

M.O. 620

Levant

Meteorological Office

REPORT FOR THE YEAR
ENDING
MARCH 31, 1956

LONDON

HER MAJESTY'S STATIONERY OFFICE

PRICE 3s. 6d. NET

M.O. 620

ANNUAL REPORT
of the Director of the
METEOROLOGICAL OFFICE

*Presented by the Meteorological Committee
to the Secretary of State for Air*

FOR THE YEAR
APRIL 1, 1955, TO MARCH 31, 1956



LONDON
HER MAJESTY'S STATIONERY OFFICE
1956

Decimal Index
451.5 (058)

METEOROLOGICAL COMMITTEE

Appointed by the Secretary of State for Air

Chairman : Mr. George Ward, M.P. (to December 1955)
Mr. Christopher Soames, C.B.E., M.P. (from December 1955)

Vice-Chairman : Sir David Brunt, F.R.S. (Royal Society)

Members: Mr. W. J. Bigg, C.M.G. (Colonial Office)
Instructor Captain P. Bracelin, C.B.E., R.N. (Admiralty)
Mr. I. V. H. Campbell, C.B. (Air Ministry) (to August 1955)
Mr. R. W. N. B. Gilling (Ministry of Transport and Civil Aviation)
Major General R. W. Goodbody C.B., D.S.O. (War Office)
Professor W. M. H. Greaves, F.R.S. (Royal Society of Edinburgh) (to December 1955)
Mr. W. Lewis (Scottish Office)
Mr. G. M. Macintosh, O.B.E. (Ministry of Transport and Civil Aviation)
Professor H. S. W. Massey, F.R.S. (Royal Society)
Air Marshal Sir Thomas G. Pike, K.C.B., C.B.E., D.F.C. (Air Ministry)
Sir Edward Salisbury, C.B.E., F.R.S. (Ministry of Agriculture and Fisheries)
Professor P. A. Sheppard (British Universities)
Mr. H. T. Smith (Air Ministry) (from August 1955)
Sir Graham Sutton, C.B.E., F.R.S. (Director, Meteorological Office)
Sir Owen Wansbrough-Jones, K.B.E., C.B. (Ministry of Supply)

Secretary: Mr. R. J. Williams

METEOROLOGICAL RESEARCH COMMITTEE

Appointed by the Secretary of State for Air

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

Members : Dr. G. E. Bell (Ministry of Transport and Civil Aviation)
Instructor Captain P. Bracelin, C.B.E., R.N. (Admiralty)
Dr. A. W. Brewer (from July 1955)
Professor S. Chapman, F.R.S.
Professor G. M. B. Dobson, C.B.E., F.R.S.
Professor H. S. W. Massey, F.R.S.
Mr. J. Paton, F.R.S.E. (from May 1955)
Professor P. A. Sheppard
Sir Graham Sutton, C.B.E., F.R.S. (Director, Meteorological Office)
Squadron Leader A. W. Tarry (Air Ministry)
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.

ADVISORY COMMITTEE ON METEOROLOGY FOR SCOTLAND

Appointed by the Meteorological Committee

- Chairman :** Sir Graham Sutton, C.B.E., F.R.S. (Director, Meteorological Office)
- 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) (from February 1956)
Dr. A. E. M. Geddes, O.B.E., F.R.S.E. (University of Aberdeen)
Professor W. M. H. Greaves, F.R.S. (Royal Society)
Dr. D. Jack, F.Inst.P., F.R.S.E. (University of St. Andrews)
Mr. J. S. Munro (Fisheries Division, Scottish Home Department) (to February 1956)
Sir Charles Normand, C.I.E., (Royal Meteorological Society)
Mr. Alex Paton (Department of Agriculture for Scotland)
Mr. J. 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 July 12, 1955.

Professor Greaves died on Dec. 24, 1955. The Royal Society have yet to nominate their new representative.

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 :** Professor D. R. Bates, F.R.S.
Sir David Brunt, F.R.S.
Professor G. M. B. Dobson, C.B.E., F.R.S.
Mr. E. Gold, C.B., D.S.O., F.R.S.
Dr. F. E. Jones
Sir Charles Normand, C.I.E.
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 28, 1955.

CONTENTS

	<i>Page</i>
FUNCTIONS OF THE METEOROLOGICAL OFFICE	5
FOREWORD BY THE DIRECTOR	6
FORECASTING	
Central Forecasting Division	8
Observations and Communications Division	10
Public Services Division	13
Climatological Services Division	15
Marine Division	19
SERVICES	
Services for the armed forces	24
Services for civil aviation	26
RESEARCH	
Commonwealth relations	29
Relations with the universities	29
Physical research	30
Instrument development	31
Climatological research	32
Forecasting research	33
Special investigations	34
Visits, lectures, discussions, etc.	34
INTERNATIONAL CO-OPERATION	
World Meteorological Organization	38
International Civil Aviation Organization	39
Commonwealth Meetings	40
North Atlantic Treaty Organization	41
International Geophysical Year	41
ORGANIZATION	
Staff	42
Supply of instruments	44
Library and serial publications	46
APPENDICES	
I. ORGANIZATION OF THE METEOROLOGICAL OFFICE	49
II. DIRECTORATE OF THE METEOROLOGICAL OFFICE AND HEADS OF BRANCHES	50
III. LOCATION AND ADDRESSES OF HEADQUARTERS AND OBSERVATORIES	51
IV. PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES	52
V. STRENGTH OF THE STAFF OF THE METEOROLOGICAL OFFICE	54
VI. METEOROLOGICAL OFFICE TRAINING SCHOOL	54
VII. CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGICAL BRANCH	55
VIII. PUBLICATIONS	56
INDEX	58

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 Meteorological Committee under the chairmanship of the Parliamentary Under Secretary of State for Air advises the Secretary of State for Air on matters referred to it concerning the State Meteorological Service.

The general functions of the Meteorological Office are:

(i) Provision of meteorological services to the Army, Royal Air Force, Civil Aviation, Ministry of Supply, the Merchant Navy and Fishing Fleets.

(ii) Liaison with the Naval Weather Service of the Admiralty and provision of basic meteorological information for use by that Service.

(iii) Meteorological services to other Government Departments, public corporations, local authorities, the Press and the general public.

(iv) Organization of meteorological observations in Great Britain and Northern Ireland, and in certain colonies.

(v) Collection, distribution and publication of meteorological information from all parts of the world.

(vi) Maintenance of certain British observatories, and publication and distribution of magnetic and seismological information obtained from them.

(vii) Research in meteorology and geophysics.

The Meteorological Office also takes a leading part in international co-operation in meteorology.

The cost of the Meteorological Office is borne on Air Ministry Votes. Appendix IV shows the provision made in the Air Estimates for expenses and receipts of the Meteorological Office for the financial year 1956-57.

FOREWORD BY THE DIRECTOR

The Annual Report this year takes on a new, and, I believe, an improved form. With the willing co-operation of H.M. Stationery Office, the layout and typography have been brought more into line with modern practice, and illustrations are included for the first time. The reports on the work of the Meteorological Office have been prepared by the Deputy Directors as continuous narratives, and much repetitive matter has been omitted. I hope that the final result will be a readable account of the activities of my staff in the very wide field covered by the State Weather Service.

The year under review was of particular interest to meteorologists everywhere. At home, the Meteorological Office celebrated its centenary, and public exhibitions of its work were held in many cities. In Geneva, the Second Congress of the World Meteorological Organization took place from April 14 to May 13, 1955. The Congress was attended by representatives of 83 member countries and territories and of 7 non-member countries, and the whole field of international co-operation was thoroughly surveyed. On the whole Congress seemed well satisfied with the results of the first four years' work of the Organization and no drastic changes were proposed for the next financial period.

Following the World Meteorological Organization Congress, a Conference of Commonwealth Meteorologists was held in London, when matters of common interest were discussed between the Directors of the various services.

In July 1954 I submitted to the Air Ministry a memorandum outlining certain proposals designed to secure a more efficient service for all users. Subsequently, the Secretary of State for Air decided to set up a Committee to review the organization and future policy of the Office. This Committee, which is under the chairmanship of Lord Brabazon of Tara, has considered voluminous evidence, both written and oral, from users of meteorological information, governmental and otherwise. It is expected that the Committee will report later this year.

At present, the Meteorological Office maintains three large headquarters-type establishments in the London area, at Victory House, Kingsway ; Harrow ; and Dunstable. The inconvenience and loss of efficiency arising from this spread have been evident for some time, and a proposal for a combined headquarters has been submitted to the Air Ministry. A working party consisting of representatives of the governmental bodies principally concerned has considered the matter and has made recommendations in relation to a site near London. A decision is expected in the near future.

During the year the work of the Meteorological Office continued smoothly, and details are to be found elsewhere in this Report. Certain important matters, however, may be singled out here for special mention. The dissemination of meteorological information to the public received close attention, and arrangements were concluded with the B.B.C. for the separation of the shipping and " general user " forecasts in their programmes. The shipping bulletin in the future will be more technical, and therefore of greater value to fishing and marine users generally, while the extra time thus made available for the general

user bulletin will enable this to be couched in more familiar terms. Another major advance in the supply of information has been the installation of the automatic telephone service (WEA), at present in the London area only.

In research, the Meteorological Office has maintained a full programme, particularly in studies in the forecasting of pressure distributions by purely mathematical methods. Additional posts have been authorized for this work, and an order has been placed for the purchase of an electronic digital computer of advanced design, which is expected to be installed in the Napier Shaw Laboratories at Dunstable early in 1957. This equipment will be employed in the first instance solely for research, but the introduction of numerical methods into operational forecasting is foreseen, and realistic trials are planned when the machine is in full operation.

The staff situation continues to cause anxiety, especially in the Scientific Officer and Assistant grades. To deal with the ever increasing demands of both investigations and operations the Meteorological Office needs to recruit many more mathematicians and physicists in the Scientific Officer class. The slow rate of recruitment is to be attributed to two main causes, the general shortage of applied mathematicians and physicists and the lack of attention paid to meteorology in British universities. In the Assistant class there is a grave shortage of experienced observers who are essential for the maintenance of a high standard of work at airfields. Both problems are receiving urgent attention.

In addition to leading the United Kingdom team at the Second Congress of the World Meteorological Organization, I visited Geneva in February to review the work and organization of the Technical Secretariat of the Organization.

The following papers by the Director and the Principal Deputy Director were published during the year ended March 31, 1956.

SIR GRAHAM SUTTON, F.R.S. :—

High-speed computing and the operational meteorologist. *Weather, London*, 10, 1955, p. 190.

The Meteorological Office, 1855–1955. *Nature, London*, 175, 1955, p. 963.

Weather forecasting : the future outlook. *Nature, London*, 176, 1955, p. 993.

J. M. STAGG, D.Sc. :—

The Meteorological Office and the Second World War. *Met. Mag., London*, 84, 1955, p. 178.

The following papers by the Director's personal staff were published during the year ended March 31, 1956.

J. DURWARD, M.A. :—

Conference of Commonwealth Meteorologists, May 1955. *Met. Mag., London*, 84, 1955, p. 267.

Second Congress of the World Meteorological Organization. *Met. Mag., London*, 84, 1955, p. 265

FORECASTING

This Deputy Directorate consists of five Divisions. These are designated : (a) Central Forecasting, (b) Observations and Communications, (c) Public Services, (d) Climatological Services, (e) Marine.

The functions of the Deputy Directorate are therefore by no means confined to forecasting, but embrace the duty of meeting from the Meteorological Office storehouse of data, scientific knowledge and experience, the numerous and diverse requirements of landmen and seamen for meteorological information. The Divisions (a) and (b), with the Deputy Director, are situated at Dunstable, (c) is at Victory House, Kingsway, whilst (d) and (e) are located at Harrow. This continued geographical separation is singularly unfortunate, and constitutes a serious handicap in maintaining the close liaison and personal contact desirable between the staffs of Divisions having closely related responsibilities.

CENTRAL FORECASTING DIVISION

The main work of the Central Forecasting Division at Dunstable is two-fold. It consists of the provision of general day-to-day forecasting guidance to outstations, and the supply of forecasts, warnings, and other weather information direct to certain Government Departments and nationalized industries, and to the community in general.

The forecasting guidance is given primarily in the form of analyses of current surface and upper air charts covering a wide area, and of charts showing the synoptic situation expected 24 hours later. These analyses and the developments expected, including the associated weather, are discussed in a "general synoptic review" which is issued at the same time. Dissemination of this information, both to this country and overseas, is made by means of teleprinter and radio broadcasts, and increasingly also through facsimile transmissions by radio and land-line.

An extension of the guidance to outstations was introduced on September 1, 1955, from which date forecasts of winds at 1500 G.M.T. up to the level of 100 mb. over each of the eight radio-sonde stations in the United Kingdom were issued daily at about 0630 G.M.T.

Bulletins for broadcasting.—Forecasts, and warnings of hazardous weather, are made known to the general public and to certain specialist users in a variety of ways. Those initiated by the Central Forecasting Division itself are primarily in the form of bulletins for broadcast on the Home, Light and European Services of the British Broadcasting Corporation, and for printing in the daily newspapers. Broadcasts on the B.B.C. television service are made by forecasters on the staff of the forecasting unit at Victory House, Air Ministry, under the guidance of the Central Forecasting Office at Dunstable.

Amongst the most important of the specialist users are seamen whose livelihood and safety may depend on the weather. A reminder of this was received in the form of a request for forecasts for the Denmark Strait, between Greenland and Iceland, and for a sea area to northward of Iceland. These are now included regularly in the North Atlantic Bulletin which is a comprehensive weather broadcast made twice daily from Portishead, covering the

eastern half of the North Atlantic. Forecasts were also made on several occasions for trawlers in the Barents Sea, in latitudes where ice accretion on the ship's superstructure is sometimes a major hazard. For the North Sea area an additional safeguard against the unforeseen development of severe gales, which was introduced, is the exchange of warnings between Dunstable and the Headquarters of the Norwegian Meteorological Service at Oslo. By arrangement with the Ministry of Transport and Civil Aviation and other bodies, visual gale-warning signals in the form of canvas cones were exhibited at many coastguard stations and other points on the coast.

Extended period forecasts.—With a view to extending forecasts substantially beyond 24 hr., forecast charts for an area extending over North America, the North Atlantic and Europe are constructed for periods of two and three days ahead, as a daily routine. The conclusions from these charts are used as a basis for issuing outlooks for similar periods ahead, whenever the forecaster considers that his confidence in the developments shown justifies this. An interesting application of these longer-range forecasts is the warnings of persistent fog broadcast by the B.B.C., and now also given in greater detail to the Department of Scientific and Industrial Research to assist in the investigations into "smog", which have been undertaken at London, Sheffield, Manchester, Birmingham, Leeds and Glasgow. They are also of value in connexion with the "fine spell" service for farmers.

Changes in B.B.C. sound programme bulletins.—Arrangements were completed with the B.B.C. for substantial changes in their weather broadcasts, to be introduced in April 1956. Shipping forecasts are to be transferred from the Home Service to the Light Programme (wave-length 1500 m. only) which gives a better radio coverage. The broadcasting time for these forecasts will be doubled. This separation will allow more time for the land-area broadcasts, making possible a form of forecast which should be more satisfactory to listener and forecaster alike.

Official publications.—The Central Forecasting Division is responsible for the *Daily Weather Report* and *Daily Aerological Record*, which form a permanent record of many surface and upper air observations. These publications, which are printed by Her Majesty's Stationery Office Press at the Meteorological Office, Dunstable, have an international distribution, and may also be purchased by members of the public. A new format for the *Daily Weather Report* was introduced on July 1, 1955, the major change being the entry of observations in the form of the international synoptic code. From January 1, 1956, the observations of height and temperature in the *Daily Aerological Record* were given in geopotential metres and degrees Celsius, instead of in geopotential feet and degrees Fahrenheit as formerly, this change of units in upper air work having been introduced in the United Kingdom from that date, in accordance with international recommendations. A related publication, the *Monthly Supplement to the Daily Weather Report*, was completely re-designed during 1955, and first appeared in January 1956 as the *Monthly Summary*. This, as its title implies, is a survey of the month's weather over the British Isles, and is published shortly after the end of the month. A prominent feature of the new format is graphs of daily temperature, sunshine and rainfall during the month for London, Manchester and Glasgow.

OBSERVATIONS AND COMMUNICATIONS DIVISION

Collection of surface and upper air observations and their dissemination for use in constructing synoptic charts is the life blood of the Forecasting Service. This Division is responsible for organizing the provision of the observations and the meteorological communications required for the Central Forecasting Office and outstations. A network of stations reporting surface weather conditions was maintained in the United Kingdom, manned by Meteorological Office staff. In addition reports were supplied by Royal Naval Air stations, by United States Air Force units based in this country, and by a number of part-time observers, including coastguards, railway and postal officials, and retired private individuals. The organization of reports from ships is referred to under the Marine Division.

Surface observations.—It is important that not only should the well populated and most frequented regions of the country be represented by reporting stations, together with the major airfields, but also that the distribution of stations forming the basic network should be reasonably uniform and include the more remote areas. During the year a special review of the existing network was instituted with the object of obtaining the most efficient distribution of stations and assuring their permanence, as far as this is practicable, and this study is continuing.

Radio-sonde and radar-wind observations.—To obtain observations of upper air conditions a network of eight radio-sonde and radar-wind stations was maintained in the United Kingdom manned by Meteorological Office staff. Each station made observations of pressure, temperature and humidity twice daily to an average height of 61,500 ft., and of upper wind four times daily.

In consequence of the steadily increasing height of aircraft operation and the ever-growing interest in the upper atmosphere displayed in other fields, a constant effort to obtain information from greater and greater heights was made. To this end, trials of different types of balloons were continued in conjunction with the manufacturers, and are still in progress. One type of balloon weighing 1,250 gm. has shown considerable promise and achieved an average height of somewhat over 80,000 ft. Towards the end of the year these larger balloons were brought into routine use at two stations. During the year a technique for correcting the temperature measurements for errors due to solar radiation and thermometer lag was developed and brought into use.

To conform with resolutions of the World Meteorological Organization, the degree Celsius for the specification of temperature and the geopotential metre for the specification of height, in upper air reports, were introduced on January 1, 1956. These changes necessitated the revision of many associated forms and publications. At the same time new definitions of the tropopause, based on a recommendation of the World Meteorological Organization, were also introduced.

Training and advice in radio-sonde procedures were given to personnel of the two British Antarctic expeditions which will operate during the International Geophysical Year.

Meteorological flights.—To supplement the networks of surface and upper air stations, instrumental and eye observations from aircraft are required, especially over the seas adjacent to the British Isles. Meteorological reconnaissance flights, made by the Royal Air Force Hastings aircraft based on Aldergrove, and manned by R.A.F. crews, provide this valuable information. Up to five such flights were made weekly on tracks chosen in relation to the prevailing weather situation. Usually these were over the eastern North Atlantic, but when necessary they were diverted elsewhere, as for example during the prolonged cold spell experienced in February 1956, when they were sent over the North Sea. Similar information over England was obtained by daily Spitfire ascents to 30,000 ft. made by a civilian contractor under the direction of R.A.F. Home Command. The ascents normally took place over Worcester.

Thunderstorm location.—Location of the positions of thunderstorms by the "sferic" system was continued. The four direction-finding stations at Hemsby (Norfolk), Camborne (Cornwall), Leuchars (Fife) and Irvinestown (Northern Ireland) were maintained. This network gives satisfactory fixes up to a range of 1,500 miles, but during the year it became clear that two of the sites will soon be no longer available for use. A new site was selected in eastern Scotland to replace the existing station at Leuchars, whilst a search for a new site in Northern Ireland to replace the existing station at Irvinestown is still in progress.

The "sferic" technique, involving as it does the location of lightning flashes situated far from the observing stations, particularly lends itself to international co-operation. During the year a memorandum was sent to the World Meteorological Organization for inclusion in *Technical Note No. 12 "Atmospherics techniques"*. At the invitation of the Norwegian Meteorological Service assistance was given with trials of a proposed "sferic" site at Tromsø.

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 meteorological 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.

Teleprinters.—Meteorological information has continued to be collected by teleprinter from stations in the United Kingdom and from neighbouring countries on the Continent. The dissemination of "raw" and "processed" data to recipients is accomplished by means of five distinct teleprinter broadcasts operating to fixed schedules. These are as follows :

(i) Channel I domestic broadcast which serves all stations in the United Kingdom with basic data extending from north Greenland and Spitsbergen to Gibraltar and Sicily, and from Poland to mid Atlantic, together with analyses and forecasting guidance. During the year under review there were about the average number of changes, due to operational necessity, in stations receiving the broadcast, the total number remaining at about 190.

(ii) Channel II domestic broadcast which serves only the more important forecasting centres, and carries supplementary data for areas eastwards to the Ural Mountains, and for Turkey, the Balkans and north Africa.

(iii) North Atlantic broadcast, which is supplied to a limited number of centres in the United Kingdom concerned with transatlantic flying, or having other related commitments. Surface and upper air reports transmitted by radio-teleprinter from New York to Paris *via* the Azores and thence by land-line to Dunstable are relayed automatically, and for much of the time recipients in the United Kingdom receive the data within a few minutes of their being transmitted from New York. But during occasional bad radio-propagation conditions no reports may be received for many hours on end. Such radio "outages" have been very frequent during the period under review.

(iv) Mediterranean broadcast of weather reports and forecasts, which serves selected stations in the United Kingdom having special responsibilities relating to the Mediterranean area.

(v) International meteorological teleprinter network in Europe, of which the main centres are Dunstable, Paris and Frankfurt, with connexions to De Bilt, Brussels, Shannon, Zurich, Rome, Copenhagen, Oslo, Stockholm and Helsinki. This network constitutes by far the most important and efficient means of exchange of data between countries of western Europe. Arrangements for co-ordination between the main centres is the responsibility of the Telecommunications Working Group of the European Regional Association of the World Meteorological Organization. A meeting of this Working Group, of which the principal United Kingdom member (Assistant Director (Observations and Communications)) is Chairman, was held in Paris in January 1956 with 18 European countries represented.

Radio communications.—Radio reception of foreign broadcasts and ocean weather ships on the Atlantic is centralized at Dunstable; the transmitting stations received as a routine ranging from Washington to New Delhi and Tokyo, and from Angmagssalik to Dakar. A selection of the reports contained in these intercepts is included in the teleprinter broadcasts from Dunstable, thus making it unnecessary for outstations in the United Kingdom to carry out W/T reception themselves.

Radio transmissions were operated from Dunstable, though the aerials for two of the three broadcasts are located some two or three miles away, and the third is radiated from Rugby, about 50 miles distant. In discharge of international responsibilities, sub-continental collective messages are prepared and broadcast for reception throughout Europe, and Continental collective messages, containing a distribution of weather reports covering the whole of Europe and the eastern Atlantic, for reception in Asia, Africa, and North America.

Facsimile.—Facsimile broadcasts were made to six stations in the United Kingdom by land-line from Dunstable, in addition to the experimental radio-facsimile broadcast. Valuable technical experience was obtained which will be useful for future development.

Concurrently, the subsidiary meteorological office in the central area at London Airport was operating almost entirely on charts and other information transmitted by facsimile over a line from the main meteorological office some distance away on the perimeter of the airport.

Amplified radio-facsimile broadcasts were provided on the request of the Naval Weather Service while the Fleet was engaged in exercises in northern waters during the autumn. Suitable frequencies on which to transmit radio-facsimile broadcasts for all purposes were difficult to obtain.

The number of foreign countries making regular or experimental radio facsimile broadcasts increased, and now include the United States, Canada, U.S.S.R., Germany and Sweden. Transmissions are intercepted at Dunstable as required.

The first recorded private user of facsimile charts received by radio from Dunstable found them most helpful when used in conjunction with telephonic weather consultations with a nearby forecasting centre.

Flood warnings.—The meteorological teleprinter system was again used during the 1955–56 season 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 connexion with the east coast flood-warning scheme.

Publications.—Part I of the “ Handbook of weather messages, transmission schedules and station index numbers ” was issued and is on sale, together with Parts II and III which deal with codes and methods of plotting data.

A reference work on meteorological telecommunications for official use was prepared and copies will be available shortly.

PUBLIC SERVICES DIVISION

This Division, which was created in April 1954 and includes the London forecasting unit of Meteorological Office Headquarters in Victory House, Kingsway, had a busy year.

Centenary Year exhibitions.—Much activity was connected with meteorological exhibitions held in a number of cities in the United Kingdom as part of the Centenary celebrations of the Meteorological Office. The purpose of these exhibitions was to bring the work of the Meteorological Office, in its many facets, to the direct attention of the general public, and a main feature was a forecasting unit in day-to-day operation, the forecaster on duty at each exhibition being one of the panel who appear in turn on the B.B.C. television programmes. Exhibitions were held in London, Edinburgh, Birmingham, Manchester, Cardiff, and Belfast during the months June to October inclusive, for periods of about a fortnight in each place. An additional means of adding interest to the exhibitions was the sale of locally prepared souvenir *Daily Weather Reports* and, at Edinburgh and Cardiff, by the visit of an ocean weather ship which was open to inspection by the public. The exhibitions were well attended, the interest of schools being particularly lively.

Television broadcasting.—The nightly demonstration of charts and forecasts on the B.B.C. television transmissions by forecasters from Victory House, was maintained throughout the year. Certain developments in technique were introduced.

An important event of the year in this field was the introduction of broadcasting of forecasts by the Independent Television Authority. One of the operating companies of this Authority is Associated Rediffusion Limited which

broadcasts on the London transmitter from Monday to Friday inclusive. This company appointed its own television forecaster, who, by arrangement with the Air Ministry, is provided with facilities for studying the synoptic charts and official forecasts in the forecasting unit in Victory House and discussing the weather situation with the duty forecaster there. The other operating company of the Independent Television Authority in London is Associated Television Limited. By arrangement they obtain, from the same source, charts and a script for broadcasting from the London transmitter on Saturdays and Sundays. In February 1956 the question arose of providing the forecasting services for the operating companies of Independent Television Authority serving Birmingham, and it was agreed that, at least initially, a similar service be provided for them from Victory House, as is provided for Associated Television Limited operating in London.

Dial telephone service for forecasts.—A further high light in the development of forecasting services for the general public was the completion, in collaboration with the General Post Office, of arrangements to provide an automatic dialling telephone service (WEA) for the issue of forecasts to the public, on similar lines to the TIM service. This was inaugurated on March 5, 1956, on a 24-hour basis. The forecasts, which are prepared by the forecasting unit in Victory House, relate to an area of radius about 20 miles from London and cover a period of 9 hours ahead. From 6 p.m. until midnight an outlook for the following day is included. If the service pays its way, it is intended to extend it progressively to other parts of the country. The introduction of this service should somewhat reduce the heavy, and previously rapidly increasing, load of telephone inquiries received in the forecasting unit at Victory House, where well over 100,000 such inquiries were received during 1955.

Radar storm-warning equipment on Victory House roof.—In connexion with forecasting for the London area at Victory House, an interesting experiment was begun in June 1955 with the installation of a radar storm-warning set on the Air Ministry roof, its purpose being to ascertain whether the warning of rainfall given by a radar set of this kind could be of value in supplying information to the general public, particularly in the form of very short-period but very precise forecasts. An Experimental Officer was specially appointed to operate the set, and over the period from July to December some interesting and very encouraging results were obtained. Information about the occurrence of rain, and short-period forecasts about the movement of rain areas, could be supplied, and given with a detail and precision which would have been impossible without the installation. On September 23, 1955, the B.B.C. included in the television weather programme a film record of the tube display of the radar set as it occurred during the heavy rain in the London area the previous night. The storm-warning radar is also of assistance in providing a unique service for the London Transport Executive when sudden storms develop, and stations and trains are liable to become quickly overcrowded. Warnings of the likelihood of sudden storms are passed from Victory House to a Controller of the Executive, so that appropriate ameliorative action may be taken. Plate II (between p. 30 and p. 31) shows the scanner aerial on the roof of Victory House.

Other developments.—The increasing awareness by the public of the value of weather forecasting was shown by a demand for two further innovations. On

November 21, 1955 the daily issue was begun of a *Forecast chart and weather for shipping*, for distribution by the Port Meteorological Officer to ships about to leave the Port of London. The chart extends westwards from the North Sea and the Bay of Biscay to cover the North Atlantic as far as about 40°W., and is amplified by a descriptive statement, whilst the forecasts are the latest ones for selected coastal sea areas of the British Isles. On December 12, 1955, the *Manchester Guardian* commenced daily publication of a large-area forecast chart, supplied from Victory House, covering the North Atlantic and western Europe.

New edition of "Your weather service".—A new Centenary Year edition of "Your weather service", a brochure describing the work of the Meteorological Office, was published by H.M. Stationery Office, price 1s. 6d. The first print of 15,000 copies was sold out within a week of publication.

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

The British Climatological Branch is responsible for the supervision and periodical inspection of all voluntary climatological stations, including rainfall stations, in Great Britain and Northern Ireland. These stations are maintained by private observers, local authorities, universities and other educational establishments, industrial firms, Trusts, and Government departments. Great public spirit is shown by those who participate in the operation of these stations, often at personal inconvenience occasioned by the necessity for daily readings at fixed times throughout the year, whatever the weather. During the year records were received from 33 new stations, but 21 stations ceased to report, including that at Birmingham (Spark Hill) where continuous records had been maintained since 1907, and that at Southport where records had been maintained since 1896. The Birmingham record ceased on the death of the observer, whilst the reduction of the observing programme at Southport was the result of an economy measure. The cessation of the comprehensive and detailed records maintained and published annually for so many years by Southport Corporation is a sad loss.

As many inspections of climatological and rainfall stations were arranged as practicable, but the vitally important task of inspecting rainfall stations is much in arrears, and with present staffing it will take some years to overtake these.

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

Slow progress was made with the preparation of rainfall averages for the period 1916–50. Further tabulations of hourly values of dry-bulb and wet-bulb temperature were completed; the analysis of the data for one station for a period of ten years was published as a Branch memorandum.

The standard deviations of monthly mean temperatures during the period 1921–50 were computed for about 50 stations; these data are useful for studying the variability of temperature from year to year, and, by means of a statistical method, were also used in preparing averages of accumulated temperature above and below various thresholds. Hourly values of rainfall amount and duration, and of wind speed and direction, for a few selected stations were processed in connexion with the problem of driving rain.

Further consideration was given to the adoption of punched-card methods for surface land data, and it was decided that such data should be put on to punched cards as a routine. A pilot trial showed that cards could best be punched at Headquarters direct from a new type of summary form; such forms were prepared and tried out at four outstations. The possibility of putting a backlog of surface data on to punched cards was under consideration, but some difficulties remained to be overcome.

Publications.—The *Monthly Weather Report*, containing full summaries of observations, was published regularly; its layout was revised during the year to include certain additional information. The Annual Summary (for 1954) was published in August, an earlier date than for many years. The volume of *British Rainfall* for 1953 was published in August 1955, and that for 1954 was sent to the printers. A report on the Snow Survey of Great Britain for the season 1954–55 was prepared and published in the *Meteorological Magazine*.

Hydrology.—A special section of the British Climatological Branch working on hydrological problems maintained close contact with outside bodies, in particular, 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 drainage). Consultations with individual River Boards continued, and a number of them were given advice regarding existing rainfall records in their areas and the need for new observations.

Through representation in the Hydrological Research Group of the Institution of Water Engineers, the section is co-operating in an evaporation investigation which has been started at a reservoir in Kempton Park belonging to the Metropolitan Water Board. The object of the investigation is to secure data on the actual evaporation from a reservoir covering 40 acres, for comparison with readings from a standard evaporation tank and with estimates computed from climatological data. The section also had a series of discussions 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, and effects of percolation and run-off on afforestation.

Special work.—Following discussions with representatives of the Building Research Station, Department of Scientific and Industrial Research, it was decided to prepare a leaflet entitled “Weather and the builder”, for issue to the industry. A discussion was also held with representatives of the Institution of Heating and Ventilating Engineers on the meteorological requirements of the heating and ventilating industry.

Arrangements were continued for an investigation near Cardington, Bedfordshire, with the object of obtaining detailed information about the time and area distribution of intense falls of rain. A close network of recording rain-gauges, electrically synchronized, will give minute-by-minute data for an area of about 4 square miles. It is expected that the results will be of direct meteorological value, and will also provide new information applicable to problems of storm-water drainage. Some delay was experienced in connexion with the supply of electricity to the rain-gauge sites, but it is hoped to make a start with the investigation in the summer of 1956.

Notes were prepared on the snowfall of January and February 1955, on an exceptionally cold spell in May 1955, and on the sunny July of 1955. A report was written on the Dorset rainfall of July 18, 1955, which resulted in the floods in the Weymouth and neighbouring area.

Steps were taken to improve the networks of recording anemographs, and sunshine recorders in the United Kingdom.

Inquiries.—A great many requests continued to be received for meteorological information of all kinds. There were individual members of the public who wanted advice or information for personal use, e.g. where to live for health reasons. There were large and small business concerns, legal firms, brokers and local authorities who wanted data, or guidance, in connexion with the operation of equipment, law suits, insurance, water supply, road drainage, and so forth. There were large industrial groups and commercial undertakings, national corporations, Government departments, and research institutions, whose specialized requirements called for scientific judgement in processing the relevant data, and in presenting the information suitably tailored to meet the needs of the user. The variety of inquiries dealt with included advice in connexion with the siting of an oil refinery, the consumption of fuel by a district heating scheme, the design of air-conditioning plant, provision of information in connexion with the expansion and subsequent shrinkage of hard wood block floors, the sales output of sports goods, the drying of grain and the processing of tobacco. Arrangements were made to supply the British Empire Cancer Campaign with daily values of rainfall, sunshine, and wind, in the Liverpool and north Wales areas, in connexion with an investigation into the possible influence of environmental factors on the incidence of cancer.

Agricultural Branch

The major responsibility of the Agricultural Branch is to carry out and develop the application of meteorological knowledge to agriculture, horticulture and forestry. It is also responsible for certain investigational and research work in these subjects.

Units are maintained at the Provincial Headquarters of the National Agricultural Advisory Service at Bristol and Cambridge. In addition, a scientific officer is now stationed at the meteorological office, Edinburgh, to meet the requirements of agricultural authorities and research institutions in Scotland.

Close liaison was maintained with officers of the Ministry of Agriculture, of the National Agriculture Advisory Service, and at the experimental farms. County Institutes, University departments, and research stations were visited for discussion of mutual problems, and several lectures were given in the course of the year, including a series of four to students and staff of the University College of North Wales at Bangor.

A two-way system of intelligence was maintained; agriculturists were supplied weekly with summaries of the weather, whilst descriptions of current agricultural work, and the way in which various weather characteristics would affect field operations, were sent to the forecasting offices concerned.

As the experience of the Branch grows more attention can justifiably be given to questions of publicity and education. In addition to a wide variety of lectures, many articles are now written for professional and trade papers, contributions are made to B.B.C. talks programmes, and demonstrations are arranged at Agricultural Shows.

Special work.—The main subjects of special work continue to be those which are of the greatest economic significance to land use and productivity, namely irrigation, shelter, plant disease, and frost. Irrigation needs are examined both by experiment and climatological analysis. Assistance in methods of protective shelter continues to be given in field trials at Ministry of Agriculture stations. The potato blight forecasting system during 1955 was very successful, the meteorological data confirming the absence of need for any spraying over most of the country. Attention was also given to other diseases such as chocolate spot in beans, cereal rust, and apple scab. Plans were laid to intensify investigations into the last-named disease in the spring of 1956. Frost-liability trials were carried out in a Herefordshire valley, and a paper on the subject was prepared for the *Meteorological Magazine*.

Other subjects of agricultural importance for which the Branch supplied information were the deposition of cement dust, the blowing of Fenland soil, and the reclamation of flooded land on the east coast.

In the examination of relative humidities in connexion with plant-disease problems it appeared that high humidities are least likely to occur in the lee of hill masses, in particular in the Cheshire plain, and south-west Lancashire. An intensive survey of hourly humidities was started to find out the full extent of this Föhn effect, using the dense network of stations which was maintained in that area during the last years of the war.

Other climatological investigations carried out in the Branch were concerned with accumulated temperatures, damaging hailstorms and soil temperatures. With the increasing facilities for the use of punched cards it is hoped that future progress in climatic analysis will be accelerated.

Contributions were made to reprints of Ministry of Agriculture bulletins on apples and pears, and irrigation. Owing to various delays Bulletin 165 "Weather and the land", prepared by the Agricultural Branch, was not published until December, and in consequence was not available for the Agricultural Shows.

The Head of the Branch attended an informal meeting on Physics in Agriculture held at Wageningen University, Holland, during September.

Inquiries.—As in previous years the subjects of inquiries received by the Branch covered a wide variety of topics. The answers involved not only the supply of appropriate climatological data, but also advice based on applications of meteorological physics. Problems handled related to the growth of bulbs and anemones, climates suitable for cacti, glass-house heating and climate control, length of day, amount of dew, the force of impact of raindrops, temperature and humidity conditions in markets, the use of fishing nets for frost protection, the incidence of aphides, carrot fly, wheel bulb fly, black rust, apple scab, and liver fluke in sheep. The Branch was also consulted by Branches of the Ministry of Agriculture regarding climate and sites suitable for horticultural development, and concerning weather and crop yields.

MARINE DIVISION

British voluntary observing fleet.—This consists of the following classes of observing ships :

(i) "Selected" ships which make and code meteorological observations four times daily (0000, 0600, 1200 and 1800 G.M.T.) on a world-wide basis, and transmit them by radio to specified stations, in accordance with arrangements made by the World Meteorological Organization and the International Convention for Safety of Life at Sea. During the year a monthly average of 500 British ships took part in this scheme, out of a world total of about 2,600 ships. Included in this figure are 12 British whaling vessels specially recruited for making meteorological observations in the Antarctic Ocean.

(ii) "Supplementary" ships which make, code and transmit their observations in a similar manner to "selected" ships four times daily, but in a less complete form. The number of British "supplementary" ships is about 60.

(iii) "MARID" ships (coasting vessels) which make and code observations of sea temperatures in home waters once daily, and transmit them by radio-telephone to Dunstable *via* G.P.O. coast stations. When in the North Sea these ships add observations of wind, weather and visibility to their messages. The number of MARID ships is about 90.

(iv) Thirteen light-vessels, which make and code observations of wind, waves, visibility and air and sea temperatures twice daily and transmit them by radio telephone to Dunstable.

(v) Thirty-one trawlers fishing in the North Sea and far northern waters, and six ships of varied types trading in the North Sea, make non-instrumental observations and send their coded messages by radio-telegraphy or radio-telephony, as convenient, to British, Norwegian or Icelandic radio

stations. Owing to physical difficulties, no record of these observations is required to be kept aboard the trawlers.

The Marine Division has Port Meteorological Officers in London, Liverpool, Southampton, Cardiff and Glasgow, and Agents in the Forth, Tyne and Humber areas. It is their duty to visit the masters and officers of merchant ships to interest them in keeping meteorological records, to recruit them as voluntary meteorological observers, to instruct them as necessary in making the observations, and thereafter to re-visit the ships at regular intervals.

The meteorological observations made aboard all the above vessels, with the exception of MARID ships and trawlers, are recorded in special log-books which are forwarded to the Marine Division for climatological analysis. Many of them contain interesting observations of unusual meteorological and astronomical phenomena, as well as of oceanographical and ornithological subjects. Each log-book is scrutinized and classified by a Nautical Officer in the Marine Division, and, in accordance with long-standing practice, prizes in the form of books were presented during the year to the Master, Senior Observing Officer and Radio Officer of 100 ships whose records were classified as "excellent". In addition inscribed barographs were presented to four Masters who have been responsible for consistently good meteorological work at sea for a period of 15 years or more.

Ocean weather ships.—During the year the four British ocean weather ships *Weather Explorer*, *Weather Recorder*, *Weather Observer* and *Weather Watcher*, manned the North Atlantic Ocean stations A (62°N . 33°W .), I (59°N . 19°W .), J ($52^{\circ}30'\text{N}$. 20°W .), and K (45°N . 16°W .), in rotation with French and Netherlands ships, and completed 8 years' service. In addition to undertaking a full programme of meteorological work, search and rescue exercises were carried out whenever practicable, in co-operation with aircraft of R.A.F. Coastal Command. During these exercises mail, newspapers and urgently required stores were dropped in water-tight containers by the aircraft. In addition R.A.F. aircraft on navigational exercises take opportunities of dropping mails to British and foreign weather ships on duty at stations I and J, and to British ships at stations A and K.

The weather ships' navigation aids were used regularly by both civil and military aircraft, and a total of 7,076 aircraft made use of these facilities from British ships during the year.

Special observations of the sea-water temperature gradient with a bathythermograph, as fitted in all the British weather ships, were continued. Observations with wave recorders were maintained aboard *Weather Explorer*. Oceanographical work continued on behalf of the Ministry of Agriculture and Fisheries and the Fisheries Division of the Scottish Home Department; this included the towing of plankton recorders and taking samples of sea-surface water. Magnetic variation swings were carried out "on station" for the Hydrographic Department of the Admiralty.

Log-books and upper air data were received from all weather ships operating at stations A, I, and J, the climatological work in respect of these stations being the responsibility of the Meteorological Office; for station K this is a French responsibility. Meteorological and ocean-current statistics for stations I and

J for 1954 were completed. Responsibility for statistics for station A did not appertain to the Meteorological Office until January 1, 1955. Microfilmed copies of observations recorded aboard British weather ships were distributed to other nations signatory to the North Atlantic Ocean Stations Agreement, and similar microfilms were received from other "operating countries".

Weather Observer and *Weather Recorder* between them spent 12 days on search operations for the Icelandic s.s. *Holmaborg*.

Currents and ice.—Preparation of the atlas of surface currents of the eastern North Pacific Ocean is well advanced, and work has continued on the computation of current data for the eastern part of the South Pacific Ocean, the last section of the Pacific Ocean remaining to be charted. All observations of ice in the Antarctic region from December 1945 to January 1954 were plotted on monthly charts. The objective is the revision of Antarctic ice charts. The work of revision of the sections of the Admiralty Pilots which relate to surface currents and ice was maintained, and 7 volumes were dealt with during the year.

Special work.—The final text of a new publication entitled "Meteorology for mariners", was sent for printing.

An analysis of observations made during a series of simultaneous radar wind-finding measurements at pairs of ocean weather ships during 1953-54 was completed.

Further trials were made aboard *Weather Recorder* of electrical resistance thermometers mounted on a Dan buoy, to measure simultaneous air and sea temperature gradients close to sea level. It is known aboard the ships as a "thermobuoy". It is only in association with a weather ship that fundamental observations of this nature can be made.

Owing to pressure of work little progress was possible with an investigation into the incidence of inversions at ocean weather stations, but all the relevant data were placed upon punched cards preparatory to analysis.

Substantial progress was made with the analysis of data obtained aboard ocean weather ships and H.M.S. *Vidal* for investigating errors due to differences in screen exposures using ordinary and resistance thermometers respectively.

An investigation into the secular variation of temperature over the tropical Atlantic was continued.

Inquiries.—Information, including statistical tables and charts of marine data, was supplied on request to the Naval Weather Service, other Government departments, scientific institutions, commercial firms and private individuals. The following are examples: dry-bulb, wet-bulb, and sea-temperature data and wind frequencies for three areas in the North Atlantic and North Pacific for the National Institute of Oceanography; information on the occurrence of large wave heights for the Woods Hole Oceanographic Institution, United States; air and sea temperature data 1880-1954 for 5 light-vessels around the English coasts for the Fisheries Research Board of Canada (required for investigating suspected parallelism between British Isles and British Columbia

air and sea temperatures) ; probable frequencies of high wind, sufficient to cause spray to be lifted to a great height (required in connexion with damage by spray to a block of flats at Hove, Sussex) ; occurrence of fog in the Antarctic for planning whaling operations ; and temperature and humidity data for the shipping route United Kingdom to the Far East for research into damage to sugar cargoes due to " cargo sweat ".

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 losses of the trawlers *Lorella* and *Roderigo* (capsized due to an accumulation of ice on deck in Denmark Strait, January 1955), and *Tresillian* (foundered in very heavy weather south of Cork harbour, November 1954).

PUBLICATIONS

The following papers by the Deputy Directorate of Forecasting were published during the year ended March 31, 1956.

- S. P. PETERS, B.Sc. :
The Meteorological Office faces the future. Forecasting and public services. *Met. Mag., London, 84, 1955, p. 192.*
- C. V. OCKENDEN, B.Sc. :
Communications and electronics in meteorology. *Brit. Commun. Electron., London, 1, 1955, p. 58.*
- R. G. VERYARD, B.Sc. :
History and constitution of the Meteorological Office. *Weather, London, 10, 1955, p. 178.*
Looking back on 1955. *Weather, London, 11, 1956, p. 83.*
- S. G. ABBOTT :
The thunderstorms and tornadoes of 8 December 1954. *Weather, London, 10, 1955, p. 142.*
- E. W. BARLOW, B.Sc. :
Krakatau, 1883. *Mar. Obs., London, 25, 1955, p. 221.*
- A. BLEASDALE, B.Sc., B.A. :
The assessment of rainfall and evaporation. *J. Instn Wat. Engrs, London, 9, 1955, p. 494.*
- R. E. BOOTH :
The snow of January and February 1955. *Met. Mag., London, 84, 1955, p. 129.*
- P. R. BROWN, M.Sc. :
The loss of the Sao Paulo. *Mar. Obs., London, 25, 1955, p. 108.*
Wave heights and periods at ocean weather stations India and Juliett, 1949-53. *Mar. Obs., London, 25, 1955, p. 163.*
- J. GLASSPOOLE, Ph.D. :
Rainfall in relation to water supply. *Quart. J. R. met. Soc., London, 81, 1955, p. 268.*
The weather of 1954 over the United Kingdom. *Quart. J. R. met. Soc., London, 81, 1955, p. 499.*
- R. W. GLOYNE, B.Sc. :
Some effects of shelter-belts and windbreaks. *Met. Mag., London, 84, 1955, p. 272.*
Temperature under glass. *Sci. Hort., Wye, 11, 1952-54, p. 158.*
- R. F. M. HAY, M.A. :
Some landmarks in meteorological progress, 1855-1955. Pt. II. Progress in the design of meteorological instruments. *Mar. Obs., London, 25, 1955, p. 79.*
Weather charts plotted at sea. *Mar. Obs., London, 26, 1956, p. 33.*
William Dampier's contribution to meteorology. *Weather, London, 10, 1955, p. 194.*

- W. H. HOGG, M.Sc. :
Some observations on sun and frost. *Comm. Grow.*, London, No. 3138, 1956, p. 314 and No. 3142, 1956, p. 339.
The work of a meteorological office attached to the National Agricultural Advisory Service. *Worcs. agric. Chron.*, Worcester, 23, 1955, p. 185.
- W. H. HOGG, M.Sc. and W. C. IBBETT (Ministry of Agriculture) :
Wind shelter for horticultural crops. *Agriculture*, London, 62, 1956, p. 587.
- E. N. LAWRENCE, B.Sc. :
Climatology and long-range forecasting. *Weather*, London, 10, 1955, p. 410.
Effects of a wind-break on the speed and direction of wind. *Met. Mag.*, London, 84, 1955, p. 244.
The microclimatology of caves. *Weather*, London, 10, 1955, p. 152.
Minimum temperatures and topography in a Herefordshire valley. *Met. Mag.*, London, 85, 1956, p. 79.
- D. W. S. LIMBERT :
The formation of ice in mountain regions (with emphasis on British winter hill conditions). *Mountaincraft*, London, No. 27, 1955, p. 14.
- M. K. MILES, M.Sc. :
Whitsun holiday, 1955 : eleventh hour recovery of a " blocking anticyclone ".
Weather, London, 10, 1955, p. 237.
- R. MURRAY, M.A. and C. P. W. MARSHALL :
The storms and associated storm surges of December 21-23, 1954. *Met. Mag.*, London, 84, 1955, p. 333.
- L. B. PHILPOT :
Shipping operations in Hudson Bay. *Mar. Obs.*, London, 26, 1956, p. 28.
- L. P. SMITH, B.A. :
Calculating irrigation needs. *Sci. Hort.*, Wye, 11, 1952-54, p. 11.
Orchard irrigation. *Grower*, London, 44, 1955, p. 749 and p. 813.
Seasons—good and bad. *Agriculture*, London, 62, 1955, p. 438.
Winters—black or white? *Gdnrs' Chron.*, London, 139, 1956, p. 182.
- M. T. SPENCE, B.Sc. :
Wind erosion in the Fens. *Met. Mag.*, London, 84, 1955, p. 304.
- C. H. WILLIAMS, R.N.R. :
The growth of meteorological services for seamen. *Mar. Obs.*, London, 25, 1955, p. 141.
Vice-Admiral Robert FitzRoy, C.B., F.R.S. *Naut. Mag.*, London, 174, 1955, p. 333.
- C. H. WILLIAMS, R.N.R. and J. R. RADLEY :
Hints on observing. 5. Clouds. *Mar. Obs.*, London, 26, 1956, p. 19.

The following *Meteorological Research Paper* was approved for general distribution.

No. 923 R. F. M. HAY, M.A.

Five-year means of meteorological observations made at the ocean weather stations Item and India, Jig and Juliett 1948-52.

S. P. PETERS

Deputy Director (Forecasting)

SERVICES

The Deputy Directorate for Services comprises two Divisions designated by the titles Military Services and Civil Aviation respectively. The former is concerned largely, but not exclusively, with meeting the requirements of the Royal Air Force. Thus most of the work of the Deputy Directorate is directed primarily to serving aviation, and because aircraft flights begin and end at widely scattered airfields both at home and overseas most of the staff are located at outstations concerned with the control of aviation. Although the primary purpose of these outstations is to serve aviation, the existence of this network of meteorological stations has proved a convenient means of providing

meteorological information to other types of customer. To facilitate this many of the stations are listed in the Post Office Guide as being available to answer meteorological inquiries from the general public. The increasing awareness of the advantage to be derived by applying meteorological information—not exclusively confined to forecasts—to both technical and non-technical activities has brought so many inquiries from other than aviation interests that at some stations it has led to occasional difficulties in meeting the primary purpose of the outstation. In fact it would be true to say that this Deputy Directorate is very largely the medium through which the supply of meteorological information has been decentralized.

SERVICES FOR THE ARMED FORCES

The Meteorological Office meets the meteorological requirements of the Royal Air Force, the Army and the Ministry of Supply. Collaboration is also maintained with the Naval Weather Service, particularly at places such as Plymouth and Malta where units of both the Royal Air Force and the Royal Navy are stationed.

To meet the needs of the R.A.F., three types of station are maintained, namely main meteorological offices, subsidiary meteorological offices and observing offices. The subsidiary offices almost invariably are connected by teleprinter to a main office, and thus are able to receive general guidance and technical advice. The main offices are manned 24 hours a day, but at subsidiary offices the hours at which a forecaster is available depend on the needs of the R.A.F. In general the organization of the offices into groups consisting of one main office with a number of subsidiary offices tends to parallel the R.A.F. organization, though there are a number of exceptions. The main meteorological office is itself frequently located at the headquarters of an R.A.F. Group, and frequently controls the subsidiary meteorological offices at R.A.F. stations in that same Group. At R.A.F. Command Headquarters the meteorological unit usually consists of a senior officer of the Meteorological Office who acts as a liaison officer between the Air Officer Commanding in Chief and the Director of the Meteorological Office.

No meteorological units are deployed with field units of the Army during peace time, but a special meteorological section is permanently stationed at the School of Artillery at Larkhill, and temporary detachments of meteorological staff 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.

Certain Ministry of Supply Research or Experimental Establishments have attached to them meteorological units to meet special requirements.

Services provided in the United Kingdom.—At home, main forecast offices were maintained at the Group Headquarters in the operational and Flying Training Commands of the Royal Air Force, and at Air Traffic Control Centres which are not located with a Group Headquarters. Subsidiary forecast offices were maintained at stations in these Commands though, owing to staff shortages, the facilities provided had to be curtailed at a few places. In the main, these stations continued to operate as hitherto by providing forecasts for the Royal

Air Force. They constitute the major part of the basic network of observing stations in the United Kingdom on which the meteorological organization rests. In addition, many of the stations provided forecast services for the railways, British Electricity Authority, Gas Companies and the general public. Many of these inquiries were related to industrial, farming or holiday activities.

An interesting development within Fighter Command was the introduction of a special teleprinter network connecting Fighter Command stations, and on which weather reports are exchanged every 15 minutes. The need for this has arisen from the short endurance of modern high-speed fighter aircraft, with the ensuing necessity to select at very short notice alternative airfields for landing aircraft which have very little fuel left. Developments in the types of aircraft used in Bomber Command, in particular the increased ceiling, range and speed of these aircraft, are posing new meteorological problems, and plans were made for major changes in the procedure for the supply of meteorological information to Bomber Command units in order to meet these developments.

The communication facilities for the exchange of information between the Central Forecasting Office and the main and subsidiary forecast stations consist of teleprinter circuits. During the year experimental facsimile broadcasts continued by land-line to six R.A.F. stations and by radio to another four stations. Extensions of this facsimile broadcast are planned. As an aid to the training of R.A.F. personnel, the first thirteen chapters, out of a total of eighteen, of "Elementary meteorology for aircrew" were issued. With the co-operation of the R.A.F., investigations continued on ice accretion on aircraft, turbulence at high levels and the formation of condensation trails.

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

Services provided overseas.—There was little change in the British meteorological organization on the Continent.

In Western Germany, meteorological services were provided for the Royal Air Force and the Army on lines similar to those adopted in the United Kingdom, except that German forecasters and assistants were employed under supervision of British staff. Main meteorological offices were maintained in association with R.A.F. Group Headquarters and subsidiary offices at airfields.

In the Middle East, a main meteorological office was opened in Cyprus, and a similar office closed in the Canal Zone following the re-disposition of British Forces in that area. The new office is at Nicosia Airport, and here on behalf of the Cyprus Government continuous forecasting and advisory services are also provided for civil aviation. A similar combination of services to British armed forces and, on behalf of the local Government, to civil aviation continued at Malta and Aden. In Aden, the status of the office at Khormaksar was raised to that of main meteorological office on the assumption of certain commitments formerly carried out from Habbaniya. Khormaksar also supervises a number of subsidiary offices along the south Arabian coast and meets the meteorological requirements of shipping in that area. In the Far East the

requirements of the Royal Air Force have been met by three forecasting stations and one observing station in Malaya, a reporting station in the Nicobar Islands 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.

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 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, since the signing of the Anglo-Iraqi Treaty, progress was made in arrangements for a complete hand-over, ultimately, of British manned stations to the Iraq Government.

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 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.—To meet requirements, meteorological offices were maintained at four main offices, fourteen subsidiary offices and six observing offices.

In general there was little change in the functions of the offices during the year, though at most of them the work steadily increased to meet the needs of the growing number of scheduled services from non-State aerodromes and the already existing but largely expanding services from State aerodromes. The supply of information to Air Traffic Control Centres, who in turn give broadcasts of weather reports, forecasts and weather warnings to aircraft in flight by means of radio-telegraphy and radio-telephony, remained the responsibility of the main offices at Prestwick, Preston and Uxbridge. London Airport and Prestwick continued to provide facilities for the North Atlantic routes as well as for

the many other trunk routes ; indeed at the former airport, owing to the dispersal of operations, it has been necessary to open a second office as a temporary measure until such time as all operations function in the new Central area. Among the many new services introduced during the year was the daily British European Airways Corporation helicopter service between London Airport and the South Bank.

In addition to scheduled commitments, arrangements have often to be made for special flights. Amongst these during the year may be mentioned the flight of Her Majesty the Queen and His Royal Highness the Duke of Edinburgh from London to Nigeria for which arrangements were made in conjunction with the British West African Meteorological Services, and the airlift to Cyprus from Blackbushe. Information was also supplied in conjunction with the Central Forecasting Office, Dunstable for the special record-breaking transatlantic flight made by a Canberra jet aircraft. Canadian Pacific Airlines were also supplied with forecasts in connexion with their flights Canada to Europe *via* the north polar regions.

Not all the meteorological facilities provided were directly connected with civil aviation operations. Last summer, for example, a special weather service was supplied to the British Gliding Association in connexion with the National Gliding Championships held at Lasham.

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

Special work.—The supply of weather reports, warnings and forecasts is by no means all that is needed to meet the requirements of aviation. The advancement of flying and the introduction of aircraft such as the Britannia and the Comet calls for a parallel advancement in meteorological techniques, and many investigations are carried out to meet changing requirements.

Amongst the more important investigations was that dealing with the requirements for special information for pilots when in the final stages of their approach prior to landing. In this connexion investigations were continued into the relationship between horizontal visibility and slant visibility from air to ground during mist and fog ; and on the variability of cloud base with time and distance. Another investigation was made into the value of observations of stationary orographic clouds in the forecasting of turbulent conditions.

It is the policy of the Meteorological Office to encourage forecasters to gain first-hand experience of weather conditions on the routes for which they provide meteorological service. Through the good offices of British European Airways and British Overseas Airways Corporations it was again possible to arrange for such familiarization flights.

Examinations.—All airline and commercial pilots and flight navigators are required to hold licenses which are normally obtained as the result of an examination in various subjects including meteorology ; 1,102 such candidates were examined on meteorology during the year.

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 instruction in the making and reporting of weather observations, so that they could undertake the provision of aerodrome weather reports when stationed at an aerodrome where there was no meteorological office. This training scheme continued throughout the year under review.

Services for the Commonwealth.—Some of the forecasters employed by the British Caribbean Meteorological Service are seconded from the Meteorological Office, though it is intended that eventually they will be replaced by forecasters of the Caribbean Meteorological Service.

Although it is general policy that meteorological services in the Colonies are provided by the Colonial Governments concerned, owing to the special difficulties in the Falklands the Meteorological Office agreed to accept responsibility in future for the provision of services at Port Stanley.

PUBLICATIONS

The following papers by the Deputy Directorate for Services were published during the year ended March 31, 1956. These are additional to papers produced for official use only.

- A. C. BEST, D.Sc. :
Atomic explosions and condensation nuclei. *Met. Mag., London, 84, 1955, p. 201.*
Maximum concentration at ground level of gas from a heated elevated source. *Met. Mag., London, 84, 1955, p. 297.*
The Meteorological Office faces the future. Services for aviation and defence. *Met. Mag., London, 84, 1955, p. 187.*
- W. J. BRUCE :
Example of a double warm frontal structure over north-west Europe. *Met. Mag., London, 84, 1955, p. 251.*
Night cooling curves for Wahn, Germany. *Met. Mag., London, 84, 1955, p. 105.*
- L. S. CLARKSON, M.Sc. :
Analysis of winds at 40,000 ft. and 50,000 ft. over Singapore. *Met. Mag., London, 85, 1956, p. 1.*
- G. W. HURST, B.Sc. :
Wind derivation from vertical photographs. *J. Inst. Navig., London, 8, 1955, p. 250.*
- D. C. E. JONES, B.Sc. :
Exceptionally severe clear-air turbulence and other phenomena on April 14, 1954. *Met. Mag., London, 84, 1955, p. 107.*
- F. E. LUMB, M.Sc. :
An explanation of the behaviour of the depression of October 4–6, 1952 in terms of thermal-development theory. *Met. Mag., London, 84, 1955, p. 211.*
- R. K. PILSBURY :
Preliminary analysis of standing wave reports received at Northolt during the winter of 1953–54. *Met. Mag., London, 84, 1955, p. 313.*
- B. RAMSEY :
Upper winds in the south-east Asia–West Australia region. *Met. Mag., London, 84, 1955, p. 372.*
- W. E. SAUNDERS, B.Sc., and C. H. HINKEL, B.Sc. :
Speed of movement of warm fronts on the Atlantic. *Met. Mag., London, 84, 1955, p. 241.*
- H. S. TURNER, B.A. :
Clear air turbulence and topography. *Weather, London, 10, 1955, p. 294.*

The following *Meteorological Research Paper* was approved for general distribution.

No. 932 J. HARDING, B.A., M.Sc.

The profile of jet streams in the Middle East.

A. C. BEST
Deputy Director (Services)

RESEARCH

The Deputy Directorate of Research consists of five divisions designated for physical research, instrument development, special investigations, climatological research and forecasting research. Research, both fundamental and *ad hoc*, is a major activity within the Office, and provides for meteorology in the same way that other Government research laboratories provide for certain other branches of science. A career in research is now open to any recruit to the scientific staff, and attractive problems await the attention of the physicist or mathematician.

The work is carried out within the framework of a programme reviewed annually by the Meteorological Research Committee (see p. 2) and its sub-committees. Research reports are presented by the authors for discussion by the sub-committees, and in this way benefit is received of suggestions from authorities in the universities and other Government departments. Many research papers are published subsequently under the author's name, either by the Office or in one of the scientific journals.

COMMONWEALTH RELATIONS

Through personal visits and correspondence, advice on research problems continued to be sought by Commonwealth countries on a considerable scale. Arising from representations made by meteorological services in the Colonies, arrangements were made with the Colonial Office for a senior member of the research staff to make a special study of the requirements for research in tropical meteorology and to visit a number of colonial territories to discuss the problem with the Directors.

RELATIONS WITH THE UNIVERSITIES

Although meteorology is not treated as a separate subject in many of our universities there is an active department in the Imperial College, London, special staff appointments in the universities of Oxford, Cambridge and Edinburgh, and a considerable amount of interest in the departments of physics, mathematics and geography elsewhere. It is the policy of the Air Ministry to encourage such interest in a tangible way. An annual grant for meteorological research, £5,000 in the present year, was made to the Royal Society for disbursement through its Gassiot Committee, and a further special grant of £50,000, to be spread over five years, was voted to the same body for research requiring the use of high-level rockets. Smaller direct grants to support research were also made during the year to the Universities of Cambridge, London (Imperial College) and Wales (Aberystwyth).

Broadly speaking university activity tends towards the more basic physical problems, while the Office gives priority to matters of more immediate practical

importance, but no attempt is made to define boundaries ; a great deal depends on inspiration and aptitude and much of the research in the Office continues to be of a fundamental character.

Through the medium of Royal Society committees, the Meteorological Research Committee, the activities of the learned societies and frequent visits, relations between the Meteorological Office and the universities continued intimate and cordial.

PHYSICAL RESEARCH

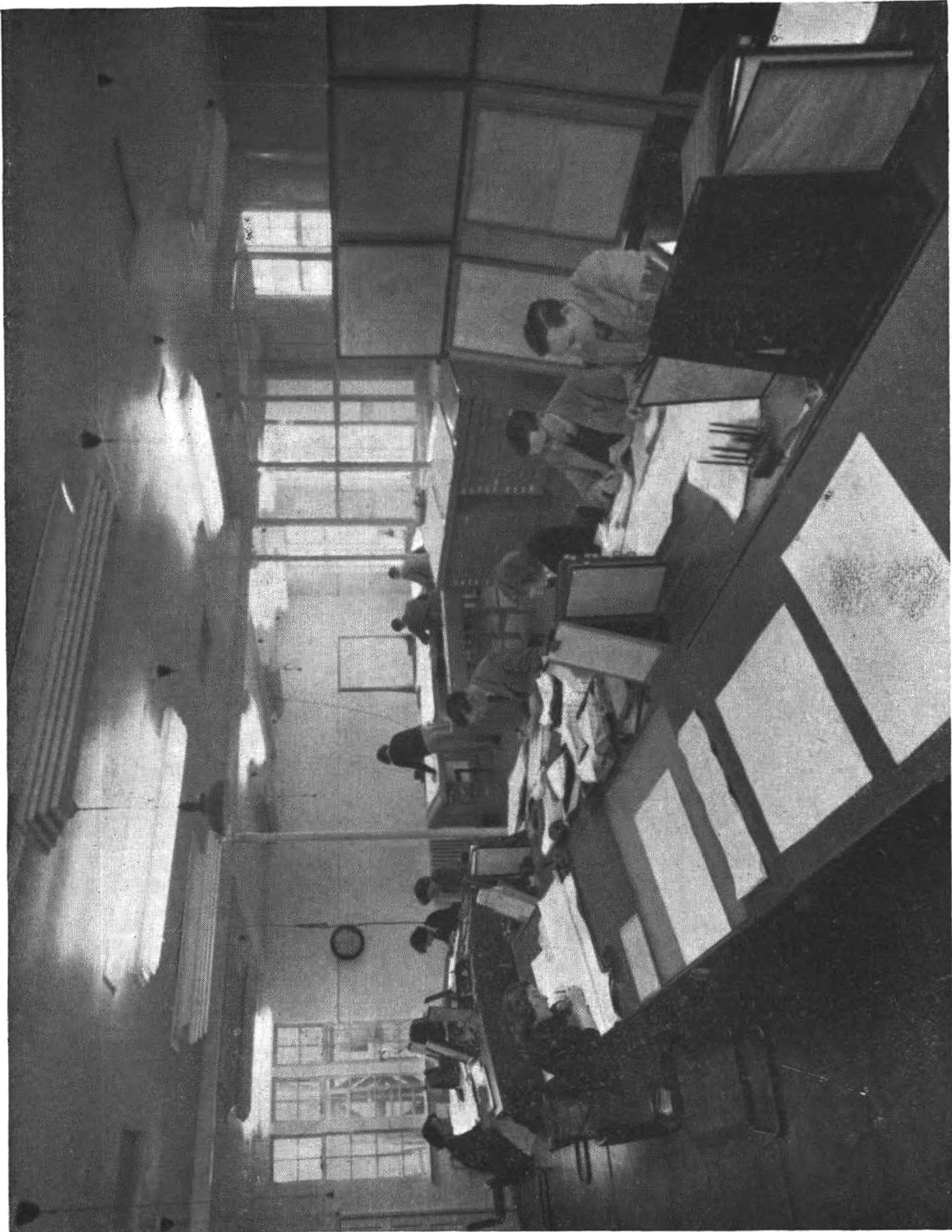
Although all meteorology is in a broad sense a branch of physics, or geophysics, it is customary to use the term meteorological physics to connote the study of the physical processes where laboratory and experimental techniques are required. The Physical Research Division comprises activities at a number of centres of which the most important are Kew Observatory, the Meteorological Research Flight located with the Royal Aircraft Establishment at Farnborough, and the Meteorological Section with the Chemical Defence Research Establishment at Porton.

At Kew Observatory basic studies of atmospheric radiation and heat balance made important progress, and a programme of observations developed there was commended by an international committee for adoption during the International Geophysical Year, 1957-58. Studies of the physics of fog are also in hand, and recent work reveals discrepancies between observed visibilities and calculations from accepted theory on particle concentrations. Associated work on evaporation by a small group at Cambridge indicates differences in transpiration of moisture from different types of crop, a point which may have importance in controlled irrigation.

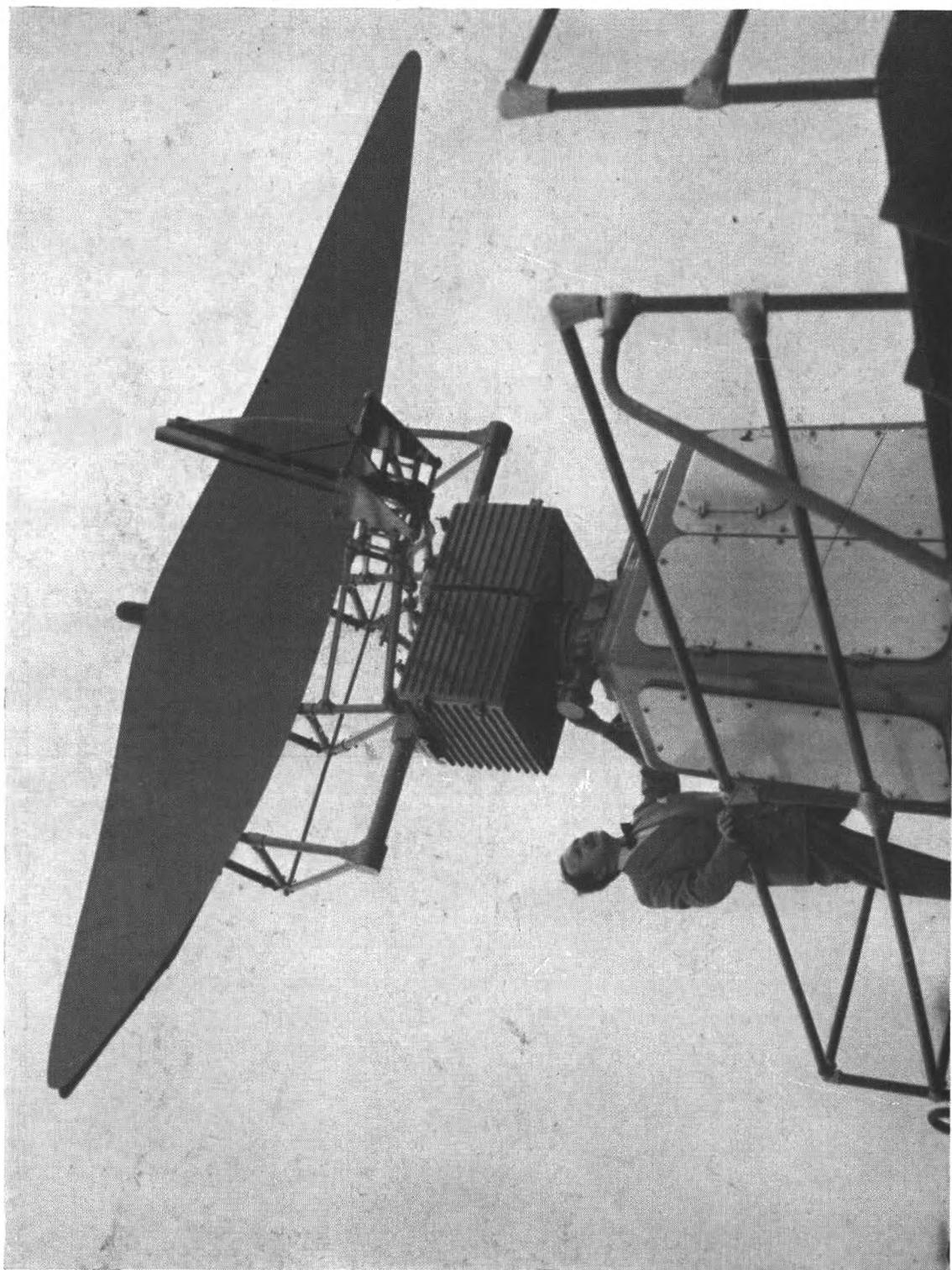
The Meteorological Research Flight, employing three Scientific Officers with supporting staff, was engaged with many problems for which aircraft are necessary. Three aircraft, one Hastings, one Varsity and one Canberra, were exclusively at the disposal of this Section. Plate III shows the interior of the Hastings aircraft. A great effort was made to equip the aircraft with modern meteorological instruments mainly developed by the section itself. A large amount of basic data was obtained on such matters as condensation trails, clear-air turbulence, cloud structure, water content and particle sizes, condensation and freezing nuclei, humidity within the stratosphere, and ozone distribution. Remarkable new evidence was obtained on the occurrence of dry air within frontal regions.

By the installation of a number of accelerometers and other equipment, information on the occurrence and nature of gustiness to heights of 50,000 ft. was accumulated for analysis at the Royal Aircraft Establishment.

The Flight co-operated also with Porton in experiments on large-scale diffusion by collecting fluorescent tracer particles released from the ground. The technique is very sensitive, and is providing unique evidence on the way in which surface smokes become diluted by upward and horizontal diffusion. These experiments should indicate the effectiveness of silver iodide smokes, generated at the ground, in reaching cloud layers above a critical point in the theory of rain-making.

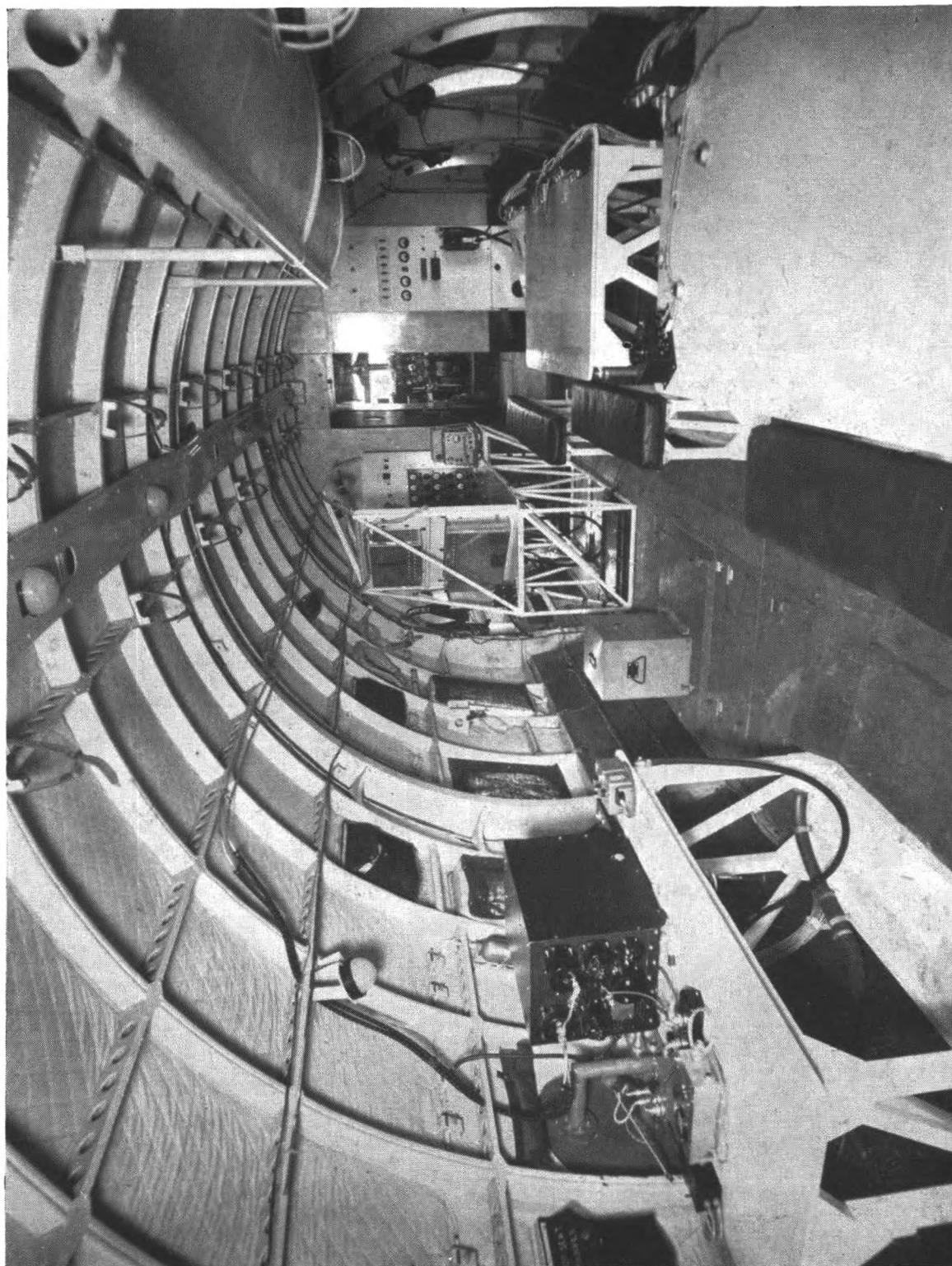


THE FORECAST ROOM AT THE CENTRAL FORECASTING OFFICE, DUNSTABLE

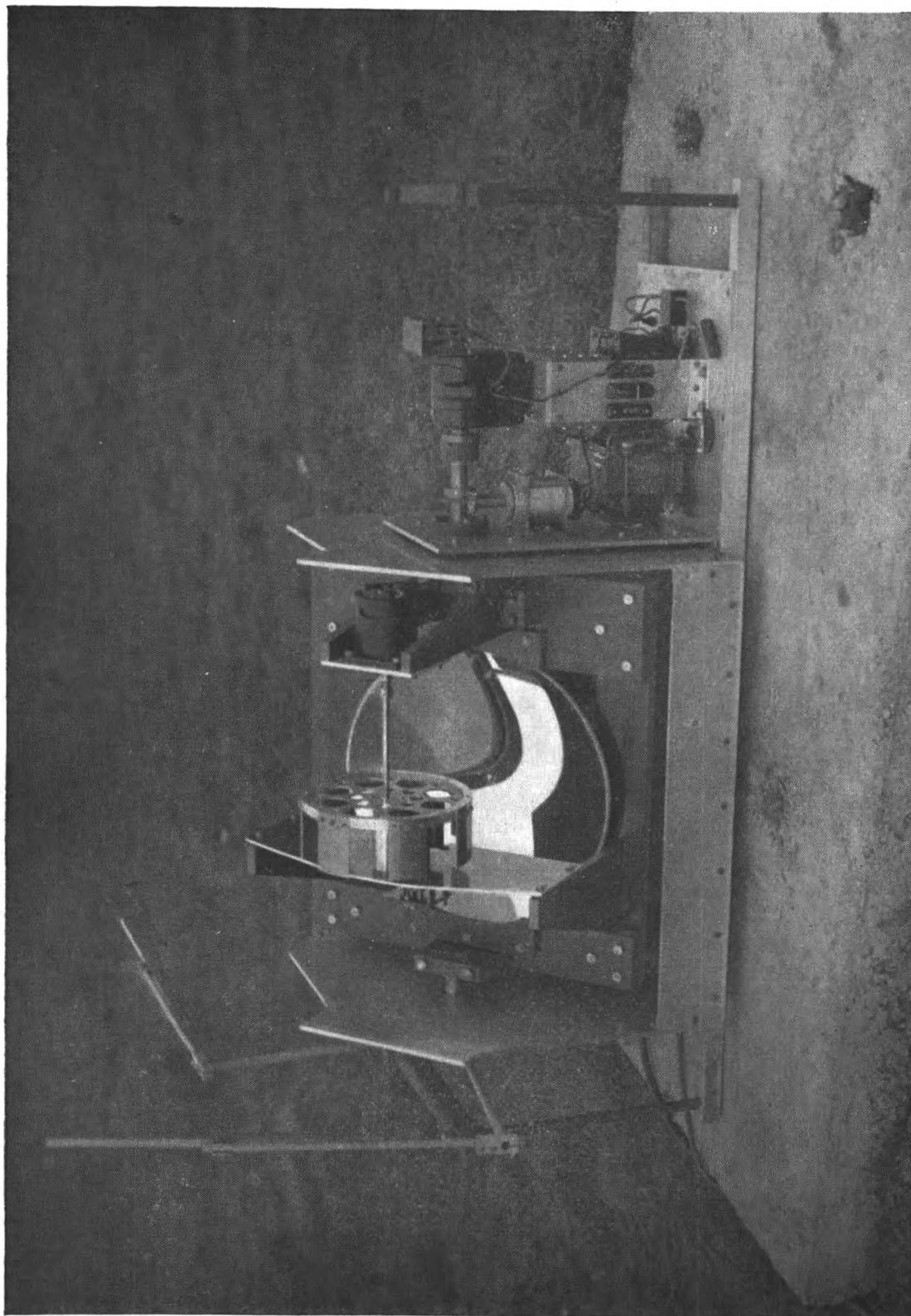


THE SCANNER AERIAL OF THE DECCA TYPE STORM-WARNING APPARATUS WHICH IS INSTALLED ON THE
“ AIR MINISTRY ROOF ” AT VICTORY HOUSE, KINGSWAY, LONDON, 190 FT. ABOVE MEAN SEA LEVEL

The scanner can be rotated and the tilt varied to observe different segments of the sky. (see p. 14.)



INTERIOR OF HASTINGS AIRCRAFT OF THE METEOROLOGICAL RESEARCH FLIGHT
(see p. 30.)



THE MODULATED ROTATING-BEAM CLOUD SEARCHLIGHT

The searchlight, shown here with the cover removed, scans in a vertical plane. A photoelectric detector, some distance away, responds when the cloud immediately overhead is illuminated. The cloud height is then determined by trigonometry. The searchlight beam is modulated by a rotating shutter and the photo-cell output fed to a tuned amplifier. This enables the instrument to be used by day. (see p. 31)

The section at Porton continues to devote most attention to turbulence and diffusion problems with particular emphasis now on the greater distances. The section also took control of the series of experiments to study the effects on rainfall of silver iodide seeding from the ground. Five generators, spaced along a line some 25 miles long, release silver iodide in a fine smoke, each at the rate of about 2 oz. per hour. They are operated when there is thick cloud with a southerly or south-westerly wind. Any effect on rainfall should be revealed by statistical studies of rainfall over a period of perhaps three years at places at some considerable distance, probably 50 miles or more, to the north and east. The Meteorological Office is much indebted to the Ministry of Supply and their staff at Porton for collaboration in this important work. It should be understood that the whole subject of rain-making remains controversial with much speculation and little convincing scientific evidence. Certainly at the present time there is no evidence that any method of interference yet proposed will have a noticeable effect on rainfall in this country, but the importance of the subject and its public interest justify the continuation of research.

The Meteorological Office radar research station is at East Hill, near Dunstable. It was mainly occupied with the study of precipitation, the meteorological phenomenon most easily seen by radar. Subjects of research included the growth of raindrops during fall, and the relation between the intensity of the radar echo and the size and number of the reflecting raindrops. The station collaborated with Imperial College, London, in a study of the height at which precipitation first forms in cumulus cloud, and with the Meteorological Research Flight in an examination of the flow of air into cumulus cloud. Unfortunately the station seems likely to become untenable within one or two years due to the encroachment of buildings. A new site and new equipment are therefore being considered.

The Physical Research Division also administers the Edinburgh Meteorological Office, mainly concerned with Scottish climatology and the geophysical work at the Observatories of Eskdalemuir and Lerwick. This continued as in previous years with little change.

INSTRUMENT DEVELOPMENT

The well-equipped laboratories of the division for instrument development are at Harrow. The improvement of standard instruments and the development of new ideas continues to demand more specialized knowledge with the extension of electronics, radio and radar. Notable progress was made with two equipments for measuring the height of cloud base by day by pulsed light and a modulated rotating beam respectively, the latter is illustrated in Plate IV (facing p. 31). It was concluded that the latter system would be the more suitable for routine use at airfields where the primary requirement is for precise measurements of the height of the base of low cloud, and where continuous remote recording is very desirable; further development is in hand.

Interest was renewed in the use of a high-power searchlight for obtaining measurements of air density up to perhaps 60-Km. height, applying the theory of light scattering. It appeared that a modulated beam, as used in America,

may be more successful than the pulsed-light technique, which was examined on behalf of the Office by the Radar Research Establishment, Malvern. The development of the modulated-beam technique was accordingly taken in hand.

The new radar-sonde system, which was under development by contract with the supervision of Ministry of Supply, was handed over and trials were begun. While this system, which is fully automatic, should have many virtues, its cost may be high in relation with current radio-sonde and radar-wind methods, and the performance of the equipment for routine observations remains to be ascertained.

The peculiar difficulties confronting the meteorologist were well illustrated by experience in attempts to measure rainfall at sea. The amount of rain which falls into the sea is not of much practical interest in itself, but as the oceans cover 70 per cent. of the earth's surface it is of great significance for the understanding of the general circulation. So far, difficulties of exposure have made it impossible to obtain useful measurements on board ship and experiments have begun with rain-gauges slung above the superstructure.

Progress was also made with the design of thermometers for use on high-speed aircraft, aircraft hygrometers and a fog-density indicator.

The routine testing and calibration of instruments, especially of radio-sondes, an important responsibility quite separate from the research and development work, was maintained throughout the year.

CLIMATOLOGICAL RESEARCH

The Climatological Research Division, located also at Harrow, is effectively responsible for studies in general world climatology, and a considerable proportion of its effort goes in the preparation of meteorological handbooks, especially for the Admiralty, and in giving advice and answering inquiries about climate in other parts of the world. Interest in such matters is widespread in other departments of Government and in industry. The scientific staff of this Division are, however, in a position to devote themselves mainly to investigations, especially for the upper air. Work was continued in charting the upper atmosphere to obtain mean monthly temperatures and winds, with their variabilities, all over the world. The study of temperatures was brought to the stage of publication. A detailed study was made of the winds over the north polar regions and a preliminary sketch of the average winds over the world at 20 Km., but it will take perhaps two years to complete the world analysis of wind.

The tropopause, dividing the stratosphere from the troposphere, is an important boundary, and seasonal world averages of its height were prepared. There is a sudden lowering of height in passing from the tropical zone to higher latitudes ; the lowering is often discontinuous, and the two tropopauses may overlap in the neighbourhood of 30° latitude where the subtropical jet stream is found at a height of 13 Km. A special study of the Pacific Ocean area showed that the jet stream is not always continuous around the earth in that region.

A set of new seasonal world maps of mean vapour pressure at the earth's surface was prepared for publication. It is intended to extend the climatological study of humidity into the upper atmosphere.

FORECASTING RESEARCH

Weather forecasting is so much in the public eye as sometimes to give the impression that the Meteorological Office exists for little else. The above paragraphs will have indicated a much wider field of activity, but, naturally, research into the problems of forecasting is of major importance and is well provided for at the Napier Shaw Laboratory located with the Central Forecasting Office at Dunstable. The close association between a full-time research laboratory and a centre of operational forecasting is a feature of much value to both. Certainly at few other places in the world is it possible for the research scientist to keep so closely in touch with practical forecasting problems and to have the benefit of regular discussion with expert professional forecasters.

The project of greatest current interest was the continued development of an entirely new method of forecasting the pressure distribution for some 24 hours ahead by actual calculation, treating the movement of the atmosphere as a problem in classical hydrodynamics. The mathematical equations are complicated, and can be treated realistically only by heavy computations for which an electronic calculating machine is essential. With the most advanced machine as yet available the time taken to calculate a forecast is about three hours, which would be rather long for operational use. It is however expected that with a new machine, a Ferranti 'Mercury' computer, which is to be purchased and installed at Dunstable, the time will be much reduced. The work is still in the research stage, and success cannot be guaranteed, although there is good reason to hope, that the new methods will be a real improvement on the current procedures which leave so much to the experience of the forecaster. It will be obvious to anyone with a training in mathematical physics that, now the problem has been breached, there is scope for improvement sufficient to occupy the research worker for years to come, and during the year under review additional scientific staff were authorized for this work.

Familiarity with electronic computers is also enabling the meteorologist to consider other problems which hitherto have seemed too formidable by sheer labour of calculation. Some preliminary progress in this way was made in calculating the flow of air over mountain obstacles, in computing climatic normals by harmonic analysis as a basis for longer-period forecasting, and in analyzing errors of wind forecasts. In the last context it was shown that a simple method of forecasting route winds by statistics, although not quite as good as standard synoptic methods, might nevertheless have useful applications.

It should be understood that whatever success the new electronic methods may have in calculating the future weather chart they will not, so far as can yet be seen, yield detailed information on such vital points as cloud heights and thicknesses, visibility, or rainfall in relation with topography. Parallel research on these matters must therefore continue, and a study was begun on the dispersal of stratocumulus cloud, a notoriously awkward problem in forecasting.

Weather forecasting for longer periods ahead, many days, weeks or months, continues as a tantalizing prospect towards which no clear line has yet been opened up. It is however believed that it is necessary to analyse world climate, and to describe and explain the anomalies which occur, before the scientific problem of long-range prediction can be formulated. Basic work on these lines continued.

Reverting to the important aviation problem of the disturbances in air flow over high ground, a theoretical study indicated that large lee waves may depend on a rather critical combination of factors, and it was also discovered that radio-sonde observations provide useful information on such waves. An interesting idea was put forward which may permit this problem to be studied also by model experiments using an incompressible fluid ; dimensional analysis suggests that the effects of compressibility in the atmosphere may be simulated by an appropriately designed cross-section in a fluid tunnel.

SPECIAL INVESTIGATIONS

The Division for Special Investigations is primarily concerned with various problems which arise particularly in the defence services and in planning for civil aviation. A useful new contribution to a very old problem was a quantitative method of taking account of the gustiness of the wind in assessing the "usability" of an airfield—or of a proposed airfield. Standard vector deviations of upper winds over the world were estimated, and considerable progress was made in the revision and extension of a publication giving the mean equivalent headwinds, season by season, over the principal international air routes.

A problem of great importance to airline operators concerns the economic operation of services over routes, such as the North Atlantic, where owing to the high variability of the wind the geographically shortest route is not always the quickest or the best. For such routes a requirement exists for the frequency distribution of headwinds over a number of alternative tracks. A theoretical study of this question, based on statistical methods, was made, and the results give promise of providing a rapid and reliable estimate of the possible saving of time by the application of variable track techniques.

The relation between atmospheric pollution and meteorological conditions achieved greater prominence with the publication of the report of the Beaver Committee and the introduction of legislation directed towards smokeless zones and cleaner air generally. The Meteorological Office is represented on a new Interdepartmental Committee set up to co-ordinate and promote research on atmospheric pollution, and new work was begun on the effects of pollution upon the density and persistence of fog. The theory of convection from a heated source also came under review because of its importance in the problem of pollution from industrial stacks.

VISITS, LECTURES, DISCUSSIONS, ETC.

The Director and numerous other members of the staff gave lectures or took part in discussions, and most of the universities were visited in this way. By invitation, the Director delivered a Friday Evening Discourse to the Royal

Institution, and the Deputy Director (Research) gave a course of three Afternoon Lectures to the same body. The Annual Popular Lectures of the Royal Meteorological Society, attended by many hundreds of school children, were also delivered by a member of the staff.

Within the Meteorological Office six Monday Discussions on scientific subjects were held in the rooms of the Royal Society of Arts; the Meteorological Office is much indebted to the Society for this hospitality. A number of colloquia were held, both at Dunstable and at Harrow. Official facilities were freely provided for staff to attend meetings of the learned societies and professional institutions.

There was a number of visits abroad by members of the scientific staff, among the most important being the attachment for a period of nine months of a Principal Scientific Officer to the Numerical Weather Prediction Unit of the United States Weather Bureau in Washington. By a reciprocal arrangement a member of the staff of the United States Weather Bureau was attached to Kew Observatory for collaboration in the research there. Another scientific officer spent three weeks in Stockholm studying the method of forecasting by electronic calculation which is also being developed there.

A senior officer of the Pakistan Meteorological Service, holding a Fellowship under the United Nations Technical Assistance Scheme, was attached to the Instrument Development Division for six months to study British techniques in instrumentation.

PUBLICATIONS

The following papers by the Deputy Directorate of Research were published in the year ended March 31, 1956.

- R. C. SUTCLIFFE, Ph.D. :
Rain—natural and artificial. *Brit. J. appl. Phys., London*, 7, 1956, p. 85.
The Meteorological Office faces the future. Scientific research and development. *Met. Mag., London*, 84, 1955, p. 183.
- A. G. FORSDYKE, Ph.D. :
The weather of 1954 in relation to northern hemisphere circulation patterns. *Quart. J. R. met. Soc., London*, 81, 1955, p. 504.
- B. C. V. ODDIE, B.Sc. :
Rain-making. *Agriculture, London*, 62, 1956, p. 512.
The Meteorological Office experiments on artificial rainfall. *Weather, London*, 11, 1956, p. 65.
- J. S. SAWYER, M.A. :
The vertical circulation at meteorological fronts and its relation to frontogeneses. *Proc. roy. Soc., London, A*, 234, 1956, p. 346.
- F. J. SCRASE, Sc.D., F.Inst.P. :
The application of radiation and lag corrections to temperatures measured with the Meteorological Office radio-sonde. *Met. Mag., London*, 85, 1956, p. 65.
- H. W. L. ABSALOM, B.Sc. :
International Geophysical Year. *Met. Mag., London*, 85, 1956, p. 33.
- E. T. BAKER :
An analysis of low cloud and poor visibility at Hong Kong Airport 1949–1954. *Tech. Notes R. Obs., Hong Kong*, No. 11, 1955.
- J. K. BANNON, B.A. :
Some British work in upper air climatology. *Ber. dtsh. Wetterdienstes, Bad Kissingen*, 4, Nr. 22, 1956, p. 117.

- J. K. BANNON, B.A. and A. GILCHRIST, M.A. :
Variation of temperature in the troposphere and lower stratosphere. *Quart. J. R. met. Soc., London*, **82**, 1956, p. 58.
- G. A. BULL, B.Sc. :
Short history of the Meteorological Office. *Met. Mag., London*, **84**, 1955, p. 163.
- G. A. BULL, B.Sc. and W. G. HARPER, M.Sc. :
West London tornado, December 8, 1954. *Met. Mag., London*, **84**, 1955, p. 320.
- F. H. BUSHBY, B.Sc. and M. K. HINDS, B.Sc. :
Further computations of 24-hr. pressure changes based on a two parameter model. *Quart. J. R. met. Soc., London*, **81**, 1955, p. 396.
- G. J. DAY, B.Sc. :
Some airborne observations of condensation nucleus concentration. *Geofis. pur. appl., Milan*, **31**, 1955, p. 169.
- C. S. DURST, B.A.
The accuracy of dead reckoning in the air. *J. Inst. Navig., London*, **8**, 1955, p. 91.
The effect of gusts on aircraft when landing. *J. Inst. Navig., London*, **8**, 1955, p. 354.
- C. S. DURST, B.A. and W. H. N. CARTER (Ministry of Fuel and Power) :
The influence of barometric changes on the emission of fire-damp. *Trans. Instn Min. Engrs, London*, **115**, Pt. 1, 1955-56.
- P. GOLDSMITH :
A method of increasing the range of the Dobson-Brewer frost point hygrometer in jet aircraft. *Quart. J. R. met. Soc., London*, **81**, 1955, p. 607.
- W. G. HARPER, M.Sc. :
An unusually smooth wave pattern in a condensation trail. *Met. Mag., London*, **85**, 1956, p. 38.
- G. E. W. HARTLEY, M.A. :
Remote-recording electrical anemograph. *Met. Mag., London*, **84**, 1955, p. 111.
- C. L. HAWSON, B.A. :
Meteorological Office practice for the application of radiation and lag corrections to temperatures measured by radio-sonde Mk IIB. *Met. Mag., London*, **85**, 1956, p. 75.
- N. C. HELLIWELL, B.Sc. and M. J. BLACKWELL, M.A. :
Day-time darkness over London on January 16, 1955. *Met. Mag., London*, **84**, 1955, p. 342.
- C. H. HINKEL, B.Sc. and W. E. SAUNDERS, B.Sc. :
Speed of movement of warm fronts on the Atlantic. *Met. Mag., London*, **84**, 1955, p. 241.
- H. D. HOYLE, B.Sc. :
Speed and direction of motion of simple warm-sector depressions. *Met. Mag., London*, **84**, 1955, p. 206.
Unusual behaviour of a depression, April 17-23, 1954. *Met. Mag., London*, **84**, 1955, p. 307.
- A. F. JENKINSON, B.A. :
Average vector wind distribution of the upper air in temperate and tropical latitudes. *Met. Mag., London*, **84**, 1955, p. 140.
The frequency distribution of the annual maximum and minimum value of meteorological elements. *Quart. J. R. met. Soc., London*, **81**, 1955, p. 158.
- H. H. LAMB, M.A. :
Malta's sea breezes. *Weather, London*, **10**, 1955, p. 256.
Two way relationship between the snow or ice limit and 1000-500 mb thickness in the overlying atmosphere. *Quart. J. R. met. Soc., London*, **81**, 1955, p. 172.
The weather of 1954. *Scot. geogr. Mag., Edinburgh*, **71**, 1955, p. 14.
- H. H. LAMB, M.A. and G. P. BRITTON :
General atmospheric circulation and weather variations in the Antarctic. *Geogr. J., London*, **121**, 1955, p. 334.
- D. H. McINTOSH, M.A., B.Sc. :
The occurrence of spells in London rainfall and temperature. *Met. Mag., London*, **84**, 1955, p. 366.
- R. J. MURGATROYD, B.Sc. :
Cloud physics at the Meteorological Research Flight. *Arch. Met., Wien, A*, **8**, 1955, p. 247.

- R. J. MURGATROYD, B.Sc., P. GOLDSMITH and W. E. H. HOLLINGS :
Some recent measurements of humidity from aircraft up to 50,000 ft. over southern England. *Quart. J. R. met. Soc., London*, **81**, 1955, p. 533.
- N. E. RIDER, B.Sc. :
An account of the development of the aerodynamic method for the evaluation of natural evaporation conducted in Great Britain from 1947 to 1953. *Assembl. gen. Un. geod. geophys. int. Rome 1954*, **3**, 1955, p. 135. (*Ass. int. Hydrol. Sc.*, Publ. No. 38).
An instrument for the continuous recording of soil temperatures at a number of depths. *Met. Mag., London*, **84**, 1955, p. 329.
- J. B. SHAW :
Vertical temperature gradient in the first 2,000 ft. *Met. Mag., London*, **84**, 1955, p. 233.
- P. N. SKELTON :
The supply of marine barometers by the Meteorological Office. *Mar. Obs., London*, **25**, 1955, p. 88.
- R. C. SMITH, Ph.D. :
Theory of air flow over a heated land mass. *Quart. J. R. met. Soc., London*, **81**, 1955, p. 382.
- C. E. WALLINGTON, M.Sc. :
Lee waves ahead of a warm front. *Quart. J. R. met. Soc., London*, **81**, 1955, p. 251.
Tricks with the tephigram. II. *Gliding, London*, **6**, 1955, p. 28.
Tricks with the tephigram. III. *Sailpl. & Gliding, London*, **6**, 1955, p. 158.
- J. WADSWORTH, M.A. :
The usability of airfields in gusty winds. *J. Inst. Navig., London*, **8**, 1955, p. 349.
- R. P. WALDO LEWIS, M.Sc. :
Pattern of rainfall, *Met. Mag., London*, **85**, 1956, p. 9.
- R. P. WALDO LEWIS, M.Sc. and D. H. McINTOSH, M.A., B.Sc. :
The relationship between the field and range disturbance in various latitudes. *Indian J. Met. Geophys., New Delhi*, **5**, Spec. No., Dec. 1954, p. 51.
- R. P. WALDO LEWIS, M.Sc., D. H. McINTOSH, M.A., B.Sc. and R. A. WATSON, B.A. :
Annual variation of the magnetic elements. *J. geophys. Res., Baltimore*, **60**, 1955, p. 71.

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

No.

- 912 K. H. STEWART, Ph.D. :
Radiation fog : investigations at Cardington, 1951-54.
- 913 D. G. JAMES, Ph.D. :
The nocturnal dissipation of stratocumulus cloud.
- 915 J. M. CRADDOCK, M.A. :
The representation of the annual temperature variation over central and northern Europe by a two-term harmonic form.
- 916 G. J. DAY, B.Sc. :
A refrigerated disc icing meter.
- 917 J. M. CRADDOCK, M.A. :
The variation of the normal air temperature over the northern hemisphere during the year.
- 918 H. HEASTIE, M.Sc. :
Average height of the standard isobaric surfaces over the area from the North Pole to 55°N. in January.
- 919 G. A. CORBY, B.Sc. :
Atmospheric turbulence in aviation.
- 922 C. V. ELSE :
Wind-finding trials of Radar A.A. No. 3 Mk. VII (second series).
- 924 H. D. HOYLE, B.Sc. :
The subtropical jet stream of the eastern North Pacific in January and April 1952.
- 925 J. K. BANNON, B.A. and R. A. JONES, M.Sc. :
The mean wind at 60 mb.

No.

- 928 D. N. HARRISON, D.Phil. :
Radar wind comparisons on the ocean weather ships (second series).
- 929 G. D. ROBINSON, Ph.D. :
The energy balance of surface and atmosphere at Kew, May 1953 to April 1954.
- 931 A. F. JENKINSON, B.A. :
Some statistical aspects of a rain-making experiment.
- 933 D. G. JAMES, Ph.D. :
Investigations relating to cirrus cloud.
- 935 J. S. SAWYER, M.A. :
Dynamical similarity in an incompressible fluid model of two-dimensional air flow over a ridge.
- 936 W. T. ROACH, M.Sc. :
Measurements of atmospheric radiation and the heat balance at the ground at Kew, May 1953–May 1954.
- 939 G. A. CORBY, B.Sc. and C. E. WALLINGTON, M.Sc. :
Air flow over mountains—the lee-wave amplitude.
- 941 R. ALMOND, B.Sc. :
An experimental pulsed-light cloud-base meter.
- 952 P. J. MEADE, B.Sc. :
Convection from a small, continuous source of heat in a calm, neutral atmosphere (with an appendix on the bent-over plume).
- 955 C. S. DURST, B.A. :
Comments on statistical and orthodox forecasting.
- 956 F. H. BUSHBY, B.Sc. and V. M. HUCKLE, B.Sc. :
The use of a stream function in the Sawyer-Bushby two-parameter model of the atmosphere.
- 960 D. D. CLARK, M.A. :
Development of thermometers for high-speed aircraft.
- 961 J. F. HAY, B.Sc. and F. PASQUILL, D.Sc. :
A technique for studying the local atmospheric diffusion of airborne material.

R. C. SUTCLIFFE

Deputy Director (Research)

INTERNATIONAL CO-OPERATION

WORLD METEOROLOGICAL ORGANIZATION

The most important event in international meteorology was the 2nd Congress of the World Meteorological Organization held at Geneva from April 14–May 13, 1955. The Congress was attended by representatives of 83 member-countries or territories, 7 non-member countries and 11 international organizations. The Marine Superintendent of the Meteorological Office, who is President of the Commission for Maritime Meteorology, attended the Conference in an advisory capacity.

The total expenditure over a four-year period was fixed at 1,700,000 dollars—the basis of contributing being 75 per cent. of the present scale and 25 per cent. of the United Nations scale. This resulted in a reduction of one unit on the contribution payable by the United Kingdom.

A new Secretary General, Mr. D. A. Davies, formerly Director of the British East African Meteorological Service, was appointed. The Director of the Meteorological Office was appointed a member of the Executive Committee.

Certain improvements in the status and numbers of the Secretariat were approved including the addition of a radio technologist and the employment, when necessary, of a legal expert in a consultant capacity. Twenty-two items were included in the technical programme for the next financial period. Some of the more important of these are meteorological telecommunications, World Meteorological Organization participation in the International Geophysical Year, preparation of meteorological guides and technical notes, and comparison of instruments, in particular of radio-sondes and barometers.

Before and after Congress a meeting of the Executive Committee was held, also at Geneva. The latter meeting was concerned chiefly with the "processing" of various Congress Resolutions.

Prior to the pre-Congress meeting of the Executive Committee the Director of the Meteorological Office visited Geneva to carry out a review of the Secretariat. A report was presented to the Executive Committee and to Congress, and as a result the structure of the Secretariat was revised so that the grade of the professional officers employed was raised and the number employed in a "technical" capacity increased.

Assistance was given whenever possible in the implementation of United Nations Technical Assistance Schemes sponsored by the World Meteorological Organization. Training facilities were provided in the United Kingdom, and an officer of the Meteorological Office was lent to the Egyptian Meteorological Service to advise on the organization of their instruments division.

A meeting of the European working group on meteorological transmissions was held in Paris in January 1956 under the chairmanship of the Assistant Director (Observations and Communications), Meteorological Office.

The second session of World Meteorological Organization Regional Association VI (Europe) was held at Dubrovnik, Yugoslavia, from March 12 to 24, 1956. The United Kingdom delegation was led by Mr. S. P. Peters, Deputy Director (Forecasting), who was accompanied by Mr. C. V. Ockenden, Assistant Director (Observations and Communications) and Mr. M. K. Miles. The Naval Weather Service was represented by Lt. Cmdr E. Pursor, R.N. Mr. C. V. Ockenden was elected Chairman of the Telecommunications Committee.

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 Second Air Navigation Conference held in Montreal in August 1955.

International Civil Aviation Organization First Pacific Regional Air Navigation Meeting in Manila in November 1955.

Special North Atlantic Regional Meeting held in February 1956 in Paris, for which a delegate was provided.

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 application of procedures in Commonwealth territories for civil aviation. 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 following meetings :

Ninth South Pacific Air Transport Council Meeting, New Zealand, July 1955.

Sixth South Pacific Committee for Air Navigation and Ground Organization Meeting, New Zealand, July 1955.

Second South African Committee for Air Navigation and Ground Organization Meeting, Nairobi, March 1956.

The South Pacific Air Transport Council, of which the South Pacific Committee for Air Navigation and Ground Organization is a sub-committee, includes representatives from the United Kingdom, Australia, New Zealand and Canada, and is concerned with the provision of facilities in the South Pacific.

The South African Committee for Air Navigation and Ground Organization includes representatives from the United Kingdom and the Commonwealth countries of Africa, and is concerned with the provision of facilities for the air route United Kingdom-South Africa.

The fifth Conference of Commonwealth Meteorologists was held in the Air Ministry, Whitehall Gardens from May 23 to 26, 1955. It was opened by the Secretary of State for Air, and was attended by delegates from all Commonwealth territories, by an observer from the Republic of Ireland, and by representatives of various interested government departments. Amongst the topics discussed were instruments and instrument supply, Commonwealth participation in the International Geophysical Year, current methods of forecasting, meteorological research, recruitment and training of staff, and particular problems relating to marine and aviation meteorology.

NORTH ATLANTIC TREATY ORGANIZATION

Representatives of the Meteorological Office attended the following meetings :

Twelfth meeting of the Standing Group Meteorological Committee held in Paris from June 21 to 24, 1955.

First meeting of representatives of Meteorological Agencies serving the Channel Command held at Chesham Place, London on November 8 and 9, 1955.

Joint meeting of the Communications-Electronics Co-ordination Section and the Standing Group Meteorological Committee held in Washington on November 17, 1955.

Sixth meeting of the AIRCENT Meteorological Committee held at Headquarters Allied Air Forces, Central Europe, from November 29 to December 1, 1955.

Third meeting of the Standing Group Meteorological Committee Working Group on Weather Plans held in London from January 10 to 13, 1956.

Third meeting of the Standing Group Meteorological Committee Working Group on Weather Communications held in London from January 16 to 18, 1956.

Combined meeting of the Allied Forces Southern Europe and the Allied Forces Mediterranean Command Meteorological Committees held in Ankara from February 21 to 24, 1956.

INTERNATIONAL GEOPHYSICAL YEAR

Through representation on Royal Society committees and in other ways, the Meteorological Office was intimately concerned with plans for the International Geophysical Year, 1957-58, when a co-ordinated attack is to be made on many problems of geophysics with co-operation by the Meteorological Office on a considerable scale. Staff and equipment were provided for the advance party of the Antarctic Expedition which, under Royal Society organization, arrived in the Antarctic in January 1956.

Similar support was also provided for the advance party of the Commonwealth Trans-Antarctic Expedition, under the leadership of Dr. V. E. Fuchs, which established its main base at Vahsel Bay in January 1956.

ORGANIZATION

The organization of the headquarters of the Meteorological Office introduced in April 1954 was slightly modified in October 1955 by amalgamating the three branches under the Assistant Director (Military Services) into a single branch, and similarly amalgamating the two branches under the Assistant Director (Civil Aviation). The current structure is shown in Appendix I. The names of the Directorate and Heads of Branches are given in Appendix II, and the locations and addresses of the various parts of the Headquarters and the observatories are given in Appendix III. There are nearly 200 outstations.

STAFF

Staff shortages persisted in the Scientific Officer and Assistant (Scientific) classes ; only in the Experimental Officer class can establishments be almost fully manned. Figures showing strengths in the various classes and grades are tabulated in Appendix V ; for comparison the strength figures a year ago are included in the table.

The modification in the organization referred to above released a post in the grade of Principal Scientific Officer, but three additional posts in this grade were created, two in the Assistant Directorate of Forecasting Research, and one for the special task of writing an official textbook on weather forecasting.

Only two Scientific Officers were appointed during the year ; to stimulate recruitment, visits were made to university colleges to describe the scientific work and career prospects in the Meteorological Office and posters were sent to universities for display on notice-boards. Under the Vacation Employment Scheme, 7 university students were given temporary appointments to various research establishments.

Twenty Assistant Experimental Officers were assigned to the Meteorological Office by the Civil Service Commission ; all but three were former Assistants (Scientific) in the Meteorological Office.

The large deficiency in Assistant strength presented a continual problem ; losses exceeded 250, a fifth of the total strength. Although, following a special recruitment effort, the number of new appointments almost equalled the losses, newly entered staff were ineffective during the initial training period. The shortage of trained staff creates great difficulties in maintaining efficient standards and a steady output of work, let alone meeting continually increasing demands for meteorological information and services.

The Principal Scientific Officer on loan to British East Africa was appointed as Secretary General of the World Meteorological Organization ; another Principal Scientific Officer has been appointed Director of the British East African Meteorological Service. The Principal Scientific Officer seconded to the Ministry of Defence for duty on the staff of the Supreme Allied Commander Europe returned to the Meteorological Office on promotion, and was replaced by another Principal Scientific Officer. A Principal Scientific Officer was released to take up an appointment under the United Nations Technical Assistance Administration for duty with the Egyptian Meteorological Service. One Assistant Experimental Officer joined the advance party of the Commonwealth Trans-Antarctic Expedition, and another joined the advance party establishing the station at Vahsel Bay maintained by the British National Committee for the International Geophysical Year.

Staff returning to duty within the Meteorological Office included one Principal Scientific Officer who had been awarded a Nuffield Foundation Research Fellowship to study the application of meteorology to agriculture in the Commonwealth and foreign countries, and the Principal Scientific Officer who went to the United States, under an exchange scheme, to study methods of numerical weather forecasting. The United States Officer involved in this exchange arrived in June and is working at Kew Observatory.

Mr. R. A. Hamilton was appointed an Officer of the Order of the British Empire for his services as Chief Scientist of the British North Greenland Expedition. The L. G. Groves Memorial Prize for meteorology was awarded to Dr. F. J. Scrase, O.B.E.

The Director records his appreciation of the services of the following senior members of the staff who retired from their established appointments during the year :

- Mr. H. W. L. Absalom, O.B.E., Assistant Director.
- Mr. R. P. Batty, O.B.E., Assistant Director.
- Miss E. E. Austin, Principal Scientific Officer.
- Mr. N. H. Smith, Principal Scientific Officer.
- Mr. P. N. Skelton, M.B.E., Chief Experimental Officer.

Four of these officers remained in the Meteorological Office with temporary appointments.

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

- Mr. F. M. Dean, M.B.E.
- Mr. F. Bispham.
- Mr. S. A. Hodson.
- Mr. A. R. Hosker.

Royal Air Force personnel.—Three Scientific Officers were commissioned in the Royal Air Force on being called up for national service. Nine Assistants (Scientific) are seconded to the Royal Air Force in the category of aircrew for duty as air meteorological observers on meteorological reconnaissance flights. Against a block establishment of 250 airmen posts, 180 Assistants (Scientific) were fulfilling national service obligations on March 31.

The strength of the Meteorological Section of the Royal Air Force Volunteer Reserve on March 31, 1956, was 87 officers and 21 airmen and airwomen, showing a loss of 2 officers and 4 airmen and airwomen during the year. Reservists gave valuable assistance during their fortnight's training ; 15 officers and 3 airmen took part in major air exercises in the United Kingdom and 6 officers carried out training with units of the 2nd Allied Tactical Air Force. The week-end rosters of reservist officers at North Weald and Biggin Hill have been maintained, and 2 officers have given similar assistance at Church Fenton.

Invitations to attend a refresher course at the Meteorological Office Training School were issued to meteorological officers on the Emergency List of the Royal Air Force Reserve, who had had no forecasting practice since their release from the Royal Air Force at the end of World War II. Ten courses were arranged for the 116 officers who accepted the invitation

The flow of airmen into Class H of the R.A.F. Reserve following national service continued throughout the year, the total now being 395 of whom 186 are staff with civilian appointments in the Meteorological Office. Fifty-four reservists in class H were allocated for training during major air exercises. On completion of 3½ years in class H, 131 airmen, of whom 61 are Meteorological Office staff, were transferred to class G, and have no further liability for annual training.

Training.—Training in meteorology is given to all scientific staff entering the Meteorological Office at the Training School established at Stanmore, Middlesex, under a Principal Scientific Officer. Initial courses are designed to suit the academic or scholastic standard of each grade of entrant, and to fit him for his particular role in the work of the Meteorological Office. After a few years' practical experience forecasters attend an advanced course which is mainly concerned with the application of upper air analysis to forecasting. Refresher courses provide instruction in recent advances in meteorology for forecasters who have not attended a formal course for some years. In addition, special courses are arranged for meteorological officers in the R.A.F. Reserves, for nautical officers and for voluntary observers.

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 VI. Some 500 members of the staff of the Office passed out of the School during the year. In addition 21 staff of other meteorological services attended courses, sponsored by their governments, the Colonial Office, the Crown Agents, the United Nations, or International Civil Aviation Organization Technical Assistance authorities ; these visitors came from the meteorological services of the Channel Islands, Gold Coast, Nigeria, British East Africa, Hong Kong, Jordan, Iran, Sudan, Ethiopia, Pakistan, and the Falkland Islands Dependencies Survey.

Appendix VI contains no reference to a current course for Scientific Officers. This course lasts 17 weeks, and is roughly of post-graduate standard although the field covered is less complete and the emphasis on practical synoptic meteorology is greater than in university courses leading to an M.Sc. degree.

SUPPLY OF INSTRUMENTS

Provision and production of equipment.—During the year 1,325 orders and contracts were placed. The total expenditure was £310,180, and £89,369 was received by sale of equipment and for testing and inspecting instruments. Provision and delivery of new equipment was satisfactory in the main though at times there were some delays due to raw materials being in short supply. The more important contracts placed were contracts for an electronic computer for the purpose of numerical forecasting ; for four atmospheric direction-finders ; and for radar-sondes and transponders. The Decca storm-warning equipment which had been on hire for a trial period was purchased. Six radar A.A. equipments were purchased from the Ministry of Supply at disposal prices and a contract was placed for the reconditioning of a further ten GL.III equipments.

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 inquirers at home and in the Dominions and Colonies regarding the suitability of equipment and its source of supply. Large quantities of meteorological equipment were supplied and packed for two expeditions : the Trans-Antarctic Expedition, and the advance party of the International Geophysical Year (sponsored by the Royal Society). The stores for the Trans-Antarctic Expedition included a radio-sonde station. Demands for stores numbered 11,267 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 on research. Among the more interesting may be mentioned :

For medical research additional equipment to the Department of Scientific and Industrial Research in conjunction with the Treasury Medical Department for the continued investigation of the incidence of bronchitis ; to the Ministry of Food for the investigation into food storage conditions.

For various researches including the correlation of radio-propagation measurements with meteorological elements by the Royal Aircraft Establishment, Farnborough ; the investigation of shower clouds by the Imperial College of Science ; experiments being made in connexion with the aeration of a river by the Department of Scientific and Industrial Research and to the Road Research Laboratory for experiments on problems of condensation on vehicle windows.

To various agricultural and horticultural institutes and to university schools of agriculture for investigations into potato blight, effects of temperature on growing tomatoes, night temperatures under glass and temperature investigations on experimental plots in connexion with population studies of soil fauna.

To various university exploration clubs and other institutes for expeditions to Norway, Iceland, Newfoundland and Alaska.

Testing and calibration.—The total number of instruments tested, excluding balloons, was 45,227. The number of balloons of all sizes received and subjected to 5 per cent. check was 260,128. Fees received for the testing and inspection of instruments for manufacturers and others amounted to £1,925. Instruction on the maintenance of instruments was given to climatological observers.

An electrical test section was put into operation and a considerable amount of essential test equipment obtained and installed ; 59,923 items were passed through the section during the year.

The total number of radio-sondes received from the makers and approved was 8,499. The number calibrated was 19,645, and 1,960 recovered after flights were overhauled and recalibrated for future use. The change-over to calibration in degrees Celsius was carried out smoothly. The calibration of radio-sondes for manufacturers' exports continued.

Regular inspections of the radar-wind equipments were maintained, and the inspections were followed by the installation of reconditioned sets at the remaining units in the United Kingdom namely Eskmeals, Hemsby, Leuchars and Camborne. The reconditioning of three equipments for sale to the German Weather Service was supervised. A special air-conditioning plant for use with radar equipment at tropical stations was approved. A complete equipment fitted with this air-conditioning plant was issued to Bahrain. Further sets are due on contract for other tropical stations. Training courses for radar technicians were continued.

LIBRARY AND PUBLICATIONS

The Meteorological Office Library and the major Editing Section of the Meteorological 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 from world-wide sources, records them in author and subject bibliographies, and provides an information service based on them to the staff of the Meteorological 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 335 were in force at the end of the year. The volume of publications dealt with is shown by the fact that 8,403 books and articles were received and recorded during the year.

A large collection of lantern slides, photographs and films is maintained ; during the year 234 slides, 130 photographs and 3 films were added to it.

The Library issues to the staff of the Meteorological 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 number of publications issued on loan by the Library was 11,821, 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. Much help was given to other members of staff in the use of publications in foreign languages.

Inquiries, which in some instances entailed a deep search by Library staff for the 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 effect of forests on rainfall, physiological saturation deficit, and dust-bearing winds.

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*. Wide interest in the Meteorological Office Library loans form was aroused by its publication in the new Aslib "Manual of special library practice". A selection of meteorological books was prepared for inclusion in the Library Associations "Guide to reference

books". Assistance was given to representatives of the Cavendish Laboratory and Scott Polar Institute in devising a new snow and ice section of the Universal Decimal Classification. Owing to lack of staff the necessary work on the preservation and arrangement of the 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 Commission for Bibliography and Publications of the World Meteorological Organization and the British Standards Aeronautical Glossary Committee. He also served on the World Meteorological Organization Working Group on international meteorological tables, and as observer for the World Meteorological Organization attended the meetings of the UNESCO committee on documentation in pure and applied science held in London in November 1955.

Serial publications.—Most publications of the Meteorological Office are prepared for printing by the Editing Section of the Library and Editing Branch, but the Marine Meteorology Branch is responsible for editing publications in its own field, and publications of observations, such as the *Monthly Weather Report*, are edited by the Branch responsible for preparing each one.

The main research publications of the Meteorological Office are the *Geophysical Memoirs*, *Professional Notes* and *Meteorological Reports*. A list of these published during the year is given in Appendix VIII. Three *Geophysical Memoirs* and one *Professional Note* were also in the press at the end of the year.

The *Meteorological Magazine* was published each month. The June 1955 number was a special one published in celebration of the Centenary of the Meteorological Office; it contained a message from the Secretary of State for Air, a foreword by the Director, and articles on the history and plans for future development of the Meteorological Office. The articles in other numbers covered a wide field from the possibility of production of condensation nuclei by atomic explosions to the meteorological effects of shelter-belts. 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 published dealt amongst other matters with wave statistics and meteorological conditions in ships' holds.

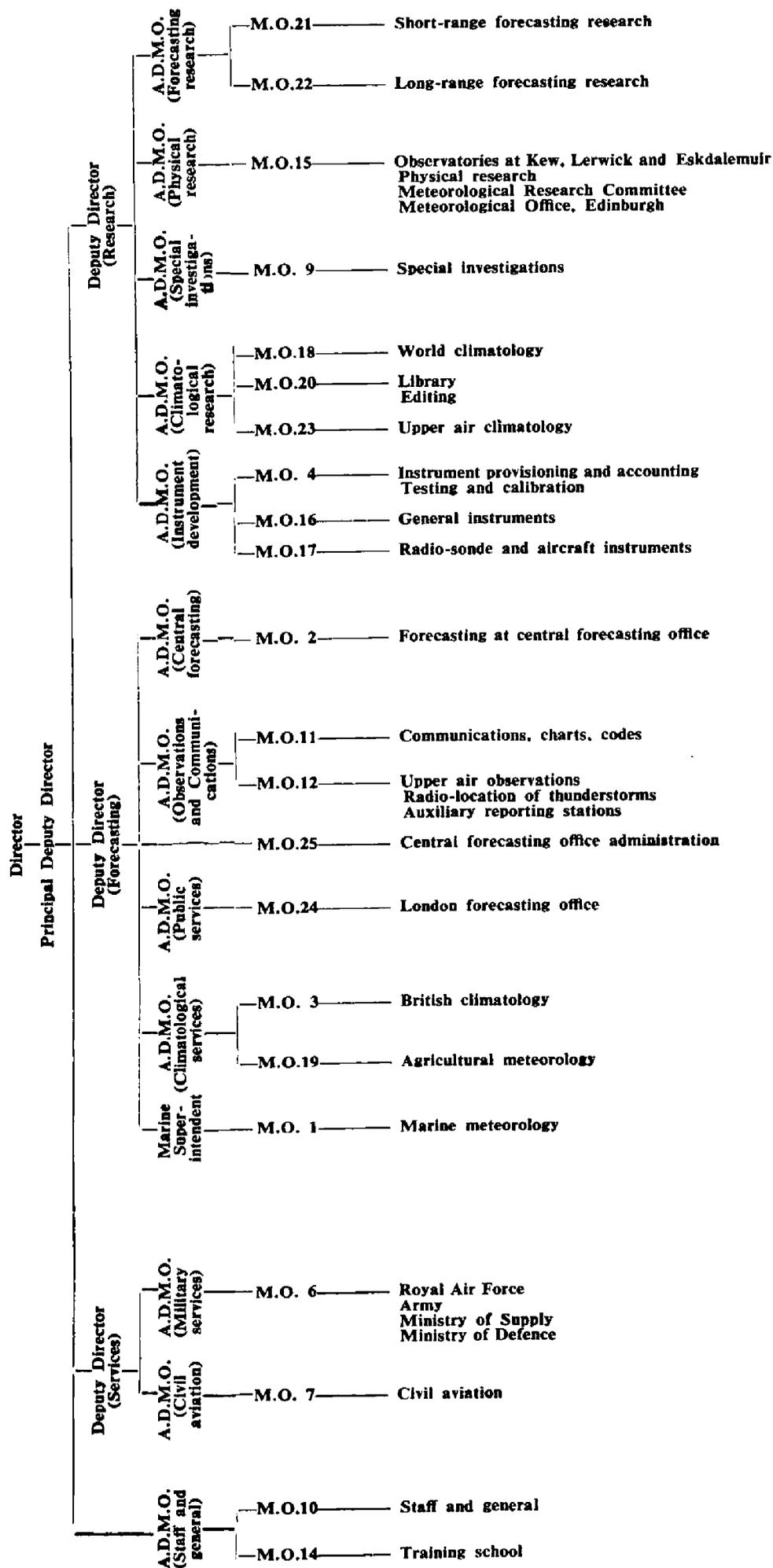
Instructional books, textbooks and charts published during the year are also listed in Appendix VIII. Publications of this class in the press at the end of the year were new editions of the "Weather map", "Observer's handbook", "Monthly meteorological charts of the Atlantic Ocean" and "Monthly meteorological charts of the Pacific Ocean" and two new publications, "Meteorology for mariners" and "Climatological and sea-surface current charts of the North Atlantic". Two of the six parts of a world-wide set of tables of temperature, relative humidity, and precipitation were also sent for printing.

Of the larger publications of observations, the *Observatories' Year Book* for 1938 was published, and the 1939 volume was in the press together with the *Réseau Mondial* for 1933 and 1934.

Publication work generally was seriously delayed by lack of staff, but arrangements are proposed which are expected to lead to overtaking the arrears of publication of the *Observatories' Year Book* within five or six years, and to an appreciable reduction in the time needed to prepare the research publications and textbooks for printing.

APPENDIX I

ORGANIZATION OF THE METEOROLOGICAL OFFICE



APPENDIX II

DIRECTORATE OF THE METEOROLOGICAL OFFICE AND HEADS OF BRANCHES

DIRECTOR

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

PRINCIPAL DEPUTY DIRECTOR

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

<p>DEPUTY DIRECTOR (RESEARCH)</p> <p style="padding-left: 20px;"><i>Assistant Director (Forecasting Research)</i></p> <p style="padding-left: 40px;">Short-Range Forecasting Research (M.O.21)</p> <p style="padding-left: 40px;">Long-Range Forecasting Research (M.O.22)</p> <p style="padding-left: 20px;"><i>Assistant Director (Physical Research)</i> ..</p> <p style="padding-left: 40px;">Physical Research and Observatories (M.O.15)</p> <p style="padding-left: 20px;"><i>Assistant Director (Special Investigations)</i></p> <p style="padding-left: 40px;">Special Investigations (M.O.9)</p> <p style="padding-left: 20px;"><i>Assistant Director (Climatological Research)</i></p> <p style="padding-left: 40px;">World Climatology (M.O.18)</p> <p style="padding-left: 40px;">Library and Editing (M.O.20)</p> <p style="padding-left: 40px;">Upper Air Climatology (M.O.23)</p> <p style="padding-left: 20px;"><i>Assistant Director (Instrument Development)</i></p> <p style="padding-left: 40px;">General Instruments (M.O.16)</p> <p style="padding-left: 40px;">Radio-sonde and Aircraft Instruments (M.O.17)</p> <p style="padding-left: 40px;">Instrument Provisioning (M.O.4)</p> <p>DEPUTY DIRECTOR (FORECASTING)</p> <p style="padding-left: 20px;"><i>Assistant Director (Central Forecasting)</i></p> <p style="padding-left: 40px;">Forecasting at C.F.O. (M.O.2)</p> <p style="padding-left: 20px;"><i>Assistant Director (Observations and Communications)</i></p> <p style="padding-left: 40px;">Communications, Charts and Codes (M.O.11)</p> <p style="padding-left: 40px;">Upper Air Observations (M.O.12)</p> <p style="padding-left: 40px;">C.F.O. Administration (M.O.25)</p> <p style="padding-left: 20px;"><i>Assistant Director (Public Services)</i></p> <p style="padding-left: 40px;">London Forecasting Office (M.O.24)</p> <p style="padding-left: 20px;"><i>Assistant Director (Climatological Services)</i></p> <p style="padding-left: 40px;">British Climatology (M.O.3)</p> <p style="padding-left: 40px;">Agricultural Meteorology (M.O.19)</p> <p style="padding-left: 20px;"><i>Marine Superintendent</i> (M.O.1)</p> <p>DEPUTY DIRECTOR (SERVICES)</p> <p style="padding-left: 20px;"><i>Assistant Director (Military Services)</i></p> <p style="padding-left: 40px;">Royal Air Force, Army, Ministry of Supply, Ministry of Defence (M.O.6)</p> <p style="padding-left: 20px;"><i>Assistant Director (Civil Aviation)</i></p> <p style="padding-left: 40px;">Civil Aviation (M.O.7)</p> <p style="padding-left: 20px;"><i>Assistant Director (Staff and General)</i></p> <p style="padding-left: 40px;">Staff and General (M.O.10)</p> <p style="padding-left: 40px;">Training (M.O.14)</p>	<p>R. C. Sutcliffe, O.B.E., B.Sc., Ph.D.</p> <p>J. S. Sawyer, M.A.</p> <p>R. H. Clements, M.A.</p> <p>J. M. Craddock, M.A.</p> <p>B. C. V. Oddie, B.Sc.</p> <p>R. F. Jones, B.A.</p> <p>P. J. Meade, O.B.E., B.Sc., A.R.C.S.</p> <p>L. Dods, B.Sc.</p> <p>A. G. Forsdyke, B.Sc., Ph.D., A.R.C.S., D.I.C.</p> <p>H. H. Lamb, M.A.</p> <p>G. A. Bull, B.Sc.</p> <p>J. K. Bannon, B.A.</p> <p>F. J. Scrase, O.B.E., M.A., Sc.D., F.Inst.P.</p> <p>R. Frith, O.B.E., M.A., Ph.D.</p> <p>D. N. Harrison, D.Phil.</p> <p>A. J. Lander, M.B.E.</p> <p>S. P. Peters, B.Sc.</p> <p>C. J. Boyden, B.A.</p> <p>—</p> <p>C. V. Ockenden, B.Sc.</p> <p>W. A. L. Marshall, M.B.E.</p> <p>A. L. Maidens, B.Sc.</p> <p>D. H. Clarke.</p> <p>J. S. Farquharson, M.A., D.Sc.</p> <p>W. R. Hanson, B.Sc.</p> <p>R. G. Veryard, B.Sc.</p> <p>J. Glasspoole, M.Sc., Ph.D.</p> <p>L. P. Smith, B.A.</p> <p>Cmdr C. E. N. Frankcom, O.B.E., R.D., R.N.R. (Retd)</p> <p>A. C. Best, O.B.E., D.Sc.</p> <p>T. W. V. Jones, B.Sc.</p> <p>F. E. Coles, B.Sc., A.R.C.S., D.I.C.</p> <p>W. H. Bigg, O.B.E., B.Sc.</p> <p>J. C. Cumming, O.B.E., M.A.</p> <p>H. L. Wright, M.A.</p> <p>K. H. Smith, B.Sc.</p> <p>A. H. Gordon, M.S. (Pasadena)</p>
--	---

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

PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES

The approximate cash provision in Air Estimates 1955-56 for meteorological services is as follows :—

Item	Service	Provision	Vote
		£	
1	<i>Staff</i>		
1a	Salaries, wages, etc. of staff at headquarters of the Meteorological Office	274,000	3
1b	Salaries, wages, etc. of civilians at meteorological observatories and outstation offices and in ocean weather ships	2,022,000	4
1c	Pay, etc. of airmen employed as air meteorological observers and meteorologists and of air force personnel of the Meteorological Research Flight ..	56,000	1
1d	National insurance contributions	3,100	1
1e	Pay, etc. of meteorological personnel of the Royal Air Force Reserve	2,500	2
1f	Superannuation allowances and gratuities	36,500	10
1g	Conveyance of personnel ; travelling allowances and expenses	94,000	5
2	<i>Equipment and Supplies</i>		
2a	Meteorological equipment	550,000	7
2b	Conveyance of equipment for meteorological services	17,000	5
2c	Solid fuel, electricity, gas, water and sanitary services for meteorological observatories and outstation offices	4,000	6
2d	Liquid fuel, lubricants, etc., for aircraft of the Meteorological Research Flight and for vehicles required for meteorological services	20,000	6
2e	Liquid fuel for ocean weather ships	52,000	6
2f	Other equipment and services for aircraft of the Meteorological Research Flight	25,000	7
2g	Other equipment and services for ocean weather ships	253,000	7
2h	General stores for meteorological services	4,000	7
2i	Food and ration allowances for air force personnel ; food for crews of ocean weather ships	37,000	6
2j	Clothing, clothing allowance and laundry services for airmen ; clothing for crews of ocean weather ships	7,500	7
3	<i>Works services for meteorological observatories and outstation offices</i>		
3a	Capital expenditure	83,000	8
3b	Maintenance expenditure	17,000	8
4	<i>Telecommunication services for meteorological purposes</i>	210,000	9
5	<i>Flights by civil aircraft for meteorological purposes ..</i>	5,000	9
6	<i>Subscription to the World Meteorological Organization</i>	7,500	9
7	<i>Fees for special services relating to meteorological research</i>	3,000	9

Item	Service	Provision	Vote
		£	
8	<i>Grant to the Royal Society in aid of meteorological research</i>	20,000	9
9	<i>Other miscellaneous effective services</i>	9,400	9
	GROSS TOTAL.. .. .	£3,812,500	
10	<i>Deduct-Appropriations in aid</i>		
		£	
10a	Repayment in respect of meteorological staff employed on special services, etc.		
	£		
	Salaries, wages, etc. ..	1,500	3
	Salaries, wages, etc. ..	408,000	4
	Movement expenses ..	14,000	5
	Contributions towards non-effective benefits..	5,000	10
		428,500	
10b	Receipts relating to meteorological equipment	100,000	7
10c	Payments by airmen for issues of clothing and footwear	1,000	7
10d	Receipts in respect of operation of ocean weather ships	72,000	9
10e	Receipts for miscellaneous meteorological services	14,000	9
		615,500	
	NET TOTAL	£3,197,000	

APPENDIX V

STRENGTH OF THE STAFF OF THE METEOROLOGICAL OFFICE

	March 31, 1955	March 31, 1956
Scientific Officers	155	153
Experimental Officers	655	668
Nautical Officers	7	8
Assistants (Scientific)	1,423*	1,385**
Ocean Weather Ship Staff (Nautical Grades) ..	37	35
Signals Grades	209	211
Radar Maintenance Grades	53	54
Clerical and Typing Staff	94	96
Miscellaneous (non-Industrial)	38	52
Miscellaneous (Industrial)	199	199
Locally entered employees (overseas)	160	247
Total ..	3,030	3,108

* Includes 207 airmen meteorologists.

** Includes 180 airmen meteorologists.

APPENDIX VI

METEOROLOGICAL OFFICE TRAINING SCHOOL

The courses which ended between April 1, 1955 and March 31, 1956 are shown in the table below.

	Length of course weeks	No. of courses	No. of trainees
Assistants, Initial course ..	8	20	259
Forecasters, Initial course ..	15	3	28
Forecasters, Advanced course ..	4	5	37
Forecasters, Refresher course ..	3	6	46
R.A.F.V.R. officers	2	2	11
R.A.F. officers on " E " list ..	2	10	116
Nautical officers	1	1	5
	days		
Voluntary observers	4	2	37

APPENDIX VII

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	8	0	15	179	15	11	2
Scotland, East	0	7	3	42	366	39	7	4
Scotland, West	1	4	2	30	408	23	12	6
England, North-east	0	9	4	24	348	32	17	5
England, East	0	11	12	20	487	29	37	8
England, Midlands	0	12	19	43	1,060	56	44	3
England, South-east (including London)	1	17	13	62	782	65	67	15
England, South-west	0	7	6	29	479	33	13	3
England, North-west	0	5	3	21	470	26	33	7
Wales, North	0	3	2	11	186	10	5	1
Wales, South	0	3	6	16	282	23	9	4
Isle of Man	0	2	0	1	13	3	1	1
Scilly and Channel Isles	0	2	0	2	18	5	1	1
Northern Ireland	0	5	0	7	90	6	4	2
Total	3	95	70	323	5,168*	365	261	62

* Includes stations in earlier columns.

Figures for the rainfall stations and the autographic rainfall records refer to the year 1954. All other figures show the position on January 1, 1956.

APPENDIX VIII

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 H.M. 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, 1956).
- Daily Weather Report*, containing weather maps for the northern hemisphere, British Isles, etc. and data (to March 31, 1956).
- Daily Weather Report Overseas Supplement*, containing surface and upper air data (to December 31, 1955).
- Meteorological Magazine* (to March 1956).
- Monthly Weather Report*, with summary for the year (to December 1955).
- Seismological Bulletin*. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to February 1956).
- Marine Observer* (quarterly) (to January 1956).
- British Rainfall 1953*. A report on the distribution of rain in space and time over Great Britain and Northern Ireland as recorded by about 5,000 observers.
- Annual Report and results of meteorological observations, 1954*. Southport Auxiliary Observatory. By George A. Lidster.
- Notes on the meteorological observations made in British Colonies and Protectorates, etc. in 1950 and summarized in the annual reports of Colonial Governments*.
- Meteorological and current summary for station India (61°00'N., 15°20'W. and 59°00'N., 19°00'W.) and station Juliett (52°30'N., 20°00'W.) for January to December, 1953 and 1954*.
- The Observatories' Year Book 1938* comprising the meteorological and geophysical results obtained from autographic records and eye observations at the Lerwick, Aberdeen, Eskdalemuir, Valentia and Kew observatories, and the results of soundings of the upper atmosphere by means of registering balloons.

OCCASIONAL

Handbook of Weather Messages :

Part I. Transmission schedules and station index numbers. 2nd edition, 1955.

International Meteorological Code adopted by the International Meteorological Organization, Washington 1947. Decode for use of shipping, incorporating the code for weather reports from and to ships and the analysis code for use of shipping. 3rd edition 1955.

Upper Air Data for stations maintained by the Meteorological Office.—Summaries of radio-sonde observations of temperature and humidity of radar wind measurements at standard pressure levels, 1946–50. Part 7, Bahrain (1947–50).

Geophysical Memoirs :

Vol. XII :

96. The free atmosphere in the vicinity of fronts. Analysis of the observations by the Meteorological Research Flight, 1950–52. By J. S. Sawyer, M.A.
97. Some features of jet streams as shown by aircraft observations. By R. Murray, M.A.

Professional Notes :—

Vol. VII :

113. Depressions crossing Labrador and the St. Lawrence basin. By A. G. Forsdyke, Ph.D.
114. A study of warm fronts. By A. G. Matthewman, M.A.
115. Cloud in relation to active warm fronts near Bircham Newton, 1942-46. By J. S. Sawyer, M.A. and F. E. Dinsdale, B.Sc.
116. Variations of the measured heights of pressure surfaces. By D. H. Johnson, M.Sc.
117. Barometric changes and the efflux of gas in mines. By C. S. Durst, B.A.
118. Rainfall of depressions which pass eastward over or near the British Isles. By J. S. Sawyer, M.A.
120. Distribution of wet-bulb temperature at Aberdeen and Eskdalemuir. By A. B. Thomson, M.A.

Meteorological Reports :

Vol. II :

16. Winds between 300 and 100 mb. in the tropics and subtropics. By A. Gilchrist, M.A.

INDEX

- Aden, 25
 Admiralty Pilots and charts, 21
 Agricultural investigations, 18
 — meteorology, 17
 Air density, 31
 — estimates, 5
 Army, Services for, 24
 Atmospheric pollution, 34
- Bibliographies, 22, 28, 35, 46
 British Broadcasting Corporation sound
 programme bulletin, 9
 — — — television, 13
 — Caribbean Meteorological Service, 28
 — climatological stations, 55
 — climatology, 15
 — Gliding Championship, 27
 — voluntary observing fleet, 19
British Rainfall, 16
 Broadcasting bulletin, 8
- Celsius scale of temperature, 9, 10
 Centenary year exhibitions, 13
 Central Forecasting Office, Dunstable, 8, 10,
 Ceremonial occasions, Forecasts for, 27
 Ceylon, 26
 Civil aviation, Examinations for, 27
 — — in the United Kingdom, Services for, 26
 — — overseas, Services for, 27
 — —, Services for, 26
 Climatology, British, 15
 Cloud, Research on, 30
 Committee, Gassiot, 3,29
 —, Meteorological, 2
 —, Research, 2
 — on Meteorology for Scotland, Advisory, 3
 Commonwealth meetings, 6,40
 —, Services for the, 28
 Communications, Land-line, 8, 25
 —, Radio, 8, 12
 Condensation nuclei, 30, 47
 — trails, 25, 30
 Current charts of the North Atlantic, 47
 Currents, 21
 Cyprus, 25
- Daily aerological record*, 9
Daily Weather report, 9
 Diffusion, 30
 Discussions, Monday afternoon, 35, 47
- East Hill, Radar research station, 31
 Edinburgh, Meteorological Office, 31
 Electronic computer, 7,33
 Equipment, Loans of, 45
 —, Provision and issue of, 44
 Eskdalemuir Observatory, 31
 Evaporation, Research on, 16,30
 Examinations for civil pilots, 27
- Facsimile, 12
 Falkland Islands, 28
 Familiarization flights, 27
 Far East area, 25
 Films, 46
 Flood warnings, 13
 Fog, 9
- Forecasting research, 33
 Forecasts, Dial telephone service, 7,14
 —, Extended period, 9,34
 — for ceremonial occasions, 27
 — — General Public, shipping, etc., 6,9
 — — special flights, 27
 Frost, 18
- General Public, Forecasts for, 6,9
 Geopotential metres, 9
 GL.III equipment, 44
 Gustiness, 30,34
- Headwinds, 34
 Heat balance, 30
 Heating and ventilating industry, 17
 Hollerith cards, 15,21
 Hong Kong, 26
 Horticultural meteorology, 19
 Humidity, 18,33
 — and plant disease, 18
 Hydrology, 16
- Ice, 21
 Inquiries, Agricultural, 19
 —, British climatological, 17
 —, Library, 46
 —, Marine, 21
 Inspection of stations, 15
 Instrument development, 31
 Instruments, Aircraft, 30
 —, Electrical, 45
 —, Provision and issue of, 44
 —, Radio-sonde, 45
 —, Testing and calibration of, 45
 International Civil Aviation Organization,
 26, 39
 — Geophysical Year, 41
 Investigations, Special, 34
 Iraq, 26
 Irrigation, 18,30
- Jet stream, 32
 Jordan, 44
- Kew Observatory, 30
- Lantern slides, 46
 Lectures, 34
 Lerwick Observatory, 31
 Library, 46
 Libya, 26
 Light-vessels, 19
- Magnetic variation swings, 20
 Malaya, 26
 Malta, 25
 Marine meteorology, 19
Marine Observer, 47
 Mediterranean broadcast, 12
 Meteorological flights, 10
Meteorological Magazine, 47
 Meteorological Office, Location and address-
 ses of headquarters and observatories, 51
 — —, Organization, 41, 49
 — —, Provision in Air estimates for, 52
 — — Training School, 44,54
 — Research Flight, 30
 — section at Porton, 31

INDEX

- " Meteorology for mariners ", 21, 47
 Middle East Command, 27
- Naval handbooks, 32
 Nicobar Islands, 26
 Nicosia Airport, 25
 North Atlantic Bulletin, 8
 North Atlantic Treaty Organization, 41
 Numerical forecasting, 7, 33, 44
 Numerical Weather Prediction Unit, 35
- Observations, Radar-wind, 10
 —, Radio-sonde, 10
 —, Surface, 10
Observatories' Year Book, 47, 48
 " Observer's handbook ", 47
 Ocean weather ships, 20
 Oceanographical work, 20
 Official publications, 9, 56
 Ozone distribution, 30
- Physical research, 30
 Plant diseases, 18
 Precipitation, Research on, 31
 Publications, 7, 22, 28, 35, 46, 56
 —, Exchange of, 46
 —, Loan of, 46
 Punched-card methods, 15, 21
- Radar A.A. equipment, 44
 — research station at East Hill, 31
 — storm warning equipment on Victory House roof, 14
 — wind equipment, Maintenance of, 45
 Radar-sonde system, 32
 Radiation, Atmospheric, 30
 Radio communications, 12
 Radio-sondes, 10, 45
 Raindrops, Growth of, 31
 Rainfall at sea, 32
 —, Hourly values, 16
 —, Intense falls, 17
 Rain-making, 31
 Research, Climatological, 32
 — Committee, Meteorological, 21
 —, Commonwealth relations, 29
 —, Forecasting, 33
 — on evaporation, 16, 30
 — — instruments, 31
 —, Physical, 29
 — programme, 29
 —, relations with the universities, 29
Réseau Mondial, 47
 Royal Air Force, Services for, 24
 — Institution, Lectures at the, 34
 — Navy, Services for, 24
- Sea-water temperature gradient, 21
 " Sferics ", 11
 Shelter-belts, 47
 Shipping, Forecasts for, 6, 9
 Ships, MARID, 19
 —, Ocean weather, 20
 — reports, 19
 —, " Selected ", 19
 —, " Supplementary ", 19
 — Voluntary observing, 19
 Smog, 9
 Snowfall, 17
 Special investigations, 34
 Staff, Complements, 42
 —, Retirements, 43
 —, Royal Air Force personnel, 43
 —, Strength of, 54
 —, Transfers, 42
 —, Training of, 44
 Stations, British climatological, 55
 —, Rainfall, 15
 Storm-warning equipment on Victory House roof, Radar, 14
- Tables of temperature, relative humidity and precipitation over the world, 47
 Telephone service for forecasts, Dial, 7, 14
 Teleprinters, 11
 Temperature, Accumulated, 16, 18
 —, Hourly values, 16
 —, Upper air, 32
 Thermobuoy, 21
 Thunderstorm location, 11
 Training, 44
 Trans-Antarctic Expedition, 41
 Tropopause, 32
 Turbulence, 30, 31
 Turbulent conditions, Forecasting of, 27
- United Nations Technical Assistance Scheme, 39
 Upper air, Research on the, 32
 Usability of airfields, 34
- Vapour pressure over the world, Mean, 33
 Visibility, 30
- Warning equipment on Victory House roof, Radar storm, 14
 —, Flood, 13
 WEA telephone service, 7, 14
 Weather and the builder, 17
 Winds, Upper, 32
 World Meteorological Organization, 6, 38
 " Your weather service ", 15

ABRIDGED LIST OF PUBLICATIONS OF THE METEOROLOGICAL OFFICE

*Publications may be ordered from the bookshops of Her Majesty's Stationery Office
at the addresses on cover page iv or through any bookseller*

Cloud Forms. Definitions and descriptions, with photographs of clouds.
(M.O. 223, 6th edition, 1949, reprinted 1954.) 2s. 6d. (2s. 8d.)

Weather Map. An introduction to weather forecasting. (M.O. 595.) *In the press*

Meteorological Glossary. (M.O. 225ii, 3rd edition, 1939, reprinted 1953.)
12s. 6d. (13s. 5d.)

Handbook of Weather Messages, Codes and Specifications. (M.O. 510.)

Part I. Transmission schedules and station index numbers. (2nd edition,
1955.) 6s. (6s. 4d.)

Part II. Codes and Specifications. (2nd edition, 1954.) 4s. 6d. (4s. 11d.)

Part III. Coding, decoding and plotting. (2nd edition, 1954.) 4s. 6d. (4s. 9d.)

(Amendments 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.) 1s. 9d. (1s. 11d.)

International Meteorological Code adopted by the International Meteorological
Organisation, Washington, 1947. **Decode for the use of shipping**, incorporating
the code for weather reports from and to ships and the analysis code for the use
of shipping. (M.O. 509, 3rd edition, 1955.) 1s. 6d. (1s. 8d.)

Marine Observer's Handbook. (M.O. 522, 7th edition, 1950, reprinted 1952.)
10s. 6d. (11s. 3d.)

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

Meteorology of Airfields. By C. S. Durst, B.A. (M.O. 507, 1949, reprinted 1950.)
2s. (2s. 3d.)

Meteorology for Aviators. By R. C. Sutcliffe, Ph.D. (M.O. 432, 1940, reprinted
1953.) 10s. (10s. 11d.)

A Short Course in Elementary Meteorology. By W. H. Pick, B.Sc., F.C.P.,
F.Inst.P. (M.O. 247, 5th edition, 1938, reprinted 1953.) 4s. 6d. (4s. 9d.)

Prices in brackets include postage

THE METEOROLOGICAL MAGAZINE

Founded by G. J. Symons, F.R.S., in 1866

The magazine contains authoritative articles on a wide variety of topics, including the first accounts of much recent research of great importance, international collaboration in meteorology and aviation, reports of scientific meetings, official notes of interest to observers, notices of Meteorological publications, reviews of new books, notes and figures of interesting weather of the past month, and letters from correspondents.

Price 2s. By post 2s. 2d.

Annual Subscription 25s. including postage

Obtainable from

HER MAJESTY'S STATIONERY OFFICE

at the addresses on cover page iv

or through any bookseller

Crown copyright reserved

Published by
HER MAJESTY'S STATIONERY OFFICE

To be purchased from
York House, Kingsway, London w.c.2
423 Oxford Street, London w.1
P.O. Box 569, London s.e.1
13A Castle Street, Edinburgh 2
109 St. Mary Street, Cardiff
39 King Street, Manchester 2
Tower Lane, Bristol 1
2 Edmund Street, Birmingham 3
80 Chichester Street, Belfast
or through any bookseller