

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, 1952 TO MARCH 31, 1953



LONDON : HER MAJESTY'S STATIONERY OFFICE
1953

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TWO SHILLINGS NET

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Decimal Index
551.5 (058)

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Recd: - 27 NOV 1953

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Mr. W. B. Foden, C.B. (Air Ministry) (to January 31, 1953)

Sir Harry Garner, K.B.E., C.B. (Ministry of Supply) (to February 22,
1953)

Professor W. M. H. Greaves, F.R.S. (Royal Society of Edinburgh)

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Professor O. G. Sutton, C.B.E., F.R.S. (Royal Society)

Dr. O. H. Wansbrough-Jones, C.B., O.B.E. (Ministry of Supply) (from
February 23, 1953)

Secretary :—Mr. R. J. Williams

The Committee met on June 12, 1953.

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Appointed by the Meteorological Committee

Chairman :—Sir Nelson Johnson, K.C.B. (Director, Meteorological Office)

Members :—Mr. E. G. Dymond (University of Edinburgh)

Dr. A. E. M. Geddes, O.B.E., F.R.S.E. (University of Aberdeen)

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Dr. David Jack, F.Inst.P., F.R.S.E. (University of St. Andrews)

Mr. J. S. Munro (Fisheries Division, Scottish Home Department)

Mr. J. Paton (Royal Meteorological Society)

Dr. R. G. Peters (Department of Health for Scotland)

Professor W. M. Smart (University of Glasgow)

Mr. A. R. Wannop, O.B.E. (Department of Agriculture for Scotland)

Sir Ernest Wedderburn, O.B.E. (Royal Society of Edinburgh)

Secretary :—Mr. R. A. Watson

The Committee met on June 26, 1952

Mr. E. G. Dymond died on October 26, 1952.

METEOROLOGICAL RESEARCH COMMITTEE

Appointed by the Secretary of State for Air

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Instructor Captain P. Bracelin, O.B.E., R.N. (Admiralty)

Professor S. Chapman, F.R.S.

Professor G. M. B. Dobson, C.B.E., F.R.S.

Sir Harry Garner, K.B.E., C.B. (Ministry of Supply) (until February 1953)

Dr. O. H. Wansbrough-Jones, C.B., O.B.E. (Ministry of Supply) (from February 1953)

Sir Nelson Johnson, K.C.B. (Director, Meteorological Office)

Wing Commander N. G. Macfarlane, D.S.O. (Air Ministry) (until May 1952)

Wing Commander K. P. Mackenzie (Air Ministry) (from May 1952 until February 1953)

Squadron Leader A. A. B. Cleaver (Air Ministry) (from February 1953)

Sir Charles Normand, C.I.E.

Professor P. A. Sheppard

Professor O. G. Sutton, C.B.E., F.R.S.

Professor Sir Geoffrey Taylor, F.R.S. (until December 1952)

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

GASSIOT COMMITTEE

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

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Professor D. R. Bates

Sir David Brunt

Professor S. Chapman

Professor T. G. Cowling

Professor G. M. B. Dobson

Mr. E. Gold

Sir Charles Normand

Professor F. A. Paneth

Professor P. A. Sheppard

Professor O. G. Sutton

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 20, 1952.

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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, 1952, TO MARCH 31, 1953

§ 1. 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.

General policy is controlled by the Meteorological Committee of which the Under Secretary of State for Air is Chairman. Almost all those Government Departments to which the Meteorological Office regularly provides services are represented on the Committee, and there are also representatives of the Royal Society, the Royal Society of Edinburgh, and the British Universities.

The general functions of the Meteorological Office are :—

- (i) Provision of meteorological services to the Army, Royal Air Force, Civil Aviation, Ministry of Supply and the Merchant Navy.
- (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 V shows the provision made in the Air Estimates for expenses and receipts of the Meteorological Office for the financial year 1953-54.

§ 2. FORECASTING SERVICES RENDERED BY THE METEOROLOGICAL OFFICE

(1) Organization for Forecasting

(a) **Central Forecasting Office.**—The headquarters of the forecasting service and the main communications centre of the Meteorological Office are situated at Dunstable. The organization of the Central Forecasting Office, into Divisions and Branches under a Deputy Director, is shown in Appendix I.

The functions of the Central Forecasting Office are :—

- (i) To collect meteorological data required for forecasting both at Dunstable and at outstations.
- (ii) To disseminate the data to meet the needs of outstations and in accordance with international requirements.
- (iii) To provide basic analyses and prognostic analyses covering a wide area for the guidance of forecasters at outstations and for the information of foreign meteorological services.
- (iv) To provide the forecasts, weather warnings and other information on current weather required by Government Departments, public services and the general public.
- (v) To prepare and keep up to date the forms, handbooks and other publications relating to the services provided.
- (vi) To carry out research work on forecasting problems with the object of increasing the accuracy of the forecasts and extending the period for which they can be provided.

No important changes were made during the year.

(b) Reporting stations.—Following the reorganization made in 1951 of the network of stations supplying reports in full synoptic code, only minor changes were necessary. Full reports were supplied by 78 stations, at 18 of which the observations were made by part-time observers, normally engaged in other walks of life. In addition, 28 auxiliary stations supplied a smaller amount of information, usually in the abbreviated code. The part-time observers at these stations included coastguards and lighthouse keepers, schoolmasters, ministers and railway officials ; a high standard of observing was maintained. New auxiliary stations were opened in Snowdonia and the Lake District. Observations in abbreviated code were also supplied by many of the smaller meteorological offices, by Royal Naval Air stations, and by United States Air Force stations in the British Isles. In all, observations from 101 stations were received in the abbreviated form at least twice daily, and in many cases at hourly intervals.

(c) Ships' reports.—*Voluntary observing ships.*—The organization of voluntary observing ships is described on p. 21.

About 135 ships' reports from the eastern North Atlantic Ocean (north of 35°N., east of 40°W.) were received daily at the Meteorological Communications Centre at Dunstable. Of these, 112 were from British ships and 23 from foreign ships ; 55 per cent. of these messages were received within one hour and 5 per cent. within two hours of the time of observation. Reception was facilitated by a direct teleprinter line between the Central Forecasting Office and the Post Office wireless station at Burnham-on-Sea.

Ocean weather ships.—The British weather ships in the North Atlantic carried out a full programme of surface and upper air observations, which were communicated to the Central Forecasting Office by point-to-point W/T. Radio weather messages from ocean weather ships operated by other nations in the North Atlantic were received regularly throughout the year.

(d) Meteorological flights.—Routine meteorological reconnaissance flights by R.A.F. Hastings aircraft were made from the R.A.F. station at Aldergrove

at the rate of two or three a week. To enhance the value of the flights alternative tracks were selected, the actual course flown on any occasion being determined by the meteorological situation.

Daily routine vertical ascents were made with great regularity in the United Kingdom by a civilian contractor under the direction of R.A.F. Home Command. Most of these ascents were made in the neighbourhood of Worcester. Less regular ascents and short-range reconnaissance flights were performed by R.A.F. Hornet aircraft based on Singapore.

(e) Radio-sonde and radar wind stations.—No changes were made in the network of radio-sonde and radar wind stations. At the eight stations in the United Kingdom and on the two British ocean weather ships measurements of pressure, temperature and humidity were made twice daily, at 0300 and 1500 G.M.T., observations of upper wind by radar being obtained four times a day at 0300, 0900, 1500 and 2100 G.M.T. At eight overseas stations under British control two complete ascents, for both temperature and wind, were made daily.

Additional ascents were made from time to time to meet special requirements, such as bombing trials by the R.A.F. and flights by the Canberra and other aircraft across the Atlantic Ocean.

For the past few years work has been proceeding on the development of a radar-sonde. A site for the ground station was selected at Pease Pottage, near Crawley in Sussex. Building started in July 1952 and was virtually completed by January 1953, when the equipment was installed. Tests were started. This is the first radar-sonde station specially designed for routine operation to be established in any country. Values of pressure, temperature and humidity will be recorded automatically in the form of graphs or teleprinter copy, and the accuracy of telemetering is of the order of one part in a thousand.

(f) Thunderstorm location.—The location of thunderstorms by the "sferic" system continued without major change, using the network of four direction-finding stations, at Hemsby (near Great Yarmouth), Camborne (Cornwall), Leuchars (Fife) and Irvinestown (Northern Ireland), together with a control and plotting section at Dunstable.

Special observations were made on behalf of scientists at Cambridge and London Universities and at the National Physical Laboratory, where investigations into the propagation and wave form of long radio waves and atmospherics were being conducted. Trials in the use of radio links, instead of telephones, for co-ordinating the observations were successfully carried out, and by this means simultaneous observations on selected "flashes" were made in the United Kingdom and at Zurich, for an experimental period of one month, in conjunction with the Swiss meteorological service.

A memorandum on certain aspects of British technique was prepared for the World Symposium on "sferics" which was attended by a Meteorological Office representative in March 1953.

(g) Meteorological communications.—*Land-line communications.*—Four teleprinter broadcasts continued to be made from Dunstable. The main broadcast (Channel 1) supplied basic data to approximately 186 stations, a small increase over last year's figure (the actual number varied slightly throughout the year). A second broadcast (Channel 2), consisting of supplementary data, was made to approximately 75 stations as compared with 62 last year. A third broadcast

of North American and North Atlantic data was made to 17 stations concerned with transatlantic flying or having major forecast commitments. A fourth broadcast supplied selected data to meteorological communications centres connected to the western European teleprinter network.

As a result of a detailed survey of existing lines and requirements of stations made during the year it was found possible to recover a number of speech and telegraph circuits.

The contents of bulletins included in the broadcasts were kept under review to ensure that the changing requirements of recipients were met to the maximum extent possible.

Plans were completed on an international basis for modifying the western European network in the near future in consequence of the proposed establishment of one main centre at Frankfurt in lieu of the two existing centres in Western Germany.

Radio communications.—The three W/T broadcasts (continental, sub-continental and national) were continued with only minor alterations to schedules. Some progress was made in negotiations for the acquisition of additional land for the erection of aerial arrays to improve reception of distant stations.

The reception of North American data via the New York—Azores—Paris radio-teleprinter circuit was still unreliable during periods of adverse radio propagation. In order to obviate delays sometimes experienced in the receipt of observations from ocean weather ships in the Atlantic, the United States authorities agreed that when point-to-point working with the appropriate shore station was impossible, stations “A”, “B” and “C” would broadcast their reports.

Following extensive trials with prototype models, delivery was taken of production facsimile equipment comprising two transmitters and six recorders. Recorders were installed at Prestwick, Duxford, Hullavington and Bawtry, and an experimental radio facsimile broadcast using sub-carrier frequency modulation was made on 4,780 Kc. from Dunstable. Difficulties which arose in providing suitable transmitters for making broadcasts on the other available frequencies of 2,655 Kc. and 9,485 Kc. were expected to be resolved.

Very satisfactory results were obtained on the reception of facsimile broadcasts made by the United States agencies in such places as Balboa, San Francisco, Alaska, Washington, Guam and the Far East.

(2) Supply of Forecasts for the General Public, Government Departments, etc.

The following are among the services rendered by the Meteorological Office :—

(a) General public, shipping, etc.—Numerous forecasts were supplied to the general public, on request and through previous arrangement, by the meteorological offices specified in the Post Office Guide. These forecasts included many connected with sporting and recreational activities.

The British Broadcasting Corporation included daily weather bulletins and forecasts for shipping in the Home and European Services. Daily television broadcasts of charts and forecasts were continued. The areas of southern Scotland and south-west England were included when the new transmitters at Kirk O'Shotts and Wenvoe were brought into operation.

(b) Railways.—Forecasts and warnings of snow, frost, fog and thunderstorms continued to be issued as in the previous year.

(c) British Electricity Authority.—Daily forecasts of meteorological conditions affecting electricity loading were issued to Grid Control Centres. The supply of special week-end temperature forecasts was continued and a broad outlook for four days ahead was supplied to the Authority bi-weekly. The meteorological unit at the British Electricity Authority Headquarters was maintained.

(d) Gas undertakings.—Warnings of expected changes in meteorological elements affecting day-to-day requirements of gas were issued as in previous years.

(e) Agriculture and Horticulture.—Frost warnings were supplied to County Branch Officers of the National Farmers' Union for dissemination to fruit growers and market gardeners.

Warnings of snowfalls or drifts expected on high ground in northern England were supplied to County Branch Officers of the National Farmers' Union for the benefit of sheep farmers.

The fine-spell notification service was used extensively by farmers and others.

(f) River Boards, etc.—Forecasts of conditions liable to result in flooding were supplied as necessary to the Thames Conservancy Board, Yorkshire Ouse and Great Ouse River Boards, East Suffolk and Norfolk Rivers Board and to certain police authorities.

Following upon the disastrous floods on the east coast on January 31, 1953, the Office co-operated in the flood-warning scheme planned by the Home Office Sub-Committee, by issuing flood alerts, gale warnings and strong-wind warnings to the River Boards concerned (see §3(1)(e) *Hydrology* (p.18).

(g) Docks and Inland Waterways Executive.—Warnings of persistent frosts likely to produce ice on canals in the Wolverhampton area, were supplied.

(h) Road engineers and automobile clubs.—Warnings of the onset of meteorological conditions likely to cause bad road conditions were supplied to various Government Departments and motoring associations. A further increase occurred in the number of local authorities utilizing snow warnings in connexion with snow-clearance schemes.

(i) Factories and other commercial undertakings.—Special forecasts were supplied, as in previous years, of weather conditions affecting industrial processes. In connexion with arrangements for effecting economies in factory heating extensive use was made by industrial subscribers of a special multi-address telegraph service providing mean week-end temperature forecasts.

(j) Belfast Harbour Power Station.—Special week-end temperature forecasts were issued throughout the year to assist in estimating the consumption of electricity.

(k) Film companies.—Special weather forecasts for the Greater London area were supplied twice daily throughout the year, and for other areas on request.

(l) Department of Scientific and Industrial Research.—Information on upper air temperatures was supplied daily to the Radio Research Station, Slough, for investigations into television reception.

Forecasts and warnings of drifting snow and ice formation on roads were supplied to the Road Research Laboratory as in previous years.

(m) Ministry of Fuel and Power.—Warnings of sharp falls in barometric pressure were issued to certain collieries, in connexion with experiments on a colliery warning system.

(n) University Research Departments.—A number of forecasts were issued to University Research Departments in connexion with experimental high-altitude balloon ascents.

(o) Ceremonial occasions.—Forecasts for State Ceremonial and pageant occasions were issued as required.

(3) Services for the Royal Air Force

(a) Organization.—There was no important change in the organization of meteorological services to the Royal Air Force, but the expansion of military services during the year necessitated the provision of new meteorological offices. Staffing limitations, coupled with some short-fall in recruitment in the experimental and scientific grades, prevented the manning of some of the meteorological offices requested by the Royal Air Force. In such cases meteorological information was provided by telephone from a neighbouring office or the period for which on-the-spot service was provided was limited to accord with the strength of staff available.

In the British Zone of Germany, German forecasters and assistants continued to be employed in our meteorological offices under the supervision of British staff.

Little change of organization occurred in the Middle East and Far East areas, although the requirements for meteorological services increased at many places. Technical control of the meteorological services in Libya continued to be undertaken by the British Meteorological office on an agency basis.

(b) Facilities.—In addition to the normal meteorological service, special facilities were provided for large-scale R.A.F. and Joint Exercises, for long-range training flights by pilots of the R.A.F. Flying College Manby and the Central Navigation and Control School Shawbury, and for flights by jet aircraft across the Atlantic, to overseas Commands, and to Australia.

Mobile meteorological units were provided during Allied Exercises in western Europe.

International Civil Aviation Organization VOLMET broadcasts and R.A.F. broadcasts of weather reports and landing forecasts by Uxbridge, Gloucester, Watnall (on a restricted scale) and R.A.F. stations in the Middle East Air Force Command were maintained, but those from Gibraltar were discontinued as a separate broadcast in July and incorporated in the Gibraltar Territorial Broadcast.

TALK-TO-MET facilities, whereby meteorological information was supplied direct from the meteorological office at El Adem to over-flying aircraft by radio-telephony, were discontinued in April.

In the Far East additional meteorological facilities continued to be provided for the military forces in Malaya and Hongkong.

(c) Royal Air Force Meteorological Policy Committee.—No meeting of this Committee was held during the year, but a meeting was held of a small Sub-

Committee to consider special problems. In addition, a Working Group was formed in December 1952 to investigate means of overcoming difficulties in the provision of meteorological services for R.A.F. formations caused by staffing limitations.

(d) Miscellaneous activities.—R.A.F. pilots continued to supply reports of severe turbulence, condensation trails and ice accretion, which facilitated the study of these phenomena.

Trial flights were made by R.A.F. jet aircraft between Habbaniya and Bahrein in order to investigate the wind profile at high levels in that region. The photographic technique employed on these flights was a substitute for the establishment of a network of radar wind stations to find out the extent of the very strong wind liable to be encountered at high levels between Egypt and India.

Four meteorological offices were supplied with the necessary equipment for the reception of experimental facsimile broadcasts of surface and upper air weather maps and analyses, etc., broadcast from the Central Forecasting Office, Dunstable.

(e) Meteorological instruction for the Royal Air Force.—It was decided that the revised version of "Meteorology for aviators" should be the advanced textbook on meteorology for the R.A.F. Whether a replacement for "Meteorological handbook for pilots and navigators" will be required depends on the new syllabi for meteorological instruction in Flying Training Command, which were being considered.

Meteorological instruction was given at a large number of schools in Flying Training Command, at Operational Conversion Units and at other R.A.F. units at home and overseas.

A film strip entitled "High-altitude meteorology" was produced and copies of lecture notes for use with it were issued.

(4) Services for Civil Aviation

(a) Organization.—Meteorological facilities were provided in the United Kingdom and overseas in conformity with the recommendations of the International Civil Aviation Organization. Changes in procedure recommended by the third Regional Air Navigation meeting of the International Civil Aviation Organization for the Europe-Mediterranean region were implemented during the year.

The main meteorological offices at Prestwick, Preston and Uxbridge continued to provide information to the associated Air Traffic Control Centres. Revised criteria issued by these offices for warnings of meteorological conditions hazardous to aircraft in flight were under discussion with the Ministry of Civil Aviation.

Broadcasts by radio-telegraphy of aerodrome weather reports and forecasts, for the information of aircraft in flight, continued to be made from Uxbridge, Preston and Prestwick. On July 1, 1952, changes in the contents of these broadcasts were made in accordance with international recommendations.

The V.H.F. radio-telephony broadcasts made on area control frequencies from Uxbridge and Prestwick continued unchanged. At the request of the Director of the Irish Meteorological Service half-hourly weather reports for Dublin were added to the broadcasts from Preston.

Revised criteria were agreed and brought into use on February 1, 1953, for special reports of deterioration or improvement in weather conditions supplied to aerodrome Air Traffic Control Offices for the use of aircraft approaching to land. Arrangements were made for a selection of these reports to be sent to the Air Traffic Control Centres for the information of controllers and for passing to aircraft in flight, as well as for broadcast by teleprinter to United Kingdom meteorological offices.

New procedures agreed between the Ministry of Civil Aviation and the Air Ministry for the setting of altimeters in the United Kingdom were introduced on November 1, 1952. From this date the Meteorological Office provided hourly forecast barometric pressure for twelve designated points within the boundaries of the United Kingdom flight information regions.

With the co-operation of the British European and Overseas Airways Corporations flights continued to be made by meteorological officers for the purpose of gaining first-hand experience of conditions on the routes for which they held forecasting responsibility. Such "familiarization flights" included those in Comet aircraft by forecasters from United Kingdom offices and from overseas staging posts along the trunk routes.

Arrangements were made for radar units at Ministry of Civil Aviation aerodromes to supply reports of radar storm echoes to local meteorological offices for their information, and for the reports received at London Airport, which include the height of the echo and its apparent direction of movement, to be transmitted to other United Kingdom stations.

(b) Ministry of Civil Aviation Meteorological Standing Committee.—This Committee, on which the Office is represented, was set up during the year to deal with meteorological problems affecting civil aviation. After the preliminary meeting, when terms of reference were discussed, a second meeting was held to consider the requirements for upper air data for current and planned operations of gas-turbine and jet aircraft, and the implementation of the recommendations of the International Civil Aviation Organization for radio-sonde and radar wind stations overseas.

(c) Services provided in the United Kingdom.—Meteorological offices were maintained at 23 civil aerodromes—a decrease of one during the year, due to the transfer of Edinburgh (Turnhouse) aerodrome to the R.A.F.

London Airport and Prestwick continued to provide facilities for North Atlantic and other trunk routes, and increasing use was made of London Airport by airlines operating on routes to European terminals. Further increases in forecast service were provided at London Airport to meet additional air traffic consequent on the introduction of "tourist" services, mainly on the North Atlantic routes, and of commercial Comet services to South Africa, Ceylon and Malaya. The office at Northolt continued to supply information for a large number of services to destinations in Europe and within the United Kingdom.

The increasing use of Blackbushe by charter operators necessitated the introduction of a 24-hr. observational watch from May 9, 1952, onwards. Stansted was also used more frequently by independent airlines, and special arrangements were made for the supply of meteorological information for long-distance flights starting from there. Meteorological services for Machri-

hanish aerodrome were provided by Renfrew from September 10, 1952, when the aerodrome was returned from the Admiralty to the Ministry of Civil Aviation.

Meteorological facilities for British European Airways Corporation's experimental helicopter flights from Gatwick were provided by the office at Croydon.

(d) Services provided overseas.—Meteorological service for civil aviation continued to be provided at a number of joint-user airfields in the Middle East Command.

Liaison was maintained with colonial and foreign meteorological services along trunk routes, and copies of papers prepared in the United Kingdom on upper wind and temperature at high levels were supplied to overseas offices and services concerned with Comet operations.

(e) Examinations.—Examinations were held in meteorology for the Commercial Pilot, Senior Commercial Pilot, Airline Transport Pilot and Flight Navigator Licences, and for Air Traffic Control Officers' primary courses; 1,072 candidates were examined during the year, an increase of 101. A syllabus for a new licence, Private Airship Pilot, was introduced.

A number of Air Traffic Control Officers of the Ministry of Civil Aviation received instruction in the making and reporting of weather observations, so that they could undertake the provision of aerodrome weather reports at any Ministry of Civil Aviation aerodrome where there was no meteorological office. Subject to certain conditions, these officers were given a certificate of competency in making meteorological observations.

(f) Special work.—Meteorological officers gave evidence at the Public Inquiries into the aircraft accidents near Snowdon on January 10, 1952, and in the English Channel on June 14, 1952. Detailed reports on the meteorological aspects of a number of other accidents, including those at Belfast (Nutts Corner) on January 5, 1953, and near Birmingham on January 1, 1953, were prepared for the Accidents Investigation Branch, Ministry of Civil Aviation.

A subsidiary forecasting office was set up at Newcastle (Woolsington) for July 11 and 12, 1952, to supply meteorological information and advice to the organizers of and competitors in the King's Cup and other National Air Races. Similar arrangements were made for the *Daily Express* South Coast Air Race at Shoreham on August 2, 1952.

Basic meteorological information was supplied daily to Malham Tarn during the period of the meteorological course organized by the Royal Meteorological Society on behalf of the Council for the Promotion of Field Studies.

London Airport and Prestwick participated in an International Civil Aviation Organization experiment designed to evaluate the improvement in forecasting accuracy of upper winds, resulting from a series of 4 radio-sonde/radar wind observations a day over the North Atlantic Region as against the normal routine of 2 full ascents a day.

Special meteorological route organizations were prepared for Royal Flights, and for record-making Canberra flights to Canada and return, to east Africa, and to Australia.

Arrangements were made mainly with the British Corporations for the supply of aircraft observations in connexion with investigations into aircraft

icing and turbulence. Investigations continued at certain civil aerodromes into the relation between horizontal visibility and visibility from air to ground during mist and fog.

(5) Services for the Royal Navy*

Certain meteorological offices overseas continued to provide weather forecasts and other information for units of the Royal Navy. Close liaison was maintained with the local Naval authorities at Malta, Port Said, the Persian Gulf and in the Far East.

Special meteorological facilities were provided for joint R.N. and R.A.F. Exercises, including forecasting units at the Maritime Headquarters at Mount Wise, Chatham, Londonderry and Pitreavie. In accordance with current policy Officers of the Naval Weather Service were attached as Liaison Officers for the briefing of Naval Staff Officers during joint Exercises.

(6) Services for the Army

The meteorological office at the School of Artillery, Larkhill, was maintained.

Meteorological information needed at Artillery Practice Camps was provided either by a member of the Meteorological Office staff attached to the camp or by a nearby meteorological office. Meteorological facilities for the Army continued to be provided in overseas commands.

The Meteorological Office was represented on a number of War Office committees.

(7) Services for the Ministry of Supply

The meteorological office formerly maintained at Windscale was withdrawn, and radio-sonde equipment was installed at Shoeburyness and Eskmeals; otherwise there were no changes in the services provided for the Ministry of Supply.

(8) Services for the Merchant Navy and Fishing Fleets

The Central Forecasting Office maintained the service of gale warnings and forecasts for shipping as in former years. These warnings and forecasts for coastal sea areas of the British Isles were disseminated in B.B.C. radio programmes and by G.P.O. coastal radio stations. In the B.B.C. Light Programme gale warnings were read out within a few minutes of issue. They were repeated at the beginning of each weather bulletin in the Home Service, at 6.55 a.m. (except Sundays), 7.55 a.m., 12.55 p.m., 5.55 p.m. clock times. The forecasts for shipping were given in the same bulletins. By arrangement with the Ministry of Transport through the Coastguard Services visual gale-warning signals in the form of canvas cones were exhibited at many points on the coast.

The North Atlantic shipping bulletin, broadcast twice daily by the Admiralty and Portishead Radio at 0930 and 2130 G.M.T., included storm warnings and forecasts for the north-eastern Atlantic Ocean. An analysis of pressure and frontal systems for the use of shipping was broadcast daily at 1130 G.M.T.

* The Director of the Naval Weather Service submits an *Annual Report* to the Board of Admiralty.

Forecast centres near ports issued on request local forecasts or weather reports to masters of ships and others concerned with the movements of shipping or with the loading and discharging of cargo.

(9) Services for the Commonwealth

(a) **Middle East area.**—*Malta.*—The Meteorological Office continued to maintain a forecasting service at Luqa and a radio-sonde/radar wind unit at Qrendi. Meteorological facilities on a greatly increased scale were provided for all R.A.F., military and civil aviation services. The exchange of meteorological information with neighbouring countries was maintained.

Cyprus.—The forecasting service and a radio-sonde/radar wind unit at Nicosia provided meteorological facilities for all R.A.F., military and civil aviation services. The issue of weather forecasts for inclusion in transmissions by the Cyprus Government Broadcasting Service began early in 1953.

Aden.—A forecast service and a radio-sonde/radar wind unit were maintained at Khormaksar to meet the requirements of the R.A.F., of shipping, and of civil aviation. Reports were provided from stations along the south Arabian coast and on Kamaran Island.

British Somaliland.—The Meteorological Office continued to exercise technical control over the reporting station at Hargeisa. Training of Somali staff in meteorological duties was undertaken at Aden.

Pakistan.—A forecasting service was maintained at the R.A.F. Staging Post, Mauripur, to meet the requirements of the Royal Air Force and of the Royal Pakistan Air Force. Efforts were made to replace the British meteorological assistants by Pakistanis. The scheme was agreed in principle, but staff were not available.

(b) **Far East area.**—*Ceylon.*—All meteorological facilities for the R.A.F. and for civil aviation services using Negombo were provided during 1952 by the British meteorological office at Negombo. In January 1953 the Ceylon Meteorological Service assumed the main responsibilities for these services, the office at Negombo undertaking observational duties and the briefing and de-briefing of R.A.F. aircrews at Negombo.

In April 1952 the Ceylon Meteorological Service took over from the R.A.F. responsibility for the national meteorological broadcasts and for the collection of meteorological reports from Male.

Male.—The free loan of meteorological equipment used by the synoptic and upper wind reporting station at Male was continued.

Malaya.—The Meteorological Office was responsible for meeting the requirements of the R.A.F. in Malaya with offices at Changi, Tengah, Seletar and Butterworth. Routine radar wind observations continued to be made from a site near Singapore using Army radar equipment operated by Army personnel, the computations being made by meteorological staff. The observations were increased from two to three weekly from June 1952.

Nicobar Islands.—A meteorological reporting station continued to be maintained at Car Nicobar.

Hongkong.—A small complement of Meteorological Office staff assisted the Royal Observatory in meeting the requirements of the Army and Royal Air Force. Forecasting facilities were provided at the R.A.F. station at Sekkong from June 1952.

(c) **British West Indies.**—The newly formed British Caribbean Meteorological Service was staffed by Meteorological Office forecasters pending their replacement by forecasters of the Caribbean Meteorological Service.

(d) **Falkland Islands.**—The Meteorological Office continued to maintain a radio-sonde/radar wind unit at Port Stanley.

(10) Services in Foreign Countries

(a) **European area.**—*Germany.*—The Meteorological Office continued to be responsible for the provision of meteorological services in the British Zone of Germany to meet the needs of British Forces and of the High Commission.

The Chief Meteorological Officer, 2nd Tactical Air Force, continued to be the British representative on the Allied Meteorological Board under the General Committee of the Allied High Commissioner.

The law relating to the fusion of the German Meteorological Services in the three western zones of Germany was passed by the Federal Parliament in November 1952, and the central administrative unit of the new Federal German Meteorological Service began to form at Frankfurt in February 1953.

The Chief Meteorological Officer, 2nd Tactical Air Force, was appointed Chief Meteorological Officer, 2nd Allied Tactical Air Force.

Austria.—A meteorological office was maintained at Schwechat (Vienna) with a British meteorological officer in charge of Austrian forecasters and assistants.

(b) **Middle East area.**—*Libya.*—Technical control of meteorological services in Libya continued to be exercised by the Director of the British Meteorological Office through the Chief Meteorological Officer, Middle East Air Force. Meteorological Office staff continued to fill posts for which suitably trained staff of local origin were not available. Forecasting offices at Idris (formerly named Castel Benito) and El Adem were linked with small networks of reporting stations in Tripolitania and Cyrenaica. Forecasts required at Benina airport were supplied from El Adem or Malta.

Egypt.—The British Meteorological Office retained responsibility for the provision of meteorological facilities for the British Military Forces in the Canal Zone.

Sudan.—One of the two forecasters included in the small staff provided by the Meteorological Office primarily to meet R.A.F. requirements at Khartoum was withdrawn during 1952.

Eritrea.—Technical control over meteorological services in Eritrea was exercised by the Director of the British Meteorological Office until September 1952, when the territory was federated with Ethiopia and British staff were withdrawn.

Jordan.—Reporting stations were maintained at Amman and Mafraq under the control of the main meteorological office at Habbaniya (Iraq).

Iraq.—The Meteorological Office continued to maintain forecasting offices at Habbaniya and Shaiba. Close liaison was maintained with the Iraqi Meteorological Service. The arrangement persisted whereby the Iraqi Meteorological Service, Baghdad, covered the meteorological commitments for civil aviation at Basra for a part of the day and night, responsibility at other times being undertaken by the forecasting offices at Habbaniya or Shaiba.

Persian Gulf.—The forecasting service and radio-sonde/radar wind unit at Bahrein and the reporting station at Sharja were maintained. As Bahrein was not staffed for a continuous 24-hr. forecasting service promulgation was made of the normal periods of forecasting watch. The scale of future meteorological services at this station was under review.

§ 3. CLIMATOLOGY AND MARINE AND AGRICULTURAL METEOROLOGY

The Climatology Division, situated at Harrow, is concerned with British Climatology (including the British Rainfall Organization), World Climatology, Agricultural Meteorology, and Upper Air Climatology, and includes the Meteorological Office Central Library (see p. 42). Marine Meteorology is the responsibility of the Marine Branch, also located at Harrow.

The Edinburgh office collects and stores climatological records (including rainfall records) made in Scotland, and maintains the library of the old Scottish Meteorological Society. It deals with meteorological questions concerning or arising in Scotland, and acts as the centre for the administration of the climatological stations in Scotland and of such telegraphic and auxiliary reporting stations as are not attached to airfields. The magnetic records of the geophysical observatories at Eskdalemuir and Lerwick are analysed and prepared for publication and discussed in the Edinburgh office.

(1) British Climatology

(a) Organization and functions.—The British Climatology Branch is charged with the supervision, including periodical inspection, of all voluntary climatological and rainfall stations in Great Britain and Northern Ireland; with collecting, summarizing, and preserving permanent records of surface observations; and with replying to climatological inquiries from the general public, commercial and industrial firms, and Government Departments.

(b) Stations.—There are five classes of stations contributing climatological observations, being the observatories and synoptic, crop weather, climatological and rainfall stations. Appendix III shows how these stations are distributed among the 15 regions into which Great Britain and Northern Ireland are divided for climatological purposes.

All these stations provide observations at 0900 G.M.T., while the synoptic stations forward climatological returns for at least the main climatological hours 0300, 0900, 1500 and 2100 G.M.T. Some stations provide hourly summaries of wind, rainfall and sunshine, and frequency tables of intense falls of rain.

Crop weather stations are maintained in co-operation with the Ministry of Agriculture and Fisheries. Climatological and rainfall stations are maintained by private observers, or by municipal or other local authorities. Great public spirit is shown by those who participate in the operation of these stations, often at personal inconvenience because of the necessity for daily readings at fixed times. Some of the climatological stations make additional reports for daily issue to the Press under a Health Resorts Scheme, while some forward weekly returns to enable the climatic variations over the country to be followed week by week.

Copies of the new edition of the "Observer's handbook" were issued to all stations in order to secure uniformity in observational procedures.

The additional rainfall stations established on Exmoor in 1951 proved to be of value in defining the distribution of the rain causing the flood disaster of August 1952 at Lynmouth.

The meteorological observations at the Royal Observatory, Greenwich, dating from 1851, terminated in July with the complete transfer of staff to Hurstmonceux. The additional record begun at the National Maritime Museum, Greenwich, was continued. During the year 24 new records were started, while 11 stations ceased to report. One of the new stations was at Moor House, 1,830 ft. under Cross Fell, maintained by the Nature Conservancy.

(c) The British Rainfall Organization.—This organization, which was taken over by the Air Ministry in 1919, collects all rainfall records and data on the duration and intensity of precipitation, droughts and rain spells, evaporation and percolation.

(d) Publications.—*The Monthly Weather Report*, which contains full monthly and annual summaries of observations at synoptic and climatological stations, was issued regularly.

British Rainfall.—The volume for 1950 was published in January 1953, that for 1951 was sent to the printers, and that for 1952 was being prepared.

The Climatological Atlas of the British Isles, comprising 52 pages of text and 56 pages of maps and diagrams, was published in August 1952.

(e) Special work.—New climatological averages were prepared and are to be issued as "Averages of temperature for Great Britain and Northern Ireland, 1921–50" and "Averages of bright sunshine for Great Britain and Northern Ireland, 1921–50." These averages were used in the *Monthly Weather Report* from January 1953. A start was made on the preparation of rainfall averages for the period 1916–50.

Hydrology.—The section working on hydrological problems maintained close contact with outside bodies, in particular with the Hydrological Research Group of the Institution of Water Engineers (water supply), the Inland Water Survey of the Ministry of Housing and Local Government (run-off records), the Ministry of Agriculture and Fisheries (land drainage and River Board work), and the Road Research Laboratory, Department of Scientific and Industrial Research (storm-water drainage). With regard to the most appropriate forms or organization for co-ordinating hydrological investigations, the basic needs in this country were examined and discussed by the various interested bodies, and Meteorological Office representatives played their full part in the developments taking place.

There were consultations with most of the new River Boards and a number of them were advised about the extent of existing rainfall records in their areas and of any need for new observations.

Increasing attention was given by water-supply engineers to the importance of making correct allowances for losses due to evapo-transpiration, and in this way especially the work in hydrology was closely linked with that of the Agricultural Meteorological Branch.

The storm over Exmoor on August 15, 1952, was the subject of a special investigation reported in the *Meteorological Magazine* for December 1952.

Information was supplied to the consultant engineer, Devon River Board, and this was used in his " Report on Lynmouth floods, August 1952 ", forming an important part of the basis for his final conclusions.

Following the disastrous east coast floods on January 31 and February 1, 1953, the Meteorological Office provided special weather warning services for the River Boards in accordance with recommendations made by the Home Office Flood Warning Sub-Committee. These emergency weather warning services were extended to cover the February and March spring tide periods. An investigation of the meteorological factors associated with the floods was started, with the Meteorological Office collaborating with the Inter-departmental Committee set up by the Cabinet under the Chairmanship of Lord Waverley to examine the whole question.

Committees.—The British Climatology Branch was represented on the following committees :—

- (i) Hydrological Research Group of the Institution of Water Engineers
- (ii) Wind Power Generation Committee of the British Electrical and Allied Industries Research Association
- (iii) British Rainfall Fund Committee of the Royal Meteorological Society
- (iv) Hydraulics Committee of the Institution of Civil Engineers
- (v) Study Committee on Basic Design Temperatures for Space Heating Installations of the Institution of Electrical Engineers.

Inland Water Survey Committee of the Ministry of Housing and Local Government.—The Assistant Director (Climatology) sat as an assessor on this Committee until it was suspended, in June 1952, on grounds of economy. Monthly and annual estimates of general rainfall, October 1945–September 1951, were prepared for a number of the areas for " The surface water year-book of Great Britain ", the data for which were being assembled by the Inland Water Survey of the Ministry of Housing and Local Government.

(f) *Inquiries.*—A great many requests were received for climatological information in connexion with law cases, water supply and flooding problems, town planning, etc., and also with the work of agricultural, industrial and research organizations, both within Government Departments and outside. Many of these inquiries involved considerable investigation and the presentation of data in special ways. Among them may be mentioned the assistance given to British Railways in determining the effect of strong winds in conjunction with extreme temperatures on overhead cables, to the Rowett Research Institute on the hatchability of hens' eggs, to the Ministry of Civil Aviation in conjunction with the Treasury Medical Adviser's Department on the occurrence of chronic bronchitis at London Airport, to the City of Leicester in regard to the project for abstracting water from the River Dove, and to the Ministry of Housing and Local Government in an inquiry into applications for powers to abstract water from the Cheshire Dee.

Rainfall data were supplied to Government Departments and to numerous engineering firms in connexion with water supply and hydro-electric schemes. In a number of cases in Civil Courts evidence was provided on aspects of climate or on particular weather records.

Monthly reports on the rainfall of the Thames and Lea Valleys were supplied to the Metropolitan Water Board, Thames Conservancy and Lea Conservancy Boards. Weekly, quarterly and annual summaries of the weather were sent

to the Registrar-General for England and Wales, and similar information was supplied for each quarter and for the year to the Government of Northern Ireland. Weekly summaries of the data from crop weather stations were prepared for circulation by the Ministry of Agriculture and Fisheries under the crop weather scheme. Data for Northern Ireland were supplied regularly to the Irish Republic, on an exchange basis.

(2) World Climatology

The Branch dealing with World Climatology is responsible for collecting and summarizing climatological observations from a number of stations overseas, and for preparing reports, memoranda and tables on weather conditions in all parts of the world, for the use of Government Departments, industry and the general public as well as for research purposes.

(a) Overseas stations.—Stations in operation overseas at the end of 1951 numbered 83, distributed as follows: Europe 7, Africa 34, Asia 19, South America 1, Oceanic islands 14. The manuscript returns from 6 stations in west Africa and 10 islands in the Pacific Ocean were received by courtesy of the Directors of the British West African Meteorological Service and the Meteorological Service of New Zealand respectively. Manuscript returns were also received from 7 bases in the Falkland Islands and Dependencies for 1951.

No further returns were received from Eritrea, except from Asmara, following the federation of this country with Ethiopia. Returns also ceased from Iran and Italian Somaliland.

“Notes on the meteorological observations in British Colonies and Protectorates, 1939 to 1947” was completed, and this publication was issued with the collected reprints for these years. Copies of meteorological summaries for 1951 were received from 10 colonies, and summaries for 1949 or 1950 from 5 colonies; arrears were received from St. Vincent for 1939 to 1950.

(b) Réseau Mondial.—Work was resumed on the 1933 data for the purpose of publication.

(c) Naval Handbooks.—The statistical tables for the handbook of weather in the Mediterranean Sea were completed, and work commenced on the text.

(d) Admiralty Pilots.—Six Pilots were revised during the year.

(e) Falkland Islands and Dependencies.—The meteorological observations at Port Stanley and at the bases in the Dependencies from 1944 to 1950 were summarized and arrangements made for publication. Work was begun at the same time on a paper describing the meteorology of the region, based on these observations.

(f) Special work.—Data giving the averages of the mean daily vapour pressure for January, April, July and October were computed for about 4,000 stations over the world. The diurnal variation of vapour pressure at some 300 selected stations was analysed and it is intended to classify the resulting curves.

For the requirements of heating and ventilation engineers, a statistical analysis was made of the distribution of simultaneous values of dry- and wet-bulb temperatures at selected tropical stations. An analysis was also made, for stations in the Far East, of the frequencies of associated temperatures and humidities at the extreme values.

Data from the monthly CLIMAT broadcasts were tabulated, and charts plotted showing the mean pressure, mean temperature and monthly rainfall, with their departures from normal.

A revision of the mean surface wind charts for the world was begun for the new edition of "Meteorology for aviators".

(g) **Inquiries.**—Nearly 600 inquiries were received during the year, of which a large proportion came from exporting firms. There was a big increase in the number of inquiries for temperature and humidity data ; over 3,000 tables of these elements were issued.

(3) Marine Meteorology*

(a) **Organization and collection of observations.**—*Voluntary observing ships.*—The Marine Branch has Port Meteorological Officers in London, Liverpool, Southampton, Cardiff and Glasgow, and Agents in the Forth, Tyne and Humber areas. It is the duty of these officers to visit the masters of merchant ships and interest them in keeping meteorological records ; they also issue meteorological instruments to certain classes of ships and test them as opportunity offers. During the year some 3,750 visits were made to ships by these officers.

The Voluntary Observing Fleet consists of the following classes of observing ships :—

(i) "Selected" ships, which make meteorological observations at the main synoptic hours of 0000, 0600, 1200 and 1800 G.M.T. Meteorological instruments, instructions and log-books are supplied to these ships and observations are transmitted by wireless in the international code to various meteorological services. Approximately 500 ships co-operate in this manner. Included in this figure are 11 whaling vessels which were specially recruited for making meteorological observations in the Antarctic Ocean.

(ii) Supplementary ships, which make observations in an abbreviated form at the main synoptic hours. These ships are supplied with modified sets of instruments and log-books, and observations are reported in the abbreviated code. The number of supplementary ships is about 50.

(iii) About 80 coastal vessels (MARID ships) which make observations of sea temperature in home waters and transmit them by radio for the benefit of the forecast service.

(iv) Thirteen light-vessels, which have been "recruited" to provide observations of wind, visibility, and air and sea temperature twice daily, at 0600 and 1500 G.M.T. These observations are transmitted by 11 of these ships to shore radio stations by radio-telephony and thence by telegram to the Central Forecasting Office, Dunstable. Seven of these light-vessels make and report observations of waves.

(v) Twenty-two trawlers fishing in Arctic waters make non-instrumental observations and send in their coded messages by W/T or R/T.

Not only are weather reports transmitted for current use, but log-books are forwarded to the Marine Branch for climatological analysis. In general these voluntary observers provide careful, accurate and regular observations. On the average nearly 70 log-books are received each month in addition to similar records maintained aboard Canadian and Norwegian observing ships.

* See also §2(1)(c), p. 6.

Among their other activities, certain "selected" and supplementary ships make observations of whales on behalf of the National Institute of Oceanography.

The R.R.S. *Discovery II*, was specially recruited for meteorological observing during the summer prior to sailing for special research work in the North Atlantic.

Ocean weather ships.—During the year each of the 4 British ocean weather ships completed 5 years' service as a weather ship. Station J, in position 52° 30' N., 20° 00' W., was manned on 362 days of the year by either a British or a Netherlands weather ship; the station was vacated on 3 days in order to land sick men at Londonderry for hospital treatment. Station I in position 59° 00' N., 19° 00' W. was manned by a British weather ship on 308 days, but, although technically "on station" the ship was moved to position 60° 47' N., 14° 01' W. for special operations during 49 days. Other absences, amounting to 8 days, were due to landing a patient to hospital and one ship having to return from station to Londonderry to replace lifeboats damaged by an exceptionally heavy sea.

In phenomenally heavy seas on December 22, 1952, O.W.S. *Weather Watcher* sustained irreparable damage to her starboard life-boat and dinghy, and had to return to Londonderry for replacements.

During her patrol on station I, O.W.S. *Weather Explorer* was on one occasion exposed to a prolonged NE. gale which blew her 168 miles off station, and caused slight structural damage which was repaired by the crew. The ship then regained normal station.

The weather ships carried out a full programme of meteorological work, including surface and upper air observations, which were transmitted to the Central Forecasting Office by W/T. Search and rescue exercises were carried out, whenever practicable, in co-operation with aircraft of Coastal Command, with the aim of keeping the ships' companies practised in search and rescue organization and drill. During these exercises mail, newspapers, and on one occasion a spare part for the radio were dropped by the aircraft.

The weather ships' navigational aids were regularly used by both civil and military aircraft flying over the North Atlantic; 7,080 aircraft made use of the facilities provided by the ships during the year. Radio contact was made frequently with ocean weather ships of other nations.

Following tests made last year with immersion suits, all ships were equipped with 3 such suits for rescue purposes.

Tests also made last year with Dan buoys resulted in Dan buoy observations of wave heights being regularly recorded.

Special observations of the sea-water temperature gradient were made on station I with a bathythermograph supplied by the Admiralty.

At the request of Dr. G. V. T. Matthews, University of Cambridge, 20 shearwaters were taken to sea aboard O.W.S. *Weather Recorder* in July 1952, and were released when the ship was more than 100 miles from any land. All but two of the birds arrived back safely, the first reaching its nest in Skokholm, Pembrokeshire, 36 hr. after its release.

Oceanographical work was carried out for the Ministry of Agriculture and Fisheries and the Scottish Home Department, Fisheries Division. This included towing plankton nets, collection of samples of sea-surface water and jettisoning drift bottles.

A 3-cm. radar for surface navigational uses was installed in all four ships.

Mr. D. J. Moore, Imperial College of Science and Technology, sailed in O.W.S. *Weather Recorder*, from June 18 to July 15, to collect data on the concentrations of condensation nuclei at sea.

Log-books and upper air data were received regularly from all four ships and microfilmed copies distributed to the other nations of the North Atlantic Ocean Stations Agreement.

During a visit to Glasgow of the United States weather ship *Rockaway* in September 1952, visits were exchanged between the officers of this vessel and of the British weather ships in harbour.

All four British weather ships underwent a complete classification survey by Lloyds's surveyors during the year, and were classed 100A at Lloyds. O.W.S. *Weather Recorder* had to undergo extensive repairs to her bottom in order to satisfy Lloyds's requirements.

In accordance with the North Atlantic Ocean Stations Agreement, a Netherlands weather ship did four tours of duty at station J during the summer. During these periods each of the British weather ships had about eight weeks in harbour for overhaul and repairs.

(b) Analysis of observations.—Routine work during the year included :—

(i) Observations from log-books received from voluntary observing ships of Great Britain, British ocean weather ships and Naval vessels were punched on Hollerith cards. The total number of observations used was 250,000.

(ii) Duplication of data from the North Atlantic by the Netherlands Meteorological Service continued. One batch of 650,000 Hollerith cards was shipped to Holland.

(iii) Tabulations of all observations in the southern hemisphere made by British observing ships, totalling 39,650 observations, were supplied to the Massachusetts Institute of Technology for a special project. The United States Weather Bureau stated that these observations form the largest and most extensive collection of ocean data received for this undertaking.

(c) Currents and ice.—The computation of data for the preparation of surface current charts of the North Pacific Ocean, eastward of longitude 160° W. was continued.

Work on the atlas of surface currents of the South Pacific Ocean, westward of longitude 160° W. was nearly completed.

Assistance was given to Mr. J. M. Wordie of Cambridge in connexion with a proposed international ice code for reporting ice from aircraft for the World Meteorological Organization.

(d) Admiralty Pilots.—The sections relating to ocean currents were entirely re-written for new editions of seven Admiralty Pilots, and general current charts prepared to accompany these. Sections relating to ice in four of these Pilots were also rewritten. The revision of the meteorological sections of the seven Pilots required during the year was co-ordinated with the World Climatology Branch and meteorological charts were prepared for each of them.

(e) Special work.—Close co-operation was maintained between the Marine Branch and the National Institute of Oceanography regarding marine meteorological problems.

The preparation of the new edition of the Greenland and Barents Sea Atlas was completed apart from some editorial work.

Papers were produced on the following subjects :—

- (i) Winds at high levels over Singapore
- (ii) Winds at high levels over Hongkong
- (iii) Humidity over the sea
- (iv) Depression of December 26–27, 1951
- (v) Sea-surface temperature in the eastern North Atlantic
- (vi) Wave data on the eastern North Atlantic
- (vii) Climatic fluctuation in the Greenland and Norwegian Seas
- (viii) Navigational problems of ocean weather ships.

Work proceeded on investigations into the synoptic aspects of the variation of sea and air temperature at ocean weather ship stations, diurnal variation of meteorological elements at ocean weather ship stations, the annual and spatial variation of vapour pressure over the sea, the climatic fluctuation in the Southern Ocean, the relation between variations of sea-surface temperature in various parts of the North Atlantic and various other subjects.

(f) Inquiries.—Much information, including statistical tables and charts of marine data, was prepared for other Government Departments, the Naval Weather Service and various commercial firms. Many of these inquiries were concerned with legal cases or investigations into shipping casualties.

Information was supplied for four formal investigations into serious shipping casualties held by the Ministry of Transport during the year ; in two of these the personal attendance of an officer was needed.

(4) Agricultural Meteorology

The Agricultural Branch is responsible for the application of meteorological knowledge and facilities to agriculture and horticulture and also for co-operation in the solving of allied research problems.

(a) Liaison with other organizations.—In order to maintain co-ordination with experimental, research and advisory work, many visits were made by the staff of the Branch to various parts of the country. In addition to provincial and county administrative centres of the National Agricultural Advisory Service, twelve of the Experimental Husbandry Farms and Horticultural Stations of the Ministry of Agriculture were visited ; help was given in relation to the making of meteorological observations both for routine and special purposes. The Branch was represented on the working party for the planning of experiments at these stations on protective cropping. Special visits were paid to the research stations at Rothamsted, Cheshunt, Bayfordbury, East Malling, Hurley, Fernhurst, the National Institute of Agriculture Engineering, the National Institute of Agricultural Botany, and the universities at London, Reading, Nottingham, Leeds, Oxford and Cambridge in connexion with current research and proposed experiments.

The issue of weekly weather summaries was continued for each of the eight National Agricultural Advisory Service provinces, and extra copies were this year sent to the newly appointed Crop Intelligence Officers of the Ministry of Agriculture.

In order to maintain a high standard of weather reporting, plans were made to inspect each crop weather station every two years ; the opportunity was taken at the time of inspection to discuss other matters of mutual interest which were being dealt with at the stations.

The Office was represented on the Agricultural Research Council Conferences, for the Prevention of Frost in Orchards, and for Problems of Glass-house Heating and Management. A paper on the use of short-term minimum temperature records in the assessment of frost risk was presented to the former Conference, and a special article on the subject was written for the *N.A.A.S. Quarterly Review*.

Lectures were given at the spring conference of the Horticultural Education Association, at the East Midlands Horticulture Conference and to several National Farmers' Union branches and discussion groups.

A meteorological display was arranged for the Horticultural Education Association and also for the National Farmers' Union Market Produce Show. Material was provided for the Royal Highland Show, the Kent Agricultural Show, the Scilly Isles Show and the Preston Guild Meeting.

(b) Special work.—Major contributions were made to a technical bulletin on the calculation of irrigation needs to be published by the Ministry of Agriculture in the spring of 1953. This will contain averages of potential transpiration (or maximum water needs) calculated by the Branch for all areas of England and Wales ; by means of such figures the water needs of any area or the irrigation plan for any crop in the open can be determined.

Help was given in the preparation of a paper by members of the Forestry Commission in Wales on shelterbelts with special reference to the needs on hill farms ; advice was also given to the British Electricity Authority on the protection of power stations from salt spray during on-shore gales.

Work on frost problems included the preparation of a paper on katabatic winds, and assistance to frost investigations in a proposed orchard at Shinfield (Reading University) and on the moss lands of south-west Lancashire (Aberystwyth University).

The climate under glass was studied at Cheshunt, Wye College and Swanley Horticultural Institute. Other experiments included those on maize germination (Oxford University), lucerne germination (National Agricultural Advisory Service, Starcross) and rhubarb forcing (National Agricultural Advisory Service, West Riding). Co-operation was also maintained with the Botany School at Oxford in connexion with a microclimate investigation in Cheddar Gorge.

Investigations were started into the relations between the radiation, illumination, sunshine and visibility records at Kew and the analysis of soil temperature data.

Arrangements were made for the supply of special frost forecasts to the Ministry of Food for the protection of potatoes during transit from storage to market.

Work on the forecasting of potato blight epidemics continued in co-operation with the Plant Pathology Laboratory and official observing stations of the Office. A report on the progress of the forecasting experiment over the last three years was prepared.

(c) Inquiries.—Many inquiries were answered during the year on a diversity of subjects. Those involving major questions of land utilization included a climate survey of the Cornish Peninsula for the Agricultural Land Service, and a survey of the water needs of the sand lands of England for Cambridge University. Other topics dealt with included potato storage, weed control, behaviour

and yield of sheep and dairy herds, the depth of water pipes, artificial illumination, day length, the blowing of soil, irrigation needs, aphides, the size of rain-drops, the growth of mushrooms, hops, wheat, maize and barley, and the assessment and planning of field trials.

(5) Upper Air Climatology

The Upper Air Climatology Branch is concerned with both routine work and research. Its routine is chiefly the custody, scrutiny, summarizing, and preparing for publication of the upper air observations from radio-sonde and radar wind stations manned by staff of the Office both at home and overseas. The research during the past year was directed partly to the preparation of world charts of average temperature and of standard deviation and partly to the study of special problems.

The work of the Branch has become increasingly important in view of the need of accurate knowledge of upper air conditions at the high levels at which aircraft are now flying.

(a) Collection and publication of observations.—Monthly returns of daily observations made by radio-sonde and radar were received from 25 stations (including two ocean weather stations). Observations from three aircraft flights were also received, and in addition radar wind observations, twice weekly, from Singapore. The Office controls eight radio-sonde stations in the British Isles, seven in the Mediterranean and Middle East, two on ocean weather ships in the Atlantic, and one in the Falkland Islands. The control of one of the remaining two stations in the British Zone of Germany was handed over to the German Meteorological Service in August 1952, but returns and Hollerith cards for all stations in the British Zone were received. Iserlohn ceased as a radio-sonde station during the year, but continued as a radar wind station for the 2nd Tactical Air Force.

Returns of daily observations were received from Valentia, Nairobi and Hongkong through the courtesy of the Directors of the Irish Meteorological Service, the British East African Meteorological Department and the Royal Observatory, Hongkong, respectively, and from ocean weather station J during the periods when it was manned by the Netherlands, through the courtesy of the Director of the Meteorological Service of the Netherlands. In addition, monthly summaries of radar winds at Lagos (Ikeja) were received from the Director of the British West African Meteorological Service. An offer from the Government Meteorologist of the Sudan Meteorological Service to send returns when radio-sonde observations at Khartoum begin in 1953 was gratefully accepted.

Arrangements were made in April 1952 for monthly returns of ozone observations at four British stations to be sent to the Branch.

The forms and Hollerith cards for recording radio-sonde data remained unchanged during the year. This checking system proved satisfactory, although it entailed considerable delay in the receipt of the data at Headquarters. The punching of Hollerith cards continued to be done at Fazakerley.

A tabulator fitted with certain additional devices and a plain sorter were installed in June 1952 in a room allocated for use as the machine room of the Branch. A further device—a progressive total switch—required for certain tabulations was fitted to the tabulator in October 1952, and a sorting rack was also installed. Instructions and specimen plug boards for use in carrying out

the routine operations were drawn up. After the installation of the special Hollerith machines the routine summarizing of monthly data from January 1951 onwards was begun, and by the end of the year the whole of the 1951 data, except those for ocean weather stations, had been dealt with.

Part 1 (Larkhill) of the volume of upper air data, giving summaries of radio-sonde observations of temperature, humidity, heights of isobaric surfaces, and radar wind measurements during the years 1946–50, was published in April 1952. Part 2 (Lerwick) was sent for printing in August 1952 and published in January 1953. Part 3 (Habbaniya) was sent for printing in February 1953. During the preparation of these early parts a considerable amount of time had to be spent in arriving at the best way of presenting the data and in devising efficient methods of working up and checking them.

The tabulation and plotting of CLIMAT TEMP broadcasts was continued, and a circumpolar chart was also drawn up for each of the levels 700, 500, 300 and 200 mb. By the end of the year charts had been drawn up to May 1952. Arrangements were made for the Falkland Islands to send CLIMAT TEMP data by signal at the beginning of each month.

(b) Special work.—*Charts of average upper air temperature and standard deviations.*—The compilation of charts of averages and standard deviations of upper air temperature over the world, for mid-season months at six standard isobaric levels, was almost complete by the end of the year. In the autumn of 1952 provisional charts for July and October were circulated for comment to certain meteorological services overseas. The charts for January were then entirely redrawn, and those for April, July and October substantially revised in the light of comments received, and with the aid of newly-acquired data. Further information in the form of charts or tables was received during the year from the meteorological services of Australia, Canada, India, New Zealand, the Philippines, the Union of South Africa and the United States. Averages for intermediate months were computed for some stations, and a preliminary study was made of the changes with height in the average annual variation of temperature in different regions.

Upper winds over the world.—Towards the end of the year the revision of *Geophysical Memoirs* No. 85, "Upper winds over the world", became a matter of urgency as Her Majesty's Stationery Office reported that it would shortly be out of print. A detailed scheme for the revision was drawn up, and letters were sent to certain overseas meteorological services that were known to have recent data available, asking for their co-operation. A beginning was made with the revision.

Upper winds in the tropics and subtropics.—A preliminary study was made of high-altitude winds in the tropics and subtropics. In these regions little reliance can be placed on winds deduced from the distribution of temperature, and direct observations are therefore essential. Vector mean winds were compiled for some fifty stations for the four mid-season months of 1951, and from a study of the results some features of the strong winds at high altitudes were explored. A special study was made of the upper winds at Aden.

Tropopause.—Studies of the tropopause and attempts to summarize tropopause data in the tropics showed the need for amplifying the definitions of the tropopause in regions where two tropopauses were observed; tentative proposals were formulated.

Statistical studies.—A method of classifying the temperatures of the upper tropopause and lower stratosphere according to the level of the tropopause was demonstrated for Larkhill. A study was made of the relationships between temperature at various levels in the stratosphere and troposphere, the pressure at the tropopause and the height of the 300-mb. surface for a number of stations from the Arctic to the Mediterranean. The closeness of the relationship decreased with height in the stratosphere. Interesting anomalies in high latitudes in winter and spring pointed the way to further research.

(c) *Inquiries.*—Inquiries received during the year for upper air data included all elements—temperature, humidity, wind, heights of isobaric surfaces, tropopause and air density. In addition about 20 inquiries on statistical methods were dealt with. In response to a request from the Australian Meteorological Branch, duplicates of the Hollerith cards giving data for three years' observations in the Falkland Islands were supplied.

§ 4. RESEARCH AND DEVELOPMENT

(1) Co-ordination of Research

(a) *Meteorological Research Committee.*—The general lines on which meteorological research should be developed are formulated by this Committee (see p. 3), the constitution and functions of which are described in the Report for August 1945 to March 1947. Sir David Brunt succeeded Professor G. M. B. Dobson as Chairman. Two meetings of the Committee were held during the year.

As in the three preceding years, the detailed work of the Committee was done largely through three Sub-Committees, each concerned with a particular field of work and each consisting of a selection of members of the main Committee together with outside specialists, and representatives of interested organizations and of the Meteorological Office. The Chairmen of these Sub-Committees were :—

Instruments development	Prof. P. A. Sheppard
Synoptic and dynamical research	Sir Charles Normand
Physical research	Prof. O. G. Sutton.

Twelve meetings of Sub-Committees were held during the year to consider papers describing the results of research, to review progress and to make recommendations to the main Committee. Between 60 and 70 papers and reports were dealt with. Approved papers were circulated to other institutions and individual workers, and arrangements were made for the communication of selected papers to a scientific society or journal.

In large measure the research and investigational work with which the Committee is concerned is conducted within the Meteorological Office. Additional staff could profitably be used when restrictions on man-power are relaxed. As previously, valuable assistance in special instrumental development was received from the Clarendon Laboratory, Oxford, and research establishments of the Ministry of Supply.

The Joint Committee set up in 1949 by the Meteorological Research Committee and the Aeronautical Research Council, to further the investigation of gusts in relation to aeronautics, held two meetings.

(b) Joint Meteorological Radio Propagation Sub-Committee.—After consultation with the Director of Radio Research it was decided to discontinue this Sub-Committee of radio physicists and meteorologists, which had come into being in 1943. The meteorological aspects of radio propagation are included in the programme of the Meteorological Research Committee while the specialized radio aspects receive attention from the Tropospheric Wave Propagation Committee of the Department of Scientific and Industrial Research, on which the Meteorological Office is represented.

(c) Collaboration with the Royal Society.—The Royal Society, through the medium of the Gassiot Committee, continued to sponsor research on the composition and photochemistry of the atmosphere and on atmospheric radiation. With the assistance of grants from public funds made available through the Royal Society, research on different aspects of these subjects was in progress at a number of Universities.

In connexion with the programme for the measurement of atmospheric ozone, an improved technique for determining the vertical distribution of ozone was being developed at Oxford. Plans were also made to observe simultaneously the infra-red and ultra-violet absorption of ozone in order to estimate the atmospheric pressure at the average level of the ozone. Measurements of ozone content in the lower atmosphere, up to 10 or 12 Km., were begun using chemical absorption apparatus carried by aircraft of the Meteorological Research Flight.

An account was published of a method, developed by Dr. R. M. Goody, Cambridge University, for measuring from an aircraft the infra-red absorption of solar radiation by gases in the stratosphere. A change in arrangements for further work on this problem was considered.

Professor F. A. Paneth, Durham University, got interesting results from the chemical analysis of small samples of air obtained during rocket ascents in America.

(d) Other activities.—The Meteorological Office is represented on the British National Committees for Geodesy and Geophysics and for Scientific Radio, on the Gust Research Committee of the Aeronautical Research Council and the Meteorological Research Committee, on the Air Navigation Committee of the Aeronautical Research Council, on the Atmospheric Pollution Research Committee, on the Road Research Laboratory Joint Committee on Soils of the Department of Scientific and Industrial Research, and on several other scientific committees of Government Departments and other bodies. Contact was maintained with research proceeding elsewhere within the Commonwealth and in other countries.

As in recent years, several university students of physics or mathematics spent periods of up to eight weeks during their summer vacation at Meteorological Office research centres to obtain insight into the investigations in progress.

(e) Research programme.—The main items to which effort was directed are mentioned briefly below. Many of them, in particular item (v), consist of a number of related investigations.

(i) Development of aircraft thermometers and hygrometers, if possible with automatic recording suitable for high-speed (jet) aircraft

(ii) Development of instruments and technique for use on aircraft in exploring the liquid and solid content of clouds and the processes of turbulence in cloud and in clear air

(iii) Development of radar equipment for the measurement of wind, pressure, temperature and humidity in the upper atmosphere more accurately and to greater heights

(iv) Development of the optical radar method for measurement of the height of cloud base

(v) Dynamical, statistical and synoptic investigations related to the improvement of the technique of forecasting for a day or two and for longer periods

(vi) Application of computing machinery to forecasting problems

(vii) Investigation of the formation, persistence and dispersal of radiation fog—visibility in relation to aircraft operational problems

(viii) Investigation of the physical processes of cloud and precipitation, together with the meteorological factors affecting ice accretion on aircraft

(ix) Investigation of turbulence in cloud and in clear air

(x) Investigation of the temperature and humidity structure of the troposphere and lower stratosphere in various situations and further examination of the circumstances affecting the formation of condensation trails

(xi) Investigation of the large-scale circulation within the stratosphere and troposphere and exchange of air between these regions

(xii) Various problems associated with the operation of high-level high-speed aircraft.

(2) Instrument Development

The Instrument Development Division is situated at Harrow. There is one Branch devoted to general instruments and a second to radio-sonde and aircraft instruments. In addition, the Branch concerned with the provisioning, accounting, testing and calibrating of instruments is controlled by the Assistant Director (Instrument Development); its work is described on p. 41.

(a) General instruments.—The design of a recording photo-electric visibility meter for use both by day and night was basically completed. The instrument was thoroughly tested, found to require little maintenance, and to measure visibility in the range 300 to 3,000 yd. with an accuracy sufficient for most purposes.

Following a change of approach, agreed between the Ministry of Civil Aviation and the Meteorological Office, work on the development of methods of measuring ground-to-air "slant" visibility was suspended.

Work continued on the design of instruments for research into the development and structure of fog.

Further tests on various recorders for wind speed and direction were carried out and a design decided upon for field trials.

Extensive field trials have shown that the rate-of-rainfall recorder, in its present form, is not suitable for obtaining reliable statistical information about the intensity and frequency of heavy falls of rain. Other designs were considered.

(b) Aircraft instruments.—Wind-tunnel tests confirmed that the variations in the speed-correction coefficient of the standard Meteorological Office flat-plate thermometer arise from phenomena concerning the thermometer itself rather than from external causes such as errors in pressure and air-speed

measurement. Thermometers of experimental design underwent development tests in high-altitude aircraft of the Meteorological Research Flight and in a wind tunnel at the Royal Aircraft Establishment, Farnborough.

An automatic self-balancing Wheatstone bridge employing a two-way digital computer was designed and put under test as a thermometer temperature indicator.

A fully automatic frost-point hygrometer embodying a germanium crystal as thimble was developed in the Clarendon Laboratory, Oxford, and was under test. Most of the instability in automatic frost-point hygrometers arises from the thermal inertia of the thimble. Experiments were made to develop a thimble of low inertia.

With very dry air ordinary frost-point hygrometers fail owing to ice forming as a film instead of in crystals at the very low frost-point temperatures. To overcome this trouble development was begun of a frost-point hygrometer employing a technique based on the phase changes which accompany the reflection of plane polarized light at a metal surface.

(c) Radio-sonde and radar wind instruments.—The building and equipment of the radar-sonde theodolite station was begun.

Flight trials of the light-weight sonde proved satisfactory, and preparations for the manufacture of the sonde and ground equipment were made.

Experiments were made on improvements to components of the standard radar wind equipment, and on the adaptation of another radar set for wind measurement.

The pulsed-light cloud-base meter was considerably modified and is to undergo further trials.

(3) Forecasting Research

The Forecasting Research Division is accommodated at the Napier Shaw Laboratory, Central Forecasting Office, Dunstable. Its main activities may be sub-divided as follows :—

(a) Research on short-period forecasting (up to 24 hours ahead).—

(i) The possibilities of forecasting winds up to heights of some 50,000 ft. received much attention in view of the increasing operational heights of modern aircraft. There is no doubt that the greatest difficulty lies in obtaining observational reports of conditions at these great heights with sufficient frequency and accuracy. This is largely a matter of instrument development.

(ii) An electronic computing machine was used to carry out a number of calculations which may lead to a system of mathematical forecasting based on the dynamics of the atmosphere. Results so far are of great theoretical interest and not without promise of practical value.

(iii) The formation of anticyclones was studied, with the conclusion that they occurred with two different types of three-dimensional dynamical development; the growing sinusoidal oscillation and the anticyclonic disruption of the upper westerlies.

(iv) A number of statistical synoptic investigations gave useful information about jet streams in the upper troposphere, cloud structure associated with fronts and the amounts of rainfall from depressions moving on

selected tracks. The analysis was begun of the results of some 40 flights through fronts and jet streams specially undertaken by the Meteorological Research Flight.

(b) Research on medium-range forecasting (up to about 4 days ahead).—Weather charts constructed twice daily for most of the northern hemisphere were the basis of various statistical studies (on cold pools, long waves in the westerlies, large-scale oscillations of thickness of the 1000–500-mb. layer, and other related matters) and were also used to obtain experimental forecasts of the general character of the weather for about 4 days ahead.

It was decided that the knowledge acquired was sufficiently promising to justify further development of the techniques within the Forecasting Division of the Office.

(c) Research on long-range forecasting (beyond a period of a few days ahead).—All the methods of long-range forecasting (beyond the range of a few days ahead) which are known to have been proposed or tried, in this country or elsewhere, were surveyed. It was concluded that no system has established a degree of success to justify even experimental forecasts in the Meteorological Office at present. It was, however, decided that the time had come to intensify research on the scientific problems involved and a programme of research was adopted.

(4) Research in Physical Meteorology

Some of the main activities are mentioned below.

(a) Cloud and precipitation.—

(i) More than thirty cloud exploration flights were carried out by Hastings aircraft of the Meteorological Research Flight, based at the Royal Aircraft Establishment, Farnborough, to obtain measurements and other observations of the drop-size distribution, liquid-water content, temperature, vertical motion, and the nature of the particles within clouds. Modified instruments for these purposes were under development and test. During several of the flights concurrent radar observation of the cloud under exploration was made by the Meteorological Office radar station at East Hill, operating with 10-cm. and 3-cm. wave-lengths. Analysis of the large amount of data progressed steadily.

(ii) Increased attention was given to the characteristics and conditions of occurrence of cirrus cloud. Samples of cirrus-cloud particles were examined.

(iii) A comprehensive report on the features of large cumuliform cloud in the tropics was prepared from radar and other information obtained during trials of the detection of cloud by airborne radar carried out by Royal Air Force aircraft in the Singapore area.

(iv) Further study was made of the conditions affecting the formation and persistence of aircraft condensation trails. The Meteorological Research Flight made flights for this purpose and data from other sources were also analysed.

(v) The movement of belts of precipitation, as determined by radar observation at East Hill, was investigated in relation to the upper wind.

(b) Ice accretion on aircraft.—The Meteorological Research Flight obtained measurements of the rate of icing, for examination in relation to other measurements and observations made in the clouds explored. It is hoped that special

reports received from Royal Air Force and civil aircraft will yield information on the variability of icing in cloud.

(c) Turbulence in cumulonimbus cloud.—In continuation of the work of recent years a few flights, controlled by the East Hill radar station, were made by Meteor aircraft of the Royal Aircraft Establishment to explore the vertical currents in cumulonimbus cloud.

(d) Turbulence in clear air.—Several lines of study were in progress.

Statistical investigation of the fluctuations of wind was made from *camera obscura* measurements at East Hill of the motion of series of smoke puffs emitted at heights up to 40,000 ft. above the station by aircraft of the Meteorological Research Flight. Vertical smoke trails of satisfactory length and duration were produced at heights between 20,000 and 30,000 ft., and indications were found that photographs and other observations of these trails may prove of value in determining details of vertical shear of the wind.

The minute-to-minute fluctuations of wind components and temperature during a radio-sonde/radar wind balloon ascent to about 30 Km. above ground were used to derive measures of turbulence in different layers of the atmosphere. The new radar-sonde theodolite equipment was being developed and should facilitate research on these lines.

Autographic records of the fine structure of the atmosphere were obtained by the Meteorological Research Flight, using an ultra-rapid thermometer and hot-wire anemometers devised for the purpose. Analysis of the records was begun.

The characteristics of radar echoes received on occasions from layers of air free from cloud were under examination at East Hill. These echoes were taken to indicate the occurrence of extremely sharp inhomogeneities of air temperature and humidity.

Continued examination of the meteorological circumstances on occasions when turbulence or bumpiness was experienced by civil or R.A.F. aircraft in clear air at heights above 20,000 ft. confirmed the association of this turbulence with high-speed air currents (jet streams) in the upper troposphere and lower stratosphere.

(e) Turbulent transfer near the surface of the earth.—For more detailed investigation of the basis of the technique which has been developed in recent years for determining the evaporation from cropped land, the Meteorological Office unit attached to the School of Agriculture, Cambridge University, made about 50 field experiments over short grass in an open exposure at Cardington. Analysis of the data obtained, which included simultaneous determinations of the aerodynamic drag of the earth's surface and vertical profiles of humidity, temperature and wind, was begun.

Other aspects of this problem were under study at Kew Observatory (see p. 35).

(f) Upper troposphere and lower stratosphere.—Frequent flights were again made by the Meteorological Research Flight to measure humidity and temperature to the greatest height attainable by the Mosquito aircraft used. The expected provision of a Canberra aircraft in 1953 will enable these and other explorations to be carried further into the stratosphere.

In the second part of the year, at the request of Professor G. M. B. Dobson, sampling of the ozone content by a chemical method was undertaken during several of the high-level ascents.

A paper was prepared on the global circulation of stratosphere air and the mechanism of change in tropopause level, taking into account dynamical and radiational effects.

(g) **Radiation fog.**—Observations, commenced in the previous year, to assist in the study of the factors which determine whether fog will or will not develop on apparently favourable occasions, were continued at Cardington. On radiation nights measurements of temperature, humidity and wind speed were made at intervals of height up to 2,000 or 3,000 ft. using a kite balloon, measurements at the lowest levels being made on towers; visibility was recorded and temperature within the ground measured. Experiments were also made with an instrument for indicating the presence of fog, and possibly its density, at levels above the ground.

(5) Work of the Observatories and Geophysical Research

(a) **Kew Observatory.**—*Meteorological observations and records.*—Auto-graphic records of atmospheric pressure, dry- and wet-bulb temperature, wind, rainfall, sunshine and evaporation, together with standard measurements of certain of these elements and of grass minimum and earth temperature, cloud, visibility, and weather, were maintained according to normal procedure. A night-sky recorder was operated regularly. Records of atmospheric pollution were obtained from an Owens automatic filter and from a Department of Scientific and Industrial Research smoke filter.

Tabulations were prepared for the *Observatories' Year Book* and other official publications. To meet the needs of many inquirers it was found convenient to distribute a weekly statement of observations.

Measurement of solar radiation.—Recording continued of solar intensity at normal incidence, of total and diffuse radiation on a horizontal surface and of the natural illumination of a horizontal surface. The properties of the recording photometer of the illumination instrument in its original and modified forms were investigated, and various corrections were applied to the tabulated results. The corrected record, which had an unexpectedly high degree of internal consistency, was analysed to determine the mean visual albedo of the atmosphere and of clouds. Progress was made with the analysis, mentioned in last year's Report, of the other radiation records.

Work continued on the modified bimetallic actinograph. A model, which was made, performed satisfactorily in the laboratory and on short field trials, but further test is required in an extended field trial.

In anticipation of an increased requirement for the calibration of radiometers, the calibration procedure was standardized as far as possible with the object of economy of staff time.

A paper on the comparison of pyrheliometers was published by the Royal Meteorological Society.

Atmospheric electricity.—Continuous photographic records of the electrical potential gradient were obtained. Measurements of the potential gradient and the air-earth current were made on suitable days.

Seismology.—The Galitzin seismographs (two horizontal components and one vertical component) and the short-period vertical component seismograph gave satisfactory records. The *Monthly seismological bulletin* included the analysis of 470 earthquakes, the epicentres of 90 being determined. A very

large earthquake in Kamchatka on November 4, 1952, was notable for an unusual number of aftershocks, most of which are not included in the figures given above. Copies of seismograms were supplied at the request of several observatories in other countries.

The International Seismological Summary staff, lately increased, continued to be accommodated in the Observatory.

Other investigations.—Further study was made of short-period fluctuations of wind and temperature near the ground. Evaluation of records taken at heights between one and two metres confirmed the anomalous values of the vertical flux of heat previously found at lower heights. Apparatus capable of detecting more rapid fluctuations was built, and its characteristics investigated in the laboratory. Field recordings with this apparatus will be made in the near future. Analysis of the energy-frequency relation in the horizontal and vertical components of the wind fluctuations gave encouraging first results. A paper on the earlier part of the fluctuations investigation was communicated to the Meteorological Research Committee.

A modified form of the aspirated radiation balance meter developed by Gier and Dunkle, University of California, was made and will be used, together with other special apparatus, to investigate the heat balance at the ground.

Miscellaneous.—Advice was given to the Ministry of Supply concerning the recording of solar radiation during tropical trials, and instruments were lent for the purpose. A radiometer was also lent to the British north Greenland Expedition. There were again several inquiries concerned with biological aspects of the radiation records; general inquiries on radiation questions continued to increase.

Workshop assistance was given to other parts of the Meteorological Office, e.g. in the construction of a set of drag plates and the repair of special anemometers for use in the measurement of the aerodynamic drag of the earth's surface, and in the construction of an instrument devised for the measurement of the liquid water content of fog.

(b) Meteorological Office, Edinburgh.—Following the decision to resume publication of the *Observatories' Year Book* in an abridged form, the material for Aberdeen (now closed), Eskdalemuir and Lerwick was prepared in the new style for the 1938 volume.

Investigation continued into relationships between geomagnetic and ionospheric disturbances. A paper on geomagnetic and ionospheric (*F.2*) diurnal and storm-time variations was communicated to the *Journal of atmospheric and terrestrial physics*.

The three-hourly geomagnetic range-indices (*K*) for Eskdalemuir and Lerwick, together with modified values of *K* to be used in evaluating a planetary index of magnetic disturbance, were forwarded regularly to De Bilt in accordance with the arrangements of the International Association of Terrestrial Magnetism and Electricity. The *K* indices are published in the *Journal of atmospheric and terrestrial physics*. Particulars of "sudden commencements," "sudden impulses" and the magnetic effects of solar flares were also supplied to De Bilt. The identification of effects of solar flares was assisted by information on flares observed at the Royal Greenwich Observatory and the Royal Observatory, Edinburgh, by the times of enhancement of radio atmospherics recorded at the Royal Observatory, Edinburgh, and by the times of radio fadeouts received from Cable and Wireless Limited.

(c) **Eskdalemuir Observatory.**—*Meteorological observations and records.*—The normal instrumental and other observations at prescribed hours were made for synoptic and climatological purposes. Autographic records of atmospheric pressure, dry- and wet-bulb temperature, wind, rainfall and sunshine were maintained. A night-sky (pole-star) recorder continued in operation. Records of atmospheric pollution (by smoke filter) were obtained for the Director of Fuel Research, Department of Scientific and Industrial Research.

Solar radiation.—Records of total and diffuse radiation received on a horizontal surface were resumed in June 1952, after repair to the instruments. The record of diffuse radiation ceased again in December 1952, the outer dome cover having been blown away.

Terrestrial magnetism.—Magnetic declination, horizontal force and vertical force were recorded continuously by two sets of la Cour variometers, ordinary-run and quick-run. All magnetic storms during the period were registered successfully. Improvements were effected in the optical systems of the variometers, and the duration of run of the quick-run set was changed from 21 to 24 hr.

The autographic records were standardized by absolute observations of declination, horizontal force and vertical force made thrice weekly using a Kew-pattern unifilar magnetometer, a Schuster-Smith coil magnetometer and a Schultze dip inductor. In addition, comparison observations were made with a Q.H.M. quartz horizontal-force magnetometer and a B.M.Z. vertical-force balance magnetometer.

The records were tabulated preparatory to further elaboration for inclusion in the *Observatories' Year Book*. International daily character figures and three-hourly range-indices (*K*) were assigned. Hourly values of declination were sent weekly to the *Colliery guardian* and the *Iron and coal trades review*, while copies of magnetograms were supplied on request to the National Coal Board and other establishments. Notification of magnetic disturbance exceeding certain limits was sent to the Radio Research Station at Slough, the Marconi Company at Chelmsford and the Cavendish Laboratory. Notice of solar activity likely to be associated with magnetic disturbance was received from the Astronomer Royal from time to time.

A report was made to the Director, Meteorological Service, Dublin, concerning the extent to which magnetic disturbance may have affected the regular measurements of declination, horizontal force and dip made during the year at Valentia Observatory.

Facilities were given in May to members of the Department of Geophysics, Cambridge University, to determine the temperature characteristics of two vertical-force instruments used in field work in northern England.

Two large parties of mining engineers visited the Observatory.

Atmospheric electricity.—Continuous photographic records of atmospheric electrical potential gradient were maintained, and measurements of the electric potential at one metre above level ground were made several times monthly. The Wulf electrometers used were calibrated at intervals.

(d) **Lerwick Observatory.** — *Meteorological observations.* — Full hourly synoptic observations were made and transmitted to the Central Forecasting

Office Dunstable, by teleprinter. The necessary autographic records were maintained and climatological tabulations prepared.

Records of atmospheric pollution were obtained for the Director of Fuel Research, Department of Scientific and Industrial Research.

The daily programme of upper air observations consisted of radio-sonde ascents at 0200 and 1400 G.M.T. and radar wind measurements at 0200, 0800, 1400 and 2000 G.M.T. No radio-sonde ascent was omitted and the average level to which temperature was determined was 86 mb. (about 55,000 ft.), a record for the station. Difficulty in obtaining spare parts and shortage of staff trained in the manipulation of the radar equipment led to a 40 per cent. reduction of the number of radar wind soundings in the months July to September 1952 and February to March 1953 ; about 5 per cent. of soundings were missed (because of failures in ground equipment) in the remaining months of the year.

Solar radiation.—Records of total and diffuse solar radiation were maintained. Hourly values of radiation were tabulated.

Ozone.—Using a Dobson ozone spectrophotometer, measurements of the amount of atmospheric ozone were made twice daily from March to October and once daily from November to February, but were limited to occasional direct sun observations at noon during a few weeks in midwinter.

Terrestrial magnetism.—As at Eskdalemuir, continuous photographic registration of magnetic declination and horizontal and vertical force was maintained by two sets of la Cour magnetographs. Supplementary records were obtained from less sensitive variometers. Absolute measurements of the magnetic elements were made three times weekly, using a Kew unifilar magnetometer for declination, a Smith coil magnetometer (and also a Q.H.M. magnetometer) for horizontal force, and a balance magnetometer (B.M. or B.M.Z.) for vertical force. Hourly and other readings were obtained from the variometer records. International daily character figures and three-hourly range-indices (*K*) were assessed.

Aurora.—Regular watch for auroral display was kept during the winter period September to April, though cloud seriously reduces the opportunities for visual observation of aurora at Lerwick.

Atmospheric electricity.—Autographic records for electric potential gradient were obtained. The provision of electric heating in the instrument room increased the reliability of the recording equipment. Frequent measurements of the atmospheric electrical potential one metre above level ground were made for standardization purposes.

Miscellaneous.—Equipment for recording the field strength of V.H.F. radio signals was maintained for the British Broadcasting Corporation during the second half of the year.

(6) Special Investigations

Much attention was paid to the meteorological conditions likely to affect the operation of Comet aircraft on the routes at present in use and on those which are in contemplation. In particular, endeavour was made to estimate the magnitude of errors likely to be made in wind forecasts on those routes. A geophysical memoir on the variation of wind with time and place was completed in draft.

The discussions of the suitability of Gatwick as an alternative airport to London led to many data being required showing the comparison of London Airport, Gatwick and other possible sites in regard to visibility and cloud height.

§ 5. ORGANIZATION

(1) Structure

(a) Headquarters.—The administrative headquarters of the Meteorological Office is situated in Victory House, Kingsway, London, W.C.2. Here are accommodated the Director, Principal Deputy Director, Deputy Director (Services), Deputy Director (Research) and some of the Assistant Directors and Heads of Branches, with their staffs.

The Headquarters structure is shown in Appendix I, and a list of the Directorate and Heads of Branches in Appendix II.

(b) Branch Meteorological Office, Edinburgh.—No important change in organization was made during the year.

(2) Staff

(a) Retirement and transfers.—The Office has lost by retirement Mr. R. H. Mathews, O.B.E., B.A., after 32 years' service, during the last three of which he was Assistant Director (Climatology), three Principal Scientific Officers transferred to the World Meteorological Organization and one to the International Civil Aviation Organization. Another Principal Scientific Officer was seconded to the Ministry of Defence for duty with the Supreme Headquarters Allied Powers in Europe and one was released to serve as Chief Scientist on the British north Greenland Expedition.

(b) Complements.—Recruitment of civilian staff for established appointments in the scientific, experimental and assistant classes continued through competitions held by the Civil Service Commissioners. Thirty-two successful candidates in the scientific and experimental classes accepted established appointments of whom 18 were already employed in the Meteorological Office in a temporary capacity or a lower grade. During the year established appointments were also given to 66 assistants, all of whom were already in the Meteorological Office.

The number of candidates presenting themselves for Assistant Experimental Officer posts, either established or temporary, was below requirements. On the other hand staffing limitations restricted the recruitment of Temporary Assistants.

The rate of resignation of Temporary Assistants remained high, though a little lower than in the previous two years. The percentage of airmen meteorologists who did not accept civilian appointment on completion of National Service was 41 per cent. compared with 32 per cent. the previous year.

The following table shows the constant turnover of assistants :—

Number of airmen meteorologists not accepting appointments as civilian assistants on completion of national service	61
Resignations and other losses of assistants	191
Total losses	252
Number of assistants recruited throughout the year	289
Number of assistants still under training on March 31, 1953	83

Recruitment of Radio Meteorological Mechanics continued slowly throughout the year but lagged behind requirements.

(c) **Strength of staff.**—The strength of staff at March 31, 1953, is shown in the table below.

For the purpose of comparison the strength for a year ago is also given.

	March 31, 1952	March 31, 1953
Scientific Officers	165	162
Experimental Officers	643	658
Nautical Officers	8	8
Assistants (Scientific)	1433*	1477†
Ocean Weather Ship Staff (Nautical Grades)	33‡	37‡
Signals Grades	203‡	206‡
Radar Maintenance Grades	46	52
Clerical and Typing Staff	97‡	102‡
Miscellaneous (non-industrial)	35‡	38‡
Miscellaneous (industrial)	183‡	191‡
Locally entered employees (overseas)	192	186
Total	3,038‡	3,117‡

(d) **Uniformed personnel.**—The number of airmen serving in the trade of Meteorologist on engagements under the National Service Acts, was 222 on March 31, 1953. They were held against a block establishment of airmen assistants.

Royal Air Force Reserve (Meteorological Section).—Following appointment to the staff of the World Meteorological Organization, Squadron Leader J. L. Galloway was placed on the non-training list on June 23, 1952. Mr. R. M. Poulter, O.B.E. was commissioned as Squadron Leader, R.A.F.V.R. on August 5, 1952, appointed Chief Meteorological Officer, Royal Air Force Reserve and placed in charge of the technical training of meteorologists in both volunteer and class "H" branches of the R.A.F. Reserve.

The strength of the Meteorological Section Royal Air Force Volunteer Reserve on March 31, 1953 was 104 officers and 47 airmen and airwomen, showing a gain of 15 officers and 4 other ranks during the year. Of these 82 officers and 46 other ranks were qualified to perform duties appropriate to their ranks without further training.

Considerable assistance was given by this Reserve during their fortnight's training in filling posts vacant through leave or other absence of Meteorological Office staff. Six officers and four other ranks participated in major air exercises. The assistance given was not limited to normal training liability; 24 officers and four airmen and one airwoman completed among them 562 days of additional continuous training.

Week-end training also gave much help; for instance forecasters needed at week-ends by Auxiliary Squadrons at Biggin Hill, North Weald and Thornaby were obtained from among officers of the Royal Air Force Volunteer Reserve who took duty in turns.

During the year, as part of their training, 23 officers took courses of instruction in higher forecasting work at the Meteorological Office Training School, Stanmore.

* Includes 274 airmen meteorologists.

† Includes 222 airmen meteorologists.

‡ These figures include a number of non-meteorological grades not shown in previous years.

A useful reserve (Class "H") was built up from released National Service airmen, and good use was made of their fortnight's annual training when they filled assistant posts in many meteorological offices throughout the country. They required usually little more than a day to settle down to the work.

Air Meteorological Observers.—No change in organization was made during the year.

(e) *Training of staff.*—The Chief Instructor, Training School, is responsible for the training of staff in meteorological duties. He is also responsible for arrangements by which staff are encouraged to undertake external study in subjects related to their work.

A new course was introduced at the Training School during the year: it was for experienced forecasters and provided instruction in the more recent developments in meteorology particularly those relating to forecasting.

Course for Scientific Officers.—The normal course lasts for four months. During the year training was given to five officers of whom three were Meteorological Office staff and two belonged to the Colonial Meteorological Services.

Initial course for Forecasters.—This course lasts for 12 to 15 weeks according to the previous synoptic experience of the trainee, and provides instruction in the basic principles of meteorology and training in forecasting for newly appointed Assistant Experimental Officers. Four courses were held for 34 officers of whom 17 were formerly Assistants (Scientific) in the Meteorological Office.

Advanced course for Forecasters.—This is a six weeks' course for Assistant Experimental Officers nearing promotion. It is concerned mainly with the application of upper air analysis to forecasting. Five courses were held, 29 officers attending.

Refresher course for experienced Forecasters.—This is the new course already referred to; 64 Senior Experimental Officers attended the six courses, each of which lasted three weeks.

Initial course for Assistants (Scientific).—This course, lasting eight weeks, includes revision of basic physics, some elementary meteorological theory, and instruction and practice in those duties which an assistant carries out at a synoptic station. Twenty-four courses were held, attended by a total of 343 assistants.

Course for Voluntary Observers.—Two courses each lasting four days gave general instruction on the making of weather observations to 51 observers who contribute to the climatological statistics of the British Climatology Branch.

Training of Dominion, Colonial and foreign personnel.—The Meteorological Office was asked by a number of governments to provide courses in forecasting for personnel in their meteorological services. The following officers were trained during the year:—

Colonial Meteorological Services	7
Sudan Meteorological Service	1
Ceylon Meteorological Service	2

Course for Royal Air Force Volunteer Reserve Officers.—This is on the lines of the Advanced Course for Forecasters, but lasts only the two weeks which are laid down as the period of annual training for reservists. This year three courses were held and 23 officers attended.

External training.—The concessions granted to members of staff following approved courses of study include payment of fees and time-off with pay to attend classes and examinations. During the year one member of the Experimental Officer class obtained an honours degree in mathematics and two others a general honours degree. Five other members of the staff passed the Intermediate B.Sc. examination of London University, four obtained the General Certificate of Education at advanced level and three gained the Higher National Certificate.

(f) **Technical discussions.**—Meetings for the discussion of recently published meteorological papers or of research work in progress in the Office were held once a month from October 1952 to March 1953. These meetings are attended by members of the staff, and, on invitation, by staff of other Government Departments or University research workers interested in the subject under discussion.

The subjects discussed and the openers were :—

October 20, 1952	Orographic effects on wind with special reference to the safety of aircraft	Mr. L. Jacobs
November 17, 1952	Short-range weather fore- casting methods	Mr. V. R. Coles
December 15, 1952	Cold pools	Mr. S. E. Virgo
January 19, 1953	Atmospheric circulation at high altitudes in the tropics and subtropics	Mr. J. K. Bannon and Mr. N. E. Davis
February 16, 1953	The application of wave- length ideas in forecasting	Mr. E. J. Sumner
March 16, 1953	Fog investigations	Dr. K. H. Stewart

(3) Supply of Instruments

(a) **Provision and production of equipment.**—During the year 1,174 orders and contracts were placed. The total expenditure was £323,630. During the same period £46,991 were received by the sale of equipment and for services rendered, e.g. testing and inspecting instruments.

(b) **Issue of equipment.**—Meteorological offices at home and overseas were maintained by regular supplies of instruments and stores. Advice was given to many inquirers both in this country and in the Dominions and Colonies as to the best sources of equipment supply.

The “Vocabulary of meteorological equipment” was maintained as up to date as possible by the issue of amendment lists.

Demands for stores totalled 13,685, which is about the same number as the previous year. Included in these demands were some from the Commonwealth, Colonial and foreign Governments and from co-operating observers who are allowed to purchase their instruments from official stocks. Equipment was lent to other Government Departments and public authorities for particular investigations. The number of loans made during the year was 75.

The following loans are worthy of mention :—

Radar wind equipment to Malaya and a second set to South Africa
Equipment to the Ministry of Transport for an expedition to Hudson Bay
for the investigation of radar echoes

Equipment to Durham University for an expedition to Iceland
Equipment to British Schools Exploration Society for an expedition to central Iceland
A large amount of equipment for the British north Greenland Expedition
Equipment to the Imperial College of Science Meteorology Department for an expedition to the West Indies
Radio-sonde equipment to the Navy for the atomic bomb tests in the Monte Bello Islands
A complete set of radio-sonde ground equipment to Nigeria, pending the manufacturers supplying satisfactory equipment.

(c) Testing and calibrating.—*General instruments and aircraft instruments.*—The total number of instruments tested, excluding balloons was 138,566. The number of balloons of all sizes received and submitted to a 5 per cent. check was 378,722.

Fees received for the testing and inspection of instruments for manufacturers and others amounted to £650.

Assistance in the preparation of meteorological instruments was given to members of the British north Greenland Expedition.

Instruction on the maintenance of instruments was given to climatological observers.

Radio-sondes.—The total number of radio-sondes received from the makers was 6,014. In addition 12,276 were re-calibrated from stock, and 4,736 recovered after flight were overhauled and re-calibrated for future use.

The installation of the new calibration plant was completed, and the plant will be in full use next year.

Improvements were effected in methods of transporting radio-sondes to reduce damage in transit, and in protecting the sondes after flight from corrosion by battery acid.

(d) Maintenance of radar wind equipment.—It was possible to increase the number of inspections of radar wind equipment at stations in the United Kingdom this year. A second radar equipment was overhauled for South Africa and one equipment prepared for issue to Malaya. A number of temporary repairs to components were carried out to meet requirements for parts which are difficult to obtain.

Among the special work carried out by this section the following may be mentioned :—

Complete inspection and overhaul of the equipment at Gibraltar

Work on calibration of range zero and measurement of radar wind equipment

Guidance to Ministry of Supply contractors engaged in overhauling equipment

Information to the German Meteorological Service on radar maintenance.

(4) Library and Publications

The Meteorological Office Library is at Harrow.

(a) Library.—*Exchanges of publications.*—The exchange of publications with other national meteorological services and independent institutions was continued. The number of exchange agreements reached 325.

Publications were issued gratis, by special sanction, to 41 institutions. A check was made of all existing publications.

Accessions.—The total number of publications taken into the Library during the year, exclusive of *Daily Weather Reports*, was 8,260. This number included 278 photographic copies of papers appearing in periodicals not received in the Library. These numbers continue to emphasize the great increase in meteorological literature that has been a feature of the post-war period. Meteorological literature is widely scattered throughout periodicals on pure and applied science, so that the search for reports on important researches can no longer be limited to the few better known abstracting journals. A diligent search must now be made of publication and accession lists of numerous Government Departments and of other national libraries. This task has grown from a side issue of the between-the-wars period to an increasing quest on the part of senior staff. Published papers of direct meteorological interest catalogued during the period totalled 5,154. 156 lantern slides, 220 photographs, 8 films and 4 film strips were added to the Library's collection of visual aids for lecture and exhibition purposes.

Financial arrangement for purchase of non-periodical publications.—The arrangement whereby the Library purchases for itself, and for the technical libraries at Victory House and Dunstable, all non-periodical publications continued satisfactorily. It was agreed that the purchase grant would remain unchanged in 1953–54.

Repair of war-time omissions.—The excellent progress in the binding of publications reported for the previous year was not maintained. Staff shortages and staff changes meant that this work had to be left untouched for long periods. Only 145 books were prepared for binding as against 1,056 in 1951–52.

The third crate of original German meteorological records was microfilmed by the Air Ministry Photographic Reproductions Branch and the originals returned to Germany.

Co-operation with other British libraries.—Sixty-eight copies of each issue of the Library's *Monthly bibliography of meteorological literature* were distributed to other libraries and institutions in addition to the copies distributed to staff.

Full co-operation was maintained with the Science Museum Library, the National Central Library and the libraries of the Royal Geographical Society and the Royal Meteorological Society. Papers appearing in the *Quarterly journal of the Royal Meteorological Society* were classified, and all possible assistance was given to the Society in other library matters. Inter-library loans continued to be numerous. It is only in this way that library expenditure can be kept to reasonable limits. The following table shows the number of publications borrowed from other libraries :—

	No. of publications
Science Museum	281
Ministry of Supply	92
Other Government Departments	111
National Central Library	135
Libraries of Universities and Colleges	27
Scientific Societies and Research Institutes	92

The Library continued to be a corporate member of the Association of Special Libraries and Information Bureaux and a Library representative attended the Annual Conference. Particulars of new geophysical publications in English were supplied to the Association of Special Libraries and Information Bureaux for inclusion in the *ASLIB book-list*.

Senior staff of the Library remained members of the Circle of State Librarians, and were instrumental in bringing to the attention of Treasury officials responsible for a report on Government Libraries the special case of non-departmental libraries functioning as national libraries in specialized fields of science.

Loans.—The number of publications lent continued at the high rate of approximately 10,000 a year. Several times this number were consulted in the Library. Owing to the increase of staff at Harrow much more work was completed in the library in preference to taking publications to crowded rooms.

Papers of special interest to branches or to individual research workers were sent on loan soon after receipt so that they could be consulted by the specialist workers before the more general demands were received from the recipients of the *Monthly bibliography of meteorological literature*. Preliminary arrangements were made for special attention to be drawn to papers of particular interest to forecasters.

The demand for visual aids for lectures and exhibitions was maintained ; 844 lantern slides, 89 films, 25 film strips and 347 photographs were issued on loan to the staff and general public.

Bibliographies.—A microfilm copy of the subject index of the Library was purchased by the Canadian Meteorological Division.

The *Monthly bibliography of meteorological literature* was issued regularly with short abstracts of papers included when considered necessary.

Selected bibliographies were provided on request and included bibliographies on : jet streams and air navigation ; pressure-pattern flying ; meteorological factors for jet aircraft and the state of the atmosphere and forecasting above 25,000 ft. ; fixed nitrogen content of the atmosphere ; wind data for specified areas ; flight through thunderstorms ; forecasting night minimum temperature ; meteorology in relation to health and disease ; climate of the Sudan.

Inquiries.—Inquiries were received from other Government Departments, the general public—including several overseas inquirers—universities and research institutions, in addition to those from the staff of the Office. The following are examples of the variety of inquiries dealt with : information concerning turbulent conditions in air flow over mountain ranges ; snow cover in Greece and Palestine ; gale frequencies in British waters ; artificial precipitations and efforts to prevent hail damage to crops ; the West Indian hurricane of 1932 ; summer and winter positions of polar and arctic front ; decrease of sea-salt content of the air with distance from the coast ; isentropic analysis ; temperature and humidity gradients ; underground temperature ; percentage transmission of certain optical glass for different wave-lengths ; history of weather forecasting ; world distribution of harmonic constants for diurnal variation of temperature ; dust content of the atmosphere ; vorticity ; correlation between sun-spot numbers and levels of central African lakes ; wind pressure on buildings ; electrostatic methods of fog dispersal ; evolution of the earth's atmosphere.

Miscellaneous.—The American Meteorological Society sent a microcard reader on loan to the Library to enable the Library to give a trial to microcards. Some 2,900 of these cards were received. A report on the value of microcard technique in specialist libraries is to be prepared when sufficient experience has been gained.

Several hundred volumes of publications which had been in store were returned to the Library. These were scrutinized to justify further retention. Most were transferred to Archives, Air Ministry after re-cataloguing and parcelling. Manuscript material was retained by the World Climatology Branch.

The Guildhall Library, City of London, offered its holdings of old Meteorological Office publications, and they were transferred to the Library for sorting.

Numerous photographs were selected for the revised "International atlas of clouds and states of the sky" in preparation under the auspices of the World Meteorological Organization.

The World Meteorological Organization asked the Meteorological Office for help in building up a Technical Library at the Secretariat, and a large number of back numbers of Meteorological Office publications and some surplus publications were supplied in response.

Members of the United States Air Force were supplied with many climatological data. For considerable periods two officers and four N.C.O's were accommodated in the Library, and their requirements for information over large areas and long periods involved considerable effort in providing the essential data and translating foreign headings and explanations to tables.

Much help with papers in foreign languages was given to other members of the staff. Some short papers in German and Russian were translated and long ones sent to the Air Ministry Translation Branch. Translations from Japanese and Turkish were, by special arrangement, made by the Central Office of Information.

(b) Publications.—*Geophysical Memoirs, Professional Notes, Meteorological Reports.*—A list of papers published under these general titles is given in Appendix V. Two *Geophysical Memoirs*, two *Professional Notes* and one *Meteorological Reports* were also sent for printing.

Meteorological Magazine.—The *Meteorological Magazine* was published regularly throughout the year. The articles published covered a wide field including detailed descriptions of the severe gale over Scotland on January 15, 1952 and the torrential rain over Exmoor on August 15, 1952, training in the Meteorological Office, turbulence at high levels, cloud photographs taken from over 40,000 ft. from Comet aircraft, determination of the usefulness of forecasts, relations between solar disturbances and geophysical phenomena, and an analysis of optical phenomena observed at Oxford since 1881.

Marine publications.—Publication of the *Marine Observer* was continued with the four quarterly numbers for April, July and October 1952 and January 1953. The articles published dealt amongst other matters with meteorology in relation to carriage of goods by sea, diurnal variation of visibility at sea, errors of aneroid barometers and the weather associated with the loss of the *Flying Enterprise*.

A revised reprint of the seventh edition of the "Marine observer's handbook" was published.

The editing of a new publication "Meteorology for mariners" was nearly completed.

Work on a revised edition of the atlas "Monthly meteorological charts of the Greenland and Barents Seas" was completed, and the preparation for printing was begun.

Observatories' Year Book.—The *Observatories' Year Book*, containing the geophysical records of the observatories, has not been published since the volume for 1937 appeared in 1939. After prolonged discussion agreement was reached with Her Majesty's Stationery Office for publication of the volumes from 1938 onwards by photolithography from a text to be produced by Vari-typer in the Meteorological Office. It was decided to publish the magnetic and electrical tables in the same form as in the earlier volumes, but to abbreviate substantially the meteorological tables. A Vari-typer machine was acquired, and typing of the 1938 volume begun.

Other publications.—The "Climatological atlas of the British Isles", the "Observer's handbook", "A century of London weather" by W. A. L. Marshall, and a second edition of "Condensation trails from aircraft" were published.

Publications in the press at the end of the year included the "Handbook of statistical methods in meteorology" by C. E. P. Brooks and N. Carruthers, "Averages of temperature for Great Britain and Northern Ireland, 1921–50" and "Averages of bright sunshine for Great Britain and Northern Ireland, 1921–50".

§ 6. INTERNATIONAL CO-OPERATION

(1) International Council of Scientific Unions

The International Council of Scientific Unions decided to organize an International Geophysical Year to be held in 1957–58. A British National Committee was set up to recommend what investigations should be undertaken in the various fields of geophysics and the extent to which British participation should be provided. The Director of the Meteorological Office is a member of the National Committee.

(2) World Meteorological Organization

(a) **Commission for Maritime Meteorology.**—The Commission for Maritime Meteorology, under the presidency of the Marine Superintendent, held its first session at the Royal Geophysical Society in London from July 14 to 29, 1952. Twenty-one nations were represented at this Conference, which was opened by Mr. George Ward, Under Secretary of State for Air. The Commission adopted 12 resolutions, and submitted 31 recommendations to the Executive Committee of the World Meteorological Organization. At the conclusion of the Conference Commander C. E. N. Frankcom was re-elected president.

(b) **Regional Committee for Europe.**—A meeting of this Regional Association was held at Zürich in July, official delegations from 23 European countries taking part. The efforts of the meeting were devoted mainly to the extension of aerological networks and to the standardization of procedures and specifications.

(c) **Executive Committee.**—The meeting of the Executive Committee held

at Geneva in September was attended by the Director of the Meteorological Office, as a member, and by Commander Frankcom in his capacity of President of the Commission for Maritime Meteorology. The functions of the Executive Committee are to direct the work of the Secretariat, to control the finances of the World Meteorological Organization and to give provisional approval to recommendations made by the Technical Commissions.

(3) International Civil Aviation Organization

Representatives of the Meteorological Office attended the following meetings :—

Second south-east Asia South Pacific Regional Air Navigation meeting, Melbourne, January 1953

First Air Navigation Conference, Montreal, February 1953.

The Meteorological Office was consulted on the meteorological aspects of the United Kingdom briefs for the following meetings :—

Aeronautical Information Division, Montreal, August 1952

Communications Division, fifth meeting, Montreal, October 1953.

(4) International Air Transport Association

Representatives of the Meteorological Office attended as observers the following meetings :—

World Meteorological Group, third meeting, London; October 1952

European Middle East Meteorological Panel, seventh meeting, London, November 1952.

(5) Commonwealth Meetings

The Meteorological Office was consulted on meteorological aspects of the meetings of the South Pacific Air Transport Council, the Southern Africa Air Transport Council, the Anglo-French Joint Standing Committee, the West African Anglo-French Civil Aviation Sub-Committee, and the Eastern Caribbean Hurricane Committee.

The meteorological section of a paper on " Review of progress on problems since the 1951 jet conference " was prepared for submission at the 2nd Colonial Civil Aviation Conference in September, at which the Meteorological Office was represented.

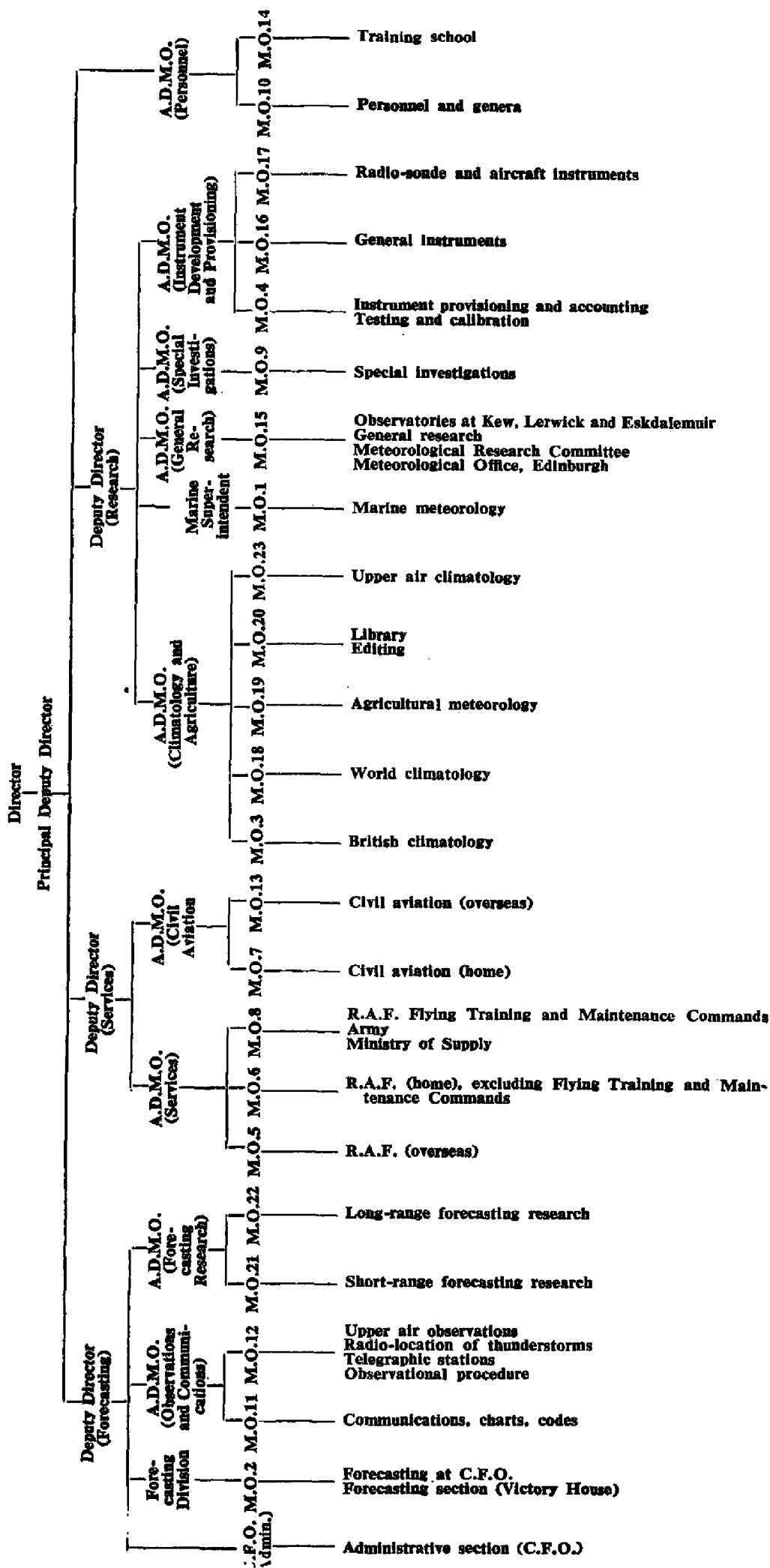
(6) International Union of Geodesy and Geophysics

The International Union of Geodesy and Geophysics at its meeting at Brussels in August 1951, expressed approval of the proposal for a Third International Geophysical Year in 1957–58.

In 1952 the Council of the Royal Society approved the setting up of a British National Committee to give preliminary thought to suitable British participation. Professor S. Chapman is the Chairman and Sir Nelson Johnson a member of the Committee.

The Meteorological Research Committee also considered the question and adopted a resolution recommending that the meteorological programme should be to investigate one or more specific problems which offer promise of early solution rather than to accumulate general data, and that this recommendation should not be interpreted as diminishing the need for a greater knowledge of upper air climatology in low latitudes.

APPENDIX I ORGANIZATION OF THE METEOROLOGICAL OFFICE



APPENDIX II

DIRECTORATE OF THE METEOROLOGICAL OFFICE AND HEADS OF BRANCHES

DIRECTOR

Sir Nelson Johnson, K.C.B., D.Sc., A.R.C.S.

PRINCIPAL DEPUTY DIRECTOR

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

DEPUTY DIRECTOR (RESEARCH)	A. H. R. Goldie, C.B.E., M.A., D.Sc., F.R.S.E.
<i>Assistant Director (General Research)</i>	H. W. L. Absalom, B.Sc., A.R.C.S., D.I.C.
General Research and Observatories Branch (M.O.15)	A. C. Best, M.Sc.
<i>Assistant Director (Special Investigations)</i>	C. S. Durst, O.B.E., B.A.
Special Investigations Branch (M.O.9)	L. Dods, B.Sc.
<i>Assistant Director (Instrument Development and Provisioning)</i>	F. J. Scrase, O.B.E., M.A., Sc.D., F.Inst. P.
General Instruments Branch (M.O.16)	R. Frith, M.A., Ph.D.
Radio-sonde and Aircraft Instruments Branch (M.O.17)	D. N. Harrison, D.Phil.
Instrument Provisioning Branch (M.O.4)	P. N. Skelton, M.B.E.
<i>Assistant Director (Climatology and Agriculture)</i>	R. G. Veryard, B.Sc.
British Climatology Branch (M.O.3)	J. Glasspoole, M.Sc., Ph.D.
World Climatology Branch (M.O.18)	J. Pepper, Ph.D.
Agricultural Meteorology Branch (M.O.19)	L. P. Smith, B.A.
Library and Editing (M.O.20) ..	G. A. Bull, B.Sc.
Upper Air Climatology Branch (M.O.23)	Miss E. E. Austin, M.A.
<i>Marine Superintendent (M.O.1)</i> ..	Cmdr C. E. N. Frankcom, O.B.E., R.D., R.N.R. (Retd)
DEPUTY DIRECTOR (FORECASTING)	E. G. Bilham, B.Sc., A.R.C.S., D.I.C.
<i>Forecasting Division (M.O.2)</i>	C. K. M. Douglas, O.B.E., B.A.,
	J. S. Farquharson, M.A., D.Sc.,
	S. P. Peters, B.Sc.
<i>Assistant Director (Observations and Communications)</i>	C. V. Ockenden, B.Sc.
Communications ; Charts and Codes Branch (M.O.11)	—
Upper Air Observations (M.O.12) ...	A. L. Maidens, B.Sc.
<i>Assistant Director (Forecasting Research)</i>	R. C. Sutcliffe, O.B.E., B.Sc., Ph.D.
Short-Range Forecasting Research Branch (M.O.21)	J. S. Sawyer, M.A.
Long-Range Forecasting Research Branch (M.O.22)	—
DEPUTY DIRECTOR (SERVICES)	J. Durward, M.A.
<i>Assistant Director (Services)</i>	R. P. Batty, O.B.E., B.A.
R.A.F. (Overseas) Branch (M.O.5)	S. T. A. Mirrlees, M.A., B.Sc.
R.A.F. (Home) Branch (M.O.6) ..	M. J. Thomas, O.B.E., B.Sc.
Flying Training, Army and Ministry of Supply Branch (M.O.8)	B. C. V. Oddie, B.Sc.
<i>Assistant Director (Civill Aviation)</i> ...	W. H. Bigg, O.B.E., B.Sc.
Civil Aviation (Home) Branch (M.O.7)	N. H. Smith, B.Sc.
Civil Aviation (Overseas) Branch (M.O.13)	J. C. Cumming, O.B.E., M.A.
<i>Assistant Director (Personnel)</i>	M. T. Spence, O.B.E., B.Sc.
Personnel and General Branch (M.O.10)	C. J. Boyden, B.A.
Training Branch (M.O.14)	K. H. Smith, B.Sc.

APPENDIX III

CLASSIFICATION OF BRITISH STATIONS WHICH REPORT TO THE BRITISH CLIMATOLOGY BRANCH

	Stations					Autographic records		
	Observatories	Synoptic	Crop weather	Climatological	Rainfall	Sunshine	Rainfall	Wind
Scotland, North	1	8	0	11	141	14	9	2
Scotland, East	0	7	3	40	343	36	19	4
Scotland, West	1	6	2	27	403	22	13	6
England, North-east	0	12	3	19	313	26	11	5
England, East	0	10	12	21	501	29	30	7
England, Midlands	0	18	15	33	1,050	50	39	3
England, South-east	1	15	9	59	744	56	56	11
London District	0	1	0	5	41	5	4	3
England, South-west	0	9	6	26	486	33	13	4
England, North-west	0	8	3	20	453	23	30	6
Wales, North	0	3	1	10	195	8	6	2
Wales, South	0	5	5	14	265	20	9	4
Isle of Man	0	3	0	1	10	4	1	1
Scilly and Channel Isles	0	1	0	2	18	3	0	1
Northern Ireland	0	3	0	7	84	4	3	1
Total	3	109	59	295	5,047*	333	243	60

* Includes stations in earlier columns.

APPENDIX IV

PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES

The approximate cash provision in Air Estimates, 1952-53, 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	218,500	3
1b	Salaries, wages, etc. of civilians at meteorological observatories and outstation offices and in ocean weather ships	1,423,000	4
1c	Pay, etc. of airmen employed as air meteorological observers and meteorologists and of air force personnel of the meteorological research flight ..	55,000	1
1d	National insurance contributions	3,100	1
1e	Pay, etc. of meteorological personnel of the Royal Air Force Reserve	3,000	2
1f	Superannuation allowance and gratuities	12,500	10
1g	Conveyance of personnel ; travelling allowances and expenses	75,000	5
2	<i>Equipment and Supplies</i>		
2a	Meteorological equipment	350,000	7
2b	Radio, radar and electrical equipment for meteorological services	30,000	7
2c	Conveyance of equipment for meteorological services	19,500	5
2d	Mechanical transport vehicles for meteorological services	22,000	7
2e	Solid fuel, electricity, gas, water and sanitary services for meteorological observatories and outstation offices	3,500	6
2f	Liquid fuel, lubricants, etc. for aircraft of the meteorological research flight and for vehicles required for meteorological services	23,000	6
2g	Liquid fuel for ocean weather ships	50,000	6
2h	Other equipment and services for aircraft of the meteorological research flight	30,000	7
2i	Other equipment and services for ocean weather ships	44,000	7
2j	General stores for meteorological services	1,500	7
2k	Food and ration allowances for air force personnel ; food for crews of ocean weather ships	33,000	6
2l	Clothing, clothing allowance and laundry services for airmen ; clothing for crews of ocean weather ships	11,900	7
3	<i>Works services for meteorological observatories and outstation offices</i>		
3a	Capital expenditure	65,000	8
3b	Maintenance expenditure	20,000	8
4	<i>Telecommunication services for meteorological purposes</i>	250,000	9
6	<i>Flights by civil aircraft for meteorological purposes ..</i>	5,000	9
6	<i>Contribution to the World Meteorological Organization</i>	7,000	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>	5,000	9
9	<i>Other miscellaneous effective services</i>	8,000	9
	GROSS TOTAL	£2,771,500	
10	<i>Deduct-Appropriations in aid</i>		
		£	
10a	Repayment in respect of meteorological staff employed on special services, etc.		
	Salary, wages, etc.	258,000	4
	Movement expenses	12,000	5
	Contributions towards non-effective benefits	6,000	10
		276,000	
10b	Receipts relating to meteorological equipment	55,000	7
10c	Payments by airmen for issues of clothing and footwear	2,500	7
10d	Receipts for miscellaneous meteorological services	13,000	9
		346,500	
	NET TOTAL	£2,425,000	

APPENDIX V

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, 1953).
Daily Weather Report, containing weather maps for the northern hemisphere, British Isles, etc. and data (to March 31, 1953).
Daily Weather Report Overseas Supplement, containing surface and upper air data (to June 24, 1952).
Meteorological Magazine (to March 1953).
Monthly Weather Report, with summary for the year (to December 1952).
Seismological Bulletin. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to February 1953).
Marine Observer (quarterly) (to January 1953).
British Rainfall 1950. 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, 1949. Southport Auxiliary Observatory. By George A. Lidster.
Notes on the meteorological observations made in British Colonies and Protectorates, etc. in 1939-47 and summarized in the annual reports of Colonial Governments.

Occasional

- Climatological atlas of the British Isles.
Observer's handbook, 1952.
A century of London weather. By W. A. L. Marshall.
Condensation trails from aircraft. 2nd edition, 1952.
Three-dimensional weather maps. Model No. 1. Typical depression in its early stages.
Upper air data for stations maintained by the Meteorological Office. Summaries of radio-sonde observations of temperature and humidity and of radar wind measurements at standard pressure levels, 1946-50. Part 1, Larkhill. Part 2, Lerwick.
Geophysical Memoirs :—
Vol. XI :—
88. Humidity of the upper troposphere and lower stratosphere over southern England. By J. K. Bannon, B.A., R. Frith, Ph.D. and H. C. Shellard, B.Sc.
89. Temperature and humidity gradients in the first 100 m. over south-east England. By A. C. Best, M.Sc., E. Knighting, B.Sc., R. H. Pedlow, B.Sc. and K. Stormonth, B.Sc.
Professional Notes :—
Vol. III :—
106. Occurrence of high rates of ice accretion on aircraft. By A. C. Best, M.Sc.
Meteorological Reports :—
Vol. II :—
11. Duststorms of the Anglo-Egyptian Sudan. By M. H. Freeman, M.Sc.
12. Aviation meteorology of the route Marseilles-Rome-Athens-Cairo.

The following books or papers by members of the staff were published during the year.

- C. K. M. DOUGLAS, B.A. :—
Gale of December 17, 1952. *Met. Mag., London*, 82, 1953, p. 71.
Synoptic aspects of the storm over north Scotland on January 15, 1952. *Met. Mag., London*, 81, 1952, p. 104.
The Tibshelf tornado. *Weather, London*, 7, 1952, p. 311.
C. K. M. DOUGLAS, B.A., and K. H. STEWART, Ph.D. :—
London fog of December 5-8, 1952. *Met. Mag., London*, 82, 1953, p. 67.

- C. S. DURST, B.A. :—
High-level cloud in the tropics. *Met. Mag., London*, 82, 1953, p. 79.
High-level winds and temperatures for jet aircraft operation. *Quart. J. R. met. Soc., London*, 78, 1952, p. 442.
- J. S. FARQUHARSON, M.A., D.Sc. :—
Cloud in the stratosphere. *Met. Mag., London*, 81, 1952, p. 341.
- C. V. OCKENDEN, B.Sc. :—
World Meteorological Organization. Third Telecommunications Sub-Commission Meeting, Paris, February 1952. *Met. Mag., London*, 81, 1952, p. 171.
- F. J. SCRASE, Sc.D., F.Inst.P. :—
Relatively high stratosphere temperature of February 1951. *Met. Mag., London*, 82, 1953, p. 15.
- R. C. SUTCLIFFE, Ph.D. :—
Principles of synoptic weather forecasting. *Quart. J. R. met. Soc., London*, 78, 1952, p. 291.
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