander*, by F.M. O'Carroll (1985), £0.25

21: *Aircraft icing over the Eastern North Atlantic*, by P.K. Rohan and F. Ó hAonghusa (1956), £0.25

22: *An investigation into turbulence reported by aircraft over the Eastern North Atlantic*, by P.K. Rohan (1957), £0.25

23: *The use of synoptic weather maps in potato blight epidemiology*, by P.M.A. Bourke (1957), £0.25

24: *An analysis of the wind components at the 300 mb level along the great circle track between Shannon and Gander*, by J.W. O'Byrne and M.J. Connaughton (1957), £0.25

26: *Annual and diurnal variation of visibility at Shannon and Dublin Airports*, by F.E. Dixon (1959), £0.25

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29: *Potential evapotranspiration as measured at Valentia Observatory over the period August 1952 to February 1962 and a comparison with values as computed by the Penman formula*, by W.A. Morgan (1962), £0.25

30: *A survey of weather conditions at Cork Airport*, by F.J. Fitzgerald (1965), £0.25

31: *Global solar radiation, potential evapotranspiration and potential water deficit in Ireland*, by M.J. Connaughton (1967), £0.25

32: *Atmospheric chemistry in the Irish Meteorological Service and a discussion of some results*, by S.L. Tierney (1967), out of print

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43: *The annual cycle of rainfall in Ireland*, by J.J. Logue (1978), £0.25

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47: *A provisional assessment of the recreational quality of weather in summer, in terms of thermal comfort and the adverse effect of rainfall*, by L.S. Leech (1985), £3.90

INFORMATION LEAFLETS

Weather services for the general public (1986), unpriced.

Weather services for aviation (1986), unpriced.

Climate services (1986), unpriced.

Weather services to agriculture (1986), unpriced.

Marine weather services (1986), unpriced.

Orders and enquiries to O/C Supplies, Irish Meteorological Service, Glasnevin Hill, Dublin 9, Ireland (Tel: 424411).

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