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M.O. 633

Meteorological Office

REPORT FOR THE YEAR
ENDING
MARCH 31, 1957

LONDON

HER MAJESTY'S STATIONERY OFFICE

THREE SHILLINGS NET

M.O. 633

ANNUAL REPORT
ON THE
METEOROLOGICAL OFFICE

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

FOR THE YEAR
APRIL 1, 1956 TO MARCH 31, 1957



LONDON
HER MAJESTY'S STATIONERY OFFICE
1957

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Appointed by the Secretary of State for Air

Chairman: Sir Charles Normand, C.I.E.

Members: Squadron Leader P. Barber (Air Ministry) (from January 1957)
Dr. G. E. Bell (Ministry of Transport and Civil Aviation)
Instructor Captain P. Bracelin, C.B.E., R.N. (Admiralty) (to December 1956)
Dr. A. W. Brewer
Dr. G. M. B. Dobson, C.B.E., F.R.S.
Instructor Captain A. E. Johnston, R.N. (Admiralty) (from December 1956)
Professor P. A. Sheppard
Sir Graham Sutton, C.B.E., F.R.S. (Director, Meteorological Office)
Squadron Leader A. W. Tarry (Air Ministry) (to January 1957)
Sir Owen Wansbrough-Jones, K.B.E., C.B. (Ministry of Supply)
Dr. T. W. Wormell

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

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

METEOROLOGICAL COMMITTEE

Appointed by the Secretary of State for Air

Chairman: Mr. Christopher Soames, C.B.E., M.P.

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Members: Mr. W. J. Bigg, C.M.G. (Colonial Office)
Instructor Captain P. Bracelin, C.B.E., R.N. (Admiralty)
Mr. E. J. Dickie, M.B.E. (Ministry of Transport and Civil Aviation) (from June 1956)
Professor N. Feather, F.R.S. (Royal Society of Edinburgh)
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Major General R. W. Goodbody, C.B., D.S.O. (War Office)
Mr. W. Lewis (Scottish Office)
Mr. G. M. Macintosh, O.B.E. (Ministry of Transport and Civil Aviation) (to June 1956)
Professor H. S. W. Massey, F.R.S. (Royal Society)
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Sir Owen Wansbrough-Jones, K.B.E., C.B. (Ministry of Supply)

Secretary: Mr. R. J. Williams, M.B.E.

The Committee dissolved after holding its final meeting on October 18, 1956.

ADVISORY COMMITTEE ON METEOROLOGY FOR SCOTLAND

Appointed by the Meteorological Committee

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Members: Sir Edward Appleton, G.B.E., K.C.B., F.R.S. (University of Edinburgh)
Mr. A. C. Cowan (Fisheries Division, Scottish Home Department)
Dr. A. E. M. Geddes, O.B.E., F.R.S.E. (University of Aberdeen)
Dr. D. Jack, F.R.S.E. (University of Edinburgh)
Sir Charles Normand, C.I.E. (Royal Meteorological Society)
Mr. Alex. Paton (Department of Agriculture for Scotland)
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)

Secretary: Mr. R. Cranna

The Committee met on November 13, 1956.

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.

Chairman: Professor H. S. W. Massey, F.R.S.

Members: The Treasurer
A Secretary (Sir David Brunt, F.R.S.)
Professor D. R. Bates, F.R.S.
Dr. A. W. Brewer
Professor G. M. B. Dobson, C.B.E., F.R.S.
Mr. E. Gold, C.B., D.S.O., O.B.E.(Mil.), F.R.S.
Dr. F. E. Jones
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Mr. J. A. Ratcliffe, O.B.E., F.R.S.
Professor P. A. Sheppard
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 of the Meteorological Office

The Committee met on June 7, 1956,

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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 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.

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 £4,000,000. Of the expenditure chargeable to Air Votes, about £2,500,000 represents expenditure associated with staff and £1,250,000 expenditure on stores, communications and miscellaneous services. Of the total expenditure, some £600,000 is recovered from other Government Departments and outside bodies in respect of special services rendered, sales of meteorological equipment, etc.

FOREWORD BY THE DIRECTOR

During the year under review the work of the Meteorological Office, both as a public service and as a scientific institution, proceeded normally. There were, however, certain events which are likely to be of special importance for the future of the Office. The Committee under Lord Brabazon, set up in March 1955 by the Secretary of State for Air to review the organization of the Meteorological Office, submitted its Report in August 1956. The Report, which is intended for departmental and interdepartmental use only, is still under discussion and no statement can be made at this stage.

Another significant event was the decision to reunite the Headquarters divisions, now scattered between London (Kingsway), Dunstable, Harrow and Stanmore, into one group of new buildings specially designed to meet the requirements of an ever growing science. The site selected is at the new town of Bracknell, Berkshire, and it is planned to complete the project in stages within the next four or five years.

Preparations for the International Geophysical Year, which is to begin in the summer of 1957, are now virtually complete. The Meteorological Office has made preparations for an extended programme of observations, especially in the upper air. Members of the Office staff are also serving with the two British expeditions to the Antarctic.

For the rest, it will be seen from the pages that follow that the Office continues to be fully occupied, both in serving the public and in advancing the science of the atmosphere. There are no sensational discoveries to report, but this is not unexpected. The meteorological problem is probably the most difficult in classical physics and it is only by the most diligent and patient efforts that progress can be made. The advances that are made are not always apparent; the forecasts of to-day may not be of considerably greater accuracy than those of twenty years ago, but they aim at much greater precision and often relate to regions of the atmosphere that were, until recently, inaccessible.

It is with considerable pleasure that I record the election of Dr. R. C. Sutcliffe, Deputy Director (Research) to the Fellowship of the Royal Society, on March 21, 1957.

I attended the Eighth Session of the Executive Committee of the World Meteorological Organization in Geneva in April 1956.

The following papers and articles by the Director and the Principal Deputy Director were published during the year ended March 31, 1957.

SIR GRAHAM SUTTON, F.R.S.

Sir D. Brunt, scholar, teacher, administrator. *Met. Mag., London*, 85, 1956, p. 161.

The Meteorological Office and the International Geophysical Year. *Mar. Obs., London*, 27, 1957, p. 19.

World Meteorological Organization. Eighth session of the Executive Committee, April 17-30, 1956. *Met. Mag., London*, 85, 1956, p. 193.

Meteorology to-day. *Financ. Times, London*, No. 21,079, 1957, p. 4.

J. M. STAGG, D. SC, Meteorology in war. *Brassey's Annu., London*, 67, 1956, p. 300.

The following papers by the Director's personal staff were published during the year ended March 31, 1957.

- I. J. W. POTHECARY, B.Sc. Recent research on fronts. *Weather, London*, **11**, 1956, p. 147.
- I. J. W. POTHECARY, B.Sc., and F. H. BUSHBY, B.Sc. Series of computed forecast charts and the movement of a depression, August 19-21, 1954. *Met. Mag., London*, **85**, 1956, p. 133.

FORECASTING

CENTRAL FORECASTING DIVISION

The Central Forecasting Division continued to provide day-to-day forecasting guidance to outstations, and also to supply forecasts, warnings, and other weather information to certain Government Departments and nationalized industries, as well as to the community in general. This work was carried out in a similar manner to that of previous years. The special forecast services included daily forecasts of the risk of icing on electrical conductor rails, which were supplied to British Railways; forecasts of the probability of rain in connection with the planting of seeds on an extensive scale, supplied to a firm of growers; and the issue during the summer season of over 100 forecasts for pigeon races.

Bulletins for broadcasting. Forecasts, and warnings of hazardous weather, are made known to the general public, and to certain specialized users, in a variety of ways. As in previous years those initiated by the Central Forecasting Division were primarily in the form of bulletins for broadcast in the Home, Light and European Services of the British Broadcasting Corporation, and for printing in the daily newspapers. As foreshadowed in the Report for the year ending March 31, 1956, substantial changes were made in April 1956 in the arrangements for B.B.C. broadcasts. The shipping forecasts were transferred from the Home Service to the Light Programme (wavelength 1500 m. only), and the time allotted to them made it possible to include in three of the four daily broadcasts a "General Synopsis" describing developments on the weather chart in some detail, as well as the latest reports from certain coastal stations and light-vessels. The remainder of each shipping bulletin consists of 24-hour forecasts for the waters from Northwest Europe to Iceland. The forecasts for the coastal waters of the British Isles continue to be broadcast also from G.P.O. Shore Radio Stations twice daily. These latter stations broadcast gale warnings in addition, and at the same time gale warning cones are hoisted along coasts which are expected to be affected by the gales. The needs of ships further out in the Atlantic are met by a twice daily broadcast from Portishead of the North Atlantic bulletin, giving detailed information concerning the weather situation, and the forecast, for the eastern half of the North Atlantic.

These changes in the arrangements for shipping forecasts relieved the pressure of broadcasting time on the Home Service wavelengths, and the opportunity was consequently taken to introduce a freer style of presentation in the forecasts for land areas.

Extended period forecasts. The daily preparation of forecasts in respect of periods of two to three days ahead was continued. Many of the forecasts issued were for a special purpose, or were required to deal only with single elements of the weather. In addition to the "fine spell" service for farmers, and the issue of warnings of persistent fog, i.e., a fog continuing for at least twenty-four hours, regular forecasts of temperature were supplied to a number of industrial firms concerned with the safety during cold weather of plant left unattended at week-ends.

Official publications. The preparation and publication of the *Daily Weather Report*, the *Daily Aerological Record*, the *Monthly Summary*, and the *Overseas*

Supplement, was maintained throughout the year.

OBSERVATIONS AND COMMUNICATIONS DIVISION

This Division is responsible for organizing the provision of the observations and the meteorological communications required for the Central Forecasting Office and outstations.

Surface observations. Since the second World War, the majority of the reporting stations in the United Kingdom have been located on airfields, and in consequence the maintenance of an adequate reporting network has not been difficult. However, the recent closing of some R.A.F. stations, and the restriction of hours of duty at others, have presented problems in obtaining replacements, and a Standing Group on reporting networks, consisting of representatives of the forecasting, aviation, and climatological interests within the Meteorological Office, has kept this matter constantly under review. Part-time observers have been recruited to fill the gaps in some areas, reporting programmes have been increased in others, whilst a few additional auxiliary stations have been established to improve the overall network. It may be mentioned, in particular, that an observer has been recruited to provide reports three times daily from Crask, in Sutherland, and since there has been, hitherto, no inland reporting station in the counties of Ross and Cromarty, Sutherland or Caithness, reports from Crask will be particularly valuable.

Radio-sonde and radar-wind observations. The network of eight radio-sonde and radar-wind stations in the United Kingdom was maintained. Each station made observations of pressure, temperature and humidity twice daily to an average height of 62,700 ft., and of upper wind four times daily. No major change was made to the equipment, but the building of a new station at Ormskirk, Lancashire, was commenced. This station will eventually replace that at Fazakerley, Liverpool.

A team selected from the operating staff of radio-sonde stations in the United Kingdom took part in international radio-sonde trials held at Payerne, Switzerland, in May and June 1956, under the auspices of the World Meteorological Organization. For these trials a suitable type of R.A.F. signals vehicle was specially equipped as a mobile radio-sonde office, and was taken from this country to Switzerland, where it operated with complete success.

To provide the staff experienced in radio-sonde and radar-wind observations needed to maintain the network of stations, and also the units on the British ocean weather ships, regular training courses were held at the radio-sonde station at Hemsby, near Great Yarmouth. During the year, 35 Meteorological Office trainees attended the course.

Meteorological flights. Meteorological reconnaissance flights made by the Royal Air Force Hastings aircraft based on Aldergrove, and by Spitfire ascents to 30,000 ft. made by a civilian contractor under the direction of R.A.F. Home Command, were maintained throughout the year. The Spitfire aircraft were replaced during the year by Mosquitoes. Both types of flight were carried out with a high degree of regularity, and with a disregard for adverse weather which reflected considerable credit upon the aircrews involved. To investigate the possibility of obtaining information to even greater heights than at present, an R.A.F. Canberra aircraft was recently attached to the flight at Aldergrove,

for trials in the combined use of the Hastings for lower level air observations and the Canberra for levels above the ceiling of the Hastings.

Thunderstorm location. The organization for locating the positions of thunderstorms by the "sferic" system, up to a range of 1,500 miles from the British Isles, was continued without change. A new site in Antrim, Northern Ireland, was, however, selected as a replacement for Irvinestown, which will shortly be no longer available. In addition, plans were made for developing a new site previously selected in Eastern Scotland to replace the existing station at Leuchars.

Following an earlier trial of British "sferic" apparatus at Tromso, where accuracy had been adversely affected by the mountainous terrain, the Norwegian Meteorological Service invited, and was afforded, assistance in a further trial of the apparatus, this time at Oslo. This trial proved entirely successful in regard to the accuracy of bearings, although Oslo is not as favourably placed for the triangulation of bearings as Tromso, in relation to the British network of stations. A successful trial was also made at Gibraltar, whence the bearings greatly added to the accuracy of thunderstorm location both in Central Europe and in mid-Atlantic.

Communications. To enable the Meteorological Office to carry out its national and international responsibilities for the collection and dissemination of weather information, the hub of an elaborate system of telecommunications is located at the Central Forecasting Office at Dunstable, where more than half a million 5-figure code groups are dealt with each day.

Teletypewriters. The most important development in meteorological telecommunications during the year was the installation of a direct teletypewriter connection between the United Kingdom (Dunstable) and Canada (Dorval) on November 1, 1956, utilizing a circuit in the trans-Atlantic cable. The main use of this circuit is to interchange surface and upper air reports, analyses and prognoses, between the British and Canadian Meteorological Services. Simultaneous 2-way transmissions at a speed of 50-55 5-figure groups per minute have been made over the circuit almost without interruption since its installation. During this period "outages" of considerable duration, due to bad radio-propagation conditions, have occurred over the normal New York-Azores-Paris radio teletypewriter circuit, on which the United Kingdom had formerly to rely for North-American information. As expected, use of the cable circuit has ensured an uninterrupted flow of data, and it is hoped that the experience now being gained in operating this circuit with Canada on a bilateral basis will prove to be a prelude to a permanent arrangement.

Channel I and Channel II domestic broadcasts and the North Atlantic, Mediterranean, and International broadcasts from Dunstable were maintained as in previous years, with only slight modifications. In order to meet the needs of some forecasting centres in the United Kingdom during the Suez crisis certain information normally included only in the "Mediterranean" broadcasts was transmitted also to the larger number of recipients of the Channel II domestic broadcast.

Telephones. Thirteen forecasting centres located on R.A.F. and Civil Aviation stations, which have been publicized as available for the supply of meteorological information to the public, have been provided with telephone

lines direct to local Post Office exchanges. This provides airfield telephone exchanges with some relief from the increasing number of telephone calls for forecasts which are being made by the general public.

Radio communications. These were maintained on a generally similar basis to previous years. A scheme has been prepared by which the national and sub-continental broadcasts of meteorological information for which Dunstable is responsible could be made by radio teleprinter (RTP), as well as by W/T, with a view to an eventual change to the quicker and more automatic RTP method only. This is in general accordance with European policy of the World Meteorological Organization.

Facsimile. Two important trials of land-line transmissions have been made during the year. For the first trial in April 1956, plotted charts of the British Isles, on a scale of 1 in 2-million, were transmitted every hour, and on a scale of 1 in 5-million for Northern Europe every three hours. As a result it was considered that, with suitably clear plotting on the original, facsimile charts broadcast by land-line would be adequate for use at smaller forecasting stations.

In the second trial in July 1956, special charts on a scale of 1 in 5-million were prepared at 3-hourly intervals, each in four sections. When joined together after transmission they gave charts covering the area from Iceland to North Africa and from well out on the Atlantic to the Ural Mountains. Opinions on the utility of these charts as replacements for locally plotted charts at main meteorological offices were varied, and indicated the need for further trials. It was decided; however, that an order for a further twenty facsimile recorders should now be placed as a first instalment of a longer term programme for providing the majority of forecasting centres with this equipment, and the Post Office was asked to design a land-line network incorporating twenty designated stations, together with the existing network.

Flood warnings. The meteorological teleprinter system was again used for the rapid collection of tide-gauge readings from Harbour Masters along the east coast for use by the Hydrographic Officer located at Dunstable, in connection with the east coast flood-warning scheme, and for the transmission over the direct teleprinter line from Dunstable to the Central Telegraph Office, London, of flood warning telegrams to authorized recipients. Because of the exceptionally high predicted tides for early September 1956, the flood warning scheme was introduced on September 1 instead of on the 15th, the usual date.

Publications. The reference work on meteorological telecommunications for official use referred to in the Report for the year ending March 31, 1956, was issued in June 1956.

The fourth edition of "Weather Map" (M.O. 595) was issued in February 1957 and placed on sale by Her Majesty's Stationery Office.

PUBLIC SERVICES DIVISION

The main development work of this Division during the year was in relation to the increasing demands of the Independent Television Authority for television services, the dial telephone service for forecasts, and Museum exhibitions.

Television Broadcasting. From October 1956 until mid-February 1957, the nightly presentation of the weather forecast on B.B.C. Television by forecasters

from Victory House did not take place on Sundays, at the request of the B.B.C., whilst presentation on Saturdays was likewise discontinued after November 24, 1956, also until mid-February 1957. On February 16, 1957, resumption of personal presentation on Saturdays and Sundays was made possible by the agreement of the Postmaster-General to the extension of television broadcasting time to include the hour from 6 to 7 p.m. on Monday to Saturday, inclusive. Since February 16, the weather forecast has accordingly been presented by a forecaster at 5.57 p.m. daily from Monday to Saturday, and between 7.25 and 7.35 p.m. on Sunday.

From April 22, 1956, a new chart showing the wind and visibility expected in coastal waters of the British Isles at midday on the following day was shown on B.B.C. Television at the end of each evening programme.

The services introduced in the previous year for the Independent Television Authority were continued and extended. The television forecaster employed by Associated Rediffusion Limited has continued to use the facilities provided at Victory House for preparing his material for broadcast on the London transmissions of this company from Monday to Friday inclusive. Scripts and charts for the weather programmes broadcast from London and Birmingham by the other contracting Companies, namely Associated Television Limited and the Associated Broadcasting Company Limited, have been provided daily from Victory House. With the opening of the Manchester transmitter on May 5, 1956, forecasts and charts were provided daily to the operating companies, Associated British Cinemas Television Limited and the Granada Television Network Limited, to cover the Manchester transmission area, whilst on the opening of the Yorkshire transmitter on November 10, 1956, to relay the Manchester transmissions, the Manchester forecast area was suitably extended to include the Yorkshire area.

Dial telephone service for forecasts. As stated in the Report for the year ending March 31, 1956, an automatic dialling telephone service (WEA) for the issue of forecasts to the public was inaugurated in London on March 5, 1956. By the end of 1956, over three million calls had been made on this service, and plans for its extension over the country were well advanced. On February 4, 1957, services commenced to operate in Liverpool, Manchester, and Birmingham; on March 4, 1957, in Glasgow and Belfast; and on March 11, 1957, in Cardiff. It is of interest to note that notwithstanding the introduction of the WEA service in the London area the total number of ordinary telephone enquiries received in the forecasting unit of Victory House though reduced by about 5 per cent. continued to be over 100,000 for the year.

Museum exhibitions. As a result of the Centenary Year exhibitions held in 1955, as described in the Report for the year ending March 31, 1956, a request was received from a group of museums in the Midlands for a meteorological exhibit. The first of these was held in Leicester Museum and was opened by the Director of the Meteorological Office on August 3, 1956. Subsequently this exhibition was placed on display in the museums of Nottingham, Burton-on-Trent and Warwick, and it has so far been seen by about 30,000 visitors. Apart from its educational value it stimulates interest in the Meteorological Office, to the benefit of recruiting.

Radar storm-warning equipment on Victory House roof. The special radar equipment for obtaining information about the occurrence of rain, which was

installed on the Air Ministry roof at Victory House in June 1955, has been further employed for experimental purposes. Assessment of the value of this type of radar set in short-period forecasting, particularly in relation to the dial telephone service (WEA), was concentrated on the wet summer months of 1956 which followed a dry spring. Charts, photographs, and films of rainfall "echoes" were made, both for immediate use and for subsequent study. New types of tracing charts have been devised for recording the areas of rain, and there have been experiments on methods of evaluating the "echo" intensity. The experimental use of this equipment at Victory House has stimulated interest in it in other operational branches of the Meteorological Office, and considerable thought has been given to the problem of disseminating the information presented by the radar display.

Other developments. A large-area forecast chart covering the North Atlantic and Western Europe, as has been supplied to the *Manchester Guardian* from December 12, 1955, was supplied also to *The Times* from June 18, 1956.

CLIMATOLOGICAL SERVICES DIVISION

The functions of the Climatological Services Division 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). There are two branches, the British Climatological Branch and the Agricultural Branch.

British Climatological Branch

During the year records were received from 32 new voluntary climatological observing stations, but 12 stations ceased to report, including that at Rhayader in Central Wales where continuous records had been maintained since 1917, and that at Parkend, Forest of Dean, where records had been maintained since 1931.

As many inspections of climatological and rainfall stations were arranged as practicable, and with the first full year of duty of a full-time rainfall inspector, a good start was made in reducing the arrears of inspection of rainfall stations. The number of these inspected was approximately 500, including those inspected by the staff of the Edinburgh Office.

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

Good progress was made with the preparation of rainfall averages from the period 1916–50. Tabulations of hourly values of dry-bulb and wet-bulb temperature in a form suitable for the extraction of combined frequencies were commenced for a network of stations over the British Isles, for a 10-year period.

Branch memoranda were prepared on monthly averages of accumulated temperature 1921–1950, extreme wind speeds over Great Britain and Northern

Ireland, and on summaries of observations of fog duration at British ports. A paper was also prepared on recent seasonal trends in the number of rain-days over Great Britain.

With effect from January 1, 1957, new climatological forms were brought into use at official stations, designed to permit the direct transfer of data on to punched cards. Consideration has been given to the re-design of climatological forms for climatological and crop-weather stations, so that data from these stations may also be put on to punched cards commencing on January 1, 1958. Some progress has been made in punching daily and hourly data for five representative stations, London Airport, Manchester Airport, Mildenhall, Renfrew and Aldergrove, covering a backlog of eight years.

Publications. The *Monthly Weather Report*, containing full summaries of observations, was published regularly. The *Annual Summary* (for 1955) was published in July, an even earlier date than in the previous year. The volume of *British Rainfall* for 1954 was published in August 1956 and that for 1955 was sent to the printers. A report on the Snow Survey for Great Britain for the season 1955-1956 was prepared and published in the *Meteorological Magazine*.

Hydrology.—The section of the British Climatological Branch responsible for the work on hydrological problems maintained close contact with the Surface Water Survey of the Ministry of Housing and Local Government, the Ministry of Agriculture and Fisheries (Land Drainage and River Board work), and the Road Research Laboratory of the Department of Scientific and Industrial Research (Storm Water Branch), whilst consultations with individual River Boards continued. Estimates of the general monthly rainfall were prepared for about 80 areas with run-off data, for inclusion in the *Surface Water Year Book* 1954-1955.

The section continued to co-operate in the evaporation investigation being carried out at a reservoir in Kempton Park belonging to the Metropolitan Water Board. A paper giving the reports so far obtained in this investigation was read at the Dijon Meeting of the International Association of Hydrology, IUGG, in September 1956, but it is not expected that the final results will be available for another year at least. 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 raingauges in open situations.

Special work. A leaflet entitled "Weather and the Builder" was published as a result of discussions with the Building Research Station, Department of Scientific and Industrial Research. A paper entitled "Can the Meteorological Office help you?" was contributed to the annual meeting of the Institution of Heating and Ventilation Engineers in July 1956.

Instrumentation for the investigation near Cardington, Bedfordshire with the object of obtaining detailed information about the time and area distribution of intense falls of rain was completed during the summer of 1956. A close network of recording raingauges, electrically synchronized, will give minute-by-minute data for an area of about 4 square miles. Observations had to be suspended for a short time during the early part of 1957, but the main interest

centres on summer thundery rainfall. Plans were made for the tabulation of the records.

Notes were prepared on the comparison of weather conditions during July and August 1954 and 1955, on the dry weather in England and Wales during the first half of 1956, and on the severe hailstorm at Tunbridge Wells on August 6, 1956.

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 locating of new towns, port development and navigational aids to shipping, the design of nuclear power stations and of air conditioning plant, the protection of water pipes against frost, the warping of roofs in prefabricated buildings and the shrinking of paper in bulk, the effects on contracts of time lost during inclement weather in outdoor work, the television viewing habits of the population, the fluctuations in the sales of commercial commodities, and the effects of weather on art paintings and on bird migration.

Agricultural Branch

The main duty of the Agricultural Branch is the application of meteorology to problems of agriculture, horticulture and forestry. It co-operates with research workers and experimental scientists in these subjects and generally acts in a liaison capacity between meteorology and agriculture or kindred sciences.

The headquarters of the Branch is at Harrow and other units are maintained at the National Agricultural Advisory Service Provincial Headquarters at Bristol and Cambridge. A member of the staff of the Meteorological Office, Edinburgh, carries out similar duties for Scotland, and specializes in problems of upland shelter.

About 24 crop-weather stations at experimental farms, county institutes, research stations and universities were inspected, and problems of common interest discussed.

Calendars of agricultural and horticultural work were prepared for use in advising forecasters of current work on the land; agriculturists were supplied with weekly weather summaries.

Many articles were written for professional and trade journals, and several broadcasts were made, including some on the European service of the B.B.C. Assistance was given in demonstrations at Agricultural Shows, and the wind-tunnel model illustrating the effect of shelter belts was lent for the Maidstone, Marden and Canterbury Shows, and for the Apple Week in Leeds.

Special work. Frost liability experiments have proved very helpful in orchard planting and are being extended.

Continued assistance was given in protective cropping experiments conducted at Ministry of Agriculture stations, and help was also given in the provision of potential transpiration data for use in irrigation planning and practice.

With the co-operation of the Plant Pathology Laboratory of the Ministry of Agriculture, work on potato blight epidemics continued. Very accurate press notices, based almost entirely on meteorological evidence, were issued by the

Ministry of Agriculture giving 14 days clear notice of the expected outbreak of the disease.

A new instrument was designed by the Instruments Development Branch to record the duration of surface wetness. This instrument proved to be extremely useful in a combined investigation into weather and the incidence of apple scab, in which the Agricultural Branch, the Plant Pathology Laboratory, the National Agricultural Advisory Service and the Rothamsted Experimental Station are each playing a part.

Other subjects investigated were air trajectories and black rust, lightning damage to field plants, drought incidence, frost liability, and soil erosion.

Enquiries. The wide variety of topics forming the subject of enquiries dealt with by the Branch included the climate of dairies, eelworm infection, animal diseases, the effect of polythene, the depth of freezing in the soil, wind pumps, early lamb production, grain drying, damage to sugar beet, orientation of dutch lights, and the forcing of rhubarb.

MARINE DIVISION

British voluntary observing fleet. The constitution of the British voluntary observing fleet was described in the Report for the year ending March 31, 1956. The number of British voluntary observing ships is now over 700, out of a world total of about 2,600. Scrutiny of the records maintained on these ships shows that, in general, the observations continue to be made carefully and accurately by the voluntary observers aboard the ships, and that the radio weather messages are regularly transmitted to the authorities concerned. A number of "selected" and "supplementary" ships made observations of whales on behalf of the National Institute of Oceanography, whilst special radar observations for the Admiralty were made aboard "selected" ships equipped to do this. Awards for "excellent" records were made to 100 ships during the year.

Radio weather messages from observing ships. An average of 166 reports were received daily at Dunstable from voluntary observing ships in the Eastern North Atlantic, and in coastal waters around the United Kingdom. 111 of these were from British observing ships, 16 from foreign observing ships in the North Atlantic, 12 from British coasting vessels and 27 from British Light Vessels. Of the reports from British observing ships 54 per cent. were received within one hour and 76 per cent. within two hours of the time of observation. Considering the normally heavy radio traffic in this area these figures reflect considerable credit on the ships' radio officers, and on the Post Office communications staffs.

British voluntary observing ships in other areas of the world regularly transmit weather messages to the meteorological services of other countries, in accordance with the plan approved by the World Meteorological Organization.

Ocean weather ships. British ocean weather ships on duty in the North Atlantic ocean carried out a full programme of surface observations every three hours, and made radio-sonde ascents every twelve hours and radio wind observations every six hours. In continuation of the rotation scheme for operating ocean stations A (62°N. 33°W.), I (59°N. 19°W.), J (52° 30'N. 20°W.)

and K (45°N 16°W.) British, French, and Netherlands ships have transmitted their observations direct to Dunstable, when operating at stations I and J. When operating at stations A and K these ships have transmitted their observations to Washington, U.S.A., and Rennes, France, respectively, whence they have been transmitted to Dunstable. Certain rescue exercises were carried out whenever practicable, in co-operation with Royal Air Force Coastal Command. During these exercises the opportunity was taken to drop mail, newspapers and urgently required stores, in watertight containers. For the first time, a fragile radar valve, urgently required as a replacement for the meteorological set aboard one of the weather ships was dropped, and successfully recovered by the ship undamaged.

Weather Watcher vacated station for two days in October 1956 in an unsuccessful search for a missing United States Clipper Aircraft. *Weather Recorder* vacated station for several days in December 1956 to stand by s.s. *Baron Cawdor* at her master's request, after his ship had sustained damage to her bridge and steering gear in heavy weather. Over the Christmas and New Year period some delays in sailing for station of British ocean weather ships resulted from shortage of seamen. The problem of crew shortage continues and no immediate solution is apparent.

Microfilm copies of observations recorded aboard British ocean weather ships were made and distributed in exchange for similar microfilms from other operating countries of the North Atlantic Ocean Station Agreement.

Currents and ice. Preparation of the atlas of surface currents of the Eastern North Pacific Ocean is nearly completed whilst work has continued on the computation of current data for the eastern part of the South Pacific Ocean. All observations received of ice in the Antarctic region from December 1945 to June 1956 have been plotted on monthly charts, the objective being the revision of Antarctic ice charts. The revision of the sections of the "Admiralty Pilots" relating to surface currents and ice was continued, and six volumes were dealt with during the year.

Special work. Trials were continued aboard *Weather Recorder* on the measurement of air temperature, humidity, and sea temperature gradients near sea level, using electrical resistance thermometers mounted on a dan buoy. Some useful observations were obtained during the summer.

Some progress was made with an investigation into the incidence of inversions at ocean weather stations at levels below about 8,000 ft., using punched card methods.

Further progress was made with an investigation into the secular variation of air and sea temperature over the tropical Atlantic.

Experiments were carried out on the measurement of rainfall at sea, in co-operation with the Instruments Division. Special raingauges were mounted as high as possible on the mast of an ocean weather ship, in order to avoid spray and the effect of the ship on the airflow, and work is continuing on these lines.

A new publication entitled "Meteorology for Mariners" was published in February 1957.

Enquiries. Information, including statistical tables and charts of marine data, were supplied on request to the Naval Weather Service, other Government

Departments, scientific institutions, commercial firms and private individuals. The following are examples: frequencies of rain and showers in the month of January for the period 1855 to 1953 for 129 ten-degree squares, for the Radio Physics Division, Commonwealth Scientific and Industrial Research Organization, Australia; the frequency of wave heights and wave periods for ten-degree squares in the Indian Ocean for the British India Steam Navigation Company and the National Physical Laboratory, for the design of new ships for trade between the Persian Gulf and Australia; air and sea temperature and humidity data for areas off the South American coast, for the Royal Mail Lines in connection with the design of ships to carry passengers and refrigerated cargo on the Brazil and River Plate route; air temperature and humidity data off the coast of Japan, and of humidity for 36 selected ten-degree squares over the whole oceans of the world, for D. Napier and Sons in connection with the production and operation of marine engines; wind, wave height and wave period data in the Indian Ocean and the Arctic, for Messrs. Saunders-Roe, aircraft designers.

Information was supplied to the Ministry of Transport and Civil Aviation for several investigations into serious shipping casualties. The personal attendance of a scientific officer was necessary at the formal investigations held during the year into the loss of the *Citrine* which sank off the Cornish coast in January 1956, and the collision of the *City of Sydney* and *Corchester* in the North Sea on February 19, 1956.

Machine pool. The punched card installation which has been working for the Marine Division since 1921, and also for the Upper Air Branch since 1948, provided a foundation for the machine pool formed during the year to meet all the punched card requirements of the Meteorological Office. Additional staff were recruited to punch 615,000 cards a year as a routine, together with a backlog of surface land data. The Marine Division has so far accumulated about 14 million cards and the Upper Air Branch about 1 million cards. Arrangements for the exchange of punched cards with the United States Weather Bureau, which until last year covered only surface and upper air data from ocean weather ships, has now been extended to cover wider fields.

S. P. PETERS

Deputy Director (Forecasting)

PUBLICATIONS

The following papers by the Deputy Directorate of Forecasting were published in the year ended March 31, 1957.

- R. G. VERYARD, B.Sc. Can the Meteorological Office help you? *J. Instn. Heat. Vent. Engrs., London*, 24, 1956, p. 309.
- R. G. VERYARD, B.Sc. Some thoughts on climatic change. *Weather, London*, 11, 1956, p. 355.
- E. W. BARLOW, B.Sc. Aurora observations during the International Geophysical Year. *Mar. Obs., London*, 27, 1957, p. 36.
- E. W. BARLOW, B.Sc. Currents of the western South Pacific Ocean. *Mar. Obs., London*, 26, 1956, p. 224.
- A. BLEASDALE, B.A. Afforestation of Catchment Areas—The Physicist's approach to problems of water loss from vegetation. *Emp. For. Rev., London*, 36, 1957, p. 59.
- R. E. BOOTH. Comparison of weather conditions during July and August 1954 and 1955. *Met. Mag., London*, 85, 1956, p. 211.

- R. E. BOOTH. Severe hailstorm at Tunbridge Wells on August 6, 1956, *Met. Mag., London*, **85**, 1956, p. 297.
- R. E. BOOTH. Weather of 1955. *Met. Mag., London*, **85**, 1956, p. 101.
- R. E. BOOTH. The cold weather of February 1956 with special reference to temperatures at Kew during the last 75 years. *Met. Mag., London*, **86**, 1957, p. 65.
- R. E. BOOTH. Looking back on 1956. *Weather, London*, **12**, 1957, p. 85.
- G. COWLING. TV Weatherman. *Weather, London*, **12**, 1957, p. 22.
- G. COWLING. The Petula's meteorological logbook. *Mar. Obs., London*, **26**, 1956, p. 214.
- P. F. EMERY. Strong winds at high levels in the equatorial-zone of the Far East. *Met. Mag., London*, **85**, 1956, p. 275.
- C. E. N. FRANKCOM, R.N.R. Statement on carrying of cargoes in ships. *Einzelveröff. Dtsch. Wetterdienst, Hamburg*. Nr. 9, 1956, p. 33.
- J. GLASSPOOLE, PH.D. Rainfall averages. *Weather, London*, **11**, 1956, p. 254.
- J. GLASSPOOLE, PH.D. Rainfall over Great Britain and Northern Ireland during 1956. *Wat. and Wat. Engng., London*, **61**, 1957, p. 65.
- W. R. HANSON, B.Sc. WEA—an automatic weather-forecast service. *Met. Mag., London*, **85**, 1956, p. 200.
- W. H. HOGG, M.Sc. Making use of the weather forecast. *Comm. Grow., London*, No. 3158, 1956, p. 45; No. 3163, 1956, p. 321; No. 3168, 1956, p. 601; No. 3176, 1956, p. 995.
- W. H. HOGG, M.Sc. Weather and the incidence of Chocolate Spot on beans. *N.A.A.S. quart. Rev., London*, No. 32, 1956, p. 87.
- A. H. HOOPER. Radio-sonde trials at Payerne, 1956, *Met. Mag., London*, **86**, 1957, p. 33.
- D. W. S. LIMBERT. Voyage of Royal Society's advance party to the Antarctic. *Mar. Obs., London*, **27**, 1957, p. 28.
- M. K. MILES, M.Sc. A meteorologist in Yugoslavia. *Weather, London*, **11**, 1956, p. 385.
- H. C. SHELLARD, B.Sc. The International Geophysical Year. *Mar. Obs., London*, **27**, 1957, p. 20.
- L. P. SMITH, B.A. Duration of high relative humidities. *Met. Mag., London*, **85**, 1956, p. 229.
- L. P. SMITH, B.A. Potato blight forecasting by 90 per cent. humidity criteria. *Plant Path. Harpenden*, **5**, 1956, p. 83.
- L. P. SMITH, B.A. Soil moisture work in England. *Inform. Ser. Dep. Sci. industr. Rev. N.Z. Wellington*, No. 12, 1956, p. 34.
- M. T. SPENCE, B.Sc. Damage to crops by lightning. *Agriculture, London*, **63**, 1956, p. 387.
- M. T. SPENCE, B.Sc. Soil blowing in the Fens in 1956. *Met. Mag., London*, **86**, 1957, p. 21.

SERVICES

There has been no change in the organization whereby the two Divisions of the Deputy Directorate for Services have continued to have as their primary function the supply of meteorological advice to the Armed Forces and to Civil Aviation respectively. Many of the network of outstations required for this purpose, and generally located on either Royal Air Force or civil airfields, are listed in the Post Office Guide as being available to answer meteorological enquiries from the general public. The number of such enquiries for meteorological advice in connection with activities not related to aviation continues to increase. About one quarter of these enquiries relate to weather for holidays, picnics, et cetera, the second most popular cause being agricultural activities.

Following the introduction of the automatic telephone weather service in London a similar service was introduced at Liverpool, Manchester, Birmingham, Glasgow, Belfast and Cardiff towards the end of the year under review. The forecasts for these provincial services are provided from the appropriate outstations.

The experimental facsimile broadcasts by land-line from the Central Forecast Office mentioned last year were continued and it has now been decided to institute such broadcasts on a routine basis to both Royal Air Force and civil airfield stations as soon as the necessary equipment and line facilities can be obtained.

SERVICES FOR THE ARMED FORCES

The Meteorological Office has continued to meet the meteorological requirements of the Royal Air Force, the Army and the Ministry of Supply as hitherto and has also collaborated with the Naval Weather Service, particularly at those places where units of both the Royal Air Force and the Royal Navy are stationed.

There has been no change in the general patterns of the outstation organization designed to serve the Royal Air Force. Generally this organization parallels that of the Royal Air Force with a main meteorological office at the headquarters of an R.A.F. Group and subsidiary offices at R.A.F. stations within that same Group. The main offices are manned 24 hours a day, the subsidiary offices for periods which depend upon the R.A.F. needs at the station concerned. The subsidiary offices are usually connected to the main meteorological office by teleprinter and so are able to receive guidance from the senior unit.

During peace time no meteorological units are deployed with field units of the Army but special sections are permanently attached to the School of Artillery at Larkhill and temporary detachments are made to artillery practice camps as necessary. Overseas almost all the meteorological services required by the Army are met by meteorological sections attached to R.A.F. formations.

During the Suez crisis a forecast section was provided at the Headquarters of the Task Force in Cyprus and provision was also made for the manning of offices in Egypt had the occasion arisen. In addition a self-contained mobile unit was attached to an Army formation which required meteorological

information for artillery use. All meteorological personnel for these units were in Royal Air Force uniform.

Services provided in the United Kingdom. Meteorological outstations serving the Royal Air Force in the United Kingdom constitute the major part of the basic network of observing stations in the United Kingdom and accordingly have not changed except in detail.

There has been no change in the forecast service provided at these stations for the Group Headquarters and stations in the operational and Flying Training Commands of the Royal Air Force and for Air Traffic Control Centres which are not located with a Group Headquarters. During the latter part of the year, however, meteorological facilities for the Royal Auxiliary Air Force were withdrawn.

The special teleprinter network which was introduced last year for exchanging weather reports every 15 minutes between stations in Fighter Command has been extended to take in additional stations.

Developments in the types of aircraft used in Bomber Command, in particular the increased ceiling, range and speed of these aircraft have presented new meteorological problems and new procedures for the supply of meteorological information to Bomber Command units to meet these developments are being tried.

As an aid to the training of R.A.F. personnel, Chapters 14 to 18 of A.P. 3307, "Elementary Meteorology for Aircrew", were issued, thus completing the publication.

Services provided overseas. There was little change in the British meteorological organization on the Continent, meteorological services being provided for the Royal Air Force and Army on lines similar to those adopted in the United Kingdom except that German personnel were employed under supervision of British staff.

In the Middle East, main meteorological offices were maintained at Nicosia in Cyprus and at Khormaksar (Aden). Besides their normal functions in respect of R.A.F. requirements, continuous forecasting and advisory services were also provided by these offices on behalf of the local Government for civil aviation. Khormaksar also supervises a number of subsidiary offices along the south Arabian coast and meets the meteorological requirements of shipping in that area. Meteorological requirements of the R.A.F. in Malta were met by a main forecasting office located at Luqa Airport. Services for civil aircraft using the airport were also provided by this office on behalf of Malta Government. In the Far East the requirements of the Royal Air Force have been met by four forecasting stations in Malaya and a forecast office at Hong Kong. The last-named office works in close collaboration with the Royal Observatory at Hong Kong. A subsidiary forecast office, working in collaboration with the Ceylon Meteorological Service, has also served the Royal Air Force in Ceylon. During the year, the observing station at Car Nicobar was taken over by the Indian Air Force Meteorological Service.

In collaboration with the foreign governments concerned and primarily to meet the requirements of the R.A.F., forecast offices were maintained in Libya, Jordan and Iraq. In Libya, on behalf of the Libyan Government, the forecast office also serves civil aviation. Supervision of the technical work of this office

is exercised from the main meteorological office in Malta. In Iraq, close liaison was maintained with the Iraq Meteorological Service, and, early in the year, the Iraq Service took over the subsidiary forecast office at Shaibah. Early in the Suez crisis, the subsidiary forecast office at Amman was closed when R.A.F. forces were withdrawn.

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, thirteen subsidiary and six observing offices. 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.

Meteorological service to aircraft in flight is provided by either of two methods (a) Area Meteorological Watch and (b) Flight Meteorological Watch. In the former method, which covers 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.

The temporary office, opened in the Central Area, London Airport in 1955, was vacated in April and the work transferred to more adequate offices in the

Queen's Building, but the disposal of operations as between the North and Central Areas necessitated the continued retention of two meteorological offices at the Airport.

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 of Their Royal Highnesses the Duke of Edinburgh and the Princess Margaret from London to various destinations.

Appreciable additional work was required at Blackbushe and London Airport in serving independent companies at Blackbushe and Southend operating the air-lift of troops to and from the Mediterranean during and after the Suez crisis and the air-lift of Hungarian refugees from Linz (Austria).

Public enquiries into the accidents to York aircraft G-AMUL at Stansted and to the Hermes G-ALDJ at Blackbushe demanded close examination of meteorological aspects, the preparation of briefs for the Treasury Solicitor and the attendance of members of the staff for the purpose of providing meteorological evidence.

It is not always possible or desirable to provide Meteorological Office observers at all civil aerodromes for the purpose of making weather observations and reports. Accordingly in 1951 a scheme of training was introduced whereby Air Traffic Control Officers at both State and non-State aerodromes could be given suitable instruction so that they could undertake the provision of aerodrome weather reports when stationed at an aerodrome where there is no meteorological office. This training scheme continued throughout the year under review.

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. The denial to the latter of the use of certain Middle East civil aerodromes and the consequential re-routing of services placed heavier burdens on the offices at Malta, Idris and Nicosia.

Special work. The supply of weather reports, warnings and forecasts by no means represents the full sum of the requirements of aircraft operation. The advancement of flying and the introduction of new types of aircraft call for parallel advancement in meteorological techniques. This particularly applies to the requirements of pilots when in the final stages of their approaching to land.

Priority has been given to devising a method for determining the slant visibility from air to ground during mist and fog.

In addition, attention continues to be given to the physical aspects of the Runway Visual Range system in use under poor visibility conditions at a number of State aerodromes, for evaluating the furthest distance at which runway lights can be seen by a pilot when his aircraft is about to touch down or take off.

Smoke pollution is also an effective agent in reducing the visibility at aerodromes near large towns and on behalf of the Fuel Research Station, East Greenwich, records of the amount of such pollution in the atmosphere were made hourly at London Airport whenever the visibility became less than 600 yards.

During the year a modulated rotating beam cloud searchlight was installed at London Airport on an experimental basis. This instrument is designed to give the height of base of low cloud both by day and night, in the form of spot readings and a written record.

Examinations. All commercial pilots and flight navigators are required to hold licences normally obtained as the result of examination in various subjects including meteorology; 1,431 candidates were examined in this subject during the year.

Services for the Commonwealth

British West Indies. Two forecasters continued to be loaned to the British Caribbean Meteorological Service pending their replacement by qualified locally engaged officers.

Falkland Islands. At the request of the Colonial Office responsibility was accepted for the provision of services at Port Stanley.

North Borneo. The Meteorological Office is often called upon to give advice to the Colonial Office on meteorological matters. As an example, arrangements were made for the Chief Meteorological Officer, Far East Air Force to visit Borneo for the purpose of reporting and submitting recommendations on proposals for a British Borneo Territories Meteorological Service made by the resident Director of Civil Aviation.

A. C. BEST

Deputy Director (Services)

PUBLICATIONS

The following papers by the Deputy Directorate of Services were published in the year ended March 31, 1957.

- A. C. BEST, D.Sc. Ice accretion on aircraft in warm front conditions. *Met. Mag., London, 85, 1956, p. 257.*
- A. C. BEST, D.Sc. Maximum gas concentration at ground level from industrial chimneys. Institute of Fuel, London, 1957.
- E. T. BAKER AND R. G. HUGHES. An analysis of low cloud and poor visibility at Sek Kong, May 1951 to April 1955. *Tech. Notes. R. Obs., Hong Kong, No. 16, 1956, p. 9.*
- L. S. CLARKSON, M.Sc. Variations with time of winds at 50,000 ft. over Singapore. *Met. Mag., London, 85, 1956, p. 99.*
- A. F. CROSSLEY, M.A. Errors in the estimation of geostrophic winds. *Met. Mag., London, 85, 1956, p. 311.*
- R. A. HAMILTON, B.A. British North Greenland Expedition 1952-4. Scientific results. V. Determination of the altitudes of points on the Greenland ice sheet by measurement of atmospheric pressure. *Geogr. J., London, 122, 1956, p. 225.*
- R. A. HAMILTON, B.A. British North Greenland Expedition 1952-4. Scientific results. *Geogr. J., London, 122, 1956, p. 203.*
- T. N. S. HARROWER, M.A. AND D. C. EVANS. Damage to aircraft by heavy hail at high altitude. *Met. Mag., London, 85, 1956, p. 330.*
- R. F. M. HAY, M.A. Air temperatures during snowfall at Ocean Weather Station I. *Met. Mag., London, 85, 1956, p. 107.*
- R. F. M. HAY, M.A. A comparison between observations from ocean weather Station J and contemporaneous British selected ships for the locality. *Mar. Obs., London, 26, 1956, p. 154.*

- R. F. M. HAY, M.A. Five year means of meteorological observations made at Ocean Weather Stations I and J. 1948-52. *Mar. Obs., London*, **26**, 1956, p. 97.
- R. F. M. HAY, M.A. Ice accumulation upon trawlers in northern waters. *Met. Mag., London*, **85**, 1956, p. 225.
- R. F. M. HAY, M.A. Meteorological aspects of the loss of *Lorella* and *Roderigo* affecting the operation of trawlers to north of Iceland in winter. *Mar. Obs., London*, **26**, 1956, p. 89.
- G. W. HURST, B.Sc. Prolonged heavy rain at Gibraltar, November 20-26, 1955, *Met. Mag., London*, **85**, 1956, p. 324.
- G. W. HURST, B.Sc. Waterspouts off the Straits of Gibraltar. *Met. Mag., London*, **85**, 1956, p. 321.
- W. H. KAVANAGH. Wave clouds over the Isle of Man. *Met. Mag., London*, **86**, 1957, p. 46.
- T. H. KIRK, B.Sc. Some meteorological aspects of high-level navigation. III. The problems of forecasting. *J. Inst. Navig., London*, **9**, 1956, p. 293.
- B. J. MOFFITT. Nocturnal wind at Thorney Island. *Met. Mag., London*, **85**, 1956, p. 268.
- F. A. SHARP, B.Sc. Barometric tendency and weather at Changi, Singapore. *Quart. J. R. met. Soc.*, **83**, 1957, p. 112.

RESEARCH

There was no change in the organization of research during the year. The advisory Meteorological Research Committee (see p. 2) with its three Sub-Committees held a total of 14 meetings during which some 58 research papers were discussed. The value to the Office of the criticism and guidance provided by the outside members of these committees is acknowledged with gratitude. In the following notes the practical application of the research is several times mentioned but it would be wrong to give the impression that the objectives are always immediate. Much of the work is of a basic character often demanding a high standard of mathematical and physical aptitude and providing an attractive field for the research scientist.

COMMONWEALTH RELATIONS

The research divisions attract numerous visitors from abroad and especially from Commonwealth countries. Pursuing the need, agreed with the Colonial Office, for a special study to be made of the research requirements in tropical meteorology an Assistant Director made visits to certain colonial territories, and other visits are planned. The Directors of the colonial services are co-operating enthusiastically in this exploratory work.

RELATIONS WITH THE UNIVERSITIES AND THE ROYAL SOCIETY

Through the medium of scientific meetings and by common membership of many committees the research staff are in close contact with their colleagues in the universities and in some cases there is active collaboration in research. Continuing established policy an annual grant, increased this year to £7,000, was made to the Royal Society for the support of basic work in meteorological physics, as approved by its Gassiot Committee, and a further instalment of the special grant of £50,000 for work with high level rockets was also made available. The first rocket launching, associated with this project, was made in Australia during February. Small direct grants from the Air Ministry to support special research activity were made to the Universities of London (Imperial College) and Aberystwyth and arrangements were made with Bedford College to support a study of old climatic records.

PHYSICAL RESEARCH

Work proceeded on the experimental and theoretical sides of atmospheric physics at Kew Observatory, Cambridge (in association with the University Department of Agriculture), Cardington (with the R.A.F. Balloon Unit), East Hill (Meteorological Office Radar Research Station), Porton (with the Chemical Defence Research Establishment) and the Meteorological Research Flight (with the Royal Aircraft Establishment, Farnborough). This work was supported also by theoretical studies carried out in the directing division of headquarters.

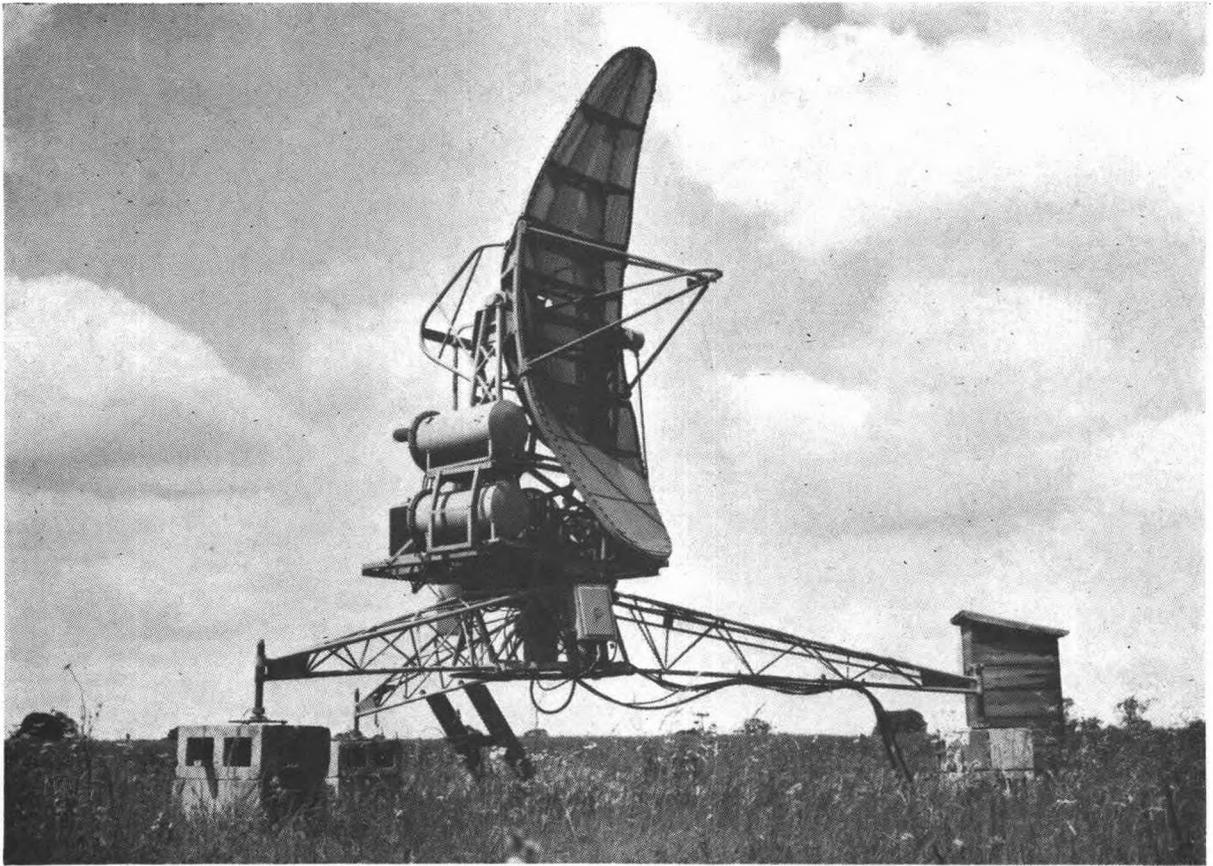
An excellent illustration of the value of the Meteorological Research Flight is afforded by its collaboration with the Royal Aircraft Establishment and the Bristol Aero-Engine Company in a study of the special conditions which were causing engine trouble with the Britannia aircraft. Unique instruments developed



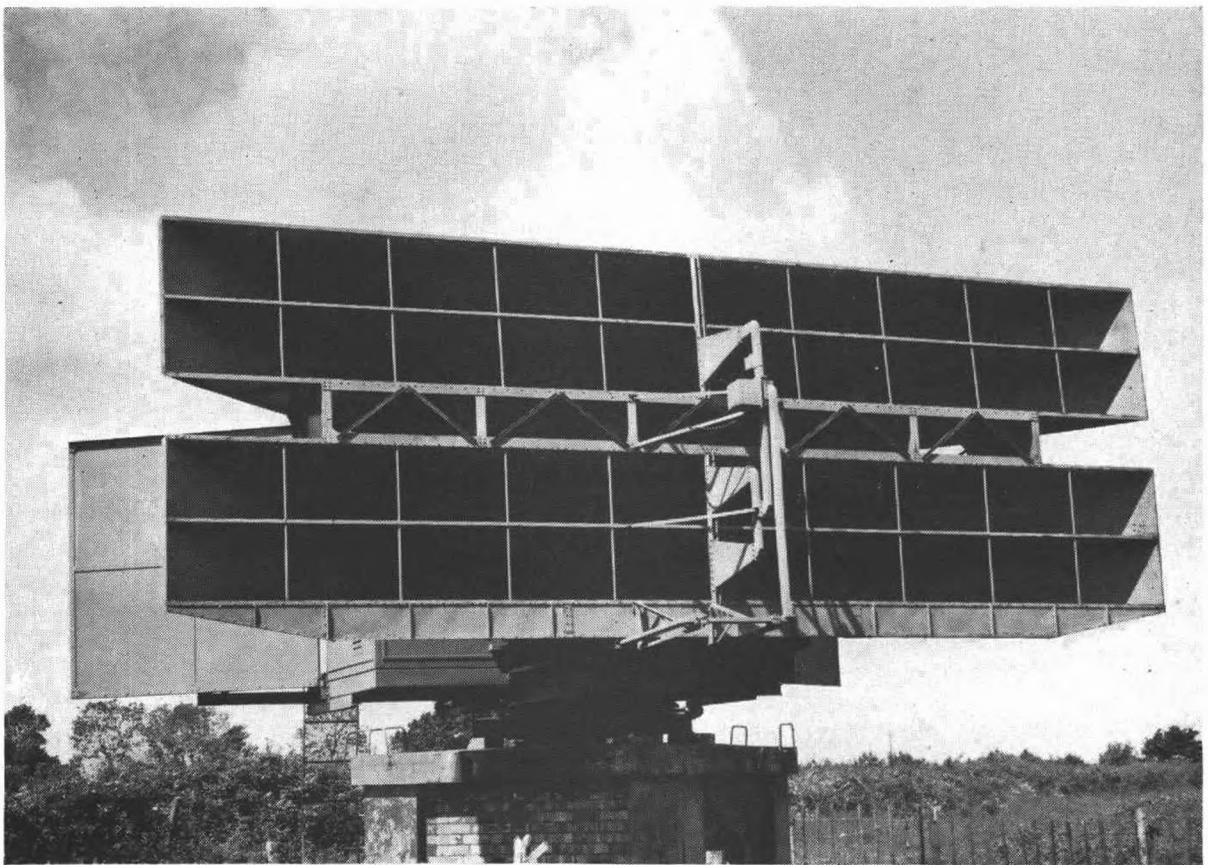
The forecast room in the Central Area of London Airport (see p. 22).



Meteorological exhibition displayed in Leicester Museum, August 3-26, 1956 (see p. 12).

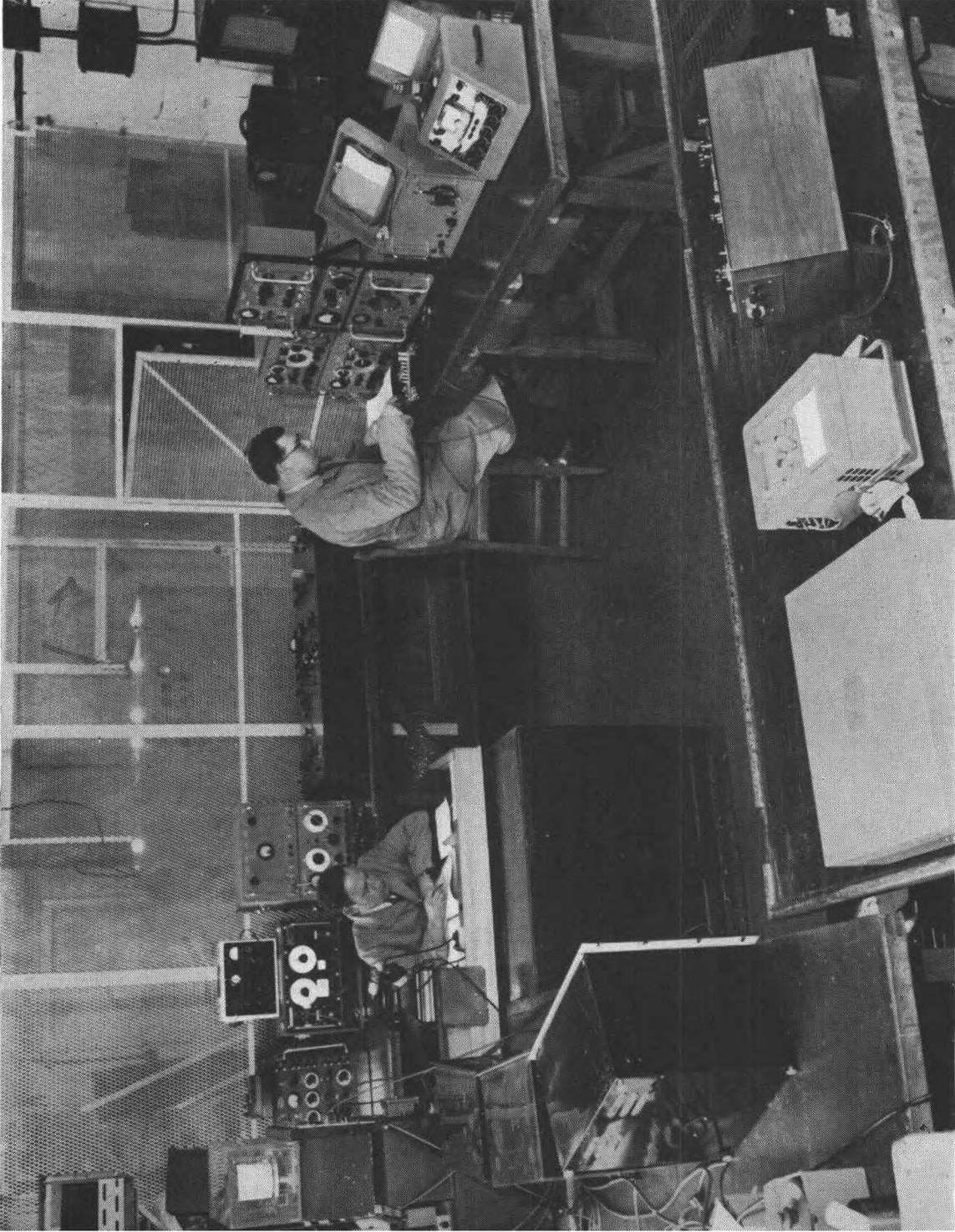


Three-centimetre wave-length height and range equipment (see p. 26).



Ten-centimetre wave-length plan position indicator (see p. 26).

Radar equipment at the Meteorological Office Radar Research Station
at East Hill.



The electronic instruments test room at Harrow. Assemblies and components are tested under working conditions. A wire cage guards against high-voltage dangers (see p. 40).

by the flight were transferred to the Britannia and used during flights to Tropical Africa. Valuable data continue to be accumulated on the physical nature of clouds, knowledge required not only in relation with the practical problems of aviation but also for the understanding of cloud formation with a view to better forecasting in some situations and, it may be hoped, to some measure of artificial control of rainfall although as will be seen from a later paragraph, this prospect remains remote.

Continuing on the theme of cloud and rainfall studies, one should note the useful work of the Radar Research Station. It will be recalled that precipitation provides a radar echo which is a nuisance in many applications of radar but of much value in meteorological research. Precipitation may be studied both in geographical distribution and in vertical section and in this way much is revealed which is not otherwise observable. By carefully relating the echo patterns with the winds it has been shown that many belts of rain move quite closely with the winds as measured at a height of about 10,000 ft. It is becoming clear that radar can be of real value to the forecaster although it remains to be decided upon what scale the introduction of this somewhat expensive apparatus can be operationally justified.

Theoretical ideas and practical experiments (mainly conducted in other countries) on the intriguing problem of artificial "rain-making" have been closely studied only to confirm the view that there is no ground for optimism except perhaps where clouds frequently form over mountains higher than exist in these islands. Meanwhile our own experiments with the release of silver-iodide from ground generators on Salisbury Plain continue as opportunity offers with no result yet detectable. Good progress is however being made at Porton on the basic problem of the upward diffusion of particulate matter released from the ground. With the use of new apparatus mounted on balloon cables, and also with the collaboration of the Meteorological Research Flight for the sampling of air-borne particles, the Porton researches on diffusion and turbulence are very active.

The national network of stations for the measurement of solar radiation and illumination has been extended. Six stations are now equipped and a monthly bulletin of data is issued. A small number of stations are also being equipped for the chemical sampling of air and rainwater.

INSTRUMENT DEVELOPMENT

Much of the work of this division is directed to the improvement of more or less standard instruments, work of much specialist interest but not readily summarized. Work continued on the cloud-height meter using a modulated rotating beam; this now promises to become satisfactory for operational airfield use in the near future. The modulated beam technique is also being developed for quite a different role: the measurement of air density up to heights of 60 Km. (some 40 miles) from measurements of the light scattered by the air.

Something of a curiosity is the "leaf-wetness recorder" developed in the Office in collaboration with the Plant Pathology Department of Rothamsted Experimental Station. This is understood to be proving invaluable for studying the periods of infection with fungus diseases such as potato blight and apple scab.

A remote recording anemometer incorporating a cup generator anemometer and recorder, a magslip and wind vane and a new M.O. single pen direction

recorder, has been adopted for routine use and will gradually replace the distant reading pressure tube anemograph. The new recorder requires almost no servicing, uses strip charts and will operate without attention for more than a week.

As a result of flight tests the conical-head thermometer appears to be a satisfactory instrument and to have achieved what was aimed at, namely, constancy of air-speed correction factor at different heights.

For the Royal Society's Antarctic Expedition, to which the Meteorological Office is also contributing in other ways (see p. 35), the Instruments Development Division designed and constructed a number of new or modified instruments.

CLIMATOLOGICAL RESEARCH

British climatology is an advanced part of the science and in view of its many applications is associated in the Office organization with central forecasting (see p. 8). The research division continues to devote attention mainly to the wider problems of world climatology with special emphasis on the upper atmosphere. The objective is twofold. A complete charting of the average conditions, and their variability, throughout the navigable region of the atmosphere is of direct importance to aviation and with the advent of rockets, guided missiles and artificial satellites the interest will extend to much greater heights. But there is a less direct interest also; by studying and explaining the general circulation of the world's atmosphere one may hope to throw light on the problem of long range forecasting. Climatological research to this end cannot be satisfied with statistical analyses of data and there is much scope for physical insight and theoretical treatment.

The studies of mean monthly upper winds over the world which have been in hand for some years were further advanced and the results for the four mid-season months should be available within about a year. Attention is now being directed also to the world distribution of upper-air humidities.

FORECASTING RESEARCH

Most of the research work of the Office is related with problems of forecasting, directly or indirectly. Thus instrument development leads to the better provision of the essential data; physical research, for example on radiation and turbulence or on condensation and precipitation processes, aims towards a better understanding of the behaviour which the forecaster is called upon to predict; climatological studies analyse past records and provide a framework for future possibilities. The Forecast Research Division accommodated at Dunstable, in the Napier Shaw Laboratory, alongside the Central Forecasting Office, is accordingly able to devote its attention to the specific problems of practical forecasting, using dynamical, statistical or analytical synoptic methods as appropriate.

The main dynamical problem remains that of predicting the isobars and pressure-contours for 24 hours or longer ahead by direct calculation from the hydrodynamical equations. The electronic calculating machine, ordered in the previous year, is expected to be installed at Dunstable during 1957; meanwhile, by the continued use of the machine at Manchester University, a considerable number of ideas aimed at improving the accuracy of the numerical forecasts or at reducing the time taken in calculation are being tested. It seems almost

certain that these new methods are destined to play an important part in forecasting procedures of the future but development work over several years will be necessary to reveal their full potential.

Useful progress was also made on the study of the lee waves in the atmosphere set up by hills, on the structure and thermodynamics of stratocumulus clouds, and on the practical application of radar to the forecasting of rainfall.

A small team continued to devote attention to the possibilities of forecasting for periods up to a month ahead. By a novel method of analysis it has been possible to demonstrate some degree of relationship between the weather anomalies of succeeding months and the outlook on this stubborn problem is accordingly rather brighter than it has been hitherto.

SPECIAL INVESTIGATIONS

The Service Departments and the Ministry of Civil Aviation continue to make full use of the Special Investigations Division and the type of work is best illustrated by a few examples: revised estimates of equivalent head winds at 30,000 and 40,000 feet for a large number of world air routes; an Aviation Meteorological Report on the West Indies; world temperature data relating to specifications for aircraft performance.

In addition the division has maintained its interest in meteorological aspects of atmospheric pollution and, in particular, has advised consulting engineers concerned with the design of installations which consume large amounts of fuel. Atmospheric radioactivity, both natural and man-made, has received the attention of a number of international bodies, including the World Meteorological Organization, and the Assistant Director for Special Investigations has been called upon to study this subject and to attend three international meetings of specialists. Collaboration in a proposed scheme of radioactivity observations during the International Geophysical Year, 1957-58, is now under consideration.

VISITS, LECTURES, DISCUSSIONS, ETC.

There is every reason to believe that the encouragement to the staff to take an active part in the scientific life of the country pays a good dividend both in enhancing the interest of the work and in awakening an interest in meteorology elsewhere. The Director delivered a number of lectures in the universities as did also several other officers. The scientific officer at Cambridge found it possible to provide a short course of lectures under university auspices. Once again a member of the staff delivered the Annual Popular Lecture of the Royal Meteorological Society, which was repeated also in Glasgow and Edinburgh to large audiences of senior school children. Internal discussions and *colloquia* were continued in London and at Dunstable and Harrow as in recent years and papers were presented at numerous meetings of learned societies and other bodies, at home and abroad.

R. C. SUTCLIFFE
Deputy Director (Research)

PUBLICATIONS

The following papers by the Deputy Directorate of Research were published in the year ended March 31, 1957.

- R. C. SUTCLIFFE, F.R.S. Water balance and the general circulation of the atmosphere. *Quart. J. R. met. Soc., London*, **82**, 1956, p. 385.
- R. C. SUTCLIFFE, F.R.S. Weather balloon ascents. *Times Sci. Rev., London*, No. 20, 1956, p. 5.
- R. C. SUTCLIFFE, F.R.S. AND J. K. BANNON, B.A. Seasonal changes in upper-air conditions in the Mediterranean-Middle East area. *Assembl. gen. Un. geod. geophys. int. Rome, 1954, int. Ass. Met., Publ. No. 10/c*, 1956, p. 322.
- J. S. SAWYER, M.A. The physical and dynamical problems of orographic rain. *Weather, London*, **11**, 1956, p. 375.
- J. S. SAWYER, M.A. Some calculations of 24-hour changes of 500-mb height and 1000-500 mb thickness based on a 2-parameter model atmosphere. *Assembl. gen. Un. geod. geophys. int. Rome, 1954, int. Ass. Met., Publ. No. 10/c*, 1956, p. 477.
- F. J. SCRASE, SC.D. Variations of temperature in the stratosphere up to 30 km. over the British Isles. *Assembl. gen. Un. geod. geophys. int. Rome, 1954, int. Ass. Met., Publ. No. 10/c*, 1956, p. 514.
- J. K. BANNON, B.A. Some meteorological aspects of high-level navigation. I. Strong winds in the upper atmosphere above 15,000 ft. *J. Inst. Navig., London*, **9**, 1956, p. 282.
- J. K. BANNON, B.A. AND R. A. JONES, M.Sc. Average wind at 60 mb. *Met. Mag., London*, **85**, 1956, p. 194.
- G. P. BRITTON AND H. H. LAMB, M.A. A study of the general circulation of the atmosphere over the Far South I, II. *Weather, London*, **11**, 1956, p. 281, p. 339.
- G. A. BULL, B.Sc. AND D. G. JAMES, PH.D. Dust in the stratosphere over western Britain on April 3 and 4, 1956. *Met. Mag., London*, **85**, 1956, p. 293.
- F. H. BUSHBY, B.Sc. AND V. M. HUCKLE, B.Sc. The use of a stream function in a two-parameter model of the atmosphere. *Quart. J. R. met. Soc., London*, **82**, 1956, p. 409.
- G. A. CORBY, B.Sc. A preliminary study of atmospheric waves using radio-sonde data. *Quart. J. R. met. Soc., London*, **83**, 1957, p. 49.
- G. A. CORBY, B.Sc. AND C. E. WALLINGTON, M.Sc. Airflow over mountains: the lee wave amplitude. *Quart. J. R. met. Soc., London*, **82**, 1956, p. 266.
- J. M. CRADDOCK, M.A. The representation of the annual temperature variations over central and northern Europe by a two-term harmonic form. *Quart. J. R. met. Soc., London*, **82**, 1956, p. 275.
- C. S. DURST, B.A. Ballooning. III. Constant-level ballooning. *J. Inst. Navig., London*, **10**, 1957, p. 70.
- C. S. DURST, B.A. AND G. A. BULL, B.Sc. An unusual refraction phenomenon seen from a high-flying aircraft. *Met. Mag., London*, **85**, 1956, p. 237.
- R. W. GLOYNE, B.Sc. The teaching of meteorology. *Weather, London*, **12**, 1957, p. 32.
- H. HEASTIE, M.Sc. Average height of the standard isobaric surfaces over the north polar regions in January. *Met. Mag., London*, **85**, 1956, p. 368.
- D. N. HARRISON, D.Phil. Ballooning. II. The use of balloons in meteorology. *J. Inst. Navig., London*, **10**, 1957, p. 67.
- D. M. HOUGHTON, M.Sc. The gale of July 29, 1956. *Met. Mag., London*, **85**, 1956, p. 289.
- D. G. JAMES, PH.D. Investigations relating to cirrus cloud. *Met. Mag., London*, **86**, 1957, p. 1.
- D. G. JAMES, PH.D. Nocturnal dissipation of stratocumulus cloud. *Met. Mag., London*, **85**, 1956, p. 202.

- A. F. JENKINSON, B.A. Mean range in an auto-regressive series. *Met. Mag., London*, **85**, 1956, p. 232.
- A. F. JENKINSON, B.A. Pattern of rainfall. *Met. Mag., London*, **85**, 1956, p. 208.
- A. F. JENKINSON, B.A. The relation between standard deviation of contour height and standard vector deviation of wind. *Quart. J. R. met. Soc., London*, **82**, 1956, p. 198.
- H. H. LAMB, M.A. Antarctic atmospheric circulation. *Nature, London*, **177**, 1956, p. 1076.
- H. H. LAMB, M.A. Fronts in the intertropical convergence zone: an observer's log and some reflections thereupon. *Met. Mag., London*, **86**, 1957, p. 76.
- H. H. LAMB, M.A. Some special features of the climate of St. Helena and the trade wind zone in the South Atlantic. *Met. Mag., London*, **86**, 1957, p. 73.
- E. N. LAWRENCE, B.Sc. British summers of the past. *Weather, London*, **11**, 1956, p. 225.
- E. N. LAWRENCE, B.Sc. Poliomyelitis and weather. *Met. Mag., London*, **85**, 1956, p. 164.
- J. K. MACKENZIE. Unusual frost points and dust haze in the stratosphere on March 9 and 10, 1955. *Met. Mag., London*, **85**, 1956, p. 233.
- J. G. MOORE, B.Sc. Average pressure and temperature of the tropopause. *Met. Mag., London*, **85**, 1956, p. 362.
- J. G. MOORE, B.Sc. Cross-sections of the mean zonal component of geostrophic wind. *Met. Mag., London*, **85**, 1956, p. 167.
- J. G. MOORE, B.Sc. The tropospheric temperature lapse rate. *Arch. Met. Geoph. Bioklim, Wien*, **9a**, 1957, p. 468.
- F. PASQUILL, D.Sc. Meteorological research at Porton. *Nature, London*, **177**, 1956, p. 1148.
- G. D. ROBINSON, Ph.D. The use of surface observations to estimate the local energy balance of the atmosphere. *Proc. Roy. Soc., London, A*, **236**, 1956, p. 160.
- G. A. TUNNELL, B.Sc. A statistical analysis of vertical variation of sunshine over Germany. *Met. Mag., London*, **86**, 1957, p. 41.
- J. WADSWORTH, M.A. Wind summaries and airfield usability. *Met. Mag., London*, **85**, 1956, p. 129.
- C. E. WALLINGTON, M.Sc. Lee waves ahead of a warm front, *Sailpl. and Gliding, London*, **7**, 1956, p. 121.
- C. E. WALLINGTON, M.Sc. The sixth O.S.T.I.V. congress—a report on the meteorological discussions. *Quart. J. R. met. Soc., London*, **82**, 1956, p. 522.

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

No.

- 949 R. F. M. HAY. Some aspects of variations of air and sea surface temperature in short periods at ocean weather stations I and J of significance to the synoptic climatologist.
- 965 D. H. JOHNSON. Objective analysis.
- 970 J. M. CRADDOCK. The harmonic representation of the annual temperature variation in different parts of the British Isles.
- 971 W. E. SAUNDERS. Variation of visibility in fog at Exeter airport, and the time of fog dispersal.
- 972 N. E. RIDER. Water loss from various cropped surfaces.
- 973 J. S. HAY. Evaporation from a saturated rough surface into a turbulent air stream.
- 974 J. I. P. JONES. A vertical gustiness recorder for use with a captive balloon.
- 976 N. C. HELLIWELL, J. K. MACKENZIE AND M. J. KERLEY. Further observations of humidity up to 50,000 feet made from an aircraft of the Meteorological Research Flight in 1955.

- No.
 977 J. MACDOWALL. An electrical dewpoint hygrometer suitable for routine meteorological use.
 978 J. K. BANNON. Long-period averages for the upper air.
 980 G. J. DAY. Further observations of large cumuliform clouds by the Meteorological Research Flight.
 981 H. HEASTIE. Average height of the standard isobaric surfaces over the area from the North Pole to 55° N. in July.
 983 R. A. HAMILTON. The measurement of humidity at Britannia S ϕ 1952-53.
 984 W. G. HARPER. Variation with height of rainfall below the melting level.
 985 G. A. CORBY. A preliminary study of atmospheric waves using radio-sonde data.
 986 F. H. BUSHBY. The objective analysis of some 500-mb. charts.
 987 P. GRAYSTONE. Equivalent head-wind statistics for variable tracks.
 988 D. B. B. POWELL. On the development of an improved daylight illumination recorder.
 990 R. F. JONES. The exhaust trail from jet engines.
 991 W. G. DURBIN. Droplet sampling in cumulus clouds. With note: Oddie, B. C. V. The relationship between drop-size distribution and visibility.
 995 R. J. MURGATROYD. Meteorological research in aircraft.
 996 J. BRIGGS. Condensation trails formed by jet aircraft.
 997 K. H. STEWART. A simple method for measuring atmospheric attenuation of light (" meteorological optical range " or visibility) at night.
 998 R. J. MURGATROYD AND M. P. GARROD. The measurements of natural freezing nuclei, made by the Meteorological Research Flight during January, 1956.
 1001 Index of Meteorological Research Papers approved for general distribution (Appendix 16 of M.R.P. 200).
 1002 E. KNIGHTING. An atmospheric model for numerical integration including the tropopause effects.
 1003 E. KNIGHTING. A non-geostrophic extension of the Sawyer-Bushby model of the atmosphere suitable for numerical integration.
 1005 D. M. HOUGHTON. Heat sources and sinks at the earth's surface.
 1006 J. S. HAY AND F. PASQUILL. Measurements of the short-range diffusion of airborne particles at a height of a few hundred feet in the atmosphere.
 1010 G. E. W. HARTLEY. Wind recording apparatus for the new ballistic range at Shoeburyness.
 1012 B. C. V. ODDIE. Atmospheric Nuclei. An estimate of the value and practicability of routine measurements.
 1014 B. C. V. ODDIE. A note on the published results of studies in atmospheric chemistry.
 1015 G. A. CORBY AND J. S. SAWYER. The air flow over a ridge—the effects of the upper boundary and high-level conditions.
 1016 V. M. HUCKLE. Numerical forecasts based on objectively analysed data.
 1017 R. F. JONES. Analysis of reports of ice accretion on aircraft.
 1019 W. G. HARPER, F. H. LUDLAM, AND P. SAUNDERS. Preliminary report on cumulus investigations, East Hill, June-August, 1956, and on plans for future similar work.
 1020 H. HEASTIE. Average height of the standard isobaric surfaces over the area from the North Pole to 55° N. in April and October.
 1021 A. H. HOOPER AND A. P. TAYLOR. Radio refraction in the free atmosphere.
 1022 W. G. HARPER AND J. G. D. BEIMERS. The movement of precipitation belts as observed by radar.
 1032 A. G. A. RAE. Response characteristics of the sensitive cup anemometer Type IV.
 1033 J. R. BIBBY. Photo-electric visibility meter Mk. II.

INTERNATIONAL CO-OPERATION

WORLD METEOROLOGICAL ORGANIZATION

The eighth session of the Executive Committee, held in Geneva in April, 1957, was attended by the Director, Sir Graham Sutton, who is a member of the Committee and also Permanent Representative of the United Kingdom to the World Meteorological Organization.

Arrangements for the International Geophysical Year were discussed at length and a scheme whereby the Secretariat of the World Meteorological Organization will act as the main collecting centre of meteorological information for the world was given its final form. The basis of the scheme is that the Secretariat will reproduce the world meteorological data on micro-opaque cards, a method of storing a very large amount of information in a small space, and afterwards sell sets of the cards to any country or institution requiring them at a price which will cover the cost of production.

The Secretariat is housed in temporary accommodation near the Palais des Nations in Geneva. The steady growth of the Organization in recent years has made imperative a move to more adequate permanent accommodation. The Executive Committee recommended the acceptance of an offer from the Canton of Geneva to construct a separate new building for the Organization a short distance from the Palais des Nations.

A Working Group of four experts, including Mr. P. J. Meade, Assistant Director (Special Investigations), was set up to examine the meteorological uses of atomic energy. The formation of this Group was due in part to the stimulus of the 1955 Geneva Conference on the peaceful uses of atomic energy.

The form of the International Meteorological Organization Memorial Prize, founded on the remaining funds of the old International Meteorological Organization, was decided. The Prize, consisting of a substantial sum of money, a gold medal and a citation, will be awarded for outstanding work in meteorology, both in the science and in its international organization. The first recipient, Dr. Th. Hesselberg, was presented with the award at a ceremony in Oslo in September 1956.

Commander C. E. N. Frankcom, the Marine Superintendent, who had been President of the Commission for Maritime Meteorology of the International Meteorological Organization and subsequently of the World Meteorological Organization, since 1946, presided over the second session of that Commission in Hamburg in October 1956. The British delegation to the meeting was led by Mr. H. C. Shellard of the Marine Division. Dr. H. Thomsen, of Denmark, was elected President in succession to Commander Frankcom, whose term of office had expired.

The second session of the Climatological Commission of the World Meteorological Organization was held in Washington from January 14–26, 1957. The British delegate was Mr. R. G. Veryard, Assistant Director (Climatological Services). Mr. Veryard was elected President of the Commission in succession to Professor Thornthwaite, of U.S.A., whose term of office had expired.

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:

International Civil Aviation Organization Third Caribbean Regional Air Navigation Meeting held in Ciudad Trujillo in April.

International Civil Aviation Organization Third Air Navigation Conference held in Montreal in September and October.

International Civil Aviation Organization Joint Financing Conference on Air Navigational Services in Iceland, Greenland and the Faroes held in Geneva in September.

A delegate was provided for the first and second of the above 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 Tenth Meeting of the South Pacific Air Transport Council held in Melbourne in October.

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 thirteenth meeting of the meteorological committee of the NATO Standing Group was held in London from June 5 to 8, 1956, with Dr. J. M. Stagg, United Kingdom delegate, as chairman: policy matters relating to the field meteorological service and supporting arrangements for NATO land, sea and air forces were discussed. Mr. C. V. Ockenden, as chairman of the working group on communications, and Mr. R. P. Batty representing the

Meteorological Office on the group dealing with plans had attended meetings of their groups immediately preceding the conference of the main committee.

Further meetings of the working groups on plans and communications have been held in Norfolk, U.S.A. from October 16 to 26, 1956, and again in Paris from March 12 to 22, 1957. Mr. Ockenden and Mr. Hay, replacing Mr. Batty (retired), represented the Office at both sets of meetings. From March 5 to 7, 1957, in Paris, the same two representatives also attended the annual meeting of the chief meteorological officers attached to allied forces under the Supreme Headquarters, Europe.

Meteorological Office representatives attended meetings of the meteorological authorities responsible for the detailed arrangements for the NATO air forces in central Europe, and for all NATO forces in the Mediterranean area. At the request of the Ministry of Defence the Meteorological Office also provided specialist advice on a standard atmosphere for ballistic calculations at a meeting of the Defence Production Committee.

INTERNATIONAL GEOPHYSICAL YEAR

The Director of the Meteorological Office, the Principal Deputy Director and Mr. H. W. L. Absalom were again closely concerned with the special committee of the Royal Society in preparations for the participation by the United Kingdom in the International Geophysical Year, July 1957–December 1958. An outstanding United Kingdom contribution is the I.G.Y. Expedition to Halley Bay on the eastern coast of the Weddell Sea, close to the southern zone of maximum auroral frequency. Mr. D. W. S. Limbert, Experimental Officer, of the Meteorological Office, was responsible in 1956 for meteorological work with the advance party of the Expedition and returned to London with the advance party in March 1957. The main party of the Expedition, which reached Halley Bay on January 4, 1957, includes the following members seconded from the Meteorological Office: Mr. J. MacDowall, Senior Scientific Officer; Mr. A. Blackie, Experimental Officer; Mr. J. M. C. Burton, Mr. D. T. Tribble and Mr. D. G. Ward, Assistant Experimental Officers. Also, Mr. P. Jeffries, Assistant Experimental Officer, a member of the advance party of the Trans-Antarctic Expedition at Shackleton, Vahsel Bay, throughout 1956, has joined the Halley Bay party for 1957. This group, which is the largest of the four scientific groups at Halley Bay, is to carry out planned programmes in meteorology (including upper-air soundings twice daily, together with measurements of radiation and ozone), geomagnetism, glaciology and seismology.

Preparations have been made for additions to the normal activities of several of the standard Meteorological Office stations during the I.G.Y.; for example, extension of the upper-air soundings at the home and oversea stations and on British Ocean Weather Ships; measurements of solar radiation and the radiation balance in the diverse circumstances of the Atlantic (ocean weather stations), Malta, Aden and the Falkland Islands; and measurements of the total atmospheric ozone at Habbaniya in Iraq.

The geomagnetic observatories of the Meteorological Office at Lerwick (Shetland) and Eskdalemuir (Dumfriesshire) will evaluate, from their standard recordings, a recently introduced index of geomagnetic activity at 15-minute intervals, to provide data for the close study of relationships between changes

in the earth's magnetic field, ionospheric and auroral phenomena. At Lerwick, continuous recordings will be made at two special subsidiary stations some 15 to 20 miles south and west of the Observatory in order to obtain measurements of the horizontal variation of the magnetic field during magnetic storms and thence information on the associated electric current systems at ionospheric levels. Further assistance was given, mainly in regard to meteorological equipment, to the Trans-Antarctic Expedition which will obtain observations at Shackleton, at South Ice (the depot 270 miles inland) and on the trans-continental journey during the early months of the I.G.Y.

At the request of the Colonial Office, training and other facilities were provided for the two physicists who (with other staff) will maintain a meteorological and geophysical programme during the I.G.Y. at the Argentine Islands, Falklands Islands Dependencies.

The Director has served as National Correspondent for Meteorology on the National Committee for I.G.Y. and Dr. J. M. Stagg has acted in a similar capacity for British sponsored geomagnetic activities. The Director has also been a member of the Publicity Sub-committee of the National Committee, and Dr. Stagg and Mr. Absalom have been members of the Antarctic Sub-committee concerned with the arrangements for the Halley Bay station.

ORGANIZATION

No change was introduced into the general organization during the year. An organization diagram covering Headquarters is given at Appendix I. The names of the Directorate and Heads of Branches are given in Appendix II and the addresses of the various parts of the Headquarters and the observatories at Appendix III. There are nearly 200 outstations.

STAFF

The staff position this year was dominated by the shortage of trained assistants. A special recruiting effort in which Senior Meteorological Officers throughout the country took part resulted in an increased intake of assistants during the autumn, but the high rate of resignations during most of the year led to a serious shortage of experienced assistants before the recruits could be trained. In order to secure productive work from new entrants as soon as possible, the initial course at the Training School was for some 120 recruits re-arranged in two parts—one of two weeks in the autumn and another of four weeks later. Some relief was obtained by this device, but the position caused concern for the rest of the year, though there were encouraging indications in the last quarter that the rate of resignations was decreasing.

There were also shortages in the Experimental Officer and Scientific Officer classes. Five Scientific Officers and twenty Assistant Experimental Officers were appointed to the Meteorological Office by the Civil Service Commission. Two Scientific Officers and two Assistant Experimental Officers were from outside the Office. Seven temporary Experimental Officers became established in the competition. Under the vacation employment scheme, fifteen university students were selected from a large entry and attached to various research branches during their long vacation.

Mr. J. H. Brazell was released in April to take up appointment as Director, East Africa Meteorological Department.

A Senior Scientific Officer, one Experimental Officer and three Assistant Experimental Officers who are members of the main party of the British International Geophysical Year expedition to the Antarctic left the country in November. They were joined at Halley Bay by an Assistant Experimental Officer who had already spent a year in the Antarctic with the advance party of the Commonwealth Trans-Antarctic Expedition. Another of the eleven staff loaned during the year was an Experimental Officer seconded to the United Kingdom Atomic Energy Authority.

Eleven members of the staff returned to the Meteorological Office, among them two Principal Scientific Officers—one from secondment with U.K.A.E.A., the other from an appointment with the Egyptian Meteorological Service under the United Nations Technical Assistance Administration.

Mr. S. P. Peters was appointed a Commander, Mr. C. V. Ockenden an Officer and Messrs. G. Howkins and R. J. Williams, Members of the Order of the British Empire. The L. G. Groves Memorial Prize for Meteorology was

awarded to Mr. F. H. Bushby and the L. G. Groves Memorial Award for Air Meteorological Observers to Flight-Sergeant J. D. Moyes.

The Bronze Medal for 1956 of the Institute of Navigation was awarded to Mr. C. S. Durst for his paper "Accuracy of Dead Reckoning in the Air". Flight-Sergeant Meadows, R.A.F.V.R. was granted the Air Efficiency Award.

Seven Experimental Officers were granted commissions in the Royal Air Force for special duties in the Mediterranean during the autumn. A party of 31, led by a Principal Scientific Officer, was with the Christmas Island expedition by the end of March.

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

Mr. R. F. Batty, O.B.E., Senior Scientific Officer;
 Cmdr. M. Cresswell, R.N.R., (ret.), Senior Nautical Officer;
 Mr. W. G. Davies, Senior Experimental Officer;
 Mr. A. J. Tabor, Senior Experimental Officer;
 Miss G. L. Thorman, Senior Experimental Officer;
 Mr. R. L. Sims, Senior Experimental Officer;
 Mr. D. J. Bowering, Senior Experimental Officer;
 Mr. W. F. Peatfield, Experimental Officer;
 Mr. F. G. Whittaker, Experimental Officer;
 Mr. B. A. Copping, Experimental Officer;
 Mr. C. F. Jestico, Experimental Officer;
 Mr. R. F. White, Scientific Assistant;
 Mr. T. Davies, Scientific Assistant.

Two of these officers returned to temporary posts in the Office.

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

Mr. A. J. Lander, Chief Experimental Officer;
 Mr. T. L. A. Waite, Senior Experimental Officer;
 Mr. T. Walton, Experimental Officer;
 Mr. J. R. Bright, Senior Scientific Assistant.

Figures showing strength in the various classes and grades are tabulated in Appendix IV; for comparison the strength figures a year earlier are included in the table.

Royal Air Force personnel. Three Scientific Officers continued to hold commissions in the Royal Air Force while carrying out their national service obligations. An additional Scientific Officer was commissioned late in the year. 161 Assistants (Scientific) were serving as airmen meteorologists on March 31 and 11 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 62 officers, airmen or airwomen remained qualified to undertake full roster duties at a Royal Air Force station. Three officers were promoted during the year and under new regulations for the Air Efficiency Award 17 officers and 3 senior N.C.Os. received medals.

Training was again provided for officers of the R.A.F. Emergency Reserve and 70 ex-wartime airmen meteorologists in Class G Reserve accepted invitations to attend a special refresher course lasting a fortnight.

Training. Details of the length and frequency of courses held during the year under review and of the number of staff attending the School may be found in Appendix V. Over 500 members of the staff passed out of the School during the year. In addition 32 staff members of other Meteorological Services attended courses, 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. Overseas visitors came from the Meteorological Services of the following countries: Belgium, Channel Islands, Ethiopia, Falkland Islands, Ghana, India, Iraq, Jordan, Malaya, Mauritius, Netherlands, Singapore, Syria and Thailand.

SUPPLY OF INSTRUMENTS

Provision and production of equipment. During the year 1,411 orders and contracts were placed. The total expenditure was £356,440 and £70,240 was received by sale of equipment and for testing and inspecting instruments. Provision and delivery of new equipment was generally satisfactory although there was a tendency for the period between the placing of the contract and date of first delivery to be generally longer than hitherto. The more important contracts placed were for a double-screened compartment to eliminate interference when testing electronic and radio equipment; a frequency meter and recorder for testing electrical equipment; for a magnetic variograph for use during the International Geophysical Year; the re-conditioning of a further ten sets of wind-finding equipment (radar GL.III). Two A/A searchlights were purchased from the War Office for experiments in the measurement of air density up to 60 Km. A quantity of special equipment has been purchased for use at home, abroad and on weather ships during the International Geophysical Year. The major item in this respect has been the purchase of 1,250-gram balloons for high altitude soundings.

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 Dominions and Colonies regarding the suitability of equipment and its source of supply. Equipment has been supplied and despatched for use on the International Geophysical Year Expedition to the Antarctic and to a project which involved setting up two radio-sonde stations in the South Pacific. Demands for stores numbered 9,804 including some from Commonwealth, Colonial and foreign Governments and from private observers co-operating with the Meteorological Office. Loans of meteorological equipment were made to other Government Departments and outside bodies engaged in research. Among the more interesting may be mentioned:

To the Ministry of Food for the investigation into the long storage of food and to the Atomic Energy Research Establishment, Harwell, for investigation into drying out of a heavy water reactor.

To various Agricultural and Horticultural Institutes and to University Schools of Agriculture for investigations into the mortality and breeding habits of sheep, irrigation of crops, cultivation of hops, the potato blight, fruit diseases and land utilization.

To various University Exploration Clubs and other Institutes for expeditions to Iceland, Turkey and Greenland.

Testing and calibration. The total number of instruments tested, excluding balloons and electrical equipment, was 22,857. The number of balloons of all sizes received and subjected to 5 per cent. check was 194,754. Fees received for the testing and inspection of instruments for manufacturers and others amounted to £1,204. Instruction on the maintenance of instruments was given to climatological observers and to a number of members of other Meteorological Services.

The Electronics Test Room is now functioning and additional test equipment has been added. Some 63,660 items were passed through the section during the year.

The total number of radio-sondes received from the makers and approved was 18,060. The number calibrated was 20,149 and 1,760 recovered after flights were overhauled and re-calibrated for future use. The calibration of radio-sondes for manufacturers' exports continued.

Radar maintenance. Regular inspections of the radar wind equipments were maintained both in the United Kingdom and in the Middle East. A further two air-conditioned overhauled wind-finding radar equipments have been installed at Aden and Benina. Training courses for radar technicians have been held and are to be continued.

LIBRARY AND PUBLICATIONS

The Meteorological Office Library and the major Editing Section of the Office constitute a single branch which is located at Harrow.

Library. The Library is the national library of meteorology and the other branches of geophysics such as terrestrial magnetism for which the Office is responsible. It acquires publications on these subjects and their applications on a world wide scale, records them in author and subject bibliographies, and provides an information service based on them to the staff of the Office, external research workers, industry, and the general public. A selection of up-to-date books is maintained on mathematics, physics and other subjects of which the staff of the Office have to take account in their work.

The larger number of the publications received in the Library come from other meteorological services, societies, research institutions and observatories in exchange for the publications of the Meteorological Office. The Library is responsible for organizing these exchanges, of which 333 were in force at the end of the year. The volume of publications dealt with is shown by the fact that 9,175 books and articles were received and recorded during the year.

A large collection of lantern slides, photographs and films is maintained; during the year 130 slides, 176 photographs and three films were added to it.

The Library issues to staff of the Office and a number of external institutions, including major meteorological services, a monthly classified bibliography of accessions. This bibliography is now the most comprehensive record of current meteorological literature produced in the world. The June 1956 bibliography had the record number of references to 585 separate books and papers. The number of publications issued on loan by the Library was 12,552 and many more were consulted in the Library itself. As part of its information service the Library sends to research staff and specialist branches new papers of special importance in their work as soon as practicable after receipt and before the general demand for borrowing them arises and much help is given to other members of staff in the use of publications in foreign languages.

Enquiries, which in some instances entailed a deep search by Library staff for the most relevant information, were as usual received from other Government Departments, research institutions, and the general public as well as from staff of the Office. The subjects involved covered a wide range including, for example, the amount of ozone in the atmosphere near the ground, the weather of 1727 (when plums were exceptionally early), balloons for high altitude cosmic ray research, and the search for a relation between sunspots and weather.

Collaboration was maintained with other scientific libraries and allied institutions. These include the Department of Scientific and Industrial Research, (for whose monthly bulletin *Translated contents lists of Russian periodicals* the Library supplies translations of titles in three U.S.S.R. geophysical periodicals), the Science Library, National Central Library, Royal Meteorological Society and the Association of Special Libraries and Information Bureaux (Aslib). Notes on new meteorological books were supplied to Aslib for the monthly *Aslib Book List*.

A discussion held by the Circle of State Librarians on "Transliteration" was opened by the Head of the Library and Editing Branch. The possible use of microcards in the Office was discussed with Her Majesty's Stationery Office and a limited trial made.

Owing to lack of staff the necessary work on the preservation and arrangement of the Library stock to make best use of the available space was carried out to a lesser extent than is desirable; nearly all the effort had to be applied to maintain the accession and information work.

The Head of the Library and Editing Branch represented the Office on the World Meteorological Organization Commission for Bibliography and Publications and the British Standards Aeronautical Glossary Committee, and also served on the W.M.O. Working Group on international meteorological tables.

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 VII. Two *Geophysical Memoirs* and three *Professional Notes* were also in the press at the end of the year.

The *Meteorological Magazine* was published each month. The articles covered the usual wide field. Examples are: Ice accumulation upon trawlers in northern waters, Poliomyelitis and weather, average wind at 60 mb., unusual refraction phenomenon seen from a high-flying aircraft, (volcanic) dust in the stratosphere over Britain in April 1956, damage to aircraft by heavy hail at high

altitude. Reports of the Meteorological Office Monday scientific discussions held each month in the autumn and winter, reviews of new books, and notes and news on matters of interest to meteorologists were also published in the Magazine.

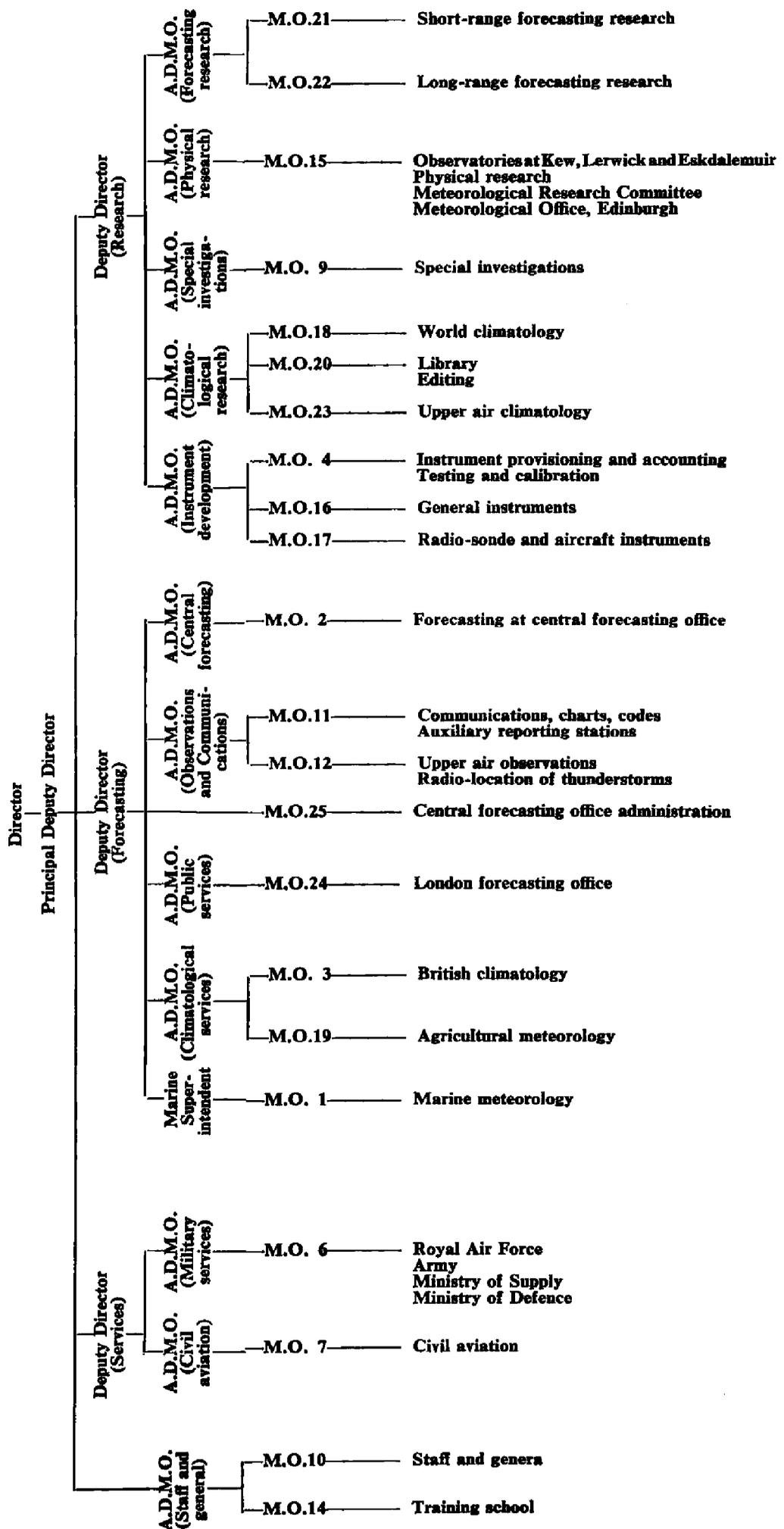
The *Marine Observer* was published each quarter. The articles included summaries of observations of weather and ocean currents made at the Ocean Weather Stations I and J in the North Atlantic and a series on the meteorological and oceanographic aspects of the International Geophysical Year.

Instructional books, text books and charts published during the year are also included in Appendix VII. Important publications of this class in the press at the end of the year were the "Handbook of Aviation Meteorology" which will replace "Meteorology for Aviators", and a new marine publication "Pilot Charts of the North Atlantic Ocean", for May and June showing wind-roses, directions of ocean currents, extent of pack ice, sea temperature, fog frequencies, and hurricane tracks.

Four of the six parts of the "Tables of Temperature, Relative Humidity and Precipitation for the World" are now in the press.

The appointment of a second varitypist to the staff enabled rapid progress to be made with the typing of the *Observatories' Yearbooks*.

APPENDIX I
ORGANIZATION OF THE METEOROLOGICAL OFFICE



APPENDIX II
DIRECTORATE OF THE METEOROLOGICAL OFFICE
AND HEADS OF BRANCHES

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

PRINCIPAL DEPUTY DIRECTOR

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Long-Range Forecasting Research (M.O.22)	J. M. Craddock, M.A.
<i>Assistant Director (Physical Research)</i> ..	B. C. V. Oddie, B.Sc.
Physical Research and Observatories (M.O.15)	R. F. Jones, B.A.
<i>Assistant Director (Special Investigations)</i>	P. J. Meade, O.B.E., B.Sc., A.R.C.S.
Special Investigations (M.O.9) ..	L. Dods, B.Sc.
<i>Assistant Director (Climatological Research)</i>	A. G. Forsdyke, B.Sc., Ph.D., A.R.C.S., D.I.C.
World Climatology (M.O.18)	H. H. Lamb, M.A.
Library and Editing (M.O.20) ..	G. A. Bull, B.Sc.
Upper Air Climatology (M.O.23) ..	J. K. Bannon, B.A.
<i>Assistant Director (Instrument Development)</i>	F. J. Scrase, O.B.E., M.A., Sc.D., F.Inst.P.
General Instruments (M.O.16) ..	R. Frith, O.B.E., M.A., Ph.D.
Radio-sonde and Aircraft Instruments (M.O.17)	D. N. Harrison, D.Phil.
Instrument Provisioning (M.O.4) ..	H. T. Smith
DEPUTY DIRECTOR (FORECASTING) ..	S. P. Peters, C.B.E., B.Sc.
<i>Assistant Director (Central Forecasting)</i>	C. J. Boyden, B.A.
Forecasting at C.F.O. (M.O.2) ..	—
<i>Assistant Director (Observations and Communications)</i>	C. V. Ockenden, O.B.E., B.Sc.
Communications, Charts and Codes (M.O.11)	W. A. L. Marshall, M.B.E.
Upper Air Observations (M.O.12) ..	A. L. Maidens, B.Sc.
C.F.O. Administration (M.O.25) ..	D. H. Clarke
<i>Assistant Director (Public Services)</i> ..	J. S. Farquharson, M.A., D.Sc.
London Forecasting Office (M.O.24)	W. R. Hanson, B.Sc.
<i>Assistant Director (Climatological Services)</i>	R. G. Veryard, B.Sc.
British Climatology (M.O.3)	J. Glasspoole, M.Sc., Ph.D.
Agricultural Meteorology (M.O.19) ..	L. P. Smith, B.A.

<i>Marine Superintendent (M.O.1)</i>	Cmdr. C. E. N. Frankcom, O.B.E., R.D., R.N.R. (Retd)
DEPUTY DIRECTOR (SERVICES)	A. C. Best, O.B.E., D.Sc.
<i>Assistant Director (Military Services)</i> ..	T. W. V. Jones, B.Sc.
Royal Air Force, Army, Ministry of Supply, Ministry of Defence (M.O.6)	F. E. Coles, B.Sc., A.R.C.S., D.I.C.
<i>Assistant Director (Civil Aviation)</i> ..	W. H. Bigg, O.B.E., B.Sc.
Civil Aviation (M.O.7)	T. N. S. Harrower, M.A., B.Sc.
<i>Assistant Director (Staff and General)</i> ..	H. L. Wright, M.A.
Staff and General (M.O.10)	K. H. Smith, B.Sc.
Training (M.O.14)	A. H. Gordon, M.S. (Pasadena)

APPENDIX III
LOCATION AND ADDRESSES OF HEADQUARTERS AND
OBSERVATORIES

LONDON

Director, Principal Deputy Director, Deputy Director (Research), Deputy Director (Services)

Assistant Directors: Civil Aviation, Military Services, Physical Research, Public Services, Special Investigations, Staff and General.

Address: The Director, Meteorological Office, Air Ministry,
Victory House, Kingsway, London, W.C.2.

Telephone: Temple Bar 1215.

Telegrams: Weather Telex London.

HARROW

Assistant Directors: Climatological Research, Climatological Services, Instrument Development.

Address: The Director, Meteorological Office, Air Ministry,
Headstone Drive, Harrow, Middlesex.

Telephone: Harrow 4331.

Telegrams: Weather Harrow.

DUNSTABLE

Deputy Director (Forecasting).

Assistant Directors: Central Forecasting, Forecasting Research, Observations and Communications.

Address: The Director, Meteorological Office,
Dunstable, Bedfordshire.

Telephone: Dunstable 455, 456.

Telegrams: Weatherdun Wire London.

STANMORE

Address: The Chief Instructor, Meteorological Office Training School,
Air Ministry, London Road, Stanmore, Middlesex.

Telephone: Stonegrove 6361.

EDINBURGH

Address: The Superintendent, Meteorological Office,
26 Palmerston Place, Edinburgh, 12.

Telephone: Edinburgh Caledonian 6561.

Telegrams: Barometer Edinburgh.

KEW OBSERVATORY

Address: The Superintendent, Kew Observatory, Richmond, Surrey.

Telephone: Richmond 4877-8.

ESKDALEMUIR OBSERVATORY

Address: The Superintendent, The Observatory, Eskdalemuir,
Langholm, Dumfriesshire.

Telephone: Eskdalemuir 203.

LERWICK OBSERVATORY

Address: The Senior Meteorological Officer, The Observatory,
Lerwick, Shetland.

Telephone: Lerwick 239.

APPENDIX IV

STRENGTH OF THE STAFF OF THE METEOROLOGICAL OFFICE

	March 31, 1956	March 31, 1957
Scientific Officer grades	153	161
Experimental Officer grades	668	674
Scientific Assistant grades	1,385*	1,455**
Technical and Signals grades	268	271
Executive and Clerical grades	85	83
Typing and Miscellaneous non-industrial grades ..	63	81
Nautical Officers	8	8
Marine staff (Ocean Weather Ships and Base):		
Officers	32	38
Crew	118	118
Industrial employees	81	81
Locally entered staff and employees overseas ..	247	253
Total ..	3,108	3,223

*Includes 180 airmen meteorologists and 9 meteorological air observers.

**Includes 161 airmen meteorologists and 11 meteorological air observers.

APPENDIX V
METEOROLOGICAL OFFICE TRAINING SCHOOL

The courses which ended between April 1, 1956, and March 31, 1957, are shown in the table below.

	Length of course	No. of courses	No. of trainees
	Weeks		
Scientific Officers	17	2	12
Forecasters, Initial Course ..	15	3	32
Forecasters, Advanced Course ..	4	6	39
Forecasters, Refresher Course ..	3	1	4
Assistants, Initial Course ..	8	13	143
Assistants, Initial Short Course	2	7	105
Assistants, Initial Course (R.A.F. N.C.O.s)	8	2	26
R.A.F.V.R. Officers	2	1	6
R.A.F. Officers on E List ..	2	6	53
R.A.F. Airmen on G List ..	2	7	70
Merchant Navy Agents ..	1	1	1
	Days		
Voluntary Observers	4	2	35
	Total	51	526

APPENDIX VI

CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGICAL BRANCH

	Stations					Autographic records		
	Observatories	Synoptic	Crop weather	Climatological	Rainfall	Sunshine	Rainfall	Wind
Scotland, North	1	9	0	17	170	16	11	4
Scotland, East	0	7	7	50	361	39	22	4
Scotland, West	1	4	3	30	415	26	16	6
England, North-east	0	9	4	24	344	29	15	5
England, East	0	11	11	22	488	31	31	8
England, Midlands	0	13	18	44	1,036	50	38	3
England, South-east (including London)	1	17	13	60	760	61	62	14
England, South-west	0	8	7	28	472	36	12	3
England, North-west	0	5	4	22	456	30	27	8
Wales, North	0	3	2	13	181	6	5	1
Wales, South	0	3	6	15	251	18	10	4
Isle of Man	0	2	0	1	12	3	1	1
Scilly and Channel Isles	0	2	0	2	18	5	1	1
Northern Ireland	0	5	0	7	85	7	4	2
Total ..	3	98	75	335	5,049*	357	255	64

*Includes stations in earlier columns.

Figures for rainfall stations and autographic rainfall records refer to the year 1955. All other figures show the position on January 1, 1957.

APPENDIX VII

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, 1957).

Daily Weather Report, containing weather maps for the northern hemisphere, British Isles, etc., and data (to March 31, 1957).

Daily Weather Report, Overseas supplement, containing surface and upper air data (to January 16, 1957).

Meteorological Magazine (to March 1957).

Monthly Weather Report, with a summary for the year (to December 1956).

Seismological Bulletin. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to February 1957).

Marine Observer (quarterly) (to January 1957).

British Rainfall 1954. 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 station India (59°00' N., 19°00' W.), station Juliett (52°30' N., 20°00' W.) and station Alpha (62°00' N., 33°00' W.) for January to December 1955.

SERIAL

Geophysical Memoirs: Vol. XII:

94. Meteorological results of the Balaena Expedition, 1946-47. By H. H. Lamb, M.A.

95. Wind and temperature to 50 Km. over England. Anomalous sound propagation experiments, 1944-45. By R. J. Murgatroyd, B.Sc. (Eng.).

98. Glazed frost of January 1940. By C. E. P. Brooks, D.Sc. and C. K. M. Douglas, B.A.

Professional Notes: Vol. VII:

119. High cloud over southern England. By R. J. Murgatroyd, B.Sc. (Eng.) and P. Goldsmith.

Meteorological Reports: Vol. III:

17. Temperature-compensated equivalent headwinds for jet aircraft. By A. F. Crossley, M.A.

OCCASIONAL

Handbook of Meteorological Instruments, Part I. Instruments for surface observations. *Meteorology for Mariners*, with a section on oceanography.

Observer's Handbook. 2nd edition, 1956.

Weather Map. An introduction to weather forecasting. 4th edition, 1956.

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, 1946-50. Part 8, Gibraltar. Part 9 Downham Market.

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HANDBOOKS, TEXTBOOKS, TABLES

Cloud Atlas for Aviators. M.O. 450. 3rd edition 1943, reprinted 1952. Post 4to. 2s. 6d. (2s. 8d.)

Cloud Forms according to the International Classification. Definitions and descriptions approved by the International Meteorological Organization with photographs of clouds. M.O. 233. 6th edition 1949, reprinted 1953. 8vo. 2s. 6d. (2s. 8d.)

Condensation Trails from Aircraft. M.O. 479. 2nd edition 1952, reprinted 1954. 8vo. 9d. (11d.)

Handbook of Meteorological Instruments. Part I. Instruments for surface observations. M.O. 577. 1956. 8vo. 45s. (46s. 6d.)

Handbook of Statistical Methods in Meteorology. By C. E. P. Brooks, D.Sc. and N. Carruthers, B.Sc. M.O. 538. 1953. 8vo. 25s. (26s. 3d.)

Handbook of Weather Messages. 2nd edition. 8vo.

Part I. Transmission schedules and station index numbers. M.O. 510a. 1955. 6s. (6s. 4d.)

Part II. Codes and specifications. M.O. 510b. 1954. 4s. 6d. (4s. 11d.)

Part III. Coding, decoding and plotting. M.O. 510c. 1954. 4s. 6d. (4s. 9d.)

Amendment lists are issued as necessary and priced separately.

Instructions for the preparation of Weather Maps with tables of the specifications and symbols. M.O. 515. 2nd edition 1954. 8vo. 1s. 9d. (1s. 11d.)

Measurement of Upper Winds by means of Pilot Balloons. M.O. 396. 3rd edition 1944, reprinted 1954. 8vo. 2s. 6d. (2s. 9d.)

Meteorological Air Observer's Handbook. M.O. 470. 1945. 8vo. 4s. 6d. (4s. 11d.)

Meteorological Glossary (continuation of the "Weather Map"). M.O. 225ii. 3rd edition reprint. 8vo. (In the press)

Meteorological Handbook for Pilots and Navigators. M.O. 448. 2nd edition 1942, reprinted 1952. 8vo. 3s. 6d. (3s. 9d.)

Observer's Handbook. M.O. 554. 2nd edition 1956. 8vo. 15s. (16s. 1d.)

Percentage Frequencies of various Visibility Ranges at certain places in the British Isles between the years 1927 and 1936. M.O. 521. 1949. 8vo. 1s. (1s. 2d.)

Weather Map. An introduction to weather forecasting. M.O. 595. 4th edition 1956. 8vo. 10s. 6d. (11s. 2d.)

Handbook of Aviation Meteorology. M.O. 630. (In the press)

Some Typical Weather Maps. M.O. 632. (In the press)

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