

Meteorological Office

REPORT FOR THE YEAR
ENDING
MARCH 31, 1958

METEOROLOGICAL OFFICE

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LONDON

HER MAJESTY'S STATIONERY OFFICE

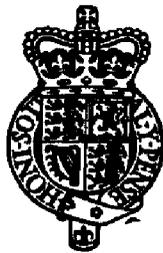
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ANNUAL REPORT
ON THE
METEOROLOGICAL OFFICE

*Presented by the Director-General
to the
Secretary of State for Air*

FOR THE YEAR
APRIL 1, 1957 TO MARCH 31, 1958



LONDON
HER MAJESTY'S STATIONERY OFFICE
1958

METEOROLOGICAL COMMITTEE

Chairman: The Lord Hurcomb, G.C.B., K.B.E.

Members: Sir Austin Anderson
Sir David Brunt, F.R.S.
Colonel N. V. Stopford Sackville, O.B.E.
Chairman, Meteorological Research Committee (ex-officio)

Secretary: Mr. W. J. B. Crotch (Secretary, Meteorological Office)

The Committee met three times during the period covered by this report.

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Dr. A. W. Brewer
Dr. G. M. B. Dobson, C.B.E., F.R.S.
Instructor Captain A. E. Johnston, R.N. (Admiralty)
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Mr. James Paton, F.R.S.E.
Professor P. A. Sheppard
Sir Graham Sutton, C.B.E., F.R.S. (Director-General, Meteorological Office)
Sir Owen Wansbrough-Jones, K.B.E., C.B. (Ministry of Supply) (to February, 1958)
Dr. H. M. Wilson, M.B.E. (Ministry of Supply) (from March 1958)
Dr. T. W. Wormell

Secretary: Mr. H. W. L. Absalom, O.B.E.

The Committee met twice during the period covered by this report.

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Members: Sir Edward Appleton, G.B.E., K.C.B., F.R.S. (University of Edinburgh)
Sir David Brunt, F.R.S. (Royal Society)
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Dr. D. Jack, F.R.S.E. (University of St. Andrews)
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Mr. James Paton, F.R.S.E. (Royal Society of Edinburgh)
Dr. R. J. Peters (Department of Health for Scotland)
Professor W. M. Smart (University of Glasgow)
Dr. J. B. Tait, F.R.S.E. (Fisheries Division, Scottish Home Department)

Secretary: Mr. R. Cranna

The Committee met on December 6, 1957.

GASSIOT COMMITTEE

Appointed by the Royal Society in accordance with Treasury Letter of February 26, 1910, to administer the Gassiot Trust, and to promote the scientific study of the branches of science to which the Trust relates, namely Meteorology, Terrestrial Magnetism, Atmospheric Electricity, Seismology and the cognate subjects.

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Sir Geoffrey Taylor, F.R.S.
Dr. T. W. Wormell
The Astronomer Royal
The President of the Royal Astronomical Society
The President of the Royal Meteorological Society
The Director-General of the Meteorological Office

The Committee met on July 25, 1957.

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FUNCTIONS OF THE METEOROLOGICAL OFFICE

The Meteorological Office is the State Meteorological Service. It forms part of the Air Ministry, the Director-General being responsible to the Secretary of State for Air through the Permanent Under-Secretary of State.

The general functions of the Meteorological Office are:

- (i) Provision of meteorological services to the Army, Royal Air Force, Civil Aviation, Ministry of Supply, the Merchant Navy and Fishing Fleets.
- (ii) Liaison with the Naval Weather Service of the Admiralty and provision of basic meteorological information for use by that Service.
- (iii) Meteorological services to other Government Departments, public corporations, local authorities, the Press and the general public.
- (iv) Organization of meteorological observations in Great Britain and Northern Ireland, and in certain colonies.
- (v) Collection, distribution and publication of meteorological information from all parts of the world.
- (vi) Maintenance of certain British observatories and publication and distribution of magnetic and seismological information obtained from them.
- (vii) Research in meteorology and geophysics.

The Meteorological Office also takes a leading part in international co-operation in meteorology. The Director-General is the Permanent Representative of the United Kingdom with the World Meteorological Organization.

Except for the common services provided by other Government Departments as part of their normal function (e.g. accommodation by the Ministry of Works; stationery by Her Majesty's Stationery Office; postal services by the Post Office) the cost of the Meteorological Office is borne by Air Votes.

The gross annual expenditure by the Exchequer, including that on the common services, is of the order of £4,500,000. Of the expenditure chargeable to Air Votes, about £3,000,000 represents expenditure associated with staff and £1,000,000 expenditure on stores, communications and miscellaneous services. Of the total expenditure, nearly £750,000 is recovered from other Government Departments and outside bodies in respect of special services rendered, sales of meteorological equipment, etc.

FOREWORD BY THE DIRECTOR-GENERAL

The outstanding event of the year for the Meteorological Office was the reorganization which followed the report of Lord Brabazon's Committee to the Secretary of State for Air. Details of the new organization in relation to the distribution of work are to be found in Appendix I. Here I propose to deal broadly with the changes as they affect the Meteorological Office as a public service and a scientific institution.

The Committee considered that the Meteorological Office should remain with the Air Ministry, and it also came to the gratifying conclusion that the present standing of the Office as a scientific institution is high, that user interests appreciated the advances in recent years and that, all told, there is considerable confidence in services provided. To facilitate the work of the Meteorological Office it was decided to reorganize it in three sections dealing with forecasting and services, research, and administration, respectively. The control of the Office is entrusted to the Director-General, who is responsible to the Secretary of State for Air through the Permanent Under-Secretary of the Air Ministry. Forecasting and other services to the community are placed under the Director of Services and research, including instrument development, under the Director of Research, both Directors being in the grade of Chief Scientific Officer. The administrative section is headed by an Assistant-Secretary with the title of 'Secretary of the Meteorological Office', a change which makes the Meteorological Office a much more self-contained unit than hitherto, with increased responsibilities for internal administration. In addition, new posts have been created in the grades of Deputy Chief Scientific Officer, Senior Principal Scientific Officer and Chief Experimental Officer.

The reorganization has given the Meteorological Office enhanced status in the hierarchy of the Government Scientific Service, with much improved career prospects for members of the scientific staff. The Brabazon Committee expressed concern concerning the latter aspect, and it is gratifying that the Meteorological Office has now come into line with other major scientific establishments in this important matter. The overall establishment in the scientific officer class has been reduced by a relatively small amount with the object of improving the chances of all entrants to this class of reaching the higher levels, and at the same time the number of senior appointments in the experimental officer class has been increased.

The most striking aspects of the reorganization are in the improved facilities for research. For the first time in its history the Office has a fully developed research side. In its review of the purely scientific activities of the Office, the Brabazon Committee paid tribute to the work of the Meteorological Research Committee, which continues with its terms of reference unchanged. Important fields of research have been recognized by the creation of a deputy-directorate with specific interests in physical meteorology, together with new assistant-directorates in micrometeorology, with special responsibilities for the Observatories, and in dynamical meteorology, with special responsibilities for the development of numerical methods in forecasting. The efforts of research workers, however, are largely wasted unless their discoveries are made available to the operational side, and a special post at Assistant Director level has been

created to ensure that the flow of information from research to forecasting, and the equally valuable return flow of forecasting experience to the research side, are maintained at a high level.

The system of general supervision of the work of the Office was also reviewed. Hitherto, the Meteorological Committee has included representatives of the various Government departments which have a user interest in meteorology, the universities, the Royal Society and the Royal Society of Edinburgh. The Brabazon Committee felt that such a body was too large to be effective and that it should be replaced by an Advisory Committee of not more than five members, all outside Government service. The chairman of the new Meteorological Committee is Lord Hurcomb and the members are: Sir Austin Anderson, Sir David Brunt, Sir Charles Normand (Chairman of the Meteorological Research Committee) and Colonel Stopford Sackville. The Committee is required to keep under review the progress and efficiency of the Meteorological Office and the broad lines of its current and future policy, as well as the general scale of effort and expenditure. It is also required to study contacts between the Office and the users. The Advisory Committee on Meteorology for Scotland remains as before.

The full benefit of the reorganization will not be felt until the headquarters units have settled in to the new buildings at Bracknell. Design work on these buildings is nearing completion and it is expected that the first block will be ready early in the summer of 1960 and that the whole group will be completed in 1961. All the staff now at Victory House, Kingsway (with the exception of the present London Forecasting Office), and at Harrow and Dunstable, together with the Training School from Stanmore, will move to Bracknell.

Another event of considerable significance for the Meteorological Office was the examination of its Financial Estimates by a Select Committee of the House of Commons. The findings of the Committee were published in the Fifth Report from the Select Committee on Estimates, H.M.S.O. Cmd. 199 (1957) and the recommendations are now under discussion within the Air Ministry.

The work of the Office during the past year is discussed in detail in the main body of the Report and only a few items can be singled out here for special mention. Public interest in weather forecasts, stimulated to a large degree by the regular television presentations, is steadily increasing and the number of telephone inquiries to Meteorological Office stations now runs into hundreds of thousands a year. Such a volume of calls makes heavy demands on staff who, for the most part, are already fully engaged in serving aviation. Some relief is afforded by the automatic telephone weather service which now takes about three million calls a year in London alone. The extension of the service to the country as a whole has begun, and this and other means of providing local forecasts are engaging the attention of the Director of Services and his staff.

The dissemination of weather information to the public has increased and it is believed that the change to less stereotyped style in the regular forecasts and in the late night 'Weather Commentary' is welcomed by listeners. A small but significant fact is that the broadcast forecasts have been made more precise by free reference to the passage of cold and warm fronts. A decade ago this would have been far too technical to attempt, but the concept is now familiar, and generally understood by many who are not primarily interested in meteorology.

Upper-air observations are now an integral part of synoptic meteorology and the Meteorological Office sends up over 12,000 radio-sondes every year

from its stations at home and overseas. The present Meteorological Office pattern sonde is among the best in the world, but in view of the importance of securing the highest accuracy at the greatest possible heights (especially important for the operation of jet air-liners) it has been decided to undertake a thorough review of the technique of upper-air soundings including, if necessary, the redesign of the radio-sonde equipment.

Work on numerical forecasting has been hindered by the delay in the delivery of the electronic computer, but otherwise is going ahead satisfactorily. The problem of long-range forecasting, that is, forecasting for periods greater than a week, is notorious for its intractability and despite much work in many countries there is still no reliable system in general use. In the past two years the Directorate of Research has tried out a new approach to monthly forecasts, with very interesting results. It remains to be seen if the method can be developed to the stage at which regular publication would be justified, and work continues.

I attended the General Assembly of the International Union of Geodesy and Geophysics at Toronto in September 1957, and the Ninth Session of the Executive Committee of the World Meteorological Organization at Geneva in October 1957.

PUBLICATIONS BY THE DIRECTOR-GENERAL

- Control of the weather. *Financ. Times, London, No. 21,381, 1958, p. 6.*
- Mathematics in Action. 2nd Ed., revised and enlarged. London, 1957.
- Meteorology and air pollution. Eighth Des Voeux Memorial Lecture. *Proc. Ann. Conf. nat. Smoke Abat. Soc., Hastings, 4 Oct., 1957. Pp. 10.*
- Meteorology for aviation. *Times Survey Brit. Aviation, London, 1957, p. 7.*
- Meteorology in the I.G.Y. *New Scientist, London, No. 10, 1957, p. 13.*
- Reorganization of the Meteorological Office. *Met. Mag., London, 86, 1957, p. 225.*
- Telling the weather. *Financ. Times, London, No. 21,243, 1957, p. 4.*
- World Meteorological Organization. Ninth session of the Executive Committee. *Met. Mag., London, 86, 1957, p. 353.*
- Meteorology to-day. *Trans. Soc. Engrs., London, 48, No. 3, 1957, p. 81.*

THE DIRECTORATE OF SERVICES

An important part of the re-shaping of the Meteorological Office in July 1957 dealt with those functions that the Office, as the national weather service, is required to carry out for all sections of the community. They are now all grouped under the Director of Services, so that in this context 'services' carries the broad dictionary sense of work done to meet a general need: military services are included as part of the whole.

The functions of the directorate are in two broad categories, central and outstation, with a Deputy Director in charge of each. The Deputy Director in charge of central services, D.D.M.O.(C), is responsible for the network of weather reporting stations throughout the country and for the rapid collection and redistribution of the reports to forecasting offices; he also supervises the international exchange of reports between this and other countries. For those purposes he has a complex system of teleprinter, radio and radio teletype communications. D.D.M.O.(C) is also responsible for the primary analysis of weather charts and for providing broad forecast guidance to outstations.

Using the weather reports and guidance from D.D.M.O.(C)'s organization the Deputy Director in charge of outstation services, D.D.M.O.(O), provides through his 110 outstations in this country the information and advice required by a wide range of consumer groups, including military and civil aviation and those members of the general community who use the direct or automatic telephone forecast service supplied from many of the meteorological outstations. D.D.M.O.(O) is also responsible for seeing to the meteorological requirements of the Royal Air Force and British civil aviation at 35 stations overseas.

The broad division of labour within the directorate therefore is that D.D.M.O.(C) is concerned with the wholesale side of the service including the collection of the raw material and the distribution of the bulk article to D.D.M.O.(O)'s outstations and to the public through the media of the radio, television and Press; whereas D.D.M.O.(O) is responsible for the retail trade at outstations where the forecasts are tailored to fit local conditions and the special requirements of his customers.

In practice the division of function is not quite as clear cut as this. For example the central forecasting office at Dunstable under D.D.M.O.(C) obtains its basic observational material for this country from 210 stations: a little over one half of these are D.D.M.O.(O)'s outstations on R.A.F. or civil airfields and it is from those Meteorological Office outstations that the main stream of round-the-clock weather reports comes. The remainder come from land stations of the Naval Weather Service, from lighthouse keepers, coastguards and private local observers or from the network of upper air observing stations and British ocean weather ships for which D.D.M.O.(C) is responsible. The Meteorological Office outstations set up primarily for the retail trade therefore supply much of the material that goes into the making of the analysis and forecast guidance which they get from the wholesale central office.

In addition to his responsibilities for central forecasting and related services D.D.M.O.(C) has charge of the work done in the Meteorological Office for the climatology of the United Kingdom, including a special enclave of agricultural meteorology and an embryo section of hydrology. In this climatological work

which is concentrated on Harrow D.D.M.O.(C) is both wholesaler and retailer, in that he collects and processes the returns from some 5,000 climatological and rainfall observing stations up and down the country—the great proportion being voluntary stations—and he makes the results available in publications, by answering enquiries, and, in the case of agriculture, through meteorological officers who are specially trained in the agricultural aspects of climatology and are attached to and operate in close association with the regional agricultural authorities at Bristol, Cambridge, Edinburgh and Leeds.

About 2,400 staff of all classes and grades are employed in the work outlined in preceding paragraphs: some 550 of these, including 190 locally recruited staff, are in establishments outside this country. All the members of the assistant, experimental and scientific officer classes require on recruitment a thorough professional training and this is given at the Meteorological Office Training School, Stanmore; a specialist course on the operation of radio-sonde and wind-finding by radar is provided at a separate school near Hemsby, Norfolk, for the staff of the upper air observing stations.

This is a period of rapid development in the theory and practice of meteorology and in the demands made on its practitioners. It is therefore necessary that basic professional training should be supplemented by a means of ensuring continuously two things: first, that new ideas, practices and equipment from the research directorate are tried out at operational stations and secondly, that the scientific and technical problems which arise at these stations are examined by the research staff. This is specially necessary in an institution like the Meteorological Office in which 70 per cent. of all the operational staff work in small groups at isolated stations each with its own technical problems.

In July 1957, a new assistant directorate of techniques and training, directly responsible to the Director of Services, was set up to guide and encourage this two-way traffic between the operational and research teams of the Office and also to supervise the initial and refresher training.

In the directorate as a whole one of the most conspicuous trends during the year has been the steadily increasing demand from the public for weather forecasts and advice. At the forecasting office in Kingsway, London, inquiries by telephone now run at an annual rate of nearly 100,000, and in the past year D.D.M.O.(O)'s outstations have answered 210,000 enquiries additional to those relating to aviation for which the stations are primarily established. Nearly 5,000,000 people used the automatic telephone weather service now available in various parts of the country.

CENTRAL FORECASTING

The dual functions of furnishing day-to-day forecasting guidance to outstations, and supplying weather forecasts to specialist users, other Government Departments, and the general public, have been discharged without any major changes from previous years. Special forecast services have included forecasts of the likelihood of icing on the conductor system of electrified railways over south-eastern England and the London Area, forecasts for pigeon races starting from places outside the British Isles, and seasonal forecasts to horticultural firms in relation to the raising of food crops. Forecasting guidance comprised, as hitherto, the broadcasting by teleprinter and radio of analyses of the existing meteorological situation over a wide area at the surface, and in the upper air, and of information regarding expected changes during the following 24 hours or more.

Bulletins for broadcasting. Forecasts, including warnings of particular weather hazards, such as fog, snow and thunderstorms, are made known to the general public, principally through the Home, Light and European Services of the British Broadcasting Corporation, and through the daily newspapers. For shipping, special forecasts and warnings covering specified sea areas around the coasts of the British Isles are broadcast several times daily on the Light Programme, and in addition from G.P.O. coastal radio stations twice daily. From the G.P.O. station at Portishead, a weather bulletin relating to the eastern half of the North Atlantic is broadcast twice daily.

For coastal waters around the British Isles a system of visual gale warnings by means of gale warning cones, hoisted at appropriate places along the coast, is also controlled from the Central Forecast Office.

Extended period forecasts. The daily preparation of forecasts for two to three days ahead has continued. Weather outlooks beyond 48 hours based on these, have been incorporated in forecasts issued to the Press, or broadcast by the B.B.C., whenever the degree of confidence in the outlook has been sufficiently high. On these extended forecasts have also been based the 'fine spell' service for farmers, and advice to certain commercial firms for which week-end temperatures pose special plant maintenance problems.

Official publications. The preparation of the *Daily Weather Report*, its *Overseas Supplement* and *Monthly Summary* and the *Daily Aerological Record* continued throughout the year.

PUBLIC SERVICES

As in the previous year, much of the planning work has been in relation to the development of the automatic telephone weather service and towards meeting the increasing demands of television, both from the British Broadcasting Corporation and the Independent Television Authority.

Television broadcasting. The main innovation by the B.B.C. was the introduction in October 1957, of a 5-minute weather talk, at 1.0 p.m. on Thursdays, by one of the 'television forecasters' from Victory House, immediately following the new weekly programme for farmers. This weather feature is believed to be popular with many viewers outside the agricultural circle for which it is particularly designed.

The nightly forecast presentations from Lime Grove Studios continued with little change, apart from minor alterations of timing.

Assistance was given to the B.B.C. in the production of a special programme about the International Geophysical Year introduced by H.R.H. The Duke of Edinburgh, and also in schools broadcasts dealing with the same subject.

Commercial television companies have increased their use of meteorological information, and during the year additional forecasts have been provided for Granada Television Ltd. (covering Lancashire and Yorkshire), Scottish Television Ltd. (covering the Lowlands of Scotland) and for T.W.W. Ltd. (covering South Wales and West of England).

Automatic telephone weather service. This service was extended by the inclusion of Edinburgh, and 'coastal area forecasts' for Essex, Kent and Sussex coasts separately, thus bringing up the total of local automatic services to eleven. As has already been mentioned, over the whole country the total number of calls on the service during the year was approximately 5,000,000. Further extensions of the service are under consideration.

Museum exhibitions. The itinerant meteorological exhibition has again been in demand and was displayed during the year in museums and art galleries in Birmingham, Coventry, Bristol, Cardiff, Cheltenham, Worcester and Northampton and was inspected by large numbers of visitors, especially school parties. In some centres, officially sponsored lectures were given by staff of the Meteorological Office, usually to large audiences. From questions asked at these lectures, it was evident that a lively and intelligent interest in the work of the Office had been stimulated by this exhibition.

Radar storm warning equipment on Victory House roof. The installation on Victory House roof for obtaining information by radar about the approach of rain has been maintained continuously, chiefly on an experimental basis, but on several occasions operational use was attempted with success.

OBSERVATIONS AND COMMUNICATIONS

Surface observations—Synoptic reporting network. Some R.A.F. stations, with their meteorological offices which had formed part of the synoptic reporting network in the United Kingdom, closed down during the year. The co-operation of the Coastguard Section of the Ministry of Transport and Civil Aviation, and of the Northern Lighthouse Board in the case of Scotland, enabled auxiliary reporting stations to be opened in partial replacement, although it is recognized that Coastguards and Lightkeepers must give their own duties priority. Arrangements were also made for the Coastguards at Shoreham, Fairlight (Hastings), Sandgate and Deal to supply weather reports at 3-hourly intervals during the daytime, in connection with the G.P.O. automatic telephone weather services for the Sussex and Kent coasts.

Radio-sonde and radar-wind observations. The network of eight radio-sonde and radar-wind stations in the United Kingdom was maintained. Each station has made observations of pressure, temperature and humidity twice daily, and of upper winds four times daily. With the commencement of the International Geophysical Year in June, special efforts were made at all stations to increase the height reached in the ascents and certain stations also increased their sounding programmes during World Meteorological Intervals.

The building of the new station at Aughton, near Ormskirk, to replace Fazakerley has been completed, and plans were completed for a new station at Shanwell, near Tayport, Dundee, to replace Leuchars.

No major changes have been made to the equipment in routine use, but experiments have been successfully carried out with a view to introducing automatic measuring and recording of radio-sonde signals.

Meteorological flights. Meteorological reconnaissance flights were made by the Royal Air Force Hastings aircraft based on Aldergrove, and by Mosquito aircraft operated by a civilian contractor under direction of R.A.F. Home Command. Both types of flight maintained a high degree of regularity, and it is noteworthy that the Mosquito flights achieved the very creditable record of carrying out, without failure, a daily programme from January 1 to December 31, 1957, except for a deliberate break of two days over Christmas.

Thunderstorm location. The organization for locating the position of thunderstorms by the 'sferic' system, up to a range of 1,500 miles from the British Isles, was continued without change. The installation of equipment at Gibraltar and Malta to provide adequate cover over the Mediterranean region, and to add to accuracy over mid and eastern Atlantic is well advanced.

Communications—Teleprinters. Changes in the standard times of upper air observations from 03 and 15h G.M.T. to 00 and 12h G.M.T. which came into effect on April 1, 1957, necessitated considerable changes in the transmission schedules of all the teleprinter broadcasts made from Dunstable. Apart from this, the contents of the Channel I, Channel II, Mediterranean and International teleprinter broadcasts were substantially the same as during the previous year, though modified slightly from time to time to meet changing circumstances.

Radio communications. For many years the standard method of disseminating coded weather reports by radio has been by wireless telegraphy (W/T) broadcasts in morse code. Using an automatic keying device these broadcasts have been made at a rate of 18 to 20 5-figure groups per minute. Radio-teleprinter (RTP) broadcasts in the International Telegraph Alphabet No. 2 (often called the 'Murray' code), can, however, be made at a speed of 45 to 50 5-figure groups per minute. For this reason, it was decided by the World Meteorological Organization that in order to permit the transmission of a greater volume of data, continental and sub-continental W/T broadcasts should be progressively replaced by RTP broadcasts throughout the whole of the European Region. A radio-teleprinter sub-continental broadcast from Dunstable was accordingly introduced on November 1, 1957, and reports have been received of its regular and reliable reception from places as far away as Moscow, Minsk and Kiev. The W/T broadcasts have been continued in order to meet the needs of any European countries and naval vessels not equipped to receive the RTP broadcasts.

Facsimile. At the end of August and beginning of September 1957, the General Post Office and the Canadian Overseas Telecommunications Organization co-operated to provide facilities for the experimental facsimile transmission of weather charts between the United Kingdom and Canada over the trans-Atlantic telephone cable during slack periods. This coincided with the Canadian National Exhibition at Toronto, and charts transmitted by Dunstable were received at the Toronto Exhibition for two hours each day. Transmissions were also made in the reverse direction from Montreal (Dorval Airport) to Dunstable. Satisfactory reception was achieved in both directions.

CLIMATOLOGICAL SERVICES

The functions of the assistant directorate of Climatological Services are the collection and preservation of surface meteorological data for the United Kingdom area, the preparation and publication of meteorological data for general public use and to meet international commitments, the processing and presentation of such data in forms convenient for various users, particularly in the fields of industry, agriculture, horticulture, water engineering and hydrology, and the investigation of various problems related to the provision of meteorological services (other than forecasting). Following the re-organization of the Meteorological Office in July 1957 there are now three sections of the assistant directorate of Climatological Services, one for British Climatology, one for British Rainfall and Hydrology, and one for Agricultural Meteorology.

British Climatology

The British Climatology section is responsible for the supervision and periodical inspection of all co-operating climatological stations in Great Britain and Northern Ireland. These stations are maintained by private observers, local

authorities, universities and other educational establishments, industrial concerns, Trusts, and Government Departments. Great public spirit is shown by those who participate in the operation of these stations, often at personal inconvenience occasioned by the requirement for daily readings at fixed times throughout the year, whatever the weather. During the year returns were received from 33 new stations but 17 stations ceased to report, including that at Tenby where observations began in 1891. 130 climatological stations were inspected.

Two courses for co-operating observers were held at the Meteorological Office Training School. Each course lasted 5 days and included visits to the Forecasting Office at London Airport and to the Harrow headquarters of the Meteorological Office. 43 observers attended in all—the largest number for many years.

Statistical work and punched-card methods. The assembly, scrutiny and summarizing of the returns from climatological stations was kept up to date.

New branch memoranda included 'Monthly and annual maps of average bright sunshine over Great Britain and Northern Ireland, 1921-50' and a 'Selected List of Papers, etc., on British Climatology'.

Good progress was made with the tabulation for a selection of stations of hourly values of dry and wet bulb temperatures in a form suitable for determination of combined frequencies.

Further consideration has been given to the design of forms for the rendering of returns by co-operating climatological stations so that their data may be put on to punched cards from 1959 onwards. A trial of a proposed form by several stations was very encouraging. Experience with the new climatological forms for returns from official stations (from which data have been punched on cards as a routine) indicated the necessity for a few amendments.

Further progress has been made in punching daily and hourly data covering a 'backlog' of eight years for five selected stations: London Airport, Manchester Airport, Mildenhall, Renfrew and Aldergrove.

Publications. The *Monthly Weather Report*, containing full summaries of observations, was published regularly. The *Annual Summary* (for 1956) was published in July.

Special Work. At the request of the Institution of Heating and Ventilating Engineers, work is proceeding on the extraction and processing of data to provide a special meteorological contribution to the Institution's 'Guide to Current Practice'.

Enquiries. The number of requests received for meteorological information of all kinds continued to increase. The variety of enquiries dealt with included advice in connection with the design of nuclear power stations, large scale harbour developments, a motorway, multi-storeyed buildings, air conditioning plant (one for an operating theatre), refrigeration installations, cooling towers and radio masts. Investigations for which information was provided included the incidence of certain illnesses, beach erosion, smoke pollution, fluctuations in the sales of commercial products, the effectiveness of insulations in electric cables. Information on the distribution of thunderstorms was given to the Electrical Research Authority. A large number of statements was supplied for legal and insurance purposes. Advice was given to private individuals on where to live; to students preparing theses; and to schools and others interested in weather observing.

British Rainfall and Hydrology

The British Rainfall and Hydrological section is responsible for the supply of advice and information relating to rainfall, evaporation and the hydrological cycle (including related technical investigations) and for the supervision and periodical inspection of all co-operating rainfall stations in Great Britain and Northern Ireland. These stations are maintained by private observers, River Boards, Waterworks, Borough Engineers and other local authorities, Hydro-electric Boards, etc., without whose help it would not be possible to assess the incidence and distribution of rainfall over this country. During the year returns were received from 242 new stations but 175 stations ceased to report. Owing to sickness and staff changes the inspection of rainfall stations was not maintained at the level achieved in the previous year, but with the recent appointment of a new rainfall inspector a good start has now been made on resuming a full inspection programme.

Close contact was maintained with the Surface Water Survey of the Ministry of Housing and Local Government, the Ministry of Agriculture, Fisheries and Food (Land Drainage and River Board work), and the Road Research Laboratory of the Department of Scientific and Industrial Research, whilst consultations with individual River Boards continued. The section continued to collaborate in the evaporation investigation being carried out at a reservoir in Kempton Park belonging to the Metropolitan Water Board; data for two years had been accumulated by July 1957, but it was decided to delay the preparation of a full report on the investigation until three years' data had been collected. The section also maintained its co-operation with the Engineer of the Fylde Water Board who is carrying out experiments at the Stocks Reservoir near Slaidburn, Yorkshire, on evaporation from open water and land surfaces, percolation in a moorland environment, interception of precipitation by a coniferous forest, effects of percolation and run-off on afforestation, and on suitable shields for rain-gauges in open situations.

Statistical work. 'Averages of rainfall for Great Britain and Northern Ireland 1916-1950', containing information for 719 stations, was prepared in typescript and passed for publication. 'Averages of rainfall for Great Britain and Northern Ireland 1916-1950 (Monthly Weather Report and Daily Weather Report Stations)', containing information for 282 stations, was prepared as a section memorandum. The new averages were brought into use in the *Monthly Weather Report* and the *Monthly Summary* of the *Daily Weather Report* with the issues for January 1958, and similar arrangements were made for tables of data and maps prepared for various journals, reports and replies to inquiries.

Preliminary consideration was given to a comprehensive programme for punching rainfall data on cards, and a start was made with a limited programme for punching daily values 1916-1950 for about 50 stations. It is hoped to expand the programme during 1958 on the basis of experience gained in the limited programme.

Publications. The volume of *British Rainfall* for 1955 was published in October 1957, and that for 1956 was sent to the printers. A report on the Snow Survey of Great Britain for the season 1956-1957 was prepared, and 156 duplicated copies were distributed to co-operating observers and others: it has been decided that henceforth the published version of the report will be printed in the corresponding volume of *British Rainfall*, and the report for the season 1956-1957 will therefore appear in *British Rainfall* 1957. Estimates of the general

monthly rainfall were prepared for about 100 areas with run-off data, for inclusion in the *Surface Water Year Book* 1955-1956.

Special work. Data for the first full summer season of observations in the rainfall investigation at Cardington were obtained in 1957. Unfortunately instrumental faults led to deficiencies of the chart records of the order of 5 to 10 per cent. of instrument-hours. Instrumentation is being improved and a reduction of the percentage of faults is expected. A preliminary report on the investigation was prepared. Liaison with the radar station at East Hill was maintained since there are possibilities on some occasions of exchanges of information useful to both sides.

The Joint Committee of the Road Research Board and the Ministry of Housing and Local Government on Rainfall and Run-off, on which the Meteorological Office is represented, is particularly interested in the Cardington investigation and also in a scheme which it sponsored to have a country-wide distribution of open-scale rain recorders maintained by local authorities to obtain data of intense falls of rain in different parts of the country relevant to storm-water drainage research. The British Rainfall and Hydrology section undertook the correspondence regarding sites and instruments with nearly 200 local authorities, as a result of which about 150 agreed to co-operate in the scheme (for which the instruments are now awaited).

In connection with the International Geophysical Year, evaporation pans of the U.S. Weather Bureau Class A type were installed at the three observatories, Kew, Eskdalemuir and Lerwick, and arrangements were also made to issue nine additional evaporation pans of this type to co-operating stations where the authorities have undertaken to maintain daily observations. There was increased interest during the year in the problems of evaporation losses from the gathering grounds and reservoirs of water supply undertakings, and topics discussed, with which the section was concerned, included the effects of afforestation of gathering grounds and the use of monomolecular surface films to suppress evaporation from open water.

Enquiries. The large volume of enquiries dealt with by the British Rainfall and Hydrology section were related as usual to problems of water supply, drainage and flooding, damage to goods, accidents, etc.

Agricultural meteorology

The duty of the section for Agricultural Meteorology is the application of meteorology to problems of agriculture, horticulture and forestry. Its officers co-operate with research workers and advisory officers in these sciences and act generally in a liaison capacity in experiment, planning or practice.

The headquarters of the section is at Harrow and other units are stationed at the National Agricultural Advisory Service Regional Headquarters at Bristol, Cambridge and (since February) at Leeds. A member of the staff of the Meteorological Office, Edinburgh, carries out similar duties for Scotland and specializes on upland shelter problems.

Routine work. Over 40 inspections of crop weather climatological stations were carried out; in general, a very high standard of observations is being maintained which may well be attributed to the constant encouragement and advice given by the section, and also to the annual instruction course for climatological observers held in the autumn.

Weekly weather summaries continued to be circulated to agriculturalists; and forecasting centres were kept in touch with current farming operations. Since September, special attention has been given to the provision of appropriate material for the meteorological contribution to the B.B.C. weekly television programme for agriculture. (See p. 11.)

Many articles were written for professional and trade papers and a number of broadcasts made. Lectures were given to Young Farmers' Clubs, Schools of Agriculture, University faculties and to the Horticultural Conference of the South-eastern Region, National Agricultural Advisory Service.

Help was given in the provision of display material for the Bath and West, Bedfordshire, and Peterborough Agricultural Shows. The model wind-tunnel illustrating the effect of shelter formed part of the meteorological display which was on show at Birmingham, Coventry and other midland cities. (See p. 12).

Special work. Steady progress continued to be made in the study of the meteorological aspects of plant disease. Forecasts of the main outbreak dates of potato blight, based on pathological and meteorological data were again successful. Some work was also done concerning apple mildew, a disease of mushrooms, cereal rusts, and on the veterinary side, husk and liver fluke; the most important progress was in connection with the disease of apple scab. The new duration-of-wetness recorder proved to be very satisfactory in extended field trials and, as a result, several more instruments have been made. The demand for this instrument which may prove to be of the highest importance in pathological research work, is already considerable.

Co-operation in field survey work was extended and joint surveys were carried out in Gloucestershire, Dorset, Warwickshire, Worcestershire, Staffordshire, Shropshire and Cheshire.

Further work was carried out in relation to protective cropping including many micro-climatic observations. The member of the staff who is in charge of the meteorological side of these experiments accompanied the Director of Rosewarne Experimental Horticulture station, where they are mainly carried out, on a tour of similar experimental sites in Holland and Germany.

Other field experiments in which the section played a contributory part included those on eelworm infection, a disease of larch trees, husbandry of hop gardens, irrigation, the climate of poultry houses, soil tilths and sugar beet germination, frost liabilities and frost prevention.

Investigational work included analysis of drought data, relative humidities and soil temperature. Climatological averages and frequencies of soil temperatures at 1 foot and 4 foot depths have been computed and will shortly be published for the first time.

Many foreign visitors came to the section during the year and an Agricultural Meteorologist to the Government of Cyprus was under advanced training for six months.

Enquiries. The enquiries were related to a miscellany of subjects, among which the following may be mentioned:—export of orchids, the drying of baled hay, aphid populations, wheat bulb fly, frit fly, quality of milk, bacteria and milk churns, seed drying, dormancy of potato tubers, mushroom production, barley trials, glasshouse heating costs, climate suitable for winter broccoli, irrigation, frost, soil temperatures and shelter.

An enquiry of particular interest which may lead to results of the highest economic significance was concerned with milk yields and weather; close

co-operation is being maintained with the Milk Marketing Board and several promising lines of investigation are being examined.

MARINE BRANCH

British voluntary observing fleet. The constitution of the British voluntary observing merchant fleet was described in the Report for the year ending March 31, 1956. The number of British voluntary observing ships at present is as follows:—

Selected ships	493
Supplementary ships	97
Coasting vessels	54
Trawlers	34
Light Vessels	13

and thus remains about 700, out of a world total of about 2,800.

In addition to sending coded radio weather messages to the appropriate meteorological centre, wherever their voyages take them, most of these voluntary observing ships keep written records of their observations. Scrutiny of the records maintained on these ships shows that, in general, the voluntary observers continue to do this work carefully, and accurately, and that the radio weather messages are regularly transmitted.

Observations from British voluntary observing ships will play a useful part in the International Geophysical Year programme, since it is only from ships that information can be obtained in quantity from oceanic areas. The study of aurorae is an important feature of the I.G.Y. programme; and British ships have already provided a gratifying number of aurora observations in all oceans, some being from tropical regions.

Since the beginning of the International Geophysical Year, 60 ships have been recruited as auxiliary ships to make non-instrumental observations in areas where observations are sparse.

Awards for 'excellent' meteorological records sent in during the year were made to 100 merchant ships. For the first time awards were also made to two trawlers and two coasting vessels, the basis of these awards being the number of observations received from the ship by radio. Barographs were presented to four Masters of ships, in recognition of consistently good meteorological work over a period of many years.

Radio weather messages from observing ships. Voluntary observing ships in the Eastern North Atlantic (east of 35°W) and in United Kingdom coastal waters sent an average of 187 messages daily to Dunstable. Of these 105 were from British observing ships, 17 from foreign ships in the North Atlantic, 16 from British coasting vessels, 8 from trawlers and 34 from British Light Vessels. In 1938/39 the total number of reports received at Dunstable from all ships averaged about 20 daily. Of the reports from British observing ships 52 per cent. were received within one hour and 75 per cent. within two hours of the time of observation.

As the result of a conference in 1955 of the meteorological services of countries bordering the North Sea special efforts have been made to obtain more reports from ships in the North Sea. In consequence, there has been an increase in such reports from British ships from an average of 167 a month in 1955 to 390 a month in the year under review. There has also been a valuable increase in the number of reports received from British trawlers in far northern waters. In

this connection it is of interest to note that at the request of the Ministry of Agriculture, Fisheries and Food, special arrangements were concluded during the year with the U.S.S.R. authorities to issue forecasts in English for British trawlers operating in the vicinity of the White Sea, and likewise with the Canadian authorities for the Davis Strait area.

Ocean weather ships. The four British ocean weather ships satisfactorily completed their tenth year of duty during the year and maintained their normal programme of surface and upper air observations at ocean stations 'A' (62°N., 33°W.), 'I' (59°N., 19°W.), 'J' (52° 30'N., 20°W.) and 'K' (45°N., 16°W.) in rotation with French and Netherlands vessels. The seaworthiness displayed by these small ships in standing up to these arduous years of duty in the stormy Atlantic Ocean has fully justified their choice for this task. However, they are now showing their age and arrangements have been made for one of them, 'Weather Explorer', to be replaced by the 'Castle' Class Frigate 'Oakham Castle' in May 1958. The extensive conversion of 'Oakham Castle' for this duty is being carried out on the Clyde. Three of the Masters and six other members of the ships' company have served aboard the weather ships throughout the ten years. Three meteorologists have served between five and six years.

Currents and ice. The atlas of surface currents of the Eastern North Pacific Ocean has been sent to the printer. Work has continued on current computations for the eastern part of the South Pacific Ocean.

The work of revision of the information relating to surface currents and ice in 'Admiralty Pilots' has continued, seven volumes being dealt with during the year.

Special work. An investigation was completed into the incidence of temperature inversions below about 8,000 ft. at the ocean weather stations 'I' and 'J', in relation to the synoptic situation.

In connection with the International Geophysical Year, radiation instruments were installed in the ocean weather ships. It has been found possible, except in bad weather, to obtain continuous records of the net flux of radiation through a horizontal surface and of total solar radiation on a horizontal surface. These records are being analysed and tabulated.

Recording electrical anemographs were installed in two ocean weather ships and the records are being studied.

Trials of a new type of sea water sampler, and of aneroid barometers, have been carried out at sea.

Variations of air temperature, sea temperature and dewpoint along selected shipping routes have been investigated.

Enquiries. Information, including statistical tables and charts of marine data, was supplied on request to the Naval Weather Service, other Government Departments, scientific institutions, commercial firms and private individuals. The following are examples: wave data in connection with proposed constructional work in the Persian Gulf, the Gulf of Paria, Gan (Addu Atoll, Maldivé Islands) and at Zuara (Tripoli); fog frequency in the Channel and North Sea coastal waters for the Radio Advisory Service for research purposes; mean annual frequency of gales in specified areas of the Atlantic, Caribbean and the Arabian Sea for Ministry of Transport and Civil Aviation.

Assessment of ice conditions in regard to the possibility of a French fleet of deep-sea trawlers extending their field of operation northward in several

Arctic localities, was supplied to the Société d'Assurance Mutuelle des Chalutiers de Grande Pêche.

Information was supplied to the Ministry of Transport and Civil Aviation for several investigations into serious shipping casualties. Personal attendance of a scientific officer was necessary at the formal investigation held in April 1957, into the loss of the m.v. *Alpheus* in the North Sea between October 30 and November 5, 1956.

Machine pool. The machine pool, now operating on behalf of all sections of the Meteorological Office continued to expand, and additional equipment was acquired, whilst card storage accommodation, formerly for about 16,000,000 cards was increased to 20,000,000. A large exchange of cards was maintained with the United States Weather Bureau.

MILITARY SERVICES

The Meteorological Office has met the meteorological requirements of the Royal Air Force, the Army and the Ministry of Supply as hitherto, and has maintained collaboration with the Naval Weather Service.

The general pattern of the outstation organization designed to serve the Royal Air Force has remained almost unchanged, and is more or less parallel to the R.A.F. organization. In general, main meteorological offices are located at the operational headquarters of R.A.F. Groups, with subsidiary offices at R.A.F. Stations in the Groups. Main offices are manned throughout the 24 hours each day, and subsidiary offices normally for shorter periods depending on the needs of the R.A.F. Subsidiary offices are usually connected by teleprinter to a main meteorological office from which they receive general guidance and advice.

No meteorological units are deployed with army field units in peace time but a special meteorological section is permanently attached to the School of Artillery, Larkhill, and temporary detachments of staff are made to artillery practice camps as required.

Overseas, meteorological services required by the Army are usually met by meteorological offices attached to R.A.F. formations.

Services provided in the United Kingdom. Main forecast offices have been maintained in operational and Flying Training Commands of the Royal Air Force, and at certain Air Traffic Control Centres. In addition to their work for the Royal Air Force many of these offices provide forecasts for regional wireless or television services, automatic telephone weather services, for the British Electricity Authority, gas companies and the general public.

The number of subsidiary meteorological offices at home has been reduced by 8 during the year. (10 closed, 2 opened.)

In Fighter Command the special teleprinter network for exchanging weather reports every 15 minutes has been extended to include some additional stations.

In Bomber Command new procedures for the supply of meteorological information have been tried in connection with the development of aircraft with increased ceiling, range and speed. Special arrangements were made to provide information required for transatlantic flights by bomber aircraft.

As an aid to the meteorological training of R.A.F. personnel, a film strip on 'Tropical Meteorology' was produced and issued.

Meteorological offices were also maintained at a few Ministry of Supply establishments. At many of these stations the meteorological information supplied was of a specialist military nature.

Services provided overseas. Although there was no major change in the British meteorological organization overseas, there have been minor changes: British meteorological staff were withdrawn from six stations, but one station was opened.

In Western Germany meteorological services have been provided for the Royal Air Force and the Army on similar lines to those adopted in the United Kingdom. However, some German personnel formerly employed by the Meteorological Office under supervision of British staff have joined the new German Military Meteorological Service and are being replaced as far as possible by British staff. Arrangements were made for the withdrawal of British staff from Celle, Oldenburg, Wahn and Wunstorf.

In the Middle East the new main meteorological office at the Air Traffic Control Centre, Nicosia, became available, and from this office on behalf of the Cyprus Government continuous forecast and advisory services were also provided for civil aviation. Similar services to British forces, and on behalf of the local Government to civil aviation, continued at the main meteorological offices at Malta and Aden. A small observing station was opened at Gan in the Maldiv Islands in December 1957.

In the Far East the requirements of the Royal Air Force have been met by a main meteorological office and three subsidiary forecasting offices in Malaya. At Hong Kong the forecaster works in close collaboration with the Royal Observatory; British staff have been withdrawn from the subsidiary office at Sek Kong.

A subsidiary forecasting office working in close collaboration with the Ceylon Meteorological Service has been maintained to serve the Royal Air Force in Ceylon.

Largely to meet the requirements of the R.A.F. in Libya and Iraq, and in collaboration with the foreign governments concerned, forecast offices were maintained in Iraq and Libya. In the latter country, on behalf of the Libyan Government, the forecast office at El Adem serves civil aviation. Supervision of the technical work of this office is exercised from the main office at Malta.

British meteorological staff were withdrawn from the subsidiary office at Mafrag in Jordan at the end of May 1957.

Special arrangements were made to provide a meteorological forecasting office, and a number of upper air observing stations at Christmas Island in connection with various tests of atomic devices.

SERVICES FOR CIVIL AVIATION

Meteorological services are provided for civil aviation both in the United Kingdom and at certain locations overseas in conformity with the standards, recommended practices and procedures of the International Civil Aviation Organization.

Three types of meteorological offices are maintained for aviation purposes, namely main meteorological offices, subsidiary meteorological offices and observing offices. Main offices are provided at Air Traffic Control Centres and major civil aerodromes and give full forecasting service on a continuous 24 hour basis. Subsidiary offices are provided at civil aerodromes of intermediate

importance, and at these offices the forecasting service does not normally operate regularly throughout the 24 hours daily. Observing offices are provided at minor civil aerodromes and as their name suggests are mainly concerned with the making and issue of weather reports.

An essential feature of the service is the supply and dissemination of reports of actual weather conditions at aerodromes. To do this a continuous watch is kept on weather conditions throughout the period of operations. Routine reports are made at hourly intervals, and at half hourly intervals at many of the principal aerodromes, and in addition these are kept up to date by special intermediate reports of sudden changes.

Services provided in the United Kingdom. Requirements continued to demand the maintenance of meteorological services at four main and thirteen subsidiary offices, while the number of observing offices decreased to five, with the transfer of Benbecula aerodrome from the Ministry of Transport and Civil Aviation to the Air Ministry. The basic functions of these offices changed but little during the year, but at most of them the work progressively increased to meet the needs of the largely expanding scheduled services from State aerodromes, and the growing number of services from non-State aerodromes.

New methods of meteorological documentation for flights on European and Mediterranean routes, designed to reduce the amount of work at meteorological offices, have been introduced at London Airport on an experimental basis. The extension of these methods to other meteorological offices, will depend on the results of the trial at London Airport.

Meteorological service to aircraft in flight is provided by either (a) Area Meteorological Watch, or (b) Flight Meteorological Watch. In the former method covering flights in Europe, warnings of certain adverse weather conditions covering particular areas are disseminated by Air Traffic Control Centres. In addition, aerodrome weather reports and forecasts are made available by means of radiotelegraphy and radiotelephony broadcasts from these same Centres, and they can also be obtained by pilots by individual request. The supply of this meteorological information to the Air Traffic Control Centres is the responsibility of the main offices at Uxbridge, Preston and Prestwick. Under the flight meteorological watch procedure which is in use on North Atlantic routes, individual watch is kept on each flight forecast issued, and amended or new forecasts supplied as appropriate during the progress of the flight. This work is undertaken by the main offices at London Airport and Prestwick for flights from those aerodromes. In addition, Prestwick provides the necessary service for certain flights from Manchester and Glasgow airports.

In connection with the projected opening of Gatwick during 1958 as London's Number 2 Airport, plans for the meteorological office and the meteorological facilities to be provided were completed.

Arrangements requiring the agreement and co-operation of Commonwealth, colonial and foreign meteorological services were made for a number of flights including those of Her Majesty the Queen and His Royal Highness the Duke of Edinburgh from London to Paris and Ottawa, and of the Queen Mother to Rhodesia and New Zealand.

Public enquiries into the accidents to Viking G-AJBO at Blackbushe, and to Viscount G-ALWE at Manchester required detailed examination of the meteorological aspects, the preparation of briefs for the Treasury Solicitor, and in the case of the Blackbushe accident, the attendance of members of the staff for the purpose of providing meteorological evidence.

The Ministry of Transport and Civil Aviation approved many applications made by independent airlines for the operation of new public services. Advice concerning meteorological facilities available for these services was given to the Ministry of Transport and Civil Aviation and to airline operators.

A special weather service was supplied to the British Gliding Association in connection with the National Gliding Championships held at Lasham in July/August.

The training of Air Traffic Control Officers and Flight Information Service Officers from both State and non-State aerodromes in the making and reporting of weather observations continued. This training scheme enables successful candidates to provide aerodrome weather reports when stationed at an aerodrome where there is no meteorological observer.

Services provided overseas. Meteorological services for civil aviation were provided at a number of joint-user aerodromes in the Middle East Command, and liaison was maintained with colonial and foreign meteorological services along trunk routes used by British operators.

Special work. The advancement of flying, and the introduction of new types of aircraft (e.g. the Britannia) on civil routes calls for parallel advancement in meteorological techniques. In particular, considerable attention is being given to the requirements of pilots when in the final stages of their approach to land.

The modulated rotating beam cloud searchlight, designed to give a continuous record of cloud height both by day and night was operated, on an experimental basis, at London Airport.

Further investigations were made into the physical aspects of the Runway Visual Range System in use at a number of State aerodromes in conditions of poor visibility, by which an assessment is made of the furthest distance along a runway at which runway lights or runway markers can be seen by a pilot about to touch-down or take-off. The establishment of a Ministry of Transport and Civil Aviation working party to investigate the inaccuracies in the present techniques employed, and to make suggestions for improvement, greatly extended the scope of these investigations.

The meteorological section of the United Kingdom Air Pilot was revised in accordance with amended procedures for the supply of meteorological warnings to air traffic controllers as specified by the International Civil Aviation Organization.

Examinations. All commercial pilots and flight navigators are required to hold licences normally obtained as the result of an examination in various subjects including meteorology; 1,989 candidates were examined in this subject during the year.

Services for the Commonwealth

Falkland Islands. Although it is general policy that meteorological services in the colonies are provided by the Colonial Government concerned, owing to the special difficulties in the Falkland Islands the Meteorological Office continued to accept responsibility for the provision of services at Stanley. In addition, the technical work of the meteorological staff at the bases in the Dependencies is controlled by the Meteorological Office, through the Chief Meteorological Officer at Stanley.

Visits. Arrangements were made for members of Commonwealth and other meteorological services to visit meteorological offices at civil aerodromes, to enable them to study the procedures in operation for providing meteorological service for civil aviation.

TRAINING AND TECHNIQUES

This assistant directorate was created in July as part of the re-organization of the Office under the Brabazon recommendations. The Assistant Director is responsible for surveillance and general guidance on the improvement of meteorological techniques in the light of current research and outstation practice and for manuals on operational techniques. He is also responsible for the training of members of the staff in meteorology and other sciences, and for the work of the Meteorological Office Training School at Stanmore. The branch includes a small team which was appointed in August to examine the application of Work Study techniques to the work of the Meteorological Office.

A small establishment of staff to study meteorological techniques and carry out synoptic and statistical examinations of various techniques was approved. A start has been made on writing a manual on the radio-sonde.

Details of the courses held at the School during the year under review and the number of staff attending the various courses may be found in Appendix IV. Students included members of the staff of other meteorological services, sponsored by their Governments, the Colonial Office, the Crown Agents, or by the World Meteorological or International Civil Aviation Organizations. Trainees attending under the auspices of the two latter Specialized Agencies of the United Nations were recipients of training fellowships awarded under the Technical Assistance Plan for economic assistance to the less developed countries. A total of 55 overseas students from 20 countries attended courses at the School.

Arrangements were made to initiate, as a regular feature of the School, a course of instruction in meteorological instruments. It was planned to start these towards the end of 1957 but shortage of instructor staff necessitated postponement until March 1958. In addition plans were laid for a fortnight's instruction in tropical meteorology to be included regularly in the course curriculum. This instruction was given for the first time in January 1958. Consideration is being given to extending the scope of courses to include other aspects of meteorology which hitherto have not been covered by formal training.

The Work Study team completed an examination of the plans for the layout of the instrument store planned for the new headquarters at Bracknell and were able to suggest improvements which not only would reduce substantially the movement of stores but also would save space and economize by 20 per cent. the area of the foundations of the new building.

The monthly discussions held in London in the rooms of the Royal Society of Arts on Monday afternoons during the winter months continued as in recent years though their character was modified in 1958 by choosing as subjects for discussion those associated with the day-to-day work of outstation forecasters and, as a rule, replacing the opening discourse by short talks on different aspects of the subject.

J. M. STAGG

Director of Services

PUBLICATIONS

The following papers by the Directorate of Services were published in the year ended March 31, 1958.

- A. C. BEST, D.Sc. Physics in Meteorology. (Applied Physics Series.) London (I. Pitman and Son, Ltd.), 1957, 8vo, Pp. viii+159. Price 18s.
- J. S. FARQUHARSON, M.A., D.Sc. Television forecasting by the British Broadcasting Corporation. *Met. Mag., London*, **86**, 1957, p. 354.
- A. L. MAIDENS, B.Sc. Sounding the upper atmosphere. *Discovery, London*, **18**, 1957, p. 156.
- R. G. VERYARD, B.Sc. The application of climatological data. *Met. Mag., London*, **86**, 1957, p. 202.
- R. G. VERYARD, B.Sc. Why the weather? *World Sci. Rev., Gerrards Cross*, May 1957, p. 21.
- R. G. VERYARD, B.Sc. World Meteorological Organization. Second Session of the Commission for Climatology, Washington, January 1957. *Met. Mag., London*, **86**, 1957, p. 184.
- D. G. ARMOUR. Storm damage in the early morning of November 4, 1957. *Weather, London*, **12**, 1957, p. 385
- A. BLEASDALE, B.A., B.Sc. Rainfall at Camelford, Cornwall, on June 8, 1957. *Met. Mag., London*, **86**, 1957, p. 339.
- L. S. CLARKSON, M.Sc. Note on the mean characteristics of the maritime equatorial troposphere over Singapore. *Met. Mag., London*, **86**, 1957, p. 273.
- F. P. U. CROKER. Standing waves in the Vale of York. *Met. Mag., London*, **86**, 1957, p. 146.
- R. DALGLEISH. Extraordinary strong winds at North Weald. *Met. Mag., London*, **87**, 1958, p. 78.
- D. C. EVANS. A second report on fog at London Airport. *Met. Mag., London*, **86**, 1957, p. 333.
- E. EVANS, M.Sc., C. J. M. AANENSEN, M.Sc. and T. E. WILLIAMS. Deterioration of visibility in radiation fog. *Met. Mag., London*, **87**, 1958, p. 33.
- C. E. N. FRANKCOM. British ocean weather ships—10th anniversary. *Met. Mag., London*, **86**, 1957, p. 304.
- J. GLASSPOOLE, Ph.D. Recent seasonal trends in the number of rain-days over Great Britain. *Met. Mag., London*, **86**, 1957, p. 358.
- J. GLASSPOOLE, Ph.D. Rainfall over Great Britain and Northern Ireland during 1957. *Wat. and Wat. Engng., London*, **62**, 1958, p. 75.
- R. A. HAMILTON, B.A. The determination of temperature gradients over the Greenland ice sheet by optical methods. *Proc. roy. Soc. Edinburgh*, **64A**, 1957, p. 381.
- R. A. HAMILTON, B.A. Surveying aneroids: their uses and limitations. I. The meteorologist's viewpoint. *Geogr. J., London*, **123**, 1957, p. 481.
- R. A. HAMILTON, B.A. and G. ROLLITT. British North Greenland Expedition 1952-54. Climatological tables for the site of the Expedition's base at Britannia SØ and the station on the inland-ice 'Northice'. *Medd. Grønland, Kjøbenhavn*, **158**, Nr. 2, 1957.
- R. A. HAMILTON, B.A. and G. ROLLITT. British North Greenland Expedition 1952-54. Meteorological observations at 'Northice', Greenland. *Medd. Grønland, Kjøbenhavn*, **158**, Nr. 3, 1957.
- T. N. S. HARROWER, M.A., B.Sc. Co-ordination of meteorological information. *I.C.A.O., Jet Operations Requirements Panel, DOC. 7828, JOR/3-2 VOL. II*, p. 77.
- C. HAWORTH and J. HOUSEMAN. Anticyclogenesis in relation to a particular thickness pattern. *Met. Mag., London*, **86**, 1957, p. 321.
- W. H. HOGG, M.Sc. A comparison between the climates at Gulval and Rosewarne. *N.A.A.S., Rosewarne Exp. Hort. Sta., Rep., London*, **1**, 1952/55, p. 81.
- W. H. HOGG, M.Sc. The weather aids can help the grower. *Mech. Hort., London* No. 8, 1957, p. 43.

- J. KONIECZNY. Abnormal temperature and visibility variations at Little Rissington on December 19-20, 1956. *Met. Mag., London*, **86**, 1957, p. 376.
- E. N. LAWRENCE, B.Sc. Estimating the frost risk of an orchard site. Repr. from: *N.A.A.S. quart. Rev., London*, No. 34, 1957, p. 4.
- E. N. LAWRENCE, B.Sc. Estimation of the frequency of 'runs of dry days'. Pts. I, II. *Met. Mag., London*, **86**, 1957, p. 257, 301.
- E. N. LAWRENCE, B.Sc. Temperatures and topography on radiation nights. *Met. Mag., London*, **87**, 1958, p. 71.
- D. W. S. LIMBERT. Waterspouts observed at Ocean Weather Station I. *Mar. Obs., London*, **27**, 1957, p. 110.
- P. L. MCALLEN. The weather forecast. *Mar. Obs., London*, **27**, 1957, p. 96.
- I. MCLEAN and K. WILLIAMSON. Migrants at North Atlantic weather ships in 1956. *Mar. Obs., London*, **27**, 1957, p. 152.
- T. A. PAVELY; J. HARDING, B.A., M.Sc.; W. G. HARPER, M.Sc., A.R.C.S., D.I.C. Hail damage to aircraft at nearly 30,000 feet on July 3, 1957. *Met. Mag., London*, **87**, 1958, p. 23.
- K. POLLARD. A preliminary study of night cooling under clear skies at Wittering. *Met. Mag., London*, **87**, 1958, p. 12.
- W. E. SAUNDERS, B.Sc. Variation of visibility in fog at Exeter Airport and the time of fog dispersal. *Met. Mag., London*, **86**, 1957, p. 362.
- W. E. SAUNDERS, B.Sc. Water-fog point—a further test. *Met. Mag., London*, **87**, 1958, p. 65.
- F. A. SHARP, B.Sc. Weather and upper winds at Singapore. *Quart. J.R. met. Soc. London*, **83**, 1957, p. 384.
- H. C. SHELLARD, B.Sc. The application of meteorology to the care of cargo in a ship's hold. *Mar. Obs., London*, **27**, 1957, p. 218.
- L. P. SMITH, B.A. Sunspot winters? Their record is a bit spotty. *Grower, London*, **49**, 1958, p. 291.
- A. J. WILLIS. Helicopters and the forecaster. *Met. Mag., London*, **86**, 1957, p. 306.
- R. F. ZOBEL, B.Sc. The evaluation of winds at 200 millibars from contour charts. *Met. Mag., London*, **87**, 1958, p. 44.

PLATE I



Crown Copyright

The forecast room in the main meteorological office at the Air Traffic Control Centre, Nicosia (see p. 21).

PLATE II



Crown Copyright

Instruction in instrument maintenance at the Meteorological Office School (see p. 24).

PLATE III



Crown Copyright

The electronic instrument test room at Harrow. In the radio-frequency compartment in the background radio-sonde receivers are tested and calibrated. The test instruments in the middle and foreground are used in the calibration of other radio-sonde ground equipment such as the measuring oscillator on the right (see p. 30).

PLATE IV



Reproduced by courtesy of the Royal Society

Thunderstorm location unit at the Royal Society Soirée held on June 28, 1957 (see p. 40).

THE DIRECTORATE OF RESEARCH

The title of research was first applied to a senior post in the Meteorological Office in 1939 when one of three Assistant Directors was given the responsibility for 'observatories and research'. In the reorganization of 1948 one of three deputy directorates held the title and in the reorganization of the current year, 1957, it passes to one of the two directorates. The Office in this way moves in accord with the spirit of the times in the recognition of the essential part which research must play in the advancement of knowledge and the improvement of technical efficiency.

Owing to the limited numbers of qualified scientists required each year as recruits to the profession of meteorology, the subject is not easily incorporated in the curricula of many universities. Indeed, only in one university in Great Britain is there a Chair in meteorology with supporting staff and facilities enabling the teaching of the subject to be covered comprehensively and research to be pursued on a broad front. In these circumstances the Office carries an exceptional responsibility for the advancement of its science and the Meteorological Research Committee with its three sub-Committees serves not only as an advisory body much valued by the Office but also as an effective link with and between the rather scattered meteorological interests outside. There were 14 meetings during the year and 54 research papers were discussed.

Research papers appear for the most part as contributions to the recognized scientific journals and the staff are encouraged in every way to take part in related scientific activities of the country. Frequent colloquia were held both at Dunstable and at Harrow, attendance at outside scientific meetings was common, and a considerable number of the staff attended scientific meetings abroad. Five staff members, including the Director-General and the Director of Research, were present at the meetings in Toronto of the International Union of Geodesy and Geophysics.

A welcome feature was the visits to our research groups of workers from other countries, and relations with Commonwealth countries were, in this respect, particularly cordial. Recommendations on the meteorological research requirements of colonial territories will shortly be made as an outcome of special studies, involving a series of oversea visits, by an Assistant Director.

Continuing the policy of recent years, research in the universities in meteorology and allied science was encouraged and financially assisted. The Royal Society received an annual grant of £7,000 and an instalment of a special grant of £50,000, the former to support basic meteorological physics, the latter to support research by high-level rockets, as approved by the Gassiot Committee of the Society.

FORECASTING RESEARCH

The largest single project remained the testing and elaboration of techniques for forecasting the pressure distribution by direct calculation from the physical equations, making use of a large electronic computer at Manchester University. There was delay in delivery of the Office computer which we now expect will be installed at Dunstable towards the end of the summer, 1958. This research, in the hands of a group of able mathematical physicists, is becoming steadily more recondite and technical. In particular, the effect of the tropopause and the

modification of vertical stability by condensation have been studied. The main practical interest will come when it is possible to compare the new methods of calculation with the old methods of expert judgment over a large number of cases. Techniques of data processing and analysis are now available which will make it possible to feed the punched tapes, upon which observations are received in the teleprinter room, directly into the computer which will then automatically select the information required for a calculation.

Other dynamical research included the study of air-flow over ranges of hills by theoretical and numerical methods. Improved insight into the dynamics of lee-waves (which have sometimes proved dangerous to powered aircraft and not only helpful to sailplanes) has been obtained.

Many other investigations have been in hand concerning, for example, the practical forecasting value of weather radar, the structure of fronts and the distribution of rainfall, but rather special interest attaches to work in connection with long-range forecasting for a month ahead. These forecasts are restricted to general predictions of the character of the coming month, whether it will be warmer or colder than normal, and drier or wetter than normal. Research in this field, which has considerable economic implications continues, and the prospects are by no means unfavourable.

CLIMATOLOGICAL RESEARCH

Much effort continued to be devoted to the major task of charting the upper atmosphere on a world-wide basis. Mean contour charts for the standard upper air pressure surfaces were nearly completed and progress was made with charting the standard vector deviation of upper winds. Attention was also given to humidity and new world maps, for the four mid-season months, of the mass of water vapour held as vapour in the atmosphere, were produced. The mechanism for the transport of water vapour from one region to another was further studied; the mean winds account for much of the northward transport in northern temperate latitudes.

Interest in applications of world climatology seems to be steadily growing and the number of enquiries handled by the research division has increased threefold in the past decade.

PHYSICAL RESEARCH

Investigations in atmospheric physics were carried out by the Meteorological Research Flight (at the Royal Aircraft Establishment) and at Porton (with the Chemical Defence Experimental Establishment), Kew Observatory, East Hill (the Meteorological Office Radar Research Station), Cambridge (at the University School of Agriculture), and Cardington (at the R.A.F. Balloon Unit). Records of meteorological variables, of seismic movements, and of the earth's magnetic and electric fields were continued at the observatories at Kew, Eskdalemuir and Lerwick.

The Meteorological Research Flight has the use of three specially equipped R.A.F. aircraft, a Canberra, a Hastings, and a Varsity. Its facilities are unique, and its work attracts world-wide interest. Knowledge of the water content of the high atmosphere was extended by examination of measurements made on Canberra flights south from Idris, Tripoli to about 20°N. and north from Farnborough to about 70°N. Such measurements are expected to yield information on the nature of large scale atmospheric circulations, water-vapour serving

as a 'tracer' gas. Ozone is another gas which might serve this purpose, and two possible methods for measuring ozone content from aircraft are being investigated. One of these, developed by Dr. A. W. Brewer of the Clarendon Laboratory, Oxford, is an electro-chemical method adaptable for use on a radio-sonde, and the Meteorological Office radio-sonde station at Liverpool is collaborating with Dr. Brewer in a series of ascents. Other activities of the Meteorological Research Flight include precise determinations of wind in the vicinity of 'jet streams' by means of radar navigational equipment installed in the Canberra aircraft, and the measurement of drop sizes in cloud and rain by a new instrument developed in collaboration with a Division of the Royal Aircraft Establishment.

The work at Porton is centred on studies of diffusion in the atmosphere over distances of order 100 miles, and the structure of the turbulence responsible for this diffusion. Experimental and theoretical studies have clarified the effects of varying stability in the lower atmosphere, and of the presence of temperature inversions, on the dispersal of atmospheric contaminants. Another investigation of turbulence in the atmosphere is being carried out by the staff of Kew Observatory, in collaboration with the National Institute of Oceanography. Fine-scale details of air-flow over the surface of a large reservoir and their modification by a surface film of cetyl alcohol (which has been used to minimize evaporation from reservoirs in tropical countries, and which might be used to suppress wave motion at sea), are being examined.

An investigation of the nature of fog particles, by optical and mechanical sampling methods, is in progress at Kew Observatory, and some interesting results were reported during the year. On many occasions an unexpectedly large proportion of the opacity is found to be due to very small particles in large numbers, the liquid water content of the fog being very low. This has implications which are important in the forecasting of the formation and natural clearance of fog, and to problems of aircraft operation and the artificial clearance of fog on airfields.

The Meteorological Office Radar Research station continued its studies of the detail of radar reflections from heavy rainfall in the Cardington area, where a close network of rain-gauges has been installed. A report was also produced summarizing many years' study of the radar reflections occasionally received from apparently clear skies, which have come to be known as 'angels'. 'Angels' are a considerable nuisance in the location and control of aircraft by radar, and there has been much speculation concerning their origin, but no generally accepted explanation. The work at East Hill has shown convincingly that many of these visitations, including some, at least, of the most spectacular, are due to birds, particularly migrant birds in transit. Ornithologists, recognizing a powerful method of investigating bird populations and movement, are showing much interest in these results.

The International Geophysical Year began in July 1957, and has added to the work of the observatories in several ways. The network of stations recording solar and terrestrial radiation has been expanded and instruments have been installed on the ocean weather ships. This is believed to be the first time such records have been obtained continuously at sea. Work on the spectrophotometric determination of ozone, on terrestrial magnetism, on seismology, and on the chemical sampling of air and rain has also been increased in varying degree, and results in the prescribed form are being communicated to the I.G.Y. data centres.

INSTRUMENT DEVELOPMENT

Much of the work of the assistant directorate of Instrument Development lies in the steady but unspectacular modification of existing instruments, to improve accuracy and reliability and to reduce the cost of purchase and maintenance. An example is the production of specifications for a precision aneroid barometer, followed by the tests of prototypes which were in progress during the year. These tests must be prolonged, but the indications are that they will be successful. A good precision aneroid may cost as much initially as a mercurial barometer, but it is less liable to damage in transit, and cheaper to repair if damaged.

Attention to constructional detail has shown the way to small improvements in the performance of the manufactured radio-sonde now in use within the Meteorological Office, but the major development in this field during the year was the successful trial of automatic recording ground station equipment, which will reduce the man-power requirements of radio-sonde stations and increase the accuracy of the record.

Radio-sonde design is now being reviewed critically to see if equipment better than that now in use can be developed for mass production at economic rates. The problem is of major importance for the Meteorological Office which makes over 12,000 radio-sonde ascents from home, ocean and overseas stations every year.

Other activities of the assistant directorate have included the modification of a searchlight for use as a probe in the determination of density in the high atmosphere and production of the equipment for detecting the very small amount of light scattered from the beam, and the further development of a frost point hygrometer using polarized light which, in the laboratory, has measured frost points considerably below those attained by existing instruments.

Test and calibration. The volume of work in this section showed some increase. This arose partly by the availability of more complete staffing complement and partly by the demand for upper-air equipment to meet the extended International Geophysical Year programme.

Of instruments other than balloons, radio-sonde and electrical equipment, 40,846 items were tested, a marked rise over the previous year but accounted for by the number of small items, particularly of radio-sonde parachutes, handled.

The number of balloons of all sizes, subjected to a 5 per cent. check, was 166,232. Within this total, balloons of the types used for pilot-balloon ascent showed a decline, those for radio-sonde or radar-wind observations increasing in number.

A change of contractors manufacturing radio-sondes resulted in a sharp decrease in the number, 11,961, of new sondes received. By drawing on the large existing stocks a record number of 23,140 radio-sondes were calibrated and made available for issue. Recovered radio-sondes, which were overhauled and re-calibrated for use a second time, amounted to 1,774.

Many of the instruments handled by this section were examined on behalf of other authorities and fees for these services totalled £2,349.

The section gave instructions on the handling, testing and maintenance of instruments to climatological observers and to members of other meteorological services. In addition advice and help was given to the Meteorological Office

Training School in setting up courses, both elementary and advanced, on instrument maintenance.

Radar maintenance. Regular inspection of radar-wind equipment at upper air stations in the United Kingdom was maintained, but no inspections were possible at overseas stations, due to staff shortages.

Reconditioned radar sets, produced under the supervision of the radar inspection team, were supplied for use overseas. The demand reduced the number of spare sets available for other replacements, and investigation was made into the probable future life of the present type of Meteorological Office radar.

The radar section provided specialist advice and assistance on instrument development projects involving advanced electronic application.

SPECIAL INVESTIGATIONS

The assistant directorate of Special Investigations at Headquarters was again mainly occupied with problems connected with the operation of military and civil aircraft at increasing altitudes. Enquiries from Service Departments, the Ministry of Transport and Civil Aviation, and operating companies concerned wind speed and direction and density and temperature of the atmosphere, at heights up to 50,000 ft., in many parts of the world. Problems of atmospheric diffusion and pollution were also studied, notably a treatment of the incidence of sulphur dioxide pollution near a generating station of the Central Electricity Authority. With the staff of other assistant directorates a new study was made, following the accident at the Windscale factory of the Atomic Energy Authority, of the Authority's requirements for meteorological observations and forecasts.

Some time was spent on questions connected with the operation of Britannia aircraft, particularly in assessing the likelihood, in different seasons of the year and on different routes, of an encounter with the special cloud conditions believed responsible for the malfunctioning of the engine of this aircraft. Recent investigations within the Meteorological Office into the structure and physics of cloud were of great value in making this assessment.

R. C. SUTCLIFFE

Director of Research

PUBLICATIONS

The following papers by the Directorate of Research were published in the year ended March 31, 1958.

- R. C. SUTCLIFFE, F.R.S. An outlook on meteorology and the Society. *Quart. J.R. met. Soc., London*, **83**, 1957, p. 285.
- P. J. MEADE, B.Sc., A.R.C.S. Atomic energy and the meteorologist. *Met. Mag., London*, **86**, 1957, p. 289.
- R. J. MURGATROYD, B.Sc. Winds and temperatures between 20km. and 100 km.—a review. *Quart. J.R. met. Soc., London*, **83**, 1957, p. 417.
- R. J. MURGATROYD, B.Sc. The Research Flight of the British Meteorological Office, *Loanda, Serv. Met. Misc. Geof. Comem. X. Aniv.*, 1956, p. 229.
- R. J. MURGATROYD, B.Sc. and M. P. GARROD. Some recent airborne measurements of freezing nuclei over southern England. *Quart. J.R. met. Soc., London*, **83**, 1957, p. 528.
- B. C. V. ODDIE, B.Sc. Atmospheric chemistry. *Met. Mag., London*, **86**, 1957, p. 194.

- J. S. SAWYER, M.A. Jet stream features of the earth's atmosphere. *Weather, London*, **12**, 1957, p. 333.
- J. S. SAWYER, M.A. The ways of the weather. London (A. and C. Black), 1957, 8vo, Pp. vi+97. Price 12s. 6d.
- P. C. BARTRUM, B.A. The diurnal variation of surface wind and pressure at Bermuda. *Met. Mag., London*, **86**, 1957, p. 296.
- J. R. BIBBY, B.A. A fog-density indicator. *Met. Mag., London*, **86**, 1957, p. 117.
- G. A. BULL, B.Sc. Note on Universal Decimal Classification. *Quart. J.R. met. Soc., London*, **84**, 1958, p. 78.
- F. H. BUSHBY, B.Sc., A.R.C.S. and MISS V. M. HUCKLE, B.Sc. Objective analysis in numerical forecasting. *Quart. J.R. met. Soc., London*, **83**, 1957, p. 232.
- P. G. F. CATON, M.A., Ph.D. Occurrence of low layer-type cloud over eastern England in relation to the synoptic situation. *Met. Mag., London*, **86**, 1957, p. 161.
- G. A. CORBY, B.Sc. AND J. S. SAWYER, M.A. The air flow over a ridge—the effects of the upper boundary and high-level conditions. *Quart. J.R. met. Soc., London*, **84**, 1958, p. 25.
- J. M. CRADDOCK, M.A. A simple statistical test for use in the study of climatic change. *Weather, London*, **12**, 1957, p. 252.
- J. M. CRADDOCK, M.A. An analysis of the slower temperature variations at Kew Observatory by means of mutually exclusive band pass filters. *London, J.R. statist. Soc.*, **120A**, 1957, p. 387.
- C. S. DURST, B.A. The problem of aircraft separation over the Atlantic. *J. Inst. Navig., London*, **10**, 1957, p. 225.
- C. S. DURST, B.A. and N. E. DAVIS, B.A. Accuracy of geostrophic trajectories. *Met. Mag., London*, **86**, 1957, p. 138.
- W. G. HARPER, M.Sc., A.R.C.S., D.I.C. 'Angels' on centimetric radars caused by birds. *Nature, London*, **180**, 1957, p. 847.
- W. G. HARPER, M.Sc., A.R.C.S., D.I.C. Variation with height of rainfall below the melting level. *Quart. J.R. met. Soc., London*, **83**, 1957, p. 368.
- W. G. HARPER, M.Sc., A.R.C.S., D.I.C., F. H. LUDLAM and P. M. SAUNDERS. Radar echoes from cumulus clouds. *Proceedings of the Sixth Weather Radar Conference, Cambridge, Mass.*, 26-28, March 1957, p. 267.
- G. E. W. HARTLEY, M.A. A wind-vane for recording or indicating mean wind direction. *Met. Mag., London*, **86**, 1957, p. 111.
- J. S. HAY, B.Sc. and F. PASQUILL, D.Sc. Diffusion from a fixed source at a height of a few hundred feet in the atmosphere. *J. Fluid Mech., London*, **2**, 1957, p. 299.
- H. HEASTIE, M.Sc. Average height of the standard isobaric surfaces over the North Polar regions in July. *Met. Mag., London*, **86**, 1957, p. 198.
- N. C. HELLIWELL, B.Sc., J. K. MACKENZIE and M. J. KERLEY. Some further observations from aircraft of frost point and temperature up to 50,000 ft. *Quart. J.R. met. Soc., London*, **83**, 1957, p. 257.
- A. F. JENKINSON, B.A. Relations between standard deviations of daily 5-day, 10-day and 30-day mean temperatures. *Met. Mag., London*, **86**, 1957, p. 169.
- A. F. JENKINSON, B.A. Standard deviation of the height of the 500-mb surface over the North Atlantic. *Met. Mag., London*, **86**, 1957, p. 245.
- D. H. JOHNSON, M.Sc., A.R.C.S. Preliminary research in objective analysis. *Tellus, Stockholm*, **9**, 1957, p. 316.
- J. I. P. JONES and H. E. BUTLER. The measurement of gustiness in the first few thousand feet of the atmosphere. *Quart. J.R. met. Soc., London*, **84**, 1958, p. 17.
- E. KNIGHTING, B.Sc. An atmospheric model including the tropopause effects. *Ber. dtsh. Wetterdienstes, Bad Kissingen*, **5**, Nr. 38, 1957, p. 78.
- E. KNIGHTING, B.Sc. Numerical weather forecasting. *Weather, London*, **13**, 1958, p. 39.
- E. KNIGHTING, B.Sc. The work of the Dunstable research group. *Ber. dtsh. Wetterdienstes, Bad Kissingen*, **5**, Nr. 38, 1957, p. 71.

- H. H. LAMB, M.A. The occurrence of very high surface temperatures. *Met. Mag., London*, **87**, 1958, p. 39.
- H. H. LAMB, M.A. On the frequency of gales in the Arctic and Antarctic. *Geogr. J., London*, **123**, 1957, p. 287.
- H. H. LAMB, M.A. Research in world weather patterns. *Mar. Obs., London*, **27**, 1957, p. 101.
- H. H. LAMB, M.A. Some interesting properties of the 'Nullschicht' or maximum wind layer. *Met. Mag., London*, **86**, 1957, p. 142.
- H. H. LAMB, M.A. Winds and weather in the Antarctic. *Advanc. Sci., London*, **13**, 1957, p. 467.
- H. H. LAMB, M.A., J. FLEMING, B.A., H. D. HOYLE, B.Sc. and J. ROBINSON, B.Sc. Jet streams over North Africa and the central Mediterranean in January and February 1954. *Met. Mag., London*, **86**, 1957, p. 97.
- M. K. MILES, M.Sc. Synoptic study of thermal troughs over the Atlantic and the British Isles. *Met. Mag., London*, **87**, 1958, p.1.
- N. E. RIDER, B.Sc. A note on the physics of soil temperature. *Weather, London*, **12**, 1957, p. 241.
- N. E. RIDER, B.Sc. Water losses from various land surfaces. *Quart. J.R. met. Soc., London*, **83**, 1957, p. 181.
- R. C. SMITH, M.Sc., Ph.D., D.I.C. Abnormally low humidity in Scotland. *Met. Mag., London*, **87**, 1958, p. 35.
- G. B. TUCKER, B.Sc., Ph.D., D.I.C. Evidence of a mean meridional circulation in the atmosphere from surface wind observations. *Quart. J.R. met. Soc., London*, **83**, 1957, p. 290.
- C. E. WALLINGTON, M.Sc. Weather notes included in paper by A. E. Slater: 'The National Gliding Championships, Lasham, 27th July to 5th August'. *Sailpl. and Gliding, London*, **8**, 1957, p. 239.
- C. E. WALLINGTON, M.Sc. and Miss J. PORTNALL. A numerical study of the wavelength and amplitude of lee waves. *Quart. J.R. met. Soc., London*, **84**, 1958, p. 38.
- R. A. WATSON, B.A. Magnetic activity following a solar flare. *J. atmos. terr. Phys., London*, **11**, 1957, p. 59.

The following *Meteorological Research Papers* were approved for general distribution.

- No.
- 989 R. FRITH, M.A., Ph.D. The measurement of surface wind.
- 1018 E. KNIGHTING, B.Sc., D. E. JONES, M.Sc., A.R.C.S. and Miss M. K. HINDS, B.Sc. Numerical experiments in the integration of the meteorological equations of motion.
- 1023 J. M. CRADDOCK, M.A. The serial correlations of daily mean temperatures at Kew Observatory.
- 1024 N. C. HELLIWELL, B.Sc. and J. K. MACKENZIE. Observations of humidity, temperature and wind at Idris, May 23-June 2, 1956.
- 1025 C. E. WALLINGTON, M.Sc. and Miss J. PORTNALL. A numerical study of the wavelength and amplitude of lee waves.
- 1038 J. I. P. JONES and H. E. BUTLER. Studies of eddy structure in the first few thousand feet of the atmosphere: Part 1. Measurements of the vertical and horizontal (longitudinal) components.
- 1039 P. J. MEADE, B.Sc., A.R.C.S. and F. PASQUILL, D.Sc. A study of the average distribution of pollution around Staythorpe.
- 1040 A. GILCHRIST, M.A. The representation of circumpolar 500 mb charts by a series of spherical harmonics.
- 1041 J. S. SAWYER, M.A. and Miss M. K. HINDS, B.Sc. Numerical calculations of the airflow over a ridge for small amplitudes.

- No.
- 1043 C. H. HINKEL, B.Sc. Report on flight tests of a prototype conical head aircraft thermometer.
- 1044 R. A. JONES, M.Sc. Studies of eddy structure in the first few thousand feet of the atmosphere. Part 2. A preliminary examination of the structure and scale of the vertical component at 2,000 feet.
- 1045 H. HEASTIE, M.Sc. Average height of the standard isobaric surfaces over the temperate and tropical regions in January.
- 1046 K. H. STEWART, M.A., PH.D. An approximate relation between slant visibility and horizontal visibility at ground level.
- 1047 K. H. STEWART, M.A., PH.D. A method for assessing the frequency of dangerous visibility conditions.
- 1048 F. B. SMITH, M.Sc., PH.D. Convection-diffusion processes below a stable layer.
- 1049 R. W. GLOYNE, B.Sc. Problems of surface air-flow and related phenomena in agriculture, horticulture and forestry.
- 1050 M. P. GARROD. Recent developments in the measurement of precipitation elements from aircraft.
- 1051 J. M. CRADDOCK, M.A. A contribution to the study of Meteorological Time Series.
- 1052 G. B. TUCKER, B.Sc., PH.D., D.I.C. An analysis of humidity measurements in the upper troposphere and lower stratosphere over Southern England.
- 1054 Index of Meteorological Research Papers approved for general distribution. (Appendix 17 of M.R.P. 200).
- 1055 D. G. JAMES, B.Sc., PH.D. Observations from aircraft of temperatures and humidities near stratocumulus cloud.
- 1056 D. H. JOHNSON, M.Sc., A.R.S.C. Forecast verification: a critical survey of the literature.
- 1058 C. S. DURST, B.A., A. F. CROSSLEY, M.A. and N. E. DAVIS, B.A. Horizontal diffusion in the atmosphere in the light of air trajectories.
- 1062 H. CHARNOCK, M.Sc. and G. D. ROBINSON, B.Sc., PH.D. Spectral estimates from subdivided meteorological series.
- 1063 J. S. SAWYER, M.A. Two-parameter techniques of numerical forecasting applied to a small intense depression.
- 1064 J. S. SAWYER, M.A. Temperature, humidity and cloud near fronts in the middle and upper troposphere.
- 1065 H. H. LAMB, M.A. The Southern Circumpolar Westerlies: broad characteristics and apparent associations.
- 1066 H. HEASTIE, M.Sc. Average height of the standard isobaric surfaces over the temperate and tropical regions in July.
- 1068 W. G. HARPER, M.Sc., A.R.C.S., D.I.C. The origin of radar 'angels'
- 1069 G. J. DAY, B.Sc. Some airborne observations of condensation nucleus concentration, I. Variations in the vertical.
- 1070 R. J. MURGATROYD, B.Sc. and N. C. HELLIWELL, B.Sc. The measurement of wind at altitude by airborne instruments.
- 1071 W. G. DURBIN, B.Sc. A diagram for obtaining true air temperatures from indicated air temperatures for aircraft resistance thermometers.
- 1073 F. B. SMITH, M.Sc., PH.D. Convection—diffusion processes below a stable layer—Part II.
- 1074 K. H. STEWART, M.A., PH.D. Some observations on the composition of fogs.
- 1075 J. K. BANNON, B.A., and L. P. STEELE. Average water-vapour content of the air.
- 1077 R. FRITH, M.A., PH.D. The development of precision aneroids—interim report.

- No.
- 1078 J. R. PROBERT-JONES, B.A. Conservation of vorticity at 100 mb.
- 1079 H. C. SHELLARD, B.Sc. Some measurements of temperature and humidity near the sea surface.
- 1080 C. A. S. LOWNDES. The relation between anomalies of surface air temperature and of 1,000-500 mb thickness over the Atlantic Sector of the Northern Hemisphere.
- 1084 A. W. BREWER, M.A., PH.D. The phosphorus pentoxide electrolytic hygrometer.

INTERNATIONAL CO-OPERATION

WORLD METEOROLOGICAL ORGANIZATION

The ninth session of the Executive Committee, held in Geneva in September/October 1957, was attended by the Director-General, Sir Graham Sutton, who is a member of the Committee and also Permanent Representative of the United Kingdom to the World Meteorological Organization. The Director-General was accompanied by Mr. C. W. G. Daking, Assistant Director (Defence and International).

A proposal whereby the World Meteorological Organization should assume responsibilities in hydrology, similar to its present responsibilities in meteorology, was considered by the Executive Committee. The Secretary-General was directed to inform Members of the proposal and request their comments, so that the Committee could decide at its tenth session whether there was sufficient support from Members to justify the submission of the proposal to Third Congress, to be held in the Spring 1959.

It was decided to establish a panel of experts to study meteorological developments required by the expected world-wide introduction of commercial jet aircraft, and to examine the implications to international meteorology of future requirements for the routine operation of these aircraft. Mr. R. J. Murgatroyd, Head of the Meteorological Research Flight, was nominated to serve on this panel.

It was found that the World Meteorological Organization was not able to carry out the programme laid down by Second Congress within the expenditure allowed for the period 1956-59, and it was decided to ask Members to approve a supplementary estimate for the remainder of the second financial period 1956-59, in order that existing commitments could be maintained and additional necessary new commitments be met.

Certain changes were made to the conditions as to eligibility of candidates for the International Meteorological Organization Memorial Prize. The second award was made posthumously to Professor C. G. Rossby.

The second sessions of the Commissions for Aerology, and Instruments and Methods of Observation, were held simultaneously in Paris in June/July 1957. The United Kingdom delegations to these sessions were led by Dr. R. C. Sutcliffe, Director of Research, who was elected president of the Commission for Aerology in succession to Professor J. van Mieghem.

The second session of the Commission for Bibliography and Publications was held in Paris in November 1957. The United Kingdom was represented by Mr. G. A. Bull.

The second session of the Commission for Synoptic Meteorology was held in New Delhi in January/February 1958. Mr. C. J. Boyden, Assistant Director (Central Forecasting), was the principal United Kingdom delegate: he was assisted by Messrs. C. V. Ockenden and J. Harding.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

The Meteorological Office, as agents for providing meteorological services on behalf of the Ministry of Transport and Civil Aviation, takes a leading part in international co-operation in all aspects of the requirements of Civil Aviation for meteorology. Standards, recommended practices and procedures are drawn up by the Meteorological Division of the International Civil Aviation Organization to establish world-wide procedures for meteorological services for Civil Aviation. The detailed application of these world-wide recommendations in different regions is discussed at Regional Air Navigation meetings. Meteorological matters which concern jointly other divisions of the International Civil Aviation Organization are also considered at Air Navigation conferences. The Meteorological Office provides advice to the Ministry of Transport and Civil Aviation on the meteorological items for the agenda for these various meetings and on matters arising from them. At the request of the Ministry of Transport and Civil Aviation delegates are provided to attend the meetings which may be held in different parts of the world.

During the year advice and assistance was given by the Meteorological Office on the meteorological aspects of the United Kingdom brief for the following meetings:

Third Meeting of the I.C.A.O. Jet Operations Requirements Panel held in Montreal in June, to predict the operational requirements for ground services for the large-scale operation of large turbine-engined aircraft as may be expected to enter commercial services by 1961.

South American/South Atlantic Regional Air Navigation Meeting held in São Paulo, Brazil in October/November.

European/Mediterranean Regional Air Navigation Meeting held in Geneva in January/February.

Joint Meeting under the auspices of the World Meteorological Organization and the International Civil Aviation Organization to consider arrangements for the dissemination of meteorological information through telecommunication services in the European Region held in Geneva in February.

Meteorological Office representatives were included in the United Kingdom delegations at the first and at the last two meetings.

COMMONWEALTH MEETINGS

Under the auspices of Commonwealth Air Transport Councils, meetings are held periodically between members of Commonwealth territories to discuss the provision of facilities and procedures for civil aviation in Commonwealth territories. The Meteorological Office provides advice to the Ministry of Transport and Civil Aviation on any meteorological aspects of matters under discussion. Such advice was given during the year for the Eleventh Meeting of the South Pacific Air Transport Council held in Wairakei, New Zealand in November.

The South Pacific Air Transport Council includes representatives from the United Kingdom, Australia, New Zealand and Canada and is concerned with the provision of facilities in the South Pacific.

NORTH ATLANTIC TREATY ORGANIZATION

The fourteenth meeting of the Meteorological Committee of the Standing Group was held in Washington, D.C., from May 21 to 23, 1957, under the chairmanship of the United States member. The United Kingdom was represented by its member Dr. J. M. Stagg, Director of Services, who was assisted by Mr. C. V. Ockenden, then Assistant Director (Observations and Communications). Policy questions affecting national meteorological services of member nations and the meteorological arrangements for field meteorological services supporting N.A.T.O. military formations were discussed.

Sessions of the working groups of the Standing Group Meteorological Committee were held in London from November 5 to 14, 1957, to consider problems concerning weather plans and communications. The United Kingdom was represented by Mr. C. V. Ockenden, chairman of the working group on weather communications, and Mr. E. Evans.

Further sessions of these groups were held in Washington, D.C., from March 18 to 27, 1958, in preparation for the fifteenth meeting of the Standing Group Meteorological Committee. At these sessions, Messrs. E. Evans and W. A. L. Marshall represented the United Kingdom.

A combined meeting of the Allied Forces, Mediterranean, and Allied Forces, Southern Europe, Meteorological Committees was held in Malta from February 18 to 20, 1958, to discuss special problems relating to wartime meteorological arrangements in these areas. Mr. T. H. Kirk represented the United Kingdom, and Mr. G. W. Hurst attended as an observer.

At the request of the Ministry of Defence, the Meteorological Office provided specialist advice on ballistic questions at a meeting of a group of experts of the N.A.T.O. Defence Production Committee in Paris from March 17 to 19, 1958. Mr. N. C. Helliwell attended.

INTERNATIONAL GEOPHYSICAL YEAR

The normal observational programmes in meteorology (surface and upper air observations, atmospheric chemistry, radiation and ozone) and geomagnetism at standard stations of the Meteorological Office go a long way towards meeting the requirements recommended internationally for the I.G.Y., but some augmentation has been desirable. Since the start of the I.G.Y. on July 1, 1957, the following additional meteorological activities have been undertaken: extension of the programme of upper air soundings during the 10-day World Meteorological Intervals at the equinoxes and solstices, with special effort to attain greater heights; the recording of solar radiation and the radiation balance at Aden, Malta, Stanley (Falkland Islands) and on British ocean weather ships in the Atlantic; and the measurement of the total ozone content of the atmosphere at Habbaniya (Iraq). Further, the surface observations at 38 selected stations listed below, upper air measurements, radiation and ozone measurements are being tabulated on special forms for transmission to the I.G.Y. Meteorological Data Centre operated by the World Meteorological Organization at Geneva, whence they and corresponding data from all over the world will be made available in microcard or other form to all who may require this information.

<i>United Kingdom</i>	<i>Overseas</i>	<i>Falklands</i>
Aberdeen	Aden	Admiralty Bay
Aldergrove	Ascension Is.	Argentine Is.
Birmingham	Bahrain	Deception
Brawdy	Christmas Is.	Hope Bay
Lerwick	El Adem	Horsehoe Is.
London Airport	Gibraltar	Loubet Coast
Prestwick	Habbaniya	Signey Is.
Scilly Isles	Hargeisa	Stanley
Spurn Point	Kuwait	St. Georgia Is.
Stornoway	Malta	
Tiree	Masirah	
Tynemouth	Nicosia	
Valley	Riyan	
	Salalah	
	Sharjah	
	St. Helena Is.	

A special contribution of the Meteorological Office geomagnetic observations at Eskdalemuir and Lerwick is to determine, from their standard photographic records, the value of a new index of geomagnetic activity at successive 15-minute intervals, to assist in the study of relationships between solar, ionospheric and geomagnetic phenomena. Also, micro-film copies of the magnetograms and of tables of hourly values of magnetic declination, horizontal force and vertical force for both observatories are to be supplied to four World Data Centres for the I.G.Y. Continuous geomagnetic records are now being obtained at two substations, several miles to the south and west of Lerwick Observatory, with the object of obtaining information relevant to the electric current systems at ionospheric levels during magnetically disturbed periods.

The I.G.Y. organization provides for the declaration of 'Special World Intervals' from time to time, during which periods specified observations are made at various places throughout the world. Messages notifying these S.W.Is. were originated at the I.G.Y. World Warning Agency, Fort Belvoir, Virginia, U.S.A. at 16h G.M.T. daily; and it was clearly of great importance that they should be given world-wide distribution in the shortest possible time. As part of a communications scheme developed by W.M.O. to this end, the Meteorological Communications Centre, Dunstable, was made responsible for broadcasting S.W.I. messages at the beginning and end of the 1630 and 1700 G.M.T. continental and sub-continental W/T broadcasts daily, for interception and re-broadcasting by other places along the chain of communications, and thus around the world. After a trial period from June 20 to 29, 1957, these arrangements came into effect on July 1, 1957, and will continue until the end of the I.G.Y. on December 31, 1958. In addition, all S.W.I. messages were broadcast nationally over the meteorological teleprinter network radiating from Dunstable, British ocean weather ships on the Atlantic were notified individually by radio signal, while 'Alert' messages were passed to the Central Telegraph Office of the General Post Office and to Cable and Wireless, London, for distribution to addresses, including the Falklands and Singapore, designated by the Director of the Radio Research Organization at Slough.

Sir Graham Sutton (Director-General) and Dr. J. M. Stagg (Director of Services) again served on the National Committee for the I.G.Y., as national

correspondents for meteorology and geomagnetism respectively. Dr. Stagg and Mr. H. W. L. Absalom were members of the Antarctic Sub-Committee. A major concern of the Committee and a considerable United Kingdom contribution to the I.G.Y. is the Royal Society I.G.Y. Expedition located at Halley Bay, $75^{\circ} 31'S.$, $26^{\circ} 36'W.$ The parts of the Expedition's programme which relate to meteorology, geomagnetism, glaciology and seismology were undertaken during 1957 by a group of six members of the Meteorological Office, viz., Mr. J. MacDowall, Senior Scientific Officer; Mr. A. Blackie, Experimental Officer; Mr. J. M. C. Burton, Mr. P. Jeffries, Mr. D. T. Tribble and Mr. D. G. Ward, Assistant Experimental Officers. Mr. MacDowall was appointed leader of the Expedition on the return of Colonel R. A. Smart, R.A.M.C., to England in January 1958 (as had been arranged in 1956). Mr. P. Jeffries, who had spent 1956 at Shackleton Base (Commonwealth Trans-Antarctic Expedition) left Halley Bay for England in January 1958, while Mr. B. G. Ellis and Mr. J. A. Smith, Assistant Experimental Officers, joined the Expedition for 1958.

At the Royal Society Soirée held on June 28, 1957, to mark the inauguration of the I.G.Y., the Meteorological Office operated a demonstration of the location of thunderstorms by radio direction-finding.

Contact was maintained with the meteorological and geophysical work being carried out at the Argentine Islands Base (Falkland Islands Dependencies Survey) and some further assistance given to the Trans-Antarctic Expedition in regard to meteorological work at Shackleton and South Ice.

NATIONAL COMMITTEE FOR GEODESY AND GEOPHYSICS

The National Committee for Geodesy and Geophysics, apart from its interest in the International Geophysical Year, was concerned mainly with the XIth General Assembly of the International Union of Geodesy and Geophysics which was held in Toronto from September 3 to 14, 1957.

Sir Graham Sutton (Director-General), Dr. J. M. Stagg (Director of Services) and Dr. R. C. Sutcliffe (Director of Research) were all members of the National Committee, Sir Graham Sutton assuming the chairmanship of the Meteorology Sub-committee, Dr. Stagg continuing as chairman of the Geomagnetism Sub-committee, while Dr. Sutcliffe remained secretary of the International Association of Meteorology and was, in that capacity, much concerned with the Toronto arrangements. Five staff members, including the Director-General, were present at Toronto and each contributed to the scientific proceedings which covered a wide range of meteorological topics.

ADMINISTRATION

ORGANIZATION

The structure of Meteorological Office Headquarters was changed on July 1, 1957, as a result of the adoption of recommendations of the Brabazon Committee. The general lines of the reorganization are described in the foreword and particular references occur in the reports of the two directors. A diagrammatic representation is given at Appendix I. Appendix II records the names of the principal officers.

The distribution of outstations remained virtually unchanged, although the contraction of the Royal Air Force enabled a few to be closed in the latter part of the year.

STAFF

The Director-General appointed a Postings Board, comprised of the deputy-directors, to consider the postings of Scientific Officers up to the grade of Principal and of Chief Experimental Officers.

Appendix III shows the strengths in the various classes and grades compared with those of a year earlier.

Though shortages continued in most grades, the staff position was easier than for many years. The position in the assistant grade—chief cause of concern for a decade—at last showed an improvement. Although the improved position was in part caused by a decrease in the establishment, a somewhat smaller rate of resignation also helped, while a continuance of the contacts between Senior Meteorological Officers and Youth Employment Officers throughout the country resulted in a steady stream of would-be recruits.

Recruitment to the Assistant Experimental Officer grade was also satisfactory: 24 were appointed, 10 of them being from outside the Office. Two recruits joined the Scientific Officer class. The Vacation Employment Scheme was continued, and 15 students were selected to work in the Office during their long vacation out of a total of 46 applicants.

A further eight members of the staff were released on loan and seven members returned to the Meteorological Office, two of them from the Antarctic where they had served with the British I.G.Y. Expedition.

Mr. M. H. Freeman was appointed an Officer and Mr. W. R. Hanson a Member of the Most Excellent Order of the British Empire. Dr. J. Glasspoole was awarded the Imperial Service Order and Mr. F. W. Creek the Imperial Service Medal. The L. G. Groves Memorial Prize for Meteorology went to Mr. J. M. Craddock and the L. G. Groves Memorial Award for Air Meteorological Observers to Flight Lieutenant E. Cahill. D. W. S. Limbert, Experimental-Officer, was awarded the Polar Medal.

Mr. R. F. Zobel, Principal Scientific Officer, attended a course at the Administrative Staff College. Mr. P. J. Meade, Senior Principal Scientific Officer, was selected to attend a twelve-month course at the Imperial Defence College starting in January.

The Director-General records his appreciation of the services of the following members of the staff who retired during the year:

Mr. C. V. Ockenden, O.B.E.—Senior Principal Scientific Officer;
 Dr. F. J. Scrase, O.B.E.—Senior Principal Scientific Officer;
 Dr. J. Glasspoole, I.S.O.—Principal Scientific Officer;
 Mr. R. M. Poulter, O.B.E.—Principal Scientific Officer;
 Miss E. E. Austin—Senior Scientific Officer;
 Mr. C. E. Britton—Senior Scientific Officer;
 Mr. C. S. Durst, O.B.E.—Senior Scientific Officer;
 Mr. C. W. Lamb—Senior Scientific Officer;
 Mr. E. V. Newnham—Senior Scientific Officer;
 Mr. M. T. Spence, O.B.E.—Senior Scientific Officer;
 Mr. N. H. Smith—Senior Scientific Officer;
 Mr. R. A. Watson—Senior Scientific Officer;
 Mr. W. Andrews—Senior Experimental Officer;
 Mr. A. W. Berry—Senior Experimental Officer;
 Mr. H. W. Davis—Senior Experimental Officer;
 Mr. C. S. Herbert—Senior Experimental Officer;
 Mr. C. C. Newman—Senior Experimental Officer;
 Mr. H. T. Smith—Senior Experimental Officer;
 Miss G. L. Thorman—Senior Experimental Officer;
 Mr. E. S. Tunstall—Senior Experimental Officer;
 Mr. F. G. Hawkins—Experimental Officer;
 Mr. C. A. Jupp—Experimental Officer;
 Mr. H. A. Curtis, B.E.M.—Senior Assistant (Scientific).

Three of these officers returned to temporary posts in the Office; seven of them had previously relinquished posts of higher rank.

The Director-General regrets to record the deaths of the following members of the staff:

Dr. J. S. Farquharson, Senior Principal Scientific Officer;
 Mr. J. M. Weir, Senior Experimental Officer.

Royal Air Force personnel. One Scientific Officer continued to hold a commission with the Royal Air Force whilst carrying out his National Service obligation. 159 Assistants (Scientific) were serving as airmen meteorologists on March 31 and 12 others were with the Royal Air Force acting as Air Meteorological Observers on meteorological reconnaissance flights.

The strength of the Meteorological Section of the Royal Air Force Volunteer Reserve continued to diminish slowly, but of their number 58 officers, airmen or airwomen remained qualified to undertake full roster duties at a Royal Air Force station. Five officers were promoted during the year and three officers received Air Efficiency Award Medals. In addition one officer received a clasp to his Air Efficiency Award.

Training was again provided for ten officers of the R.A.F. Emergency Reserve.

SUPPLY OF INSTRUMENTS

Provision and production of equipment. During the year 1,407 orders and contracts were placed. The total expenditure was £328,400 and £79,103 was received by sale of equipment and for the testing and inspection of instruments.

The provision and delivery of new equipment was generally satisfactory in respect of the replacement of standard items, but some difficulty was experienced in finding manufacturers willing to undertake the production of new types. The more important contracts placed were for a Decca wind finding radar equipment; a 'card to type' converter for use with the Ferranti electronic computer; solarimeters for use in a radiation measurement programme; a 'wetness recorder', an instrument which is likely to be of great importance in research into foliage diseases of crops and other agricultural problems; a large number of recording rain-gauges and strip chart mechanisms for use in an investigation into rainfall and run-off problems.

Issue of Equipment. Regular supplies of instruments and stores were issued for the maintenance of meteorological offices both at home and overseas. Advice was given to enquirers at home and in the Commonwealth and Colonies regarding the suitability of equipment and its source of supply.

Large quantities of instruments and equipment were again supplied for use by the International Geophysical Year Expedition and the supporting bases in the Antarctic. Demands for stores numbered 9,819, including many from Commonwealth, Colonial and foreign Governments, and from private observers co-operating with the Meteorological Office.

Loans of meteorological equipment were made (among others) to the Atomic Energy Research Establishment for measuring water content in argon at very low temperatures; to various Agricultural Institutes and Schools of Agriculture for investigations into a wide variety of subjects including the effect of wind on the trapping of insects, potato blight, poultry breeding and sheep diseases; and to several University Exploration Clubs and other bodies for expeditions.

LIBRARY AND PUBLICATIONS

Library. The Library is the national library of meteorology and the other branches of geophysics for which the Office is responsible. It continued to acquire publications on these subjects published all over the world, to record them in appropriate bibliographies and indexes, and to provide an information service based on them to both the staff of the Office and to outside enquirers.

The major part of the publications received in the Library is obtained in exchange for the publications of the Meteorological Office. At the end of the year exchange agreements were in force with 365 institutions in all parts of the world. The most noteworthy of the new agreements made during the year were those with the Hydrometeorological Service of the U.S.S.R. and the Central Meteorological Institute of Roumania.

The number of publications received during the year was 8,964. In a Library such as that of the Office articles in scientific periodicals and technical reports are of much greater importance than books. Approximately 6,000 separate books, articles, and reports were classified by the Universal Decimal system and recorded during the year.

The growth in the volume of meteorological literature is shown by the fact that the bibliography of accessions to the Library in January 1957, which was distributed in May 1957, contained the record number of 686 separate references, 101 more than the previous record figure of June 1956. Arrangements were

made to render more comprehensive the collection of publications on meteorology in relation to atomic energy.

The number of publications lent during the year was 10,751 and many more were consulted in the Library itself or borrowed for the day by the staff at Harrow. The usual assistance to individual units and officers by sending to them new papers of special importance to their work before they became available for general borrowing and also in the reading of foreign languages was maintained.

Enquiries for information were received on a wide variety of subjects. They ranged from those from schools for assistance in the study of elementary meteorology to those for information on ozone concentration up to 100,000 feet (from rubber manufacturers), the incursion of air from polar regions into tropical Africa, possible air pressure differences between different exits from mines in mountainous country, and the measurement of dust concentration in the air.

Collaboration was maintained with other scientific libraries and information centres such as the Lending Library Unit of the Department of Scientific and Industrial Research.

Towards the end of the year, following a meeting called by the Director of Research, proposals were formulated for improving the translation facilities available to the Office.

The Principal Scientific Officer of the Library and Editing Section represented the United Kingdom on the World Meteorological Organization Commission for Bibliography and Publications and attended the session of that body held in Paris from November 4 to 22, 1957.

Publications. The main research publications of the Office are the *Geophysical Memoirs*, *Professional Notes* and *Meteorological Reports*. A list of those published during the year is given in Appendix VI. Two *Geophysical Memoirs*, three *Professional Notes* and four *Meteorological Reports* were in the press at the end of the year.

The *Meteorological Magazine* was published each month. Examples of the articles published are: Reorganization of the Meteorological Office (by the Director-General), Atomic Energy and the meteorologist, Presentation of forecasts by television, Recent seasonal trends in the number of rain-days over Great Britain, Winter temperatures in long and short grass, Jet streams over N. Africa and the Mediterranean. Reports of the Meteorological Office Monday scientific discussions held monthly in the autumn and winter, reviews of new books and notes and news of interest to meteorologists were also published in the Magazine.

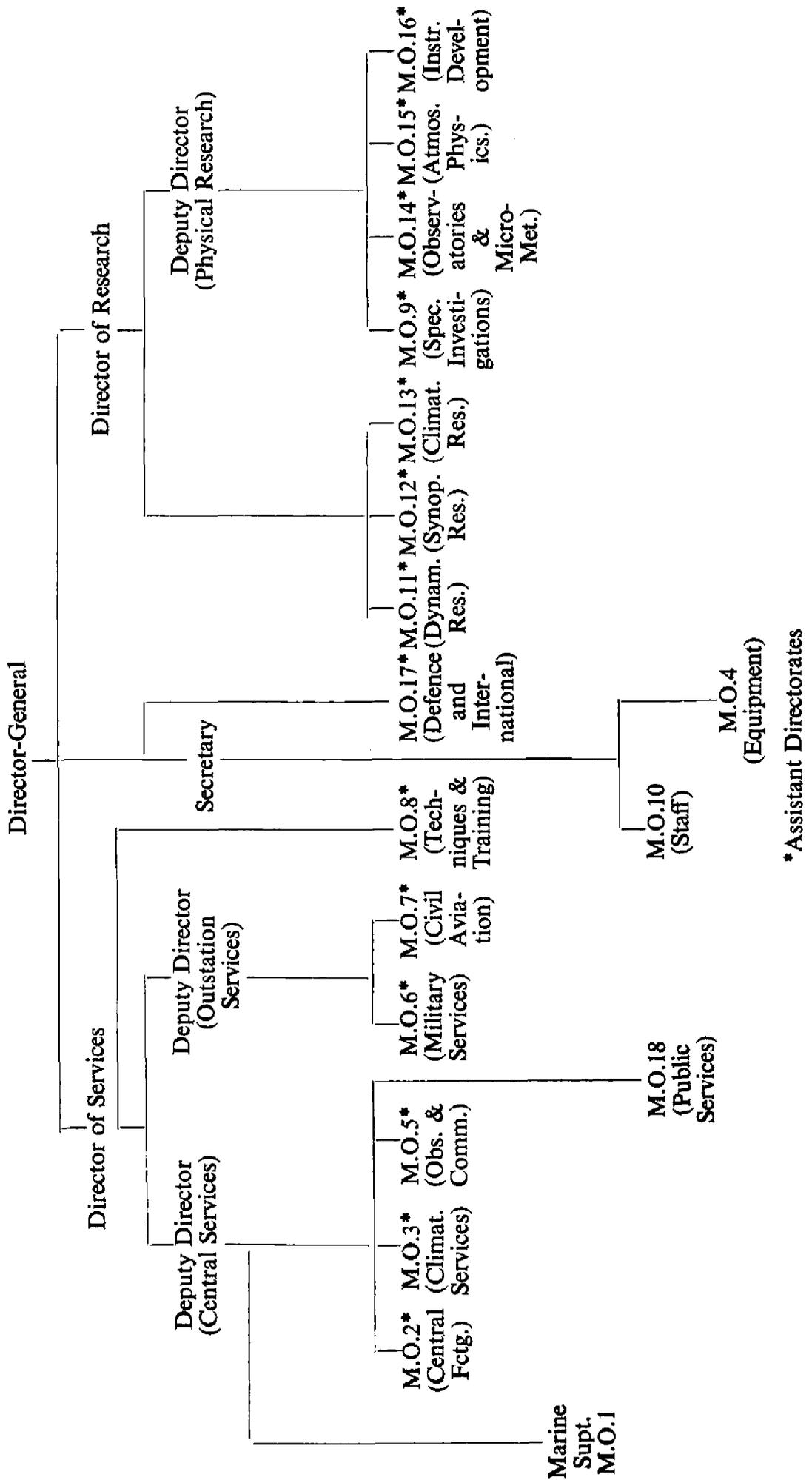
The *Marine Observer* was published each quarter. Its contents included articles on 'The application of meteorology to the care of cargo in a ship's hold', 'The exchange of heat across the sea surface', and 'Research in world weather patterns'.

The new 'Climatological and ocean current charts for the North Atlantic Ocean' were published for the months May to November. The 'Atlas of surface currents of the Eastern North Pacific Ocean' and the second edition of 'Monthly meteorological charts and sea surface current chart of the Greenland and Barents Seas' were in the press at the end of the year.

No new text books were issued during the year but reprints of some, such as the 'Meteorological Glossary', were made. An important publication in this class in the press at the end of the year was the 'Handbook of Aviation Meteorology'.

A Meteorological Office Publications Committee was set up by the Director-General to advise on all aspects of the preparation and production of the publications of the Office. The Committee has recommended, *inter alia*, that new editions should be prepared of the 'Meteorological Glossary' and 'Hygrometric Tables'.

APPENDIX I
 METEOROLOGICAL OFFICE
 HEADQUARTERS ORGANIZATION



* Assistant Directorates

APPENDIX II

PRINCIPAL OFFICERS OF THE METEOROLOGICAL OFFICE (on March 31, 1958)

DIRECTOR-GENERAL

Sir Graham Sutton, C.B.E., D.Sc., F.R.S., J.P.

ASSISTANT DIRECTOR (DEFENCE AND INTERNATIONAL) C. W. G. Daking, B.Sc.

DIRECTOR OF SERVICES

J. M. Stagg, C.B., O.B.E., D.Sc.

DEPUTY DIRECTOR (CENTRAL SERVICES) S. P. Peters, C.B.E., B.Sc.

DEPUTY DIRECTOR (OUTSTATION SERVICES) A. C. Best, O.B.E., D.Sc.

ASSISTANT DIRECTOR (CENTRAL FORECASTING) C. J. Boyden, B.A.

ASSISTANT DIRECTOR (CLIMATOLOGICAL SERVICES) R. G. Veryard, B.Sc.

ASSISTANT DIRECTOR (OBSERVATIONS AND COMMUNICATIONS) L. H. Starr, M.B.E., M.Sc.

ASSISTANT DIRECTOR (MILITARY SERVICES) T. W. V. Jones, B.Sc.

ASSISTANT DIRECTOR (CIVIL AVIATION) W. H. Bigg, O.B.E., B.Sc.

ASSISTANT DIRECTOR (TECHNIQUES AND TRAINING) H. L. Wright, M.A.

MARINE SUPERINTENDENT C. E. N. Frankcom, O.B.E., R.D., Commander, R.N.R.(retd.).

DIRECTOR OF RESEARCH

R. C. Sutcliffe, O.B.E., B.Sc., Ph.D., F.R.S.

DEPUTY DIRECTOR (PHYSICAL RESEARCH) G. D. Robinson, B.Sc., Ph.D.

ASSISTANT DIRECTOR (SPECIAL INVESTIGATIONS) *Acting* R. Frith, O.B.E., M.A., Ph.D.

ASSISTANT DIRECTOR (DYNAMICAL RESEARCH) J. S. Sawyer, M.A.

ASSISTANT DIRECTOR (SYNOPTIC RESEARCH) V. R. Coles, M.Sc.

ASSISTANT DIRECTOR (CLIMATOLOGICAL RESEARCH) A. G. Forsdyke, B.Sc., Ph.D., A.R.C.S. D.I.C.

ASSISTANT DIRECTOR (OBSERVATIONS AND MICROMETEOROLOGY) L. Jacobs, M.A., M.Sc.

ASSISTANT DIRECTOR (ATMOSPHERIC PHYSICS) B. C. V. Oddie, B.Sc.

ASSISTANT DIRECTOR (INSTRUMENT DEVELOPMENT) A. L. Maidens, B.Sc.

SECRETARY, METEOROLOGICAL OFFICE

W. J. B. Crotch, M.A., A.K.C.

APPENDIX III

STRENGTH OF THE STAFF OF THE METEOROLOGICAL OFFICE

	March 31, 1957	March 31, 1958
Scientific Officer grades	161	145
Experimental Officer grades	674	675
Scientific Assistant grades	1,455*	1,544**
Technical and Signals grades	271	282
Assistant Secretary grade	—	1
Executive and Clerical grades	83	112
Typing and Miscellaneous non-industrial grades ..	81	78
Nautical Officers	8	8
Marine staff (Ocean Weather Ships and Base):		
Officers	38	41
Crew	118	118
Industrial employees	81	81
Locally entered staff and employees overseas ..	253	239
Total	3,223	3,324

*Includes 161 airmen meteorologists and 11 meteorological air observers.

**Includes 170 airmen meteorologists and 12 meteorological air observers.

APPENDIX IV

METEOROLOGICAL OFFICE TRAINING SCHOOL

Courses which ended between April 1, 1957, and March 31, 1958.

	Length of Course Weeks	No. of courses	No. of trainees
Scientific Officers	17	1	7
Forecasters, Initial Course ..	15	4	36
Forecasters, Advanced Course ..	4	7	33
Forecasters, Refresher Course ..	3	2	9
Assistants, Initial Course ..	8	20	285
Assistants, Final Short Course ..	4	6	81
R.A.F.V.R. Officers	2	1	9
R.A.F. Officers on E List ..	2	2	10
Merchant Navy Agents ..	1	1	3
Special Radio-sonde Refresher Course	1	1	6
	Days		
Voluntary Observers	4	2	43
Total		47	522

Students attended the School from other meteorological services as follows:—

Country	No. of students
Belgium	2
Burma	1
Channel Islands	2
East Africa	10
Falkland Islands	17
Ghana	1
Hong Kong	1
Iran	1
Iraq	3
Israel	1
Jordan	1
Netherlands	1
Nigeria	1
Pakistan	1
Singapore	3
Sudan	1
Switzerland	2
Syria	1
West Indies	2
Yugoslavia	3
Total	55

APPENDIX V

CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGICAL SECTION

	Stations					Autographic records		
	Observatories	Synoptic	Crop weather	Climatological	Rainfall	Sunshine	Rainfall	Wind
Scotland, North	1	10	0	20	169	16	9	5
Scotland, East	0	8	7	50	339	41	21	4
Scotland, West	1	5	3	32	409	25	17	6
England, North-east	0	9	4	24	342	30	15	5
England, East	0	10	10	25	489	26	33	8
England, Midlands	0	12	21	47	1,034	59	40	4
England, South-east (including London)	1	18	15	61	753	64	67	14
England, South-west	0	8	9	27	475	33	12	3
England, North-west	0	4	4	23	439	26	32	7
Wales, North	0	2	3	15	183	10	4	1
Wales, South	0	3	7	15	240	22	9	4
Isle of Man	0	2	0	1	12	3	1	1
Scilly and Channel Isles	0	2	0	4	18	6	1	1
Northern Ireland	0	4	1	10	80	7	4	3
Total ..	3	97	84	354	4,982*	368	265	66

*Includes stations in earlier columns.

Figures for rainfall stations and autographic rainfall records refer to the year 1956. All other figures show the position on January 1, 1958.

APPENDIX VI

PUBLICATIONS

The publications prepared by the Meteorological Office are generally issued by Her Majesty's Stationery Office as official publications. A complete list, with the prices at which they can be purchased through any of the Sale Offices or usual agents of Her Majesty's Stationery Office is sent free to any applicant.

The following official publications were issued during the period of this report:

PERIODICAL

- Daily Aerological Record*, containing information respecting meteorological conditions in the upper air over the British Isles (to March 31, 1958).
- Daily Weather Report*, containing weather maps for the northern hemisphere, British Isles, etc., and data (to March 31, 1958).
- Daily Weather Report, Overseas supplement*, containing surface and upper air data (to December 30, 1957).
- Monthly Weather Report*, with a summary for the year (to December, 1957).
- Seismological Bulletin*. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to January, 1958).
- Marine Observer* (quarterly) (to January, 1958).
- Meteorological Magazine* (to March 1958).
- British Rainfall, 1955*. A report on the distribution of rain in space and time over Great Britain and Northern Ireland as recorded by about 5,000 observers.
- Meteorological and current summary for Ocean Weather Stations—India (59°00' N., 19°00' W.), Juliett (52°30' N., 20°00' W.) and Alpha (62°00' N., 33°00' W.) for January to December, 1956*.
- Réseau Mondial*. Monthly and annual summaries of pressure, temperature and precipitation based on a world-wide network of observing stations. 1933 and 1934.
- The Observatories' Year Book 1939* comprising the meteorological and geophysical results obtained from autographic records and eye observations at the Lerwick, Aberdeen, Eskdalemuir, Valentia and Kew observatories, and the results of soundings of the upper atmosphere by means of registering balloons.

SERIAL

- Geophysical Memoirs: Vol. XII:*
99. Tornadoes in England, May 21, 1950. By H. H. Lamb, M.A.
- Meteorological Reports: Vol. III:*
18. Airflow over mountains: notes for forecasters and pilots. By G. A. Corby, B.Sc.
- Professional Notes: Vol. VIII:*
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 122. The subtropical jet stream of the eastern North Pacific Ocean in January and April, 1952. By H. D. Hoyle, B.Sc.
 123. Forecasting cirrus cloud over the British Isles. By D. G. James, Ph.D.

OCCASIONAL

- International Meteorological Code*. Decode for use of shipping, incorporating the codes for weather reports from and to ships and the analysis code for use of shipping. 4th edition, 1957.
- Monthly Climatological and sea-surface current charts of the North Atlantic Ocean*.
Some typical weather maps.
- Upper Air Data for stations maintained by the Meteorological Office*.—Summaries of radio-sonde observations of temperature and humidity and of radar wind measurements at standard pressure levels.
1946-1950. Part 10, Ocean Weather Station Juliett. Part 11, Aldergrove.
1951-1955. Part 1, Stanley, Falkland Islands.

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