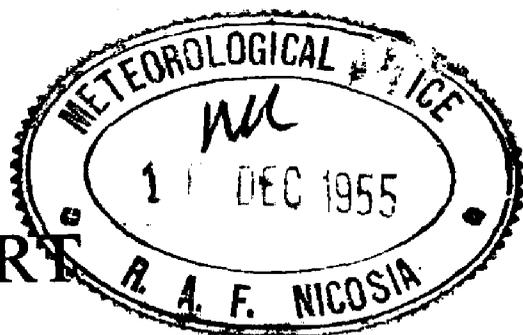


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ANNUAL REPORT

OF THE DIRECTOR OF THE METEOROLOGICAL OFFICE

PRESENTED BY THE METEOROLOGICAL COMMITTEE
TO THE SECRETARY OF STATE FOR AIR

FOR THE YEAR
APRIL 1, 1954 TO MARCH 31, 1955



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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 29, 1954.

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FOREWORD

In the twelve months covered by this Report, the Meteorological Office continued to carry out its traditional duties as the State Meteorological Service for the community in general as well as for Governmental bodies and the Armed Forces. A detailed account of these activities is given in the pages that follow. In addition, the Office has maintained a vigorous research programme and has joined fully in international work, as in the past.

Following the successful conference on ocean weather ships in Paris, February 1954, the four British weather ships have carried out a full programme of surface and upper wind observations, the fixed stations being operated jointly with the French and Netherlands vessels. On land, improved radio and radar equipment made it possible to maintain observations of wind, pressure, temperature and humidity up to an average height of about 60,000 ft. at eight stations. The greatest height reached was 108,200 ft. These results are likely to prove of considerable value in the further development of high-speed, high-altitude aircraft. The task of mapping the upper air of the globe, in which the Meteorological Office has taken the lead for some years, was continued.

Research, as in previous years, was greatly assisted by the advice tendered by the Meteorological Research Committee and its three Sub-committees. The programme covered was very extensive, but among the various items there are some that deserve special mention. Considerable progress was made in the study of "numerical forecasting", the production of maps of the pressure field 24 hr. ahead of a given initial situation by step-by-step integration of the equations of motion using an electronic computer. The method, which is still in the research stage, has already given results comparable in accuracy with those obtained in normal operational forecasting, and in some cases has shown a marked gain in accuracy over traditional methods. On the other hand, there is little progress to report in the development of a reliable system of long-range forecasting, but basic work continues. The Meteorological Research Flight, which has a unique record in high-altitude research, has continued the exploration of the stratosphere, especially in relation to its water content. These studies are essential for the understanding of the mechanism of the general circulation of the atmosphere. Following a discussion of the matter in Parliament, the Office has undertaken to carry out a long series of carefully controlled trials on the possibility of producing an increase in rainfall by "seeding" suitable clouds with particles of silver iodide released from ground generators.

On the organizational side, the structure of the Office has been changed by the re-allocation of certain high-level posts, resulting in the creation of three new Assistant Director posts carrying responsibility for Central Forecasting, Climatological Research and Public Services. The last named post reflects the additional importance now attached to services for the general public and industry.

Early in 1955 the Secretary of State for Air set up a special Committee with Lord Brabazon of Tara as Chairman, and Sir Charles Darwin, Major R. H. Thornton, Sir Folliott H. Sandford and Mr. J. R. Simpson as members, to review the work and organization of the Meteorological Office. The Committee held its first meeting on March 31, 1955.

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, 1954, TO MARCH 31, 1955

§ 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.

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

The general functions of the Meteorological Office are :—

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

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

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

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

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

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

(vii) Research in meteorology and geophysics.

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

The cost of the Meteorological Office is borne on Air Ministry Votes. Appendix IV shows the provision made in the Air Estimates for expenses and receipts of the Meteorological Office for the financial year 1955-56.

§ 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.

Recommendations, which were made at the Conference of the Commission for Synoptic Meteorology held in Washington D.C. in April 1953 and approved by the Executive Committee of the World Meteorological Organization at Geneva in October 1953, necessitated the preparation of a new edition of the "Handbook of weather messages" giving the new surface and upper air code forms and specifications to be used in synoptic and aeronautical reports and forecasts. Many associated forms and publications were also revised. The new codes for reports from reconnaissance aircraft and for reports of "atmospherics" were introduced on May 1, 1954, and those for reports from transport aircraft on September 1, 1954. The remaining changes took place on January 1, 1955.

Responsibility for research work on forecasting problems was transferred in April 1954 from the Deputy Director (Forecasting) to the Deputy Director (Research), but the work continued to be carried on at Dunstable.

(b) Reporting stations.—Observations of surface weather conditions were received from a network of reporting stations, 82 of which provided routine reports in the full synoptic code. A number of additional stations reported in the abbreviated (AERO) code. Reports were also furnished by some Royal Naval Air Force Stations, by United States Air Force units based in this country, and by part-time observers at 50 stations, who included coastguards, railway and postal officials and retired private individuals, all of whom maintained a high standard of interest and accuracy. The total number of stations reporting at least once each day was 179.

(c) Radio messages from ships.—*Voluntary observing ships.*—The organization of voluntary observing ships is described on p. 23. An average of 143 reports was received daily in the meteorological communications centre at Dunstable from voluntary observing ships in the eastern North Atlantic and coastal waters round the United Kingdom. Of these, 94 were from British "selected" ships and 16 from foreign "selected" ships in the North Atlantic,

11 from British coasting vessels and 22 from British light-vessels. Of the reports received from British "selected" ships, 54 per cent. were received within one hour and 78 per cent. within two hours of the time of observation.

British voluntary observing ships in other oceanic areas throughout the world also regularly transmitted radio weather messages to the meteorological services of other countries, in accordance with a plan drawn up by the World Meteorological Organization.

Ocean weather ships.—British weather ships on duty in the North Atlantic carried out a full programme of surface observations every 3 hr., made radio-sonde ascents every 12 hr. and radar wind observations every 6 hr. With the implementation of the rotation system of operating the "European" ocean stations A, I, J, and K in the eastern North Atlantic (as agreed at the 4th North Atlantic Ocean Stations Conference in February 1954), since December 25, 1954 British, French and Netherlands weather ships when operating at stations I and J have transmitted their observations direct to Dunstable; when operating at ocean stations A and K these ships have sent their observations to Washington D.C. and Rennes (France) respectively, whence they have been retransmitted to Dunstable.

Radio messages from other ocean weather stations in the North Atlantic were received at Dunstable regularly throughout the year.

(d) Meteorological flights.—Valuable information regarding weather conditions over the eastern Atlantic up to heights of about 18,000 ft. continued to be provided by flights made by R.A.F. Hastings aircraft based on Aldergrove. Up to five such flights were made weekly on tracks chosen in relation to the weather situation prevailing at the time.

Vertical ascents were made daily in the United Kingdom by Spitfire aircraft operated by a civilian contractor under the direction of R.A.F. Home Command. Ascents normally took place over a point near Worcester, but the location was changed for a period in July to Camphill in Derbyshire to provide information for the National Gliding Contest.

An R.A.F. Vampire aircraft made meteorological flights at Singapore on a non-routine basis as the weather situation required. These flights provided both vertical ascents and short-range reconnaissance.

(e) Radio-sonde and radar wind stations.—No change was made to the network of eight radio-sonde and radar wind stations in the United Kingdom from which observations of upper wind by radar were obtained four times daily and measurements of pressure, temperature and humidity twice daily. By improvement in apparatus and technique the measurement of temperature was made to an average height of 60,000 ft., whilst wind observations were made to an average height of 57,000 ft. The highest ascent reached 108,200 ft.

Development of the new radar-sonde theodolite equipment at Crawley continued, and trial flights were made, but the apparatus was not brought into routine use largely owing to modifications found necessary to the airborne equipment.

(f) **Thunderstorm location.**—The “sferic” system used for the location of thunderstorms continued without change, the four direction-finding stations being located at Hemsby (Norfolk), Camborne (Cornwall), Leuchars (Fife) and Irvinestown (Northern Ireland). Three of these stations were equipped with the latest type of cathode-ray direction-finding equipment, giving increased accuracy, while the fourth station is to be similarly equipped in the near future.

(g) **Meteorological communications.**—*Land-line communications.*—No important changes in the main teleprinter broadcasts were made during the year, but the information included in the broadcasts was kept under continuous review to ensure that the changing requirements of recipients were met as fully as possible. The broadcast of Mediterranean data to 8 stations which was formerly made from the Meteorological Office at Air Traffic Control Centre, Gloucester, was taken over by Dunstable in November 1954.

A re-arrangement of meteorological teleprinter circuits within R.A.F. Fighter Command was carried out.

The meteorological communications system was again used for the rapid collection and transmission to the Central Forecasting Office of tide-gauge readings made by Harbour masters for the East Coast Flood Warning Scheme which operates from September 15 to April 30 each year. The readings were also sent by teleprinter to the Netherlands Meteorological Service by the direct teleprinter line from Dunstable to De Bilt.

Experimental work was carried out in preparation for regular transmissions on the land-line facsimile broadcast from Dunstable.

Radio communications.—The three W/T broadcasts (continental, subcontinental and national) were continued without any important change.

High-powered radio-teleprinter transmitters working point-to-point between New York and the Ministry of Transport and Civil Aviation station at Birdlip were used on many occasions for the interchange of a limited amount of vital weather information under bad radio-propagation conditions, but experience showed that both this and the normal channels of communication were generally equally affected by ionospheric disturbances.

Experimental radio-facsimile broadcasts of weather charts, upper air diagrams and tabulated material from Dunstable continued, the needs of forecasters at the World Gliding Championships held at Camphill, Derbyshire in late July and early August, for instance, being entirely met by this service.

(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 by 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 shipping forecasts in the Home, Light, European and Television Services, the presentation on television continuing to be undertaken by forecasters of the Meteorological Office.

The inclusion of a regional forecast in each Home Service programme, hitherto confined to the 5.55 p.m. broadcast, was extended in April to the 12.55 p.m. broadcast, and two additional broadcasts were introduced at the same time—a general bulletin on the Home Service at 11.03 p.m. and a shipping forecast on the Light Programme at 11.50 p.m.

(b) Railways.—Forecasts and warnings of snow, frost, fog and thunderstorms continued to be issued as in the previous year. Forecasts of icing on the conductor rails or cables of electrified railways were again provided between October and March.

(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.—Many special forecasts and warnings were supplied to growers and the fine-spell notification service continued. Weekly intelligence summaries, compiled by the Agricultural Meteorology Branch, helped forecasters to give special attention to aspects of the weather which were of greatest current interest and importance to agriculturalists and horticulturalists.

(f) River Boards, etc.—During April and from mid September onwards, Officers of the Admiralty Hydrographic Department were stationed at the Central Forecasting Office for collaboration with the forecasting staff in connexion with the issue of tidal warnings to River Boards and Police Authorities.

(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 of weather conditions affecting industrial processes were supplied, as in previous years. In connexion with arrangements for effecting economies in factory heating extensive use was made by subscribers of services providing mean or minimum 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.**—Forecasts were supplied to the Fuel Research Station, Greenwich, on occasions when thick and persistent fog was expected in the London area.

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) **British Fatstock Marketing Corporation.**—Weather outlooks for periods four days ahead were supplied to the Corporation twice weekly.

(p) **Milk Marketing Board.**—Warnings of adverse conditions likely to affect storage and transport of milk were given on appropriate occasions.

(q) **St. Bartholomew's Hospital.**—Forecasts were made for St. Bartholomew's Hospital on occasions when thick and persistent fog was expected to occur in the London area.

(r) **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 for the Royal Air Force or in the number of R.A.F. units at which a meteorological office was provided. Owing to staff shortages the necessary meteorological facilities for some units were provided by telephone from a nearby meteorological office, while at others a personal forecasting service could be provided only during Exercises.

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 Mediterranean, Middle East and Far East areas, although requirements for meteorological facilities continued to increase.

The main meteorological offices at Gloucester, Uxbridge and Watnall, and those at Malta, Habbaniya, Aden and Ismailia. (Canal Zone, Egypt) continued to provide meteorological information and advice to the associated Air Traffic Control Centres.

(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 at Manby and of the Central Navigation and Control School at Shawbury, and for flights by jet aircraft.

Mobile meteorological units were provided during North Atlantic Treaty Organization Exercises in western Europe.

R.A.F. broadcasts of weather reports and aerodrome forecasts by Gloucester, Watnall (on a restricted scale) and R.A.F. stations in the Middle East Air Force Command were maintained.

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.—The 31st meeting of this Committee was held on December 17, 1954, when the meteorological requirements of Fighter Command, including the presentation of weather information and the need for frequent reports of weather and state of airfield were discussed.

(d) Miscellaneous activities.—The Royal Air Force continued to co-operate in the investigations of turbulence, ice formation on aircraft and certain aspects of condensation trails formed by jet aircraft.

Trial receptions of the experimental facsimile broadcasts of surface and upper air weather maps, analyses, etc. from the Central Forecasting Office, Dunstable, continued.

Trial observations of slant visibility were made at five R.A.F. airfields.

A new handbook, "Elementary meteorology for aircrew", on the same lines as the revised syllabi of meteorological instruction in Flying Training Command which were approved during the year, was nearing completion and will replace "Meteorological handbook for pilots and navigators".

A meteorological section for a new edition of the "Pilot's flying manual" was prepared at Manby.

(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.

The main meteorological offices at Prestwick, Preston and Uxbridge continued to give information to the associated Air Traffic Control Centres. Broadcasts by radio-telegraphy of weather reports and forecasts at these centres gave information to aircraft in flight. Increased use was also made of radio-telephony for broadcasts of weather reports and for obtaining information on request.

British European Airways and British Overseas Airways Corporations continued to co-operate in arranging flights by Meteorological Office staff for the purpose of gaining first-hand experience of conditions on the routes for which they provide meteorological service. Facilities for such "familiarization flights" were extended to forecast staff at certain overseas meteorological offices.

(b) Aeronautical Research Council.—The Meteorological Office was represented at a meeting of the Civil Aviation Research Committee at which the meteorological aspects of slant visual range were discussed. There was an increasing operational interest in this problem as an important element in research into the bad-weather operation of aircraft.

(c) Services provided in the United Kingdom.—Meteorological offices were maintained at 22 civil aerodromes throughout the year. A new office was opened at Cardiff (Rhoose) in April 1954. The meteorological offices for civil aviation at Lympne and Northolt were closed in October 1954 when these aerodromes ceased to be used by civil aviation.

Because of the move of Airways Controllers from Uxbridge Air Traffic Control Centre to the Southern Air Traffic Control Centre at London Airport, a small meteorological unit was opened in March 1955 at the latter place to assist in providing meteorological information to Airways Controllers and aircraft in flight.

There was a marked increase of work at Blackbushe because of the introduction of new services by charter operators.

At Manchester the office was required to provide a limited meteorological service for the transatlantic operations of British Overseas Airways Corporation and of Sabena (Belgian Airlines).

London Airport and Prestwick continued to provide facilities for North Atlantic and other trunk routes. As a result of the closing of Northolt to civil air traffic, the organization at London Airport was strengthened to meet the greatly increased commitment there for meteorological services for European, Mediterranean and internal routes.

Considerable work was done in planning for future requirements at London Airport, because virtually two airport organizations will function side by side for a number of years until the airport building scheme is completed.

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

Close liaison was maintained with the States of Jersey Meteorological Service in matters of mutual interest concerning the organization of meteorological facilities for aviation.

(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.

(e) Examinations.—Examinations were held in meteorology for the Commercial Pilot Licence and Instrument Rating, Senior Commercial Pilot, Airline Transport Pilot and Flight Navigator Licences, Aerodrome Controllers Certificate, and for the Air Traffic Control Officers' primary courses; 1,085 candidates were examined during the year.

Under the scheme of training instituted in 1951, a number of Air Traffic Control and Executive Officers at Ministry of Transport and Civil Aviation aerodromes were given instruction in the making and reporting of weather observations, so that they could undertake the provision of aerodrome weather reports when stationed at an aerodrome where there was no meteorological office. Training was also provided for aerodrome controllers at certain non-State aerodromes.

(f) Special work.—The meteorological section of the United Kingdom Air Pilot was revised to meet the international requirements regarding the format and contents of an aeronautical information publication. Further revisions were required to describe the various new aeronautical meteorological codes.

Basic meteorological information was supplied daily to Malham Tarn during the period of a meteorological course organized by the Royal Meteorological Society.

Meteorological staff gave evidence at the public inquiries into aircraft accidents which occurred near Elba on January 10, 1954 and near Stromboli on April 8, 1954.

Reports on the meteorological aspects of a number of other accidents (including the accident to a B.O.A.C. stratocruiser aircraft at Prestwick on Christmas Day 1954) were prepared for the Accidents Investigation Branch, Ministry of Transport and Civil Aviation.

Special arrangements were made in co-operation with the British East African, the Sudan and the Greek Meteorological Services for the flights of Her Majesty the Queen and the Duke of Edinburgh from Aden to Entebbe and Entebbe to El Adem in April and May 1954. Arrangements were also made with the co-operation of other meteorological services for other Royal Flights, including those of the Duke of Edinburgh to Canada, Princess Margaret to Canada and the Caribbean, and the Duchess of Kent to Canada.

Arrangements continued for the collection of aircraft reports for the investigation of icing and turbulence. Relevant reports of turbulence were provided to the United States Weather Bureau in connexion with the investigation of clear-air turbulence being undertaken on behalf of the International Civil Aviation Organization.

Investigations continued at certain civil airports into the relationship between horizontal visibility and visibility from air to ground during mist and fog. Other experiments on visibility in mist and fog continued at London Airport.

The meteorological offices at London and Prestwick co-operated with airline operators in special trials connected with load planning, and with the selection of least-time tracks on North Atlantic routes.

Facsimile equipment was installed on an experimental basis between the meteorological offices at London Airport and Blackbushe for the purpose of passing flight forecasts to Blackbushe for the use of pilots.

The management of a provincial newspaper received advice and assistance in setting up a meteorological inquiry bureau which included a window display of meteorological instruments in operation.

Meteorological service was provided for flights made by aircraft of the United States Navy from London Airport and Blackbushe.

FORECASTING SERVICES

(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, in the Suez area, 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, provided meteorological information for artillery and sound-ranging purposes, and meteorological instruction for courses held at the School.

Meteorological requirements at Artillery Practice Camps were met either by the temporary attachment of meteorological staff to these camps or by the provision of information from a nearby meteorological office.

Meteorological facilities for the Army continued to be provided in overseas commands.

(7) Services for the Ministry of Supply

Meteorological offices were maintained at a number of Ministry of Supply research experimental establishments and dealt with various special inquiries from Branches of the Ministry of Supply.

Special meteorological facilities were provided for the Society of British Aircraft Constructors' Show at South Farnborough.

(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., 9.10 a.m. (Sundays only), 12.55 p.m., 5.55 p.m. and in the Light Programme at 11.50 p.m. clock time. The forecasts for shipping were given in the same bulletins. By arrangement with the Ministry of Transport and Civil Aviation 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 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. Forecast centres

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

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) **Malta.**—The Meteorological Office continued to maintain a forecasting service at Luqa and a radio-sonde/radar wind unit at Qrendi. In order to meet the growing requirements of aviation, meteorological services on a considerably increased scale were provided. The exchange of meteorological information with neighbouring countries was maintained.

(b) **Middle East area.**—*Cyprus.*—The forecasting service and a radio-sonde/radar wind unit at Nicosia provided meteorological facilities for military and civil aviation. By arrangement with the Cyprus Government, forecasting services continued to be provided for 24 hr. daily to meet the requirements of civil aviation.

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. Routine and special meteorological reports were provided from stations along the south Arabian coast and on Kamaran Island. Two new reporting stations were opened in the western Aden Protectorate in collaboration with the Agricultural Department.

British Somaliland.—The Meteorological Office continued to exercise technical control over the Somaliland Government reporting station at Hargeisa and provided facilities for staff training. Weather observations were received from stations operated by the Desert Locust Survey and were broadcast by 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 the Royal Pakistan Air Force. A number of the assistant staff were supplied by the Royal Pakistan Air Force.

(b) **Far East area.**—*Ceylon.*—The Meteorological Office continued to provide a small forecasting unit at Negombo, basic data and technical assistance being obtained from the Ceylon Meteorological Service.

Malaya.—The Meteorological Office was responsible for meeting the requirements of the R.A.F. in Malaya through offices at Changi, Tengah, Seletar and Butterworth.

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 continued to be provided for the R.A.F. at Sekkong.

(c) **British West Indies.**—Many of the forecasters employed by the British Caribbean Meteorological Service are seconded from the Meteorological Office, although, in accordance with the policy mentioned in the Report for 1952–53, their replacement by forecasters of the Caribbean Meteorological Service had begun.

(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 undertake the duties also of Chief Meteorological Officer 2nd Allied Tactical Air Force and of British representative on the Allied Meteorological Board under the General Committee of the Allied High Commissioner.

Close liaison was maintained with the Federal German Meteorological Service.

Austria.—Meteorological facilities at Schwechat (Vienna) were provided by the Austrian authorities. Direct supervision of the meteorological services by a British meteorological officer at the aerodrome ceased in May 1954.

(b) **Middle East area.**—*Libya.*—The Libyan Government gradually assumed full control over the basic network of reporting stations in Cyrenaica and Tripolitania. A British forecasting office was maintained at El Adem and supplied forecasts also to Benina airport. Forecasting facilities were provided by Meteorological Office staff at Idris airport (Tripoli) for civil and military aviation.

The radio-sonde/radar wind unit continued at Benina.

Liaison was maintained with the World Meteorological Organization Adviser credited to the Libyan Federal Government.

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

Jordan.—A forecasting office at Amman and an observing office at Mafraq under the control of the Senior Meteorological Officer Habbaniya (Iraq) were provided.

Assistance was given as required to the Jordan Government, and liaison was maintained with the technical adviser provided for the territory by the World Meteorological Organization.

Iraq.—The Meteorological Office continued to maintain forecasting offices at Habbaniya and Shaiba, and a radio-sonde/radar wind unit at Habbaniya.

Close liaison was maintained with the Iraqi Meteorological Service.

Persian Gulf.—In addition to the provision of a 24 hr. forecasting service for the aerodrome, the meteorological office at Bahrain supplied a limited number of forecasts to the airport at Kuwait.

§ 3. CLIMATOLOGY AND MARINE AND AGRICULTURAL METEOROLOGY

The Climatology Divisions situated at Harrow, are concerned with British Climatology (including the British Rainfall Organization), World Climatology, Agricultural Meteorology, and Upper Air Climatology, and include the Meteorological Office Central Library (see p. 49). Marine Meteorology is the responsibility of the Marine Branch, also located at Harrow.

The Edinburgh office collects and stores climatological records (including rainfall) made in Scotland. It maintains the library of the old Scottish Meteorological Society. It deals with meteorological questions pertaining to 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 attached to airfields. The magnetic records of the two geophysical observatories at Eskdalemuir and Lerwick are prepared for publication, discussed and stored in the 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, educational and research institutions, and Government Departments.

(b) Stations.—There are five types of stations contributing climatological observations, i.e. the observatories and synoptic, crop weather, climatological, and rainfall stations. Appendix III shows how these stations are distributed among the 14 regions into which Great Britain and Northern Ireland are divided for climatological purposes. During the year additional records were received from 18 new stations and from 5 which had reported in the past. Twenty stations ceased to report, including that at Cheltenham with a continuous record since 1878, and those at Welshpool School and Lympe Airport, each with records since 1919.

All climatological stations provide observations at 0900 G.M.T., including daily temperature extremes and rainfall totals, while the synoptic stations supply climatological returns for at least the main climatological hours 0300, 0900, 1500 and 2100 G.M.T. together with daily extremes, or totals, and monthly summaries of the usual elements. Some stations provide hourly summaries of wind, rainfall and sunshine, and frequency tables of intense falls of rain.

Climatological and rainfall stations are maintained by private observers, local authorities, universities and other educational establishments, industrial firms, trusts and Government Departments. Great public spirit is shown by those who participate in the operation of these stations, often at personal inconvenience because of the necessity for daily readings at fixed times throughout the year, whatever the weather. 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.

(c) British Rainfall Organization.—This organization, which has been controlled by the Meteorological Office since 1919, collects all rainfall reports 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. The contents and layout of the Report were reviewed, subscribers being asked for their views. In general the replies showed satisfaction with the existing arrangements but a few minor changes will be made in 1955.

British rainfall.—The volume for 1952 was published in July 1954, that for 1953 was sent to the printers, and that for 1954 was being prepared.

(e) **Training.**—Two short courses for observers at climatological and health resort stations were arranged in October; there was an attendance of 31.

(f) **Special work.**—The preparation of rainfall averages for the period 1916–50 was continued.

Advice was given to the Medical Research Council on the most suitable temperature, humidity and visibility data for the London area and for a rural area (East Anglia) for the past eight years, for an investigation being carried out at the London School of Hygiene and Tropical Medicine into mortality from respiratory disease associated with weather conditions.

Special tabulations of hourly values of dry-bulb and wet-bulb temperature were received from a number of stations, and some progress made with the analysis. They were of use in answering a number of inquiries.

The meteorological section of the Irish Coast Pilot was revised, and the text and tables for a new edition passed to the Director, Naval Weather Service.

A report on the Snow Survey of Great Britain for the season 1953–54 was prepared and published in the *Meteorological Magazine*. A number of new observers were recruited to the Survey, particularly in hilly areas previously unrepresented. New forms for the entry of observations were printed and issued for the 1955–56 season.

Discussions were held with representatives of the Building Research Station, Department of Scientific and Industrial Research, on ways in which the requirements of the building industry for meteorological data, both on the research and operational sides, might be met.

The exceptional weather of the summer of 1954 was specially studied and compared with that of previous poor summers, to provide a basis for answering inquiries.

Consideration was given to the adoption of punched-card methods for certain surface climatological data, and a pilot project was put in hand to investigate the advantages, difficulties and manpower involved.

Hydrology.—The section working on hydrological problems maintained close contact with outside bodies, in particular with the Inland Water Survey of the Ministry of Housing and Local Government, the Ministry of Agriculture and Fisheries (land drainage and River Board work) and the Road Research Laboratory of the Department of Scientific and Industrial Research (storm-water drainage). Consultations with individual River Boards continued, and a number of them were advised about the extent of existing rainfall records in their areas and of any need for new observations.

Water-balance investigations were carried out for a number of catchment areas of importance for hydroelectrical or water-supply schemes.

An investigation in the Cardington-Bedford area, was planned to obtain detailed information about the time and area distribution of intense falls of rain. A close network of recording rain-gauges, electrically synchronized, will give minute-by-minute data for an area of about 4 square miles. The results should be of direct meteorological value, and will also provide information in a new form applicable to problems of storm-water drainage at present under investigation by the Department of Scientific and Industrial Research Road Research Laboratory.

Committees.—A representative of the British Climatology Branch served on the following committees :—

(i) Joint Committee of the Department of Scientific and Industrial Research and the Ministry of Housing and Local Government to advise on research to be undertaken on problems relating to the design of surface-water drainage systems.

(ii) Wind Power Generation Committee of the British Electrical and Allied Industries Research Association.

(iii) Hydraulics Committee of the Institution of Civil Engineers.

(iv) Study Committee on Basic Design Temperatures for Space Heating Installation convened by the Institutions of Mechanical Engineers, Electrical Engineers, Gas Engineers and Heating and Ventilating Engineers in April 1950. The final report was transmitted to the Ministry of Works in July 1954 for promulgation as one of the series of Post-War Building Studies.

(g) *Inquiries.*—As usual, 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 industrial and research organizations, both within Government Departments and outside. The variety of inquiries which were dealt with is illustrated by the following selection of subjects in connexion with which data or advice were sought : the incidence of respiratory diseases, including colds, in a general practice ; the possibility of improving crop forecasting for tomatoes ; the design of heating, ventilating and air-conditioning systems ; nuisance from waste-tips and brickworks ; the design of the proposed new bridge at Runcorn ; the manufacture of cathode-ray tubes ; damage to G.P.O. electronic equipment by overheating in hot weather ; carburettor icing problems ; corrosion tests on ferrous metals ; degree-day data for checking fuel consumption in heating plants ; storage of valuable skins in a museum ; deterioration of goods ; the occurrence of paper stretching and its control ; the frequency of washing omnibuses ; tests on materials exposed to sunlight ; effects of temperature on electricity consumption ; the design of high buildings and other structures ; artificial drying of peat ; river pollution research ; the spawning of mussels ; expansion joint failures in a concrete runway ; possible changes in the dates of Test Matches ; and information to decide where to live or spend a holiday.

Rainfall data were supplied to Government Departments and to numerous engineering firms in connexion with water supply, drainage and hydroelectric schemes.

Monthly reports on the rainfall of the Thames and Lea Valleys were supplied to the Metropolitan Water Board and the 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. 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.—At the end of 1954, meteorological returns were received from 64 stations overseas, distributed as follows : Europe 7, Africa 19, Asia 23, South America 1, oceanic islands 14. Of these, 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. Two new stations were opened in the Aden Protectorate, but there was a decrease in the number of meteorological returns from Libyan stations owing to the formation of the Meteorological Service of Libya in April 1954. During the year the meteorological station at Ocean Island was taken over by the New Zealand Meteorological Service and the station at Christmas Island (Indian Ocean) by the Malayan Meteorological Service.

“Notes on the meteorological observations in British Colonies and Protectorates, 1949” was published and issued with the reprints for that year. Copies of meteorological summaries for 1953 were received from 15 colonies ; arrears were received from 9 colonies for 1952.

(b) Publications.—*Réseau Mondial.*—Work was completed on the tabulation of the material in the volumes for the years 1933 and 1934.

Naval handbooks.—Work on the revision of the Mediterranean handbook, delayed owing to the inclusion of new matter, was almost completed. Some preliminary preparation was made for the revision of Part 7 of “Weather in home waters” dealing with the Norwegian and Barents Seas.

The meteorology of the Falkland Islands and Dependencies 1944–50.—This publication was issued early in 1955.

World climatological tables.—Progress was made with the preparation of a handbook giving data on temperature, relative humidity and precipitation for nearly 1,000 stations distributed throughout the world.

(c) Special work.—World maps of vapour pressure (on Mercator projection) were completed for the months of January, April, July and October ; circum-polar maps showing the estimated average vapour pressure over the polar regions were also completed for the same months.

Work began on the construction of world charts showing the mean surface air flow and the mean position of fronts and temperature, humidity and wind data for the lower layers of the atmosphere for about 250 stations being used for the work.

On the completion of the statistical analysis of the associated dry-bulb and wet-bulb temperatures at Aden, Accra and Habbaniya, a paper was begun describing their diurnal and seasonal variation.

Work continued on the tabulation and plotting of the mean pressure, mean temperature and total rainfall data from the monthly CLIMAT broadcasts. For the mean pressure charts, the broadcasts were supplemented by other sources of data in order to obtain as complete a world coverage as possible.

(d) **Inquiries.**—There has been a marked increase of inquiries over the last few years, and nearly 800 were received in the current year ; the majority again came from industry although there was a notable increase from tourists. There was also a large demand for temperature and humidity data ; 6,500 tables of these elements, prepared in the Branch, were issued. This was twice the number of tables issued last year.

(3) Marine Meteorology*

(a) **Organization and collection of observations.**—*Voluntary observing ships.*—The Marine Division has Port Meteorological Officers in London, Liverpool, Southampton, Cardiff and Glasgow and Agents in the Forth, Tyne and Humber areas. It is their duty to visit the masters and officers of merchant ships, to interest them in keeping meteorological records, to recruit them as voluntary meteorological observers, to instruct them as necessary in making the observations, and thereafter to revisit the ships at regular intervals. Meteorological instruments are issued to the majority of the ships which are inspected as opportunity offers. During the year some 3,844 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 four times daily (0000, 0600, 1200 and 1800 G.M.T.) on a world-wide basis, in accordance with arrangements made by the World Meteorological Organization and the International Convention for Safety of Life at Sea. Meteorological instruments (mercury barometer, barograph, screen and thermometers, canvas sea-water bucket), log-books and instructions for doing the work are supplied to these ships. The observations are transmitted by wireless in the international meteorological code to specified meteorological services in whatever ocean the vessel is situated. Approximately 560 British ships co-operate in this manner out of a world total of about 2,422 ships. Included in this figure are 8 British whaling vessels which were especially recruited for making meteorological observations in the Antarctic Ocean.

* See also p. 8.

(ii) "Supplementary" ships which make and transmit their coded results by radio (using an abbreviated code) on a world-wide basis, in a similar manner to "selected" ships, four times daily. The ships are supplied only with a mercury barometer, thermometers and screen, such instruments being sufficient for reporting in this abbreviated code. The number of supplementary ships is approximately 58.

(iii) "MARID" ships (coasting vessels) which make observations of sea temperature in home waters once daily, and transmit the coded results by radio-telephone to Dunstable via G.P.O. coast stations. The number of MARID ships is approximately 92.

(iv) Light-vessels, of which there are 13, make observations of wind, waves, visibility and air and sea temperature twice daily. The coded reports of 11 of these vessels are transmitted by radio-telephone to Dunstable via G.P.O. coast stations.

(v) Seventeen trawlers fishing in far northern waters and 4 ships of varied types trading the North Sea ports make non-instrumental observations, and send their coded messages by radio or radio-telephony as convenient to British, Norwegian or Icelandic stations. Owing to physical difficulties no record of these observations is required to be kept aboard these ships.

The meteorological observations made aboard all these ships are recorded in special log-books and are forwarded to the Marine Division for climatological analysis. These log-books are carefully scrutinized and prizes in the form of books are presented to the Master, Senior Observing Officer and Radio Officer of those ships whose records are classified as "excellent". "Excellent awards" were made to 100 "selected" ships during the year and the names of the recipients are published in the *Marine Observer*. In addition inscribed barographs were presented to four Master Mariners who have been responsible for doing consistently good meteorological work at sea for a period of 15 years or more.

The scrutiny of the log-books shows that the observations are generally made with care and accuracy, and that the radio weather messages are regularly transmitted to the appropriate authorities. Many of them contain detailed reports of unusual phenomena encountered at sea as well as oceanographical and ornithological observations. An average of 113 log-books were received in the Marine Division monthly during the year, and, in addition, some log-books and forms kept aboard Canadian and Norwegian ships.

Among their other activities certain "selected" and "supplementary" ships make observations of whales on behalf of the National Institute of Oceanography, and aurora observations for the Department of Natural Philosophy, Edinburgh University. Special radar observations are also made aboard "selected" ships equipped to do so.

Ocean weather ships.—During the year each of the four British ocean weather ships completed seven years' service. As a result of the latest North Atlantic Ocean Stations Agreement at Paris in February 1954 the British and European weather ships since December 25, 1954, have been remaining "on station" for 24 days instead of 21 days as formerly.

Station I, in position 61°00'N. 15°20'W. until 1200 G.M.T. July 10, 1954, and thereafter in position 59°00'N., 19°00'W. was manned by a British ship until February 17, 1955, and then in rotation with a Netherlands ship. The station was occupied for 363 days, being vacated on 2 days owing to the late sailing of the relief ship.

Station J, in position 52°30'W. 20°00'W., was occupied for 361 days by either a British or Netherlands ship until December 28, 1954, and then in rotation with French and Netherlands ships. It was vacated on 4 days whilst landing a patient to hospital at Londonderry.

Station A, in position 62°00'N. 33°00'W., was manned by a United States, Netherlands or Norwegian ship until December 29, 1954, then in rotation by a British, French or Netherlands ship. Since December 29, 1954, the station was occupied continuously.

Station K, in position 45°00'N. 16°00'W., was manned by a French or Netherlands ship until January 3, 1955, then in rotation by a British, French or Netherlands ship. Since January 3, 1955, the station was occupied continuously.

As mentioned on p.9 the weather ships carried out a full programme of meteorological work. Search and rescue exercises were carried out whenever practicable in co-operation with aircraft of R.A.F. Coastal Command. During the exercises mail, newspapers and urgently required stores were dropped in water-tight containers by the aircraft. A weekly "mail drop" combined with a navigational exercise by aircraft from R.A.F. station, Topcliffe, was inaugurated.

The weather ships' navigational aids were used regularly by both civil and military aircraft; 7,487 aircraft made use of the facilities provided by the British ships during the year, and 2,059 contacts were made by foreign ocean weather ships on stations I and J. Radio contact was made frequently with ocean weather ships on other ocean stations.

Special observations of the sea-water temperature gradient with a bathythermograph aboard the ship *Weather Observer* were continued, as were also the records of a wave recorder loaned by the National Institute of Oceanography. Arrangements were in hand to equip the other three British weather ships with bathythermographs loaned by the Admiralty.

Oceanographical work continued for the Ministry of Agriculture and Fisheries and the Fisheries Division of the Scottish Home Department; this included the towing of plankton recorders, taking samples of sea-surface water and jettisoning drift bottles. The jettisoning of plastic envelopes on behalf of the National Institute of Oceanography in connexion with an investigation into oil pollution continued until December 31, 1954.

Magnetic variation swings were carried out "on station" for the Hydrographic Department of the Admiralty.

Log-books and upper air data were received from all weather ships operating on stations I and J, and since December 29, 1954, from station A. Microfilmed copies were made and distributed to other nations signatory to the North Atlantic Ocean Stations Agreement. British ships, when operating on station K, completed forms supplied by the French Meteorological Service.

Arrangements were made for hourly surface weather reports to be made by the weather ships on stations A, I and J in connexion with the flight of H.R.H. Princess Margaret to Montreal on January 31, 1955.

Owing to a serious boiler defect which necessitated her withdrawal from service for about 6 weeks, o.w.s. *Weather Explorer* was unable to carry out her scheduled duties at station K during the period February 20 to March 16, 1955. The Royal Research Ship *Discovery II* was accordingly chartered from the National Institute of Oceanography to undertake this patrol. Six meteorologists and four radio staff were added to the ship's normal complement.

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

(i) Observations from log-books, received from British voluntary observing ships, British ocean weather ships and from Naval log-books, were punched on to Hollerith cards. The total number of observations punched was 243,718. The use of these cards by machine methods made possible the climatological investigations on a world-wide basis which were undertaken during the year.

(ii) Tabulations of all observations in the southern hemisphere made by British observing ships, totalling 31,553 observations up to July 1, 1954 when the scheme terminated, were supplied to the Massachusetts Institute of Technology and to the Meteorological Service of the Union of South Africa.

(iii) Fog record forms were collected throughout the year by the Port Meteorological Officers from the authorities who have them made on behalf of the Office in the five areas, London, Liverpool, Southampton, Cardiff and Glasgow.

(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 completed, and similar work for the South Pacific Ocean eastward of longitude 160°W. was started.

(d) Admiralty Pilots and charts.—The sections relating to surface currents were entirely rewritten for new editions of 6 Admiralty Pilots, and generalized current charts were prepared for these where necessary. Sections relating to ice in two of these Pilots were also rewritten. The revision of the meteorological sections of the 6 Pilots was co-ordinated with the World Climatology Branch, and meteorological charts were prepared for these publications in the Marine Division.

During the year information relating to currents was forwarded to the Admiralty to be placed on forty-seven of the series of Admiralty navigational charts.

(e) Special work.—The preparation of meteorological and ocean-current statistics for the ocean weather stations I and J in the North Atlantic Ocean was completed for the year 1953 and started for 1954. The preparation of similar statistics for station A for 1955 was undertaken.

An extensive revision of the text and diagrams of "Meteorology for mariners" was completed in December 1954 and approved for publication.

Investigations into errors of exposure of rain-gauges and thermometers in screens aboard ocean weather ships were continued.

Successful trials were made in ocean weather ships of electrical resistance thermometers mounted on a Dan buoy to measure simultaneous values of air temperature gradients within a few feet above the sea surface and sea temperature gradients within a few feet below the sea surface.

The series of simultaneous radar wind measurements made by pairs of ocean weather ships when relieving on station was completed in December 1954. The analysis of the results of these observations was started.

A three months' course of training was given to a United Nations Fellow of Turkey who was studying maritime meteorology.

(f) **Inquiries.**—Information, including statistical tables and charts of marine data, was supplied on request to the Naval Weather Service, other Government Departments, scientific institutions, commercial firms and private individuals ; for example monthly and annual frequencies of wave height and period and wind force from ocean weather ship records ; wave data and the possibility of day-to-day forecasting of waves for underwater oil drilling in the Persian Gulf ; and wave information in the North Atlantic at the time of the casualty *World Concord*.

Information was supplied to the Ministry of Transport and Civil Aviation for several investigations into serious shipping casualties. The personal attendance of a meteorologist was necessary at the formal investigations held during the year into the loss of the s.t. *Michael Griffiths* (west of Scotland, January 1954), the s.s. *Yew Valley* (North Sea, January 1953), the s.t. *Hassett* (east Scotland, September 1953), the obsolete battleship *Sao Paulo* (on passage Brazil to the United Kingdom, October—November 1951) and the s.s. *Islandmagee* (North Sea, November 1954). Information was also supplied for the preliminary investigations into the casualties of the ships *World Concord*, *Tresillian*, *Olaf Ringsdal Jnr*, *Lady Sheila*, *Gypsy Queen*, *Lorella*, and the *Roderigo*.

Other inquiries, amongst many, related to weather conditions over the North Sea in connexion with bird migration at night ; weather data for the north-east Pacific ; and minimum sea temperatures of importance to the transportation of chemical substances.

(4) Agricultural Meteorology

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

In addition to the unit maintained at the Provincial Headquarters of the National Agricultural Advisory Service at Bristol a second unit of the Branch is now in operation at the Provincial Headquarters of the National Agricultural Advisory Service at Cambridge.

(a) Liaison with other organizations.—Both by correspondence and personal visits the normal liaison was maintained with officers of the Ministry of Agriculture and Fisheries, with university faculties, agricultural institutes and research stations. There was a definite advance in co-operation with the Agricultural Land Service (particularly regarding shelter and problems of land utilization) and the experimental horticulture stations and experimental husbandry farms of the Ministry of Agriculture. The appointment of an officer to Cambridge made possible much closer liaison with Ministry of Agriculture staff and agricultural scientists in eastern England.

The issue of weekly weather summaries to the National Agricultural Advisory Service and to others was continued, and a large programme of inspection of crop weather climatological stations was carried out. As in previous years, a number of observers from such stations attended a course at the Training School, and advice was given on instrumental and observational techniques and in connexion with research problems. During the year lectures were given to audiences ranging from specialist conferences of staff of the National Agricultural Advisory Service to talks to Young Farmers' Clubs. The number of such requests increased over that of previous years and is still increasing. Lecture notes, slides and diagrams were loaned to a number of Meteorological Office staff who undertook talks to farmers, growers and similar audiences. Contributions were made to a number of farming programmes broadcast by the British Broadcasting Corporation.

A joint exhibit with the Ministry of Agriculture and Fisheries on irrigation was on view at the Royal Agricultural Show, Windsor, in July, and plans were made to co-operate in a demonstration at the Bath and West Agricultural Show in June 1955.

(b) Special work.—The Head of the Agricultural Branch was awarded a Nuffield Travelling Fellowship and granted a year's special leave from June 1, 1954, to study the application of meteorology to agriculture in Europe and various countries of the Commonwealth. An appreciable contribution was made to a report of the Working Group on weather and plant pathology problems of the Commission for Agricultural Meteorology of the World Meteorological Organization. Answers were given to a number of questionnaires from the World Meteorological Organization on agricultural meteorology in the United Kingdom.

As in previous years, the Branch collaborated with the Plant Pathological Laboratory in respect of potato blight. The unfavourable weather of 1954 delayed the growth of the potato crop, but conditions suitable for the spread of disease occurred frequently.

Assistance was given in current experimental work, notably that in connexion with protected cropping, at the experimental horticulture stations of the Ministry of Agriculture and Fisheries. Results so far obtained gave some guidance on the practical value of a given degree of shelter. Advice was also given concerning the design of shelter screens to be used in association with mobile glass-houses.

Members of the Branch served on a number of Ministry of Agriculture Committees and Working Parties, in particular those concerned with protected cropping, irrigation, and glass-house heating.

In order to improve the forecast service to farmers, arrangements were made with the County Agricultural Officers of the Ministry of Agriculture to send to the Branch routine reports on the state of work on the farms and the effect of past and current weather on progress and future plans. From these, extracts were made and sent to the meteorological offices listed as "Post Office Guide" stations. A weekly consolidated summary was also prepared for limited distribution within the Forecast Division. Plans were made to extend the scheme to Scotland.

A bulletin entitled "Weather and the land" was prepared at the request of the Ministry of Agriculture and will be published as Bulletin 165 in one of their official series, in time for the Agricultural Shows in the early summer.

With a view to testing the use of punch-card techniques, a year's data from the Rothamsted crop weather station were set up in a suitable form for punching.

In connexion with studies on evaporation and irrigation, estimates of "irrigation need" appropriate to a range of postulated soil-moisture deficits at the end of two-week periods were made for certain areas in south-west England. Routine monthly estimates of potential transpiration for the period April-September inclusive were supplied to a number of inquirers.

Considerable progress was made with the statistical investigations on the liability of a particular area to a given temperature minimum and on the sequences of rainless days. Work was also started on the analysis of soil temperature data.

As in past years considerable help on instrumental and observational technique was extended to a large number of workers engaged in field investigations.

(c) **Inquiries.**—Many inquiries for climatological data and information in connexion with agriculture, horticulture and forestry were dealt with. The subjects included pollution from cement works, climate in piggeries, weather and the activity of various pests and plant diseases (notably the wheat-bulb fly, chocolate spot of beans and apple scab), temperature and the percentage failure of routine milk samples, illumination and the growth of seedlings, the variation of climatic elements with distance from the sea, rainfall and the leaching of borates, wind and tree growth.

(5) Upper Air Climatology

The work of the Upper Air Climatology Branch is concerned both with routine and research. The routine work, as in previous years, consisted chiefly in 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 Meteorological Office both at home and overseas. The research during the year was directed primarily to the preparation for publication of a memoir on the distribution of upper air temperature over the world, including the distribution of pressure and temperature at the tropopause, and to the preparation of contour charts of isobaric surfaces which form part of a revision of *Geophysical Memoirs* No. 85 "Upper winds over the world". In addition studies were made of the subtropical jet stream and of winds at very high levels.

(a) **Collection and publication of observations.**—Regular monthly returns of daily observations made by radio-sonde and radar were received throughout the year from 23 stations. Of these 18 were from stations under the control of the Meteorological Office, namely eight 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 remaining five—Valentia, Nairobi, Hongkong, Lagos (Ileja) and Khartoum—were received through the courtesy of the Directors of the respective meteorological services. In addition radar wind observations from a newly opened station at Kano were received from October 1954, and from a temporary station at Wadi Halfa from December 1954. Returns of radar wind observations at Iserlohn also continued. Observations were received from three aircraft flights.

Monthly returns of ozone observations at British stations continued, as did also the returns of pilot balloon observations at high levels from selected stations overseas. Pilot balloon data from a newly established station at Ascension Island were received from early in April 1954.

The forms and Hollerith cards used for recording radio-sonde data remained unchanged throughout the year. An improved layout of forms and cards, for use in January 1956 when the Centigrade scale will be introduced for upper air work, was designed.

Punching of Hollerith cards continued at Fazakerley for most of the year, but arrangements were made for it to be transferred to the Hollerith "pool" under the administration of the Marine Division at Harrow as soon as the necessary staff were available. Assistance in making up arrears of punching was obtained from operators at the Ministry of Food at Stanmore who had become redundant.

The Hollerith tabulator and sorter were in regular operation throughout the year, and arrears of routine summarizing were gradually being overtaken. Progress was also made with the summarizing of data for 1948–50.

The publication of summaries of radio-sonde and radar wind measurements in *Upper air data for stations maintained by the Meteorological Office* continued. Part 6 (Nicosia) was sent to the printer in April 1954, Part 7 (Bahrain) in November 1954 and the material for Part 8 (Gibraltar) was almost complete by March 1955.

The tabulation and plotting of CLIMAT TEMP data were continued, and a special effort was made to supplement the information over regions where there were no CLIMAT TEMP stations. By the end of March 1955 charts had been drawn up to July 1954.

(b) **Special work.**—*Upper air temperature and standard deviations.*—Considerable progress was made with the preparation of the supplementary material for the proposed memoir. Charts of average pressure and temperature at the tropopause were completed and submitted to the Meteorological Research Committee; and in connexion with this work the charts of average temperature were re-examined to insure their consistency with the tropopause charts. In addition studies were made of the annual variation of temperature at different levels and of the extremes of temperature over the world. Climatic cross-sections from pole to pole in different longitudes were prepared.

Upper winds over the world.—Attention was directed chiefly to the collection and summarizing of data of the heights of the standard isobaric surfaces in the mid-season months and to the preparation of tables of wind frequencies. Additional data for this study were received from the meteorological services of many countries. Charts of average contour heights for the northern hemisphere, north of 55°N., for January in the period 1949–53 were prepared. The mean flow over the world at a height of 65,000 ft. (20 Km.) was also studied.

Upper winds in the tropics and subtropics.—A study was made of the rapid changes which occur in the upper troposphere over Arabia and the surrounding areas in late spring. The changes involve both temperature structure and wind, and the evidence of the past seven years suggests that the time of these changes is associated with the time of the onset of the SW. monsoon in south-west India.

An investigation was made of the wind flow in the upper troposphere over the east and central Pacific Ocean in January and April 1952.

Tropopause.—New criteria proposed by the World Meteorological Organization for defining the tropopause were tested for validity in tropical and temperate regions. These definitions, with some modifications, appear satisfactory and can be applied when multiple tropopauses occur.

Study of upper air conditions during the summer of 1954.—A study was made of upper air temperature and wind over Great Britain during June to August 1954 in relation to the average. No remarkable divergencies were found in individual months; the outstanding feature was the persistence of temperature below average and the high frequency of north-westerly winds.

Homogeneity of aerological networks.—As part of an international investigation into the homogeneity of aerological networks, average values of the 700–500-mb. and 500–300-mb. thicknesses and of their variance, at British radio-sonde stations both in the United Kingdom and in the Mediterranean, were supplied to the World Meteorological Organization.

(c) *Inquiries and visitors.*—Inquiries were mainly for data of temperature and wind and for information about the tropopause. In general they referred to levels above about 30,000 ft. and several were for data up to 100,000 ft.

A large number of visitors from overseas visited the Branch during the year, and many, who were attending training courses in this country, were given a detailed account of the work of the Branch.

§ 4. RESEARCH AND DEVELOPMENT

(1) Co-ordination of Research

(a) *Meteorological Research Committee.*—This Committee (see p. 2) and its three Sub-Committees continued their valuable work in discussing and guiding the research of the Office.

There were two meetings of the main Committee and ten meetings of the Sub-Committees whose Chairmen at the end of the year were :—

Instrument development	Prof. P. A. Sheppard
Synoptic and dynamical meteorology ..	Sir Charles Normand
Physical meteorology	Dr. T. W. Wormell

Some 65 papers and reports were dealt with. Approved papers were made available to other institutions and a considerable number were or will be published.

In accordance with the policy of encouraging meteorological research at the universities, financial support was arranged for work in Cambridge, London (Imperial College) and Wales (Aberystwyth).

The Gust Research Committee of the Aeronautical Research Council, on which the Meteorological Research Committee is represented, met twice during the year.

(b) Collaboration with the Royal Society.—The Gassiot Committee of the Royal Society, assisted by a grant from Air Ministry funds, continued to sponsor long-term research into the properties of the high atmosphere and studies of atmospheric radiation. In these connexions work was in progress at some seven universities or colleges in the United Kingdom mainly under the following headings :—

- (i) Physical and photochemical properties of atmospheric constituents
- (ii) Measurement of winds in the ionosphere
- (iii) Atmospheric radiation
- (iv) Air glow and aurora phenomena
- (v) Atmospheric ozone.

Four Meteorological Office aerological stations were associated with ozone research as part of a European network of 17 stations organized by the Ozone Survey of the International Meteorological Association. Chemical measurements of ozone were also made by the Meteorological Research Flight.

The Gassiot Committee was also concerned in plans for the use of rockets in exploring the high atmosphere.

(c) Other activities.—The Meteorological Office was represented on the Gassiot Committee of the Royal Society, on the British National Committees for Geodesy and Geophysics, for Physics, for Scientific Radio and for the International Geophysical Year.

Co-ordination of work with that of other Government Departments was facilitated by representation on numerous Departmental Committees.

The Meteorological Office again provided vacation courses for University students at its research centres. One Research Fellowship was granted to a graduate attached to Kew Observatory, and a member of the staff was awarded a Nuffield Research Fellowship enabling him to spend a year in travelling and studying applied meteorology in Europe and British Commonwealth countries. Another Principal Scientific Officer was attached to the United States Weather Bureau to co-operate with their Numerical Weather Prediction Unit during the first year of its operation.

At the request of the Treasury Medical Adviser, in collaboration with the Fuel Research Division of the Department of Scientific and Industrial Research, atmospheric pollution measurements were started at London Airport.

Relations with the universities were cordial and a considerable number of lecture-visits were made by the Director and other staff members.

(d) **Research programme.**—The main research activities are summarized in the following sections. Amongst the items of particular interest upon which work is continuing are :—

- (i) Searchlight methods of determining cloud height by day
- (ii) Radio and radar methods of determining wind, temperature and humidity to heights of 100,000 ft.
- (iii) Influence of high ground on air flow and on flying conditions
- (iv) Dynamical calculations using electronic computing machines as an aid in weather forecasting
- (v) Average values and variability of upper air winds and temperature over the world
- (vi) Studies of clouds and possible methods for the artificial modification of rainfall.

(e) **Tropical meteorology.**—The special problems of tropical regions received much attention in the Climatological Research Division.

(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. The Branch concerned with the provisioning, accounting, testing and calibrating of instruments is also controlled by the Assistant Director (Instrument Development); its work is described on p. 47. The Division gave technical advice and assistance in connexion with many special investigations, including expeditions undertaken by other Government Departments, the universities, and commercial and industrial concerns.

(a) **General instruments.**—Arrangements were made for the adoption on January 1, 1955, of the new international barometer conventions for temperature and gravity standards.

A study was made of the performance of various makes of aneroid barometer over a period of twelve months. As a result two new specifications of requirements were framed, one for a general-purpose precision aneroid and the other for a high-precision instrument.

Development of electrical remote-recording wind equipment incorporating a cup generator anemometer and a magstrip transmitting wind vane was completed. Production models were ordered for trial at about 12 operational stations.

The self-contained transportable meteorological office and observing outfit was given its first field trial. It included remote-indicating wind equipment mounted on a light-weight ladder type of mast which proved to be very satisfactory.

A strip-chart mechanism, which may be either clockwork or electrically driven, was designed for converting the standard tilting-siphon rain recorder to an open-scale instrument suitable for rate-of-rainfall investigations.

Many experiments with specially designed rain-gauges were carried out on a weather ship, but they led to the conclusion that large errors are caused by the disturbance of air flow produced by the ship.

Equipment for temperature and humidity gradient measurements near the sea surface was designed. It uses dry-bulb and wet-bulb thermistors mounted on a Dan buoy. Tests on a weather ship showed that gradients between 1.5 and 10 ft. above the instantaneous sea surface can be measured in winds up to force 5.

Development of two types of electronic equipment for the measurement of the height of cloud base by day continued, and trials were undertaken at Northolt Airport. By separating the transmitter and receiver of the experimental pulsed-light equipment by a distance of 25 yd. satisfactory signals were obtained from cloud bases ranging from about 200 ft. to 14,000 ft. An experimental model of the modulated rotating beam equipment, in which the cloud height is determined by triangulation, performed satisfactorily with cloud bases from about 50 ft. to 2,000 ft. ; some progress was made in adapting this equipment for continuous recording.

(b) Aircraft instruments.—An engineered version of the conical head thermometer for precision temperature measurements in high-speed meteorological reconnaissance aircraft was made as a prototype for production. A self-balancing bridge indicator for use with this thermometer was built and tested in the laboratory.

Improvements were made in the experimental model of the fully automatic frost-point hygrometer. The method of obtaining the frost-point temperature by measurements of the electrical resistance of the platinum film was developed. Improvements were also made to the design of the pressurized visual frost-point hygrometer.

(c) Radio-sonde and radar instruments.—Work on the radar-sonde theodolite under the supervision of the Ministry of Supply suffered a set-back through the effects of weather on the aerial, but this was overcome and installation was completed. Tests of the equipment for recording upper wind were made. It was found necessary to modify the telemetering circuit of the sonde in order to improve the stability and temperature coefficient.

An investigation of the sources of instability in the audio-frequency circuit of the standard radio-sonde was undertaken.

Improvements to the radar-wind equipment and ancillary radio-sonde equipment in use at operational stations were developed.

The suitability of a commercial adaptation of marine radar equipment for storm detection was examined, and arrangements were put in hand for a six months' trial on the roof of the Headquarters building at Victory House.

(3) Forecasting Research

The Forecasting Research Division is accommodated in 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 hr. ahead).—

(i) Development continued of a method of calculating an approximation to the synoptic situation 24 hr. ahead using an electronic computer. Results achieved were comparable in accuracy with those obtained by current methods which depend largely on the forecaster's experience, and good results were obtained on some occasions when significant errors were made in the routine forecasts.

(ii) A start was made on developing numerical methods of analysing upper air observations to prepare them for the electronic calculation of the future weather situation without the delay introduced by the need to plot the observations on a chart and make a visual interpolation between them.

(iii) Studies were made of statistical methods of forecasting high-level winds for aviation, and a systematic test of their accuracy in comparison with current methods was in progress.

(iv) Statistical synoptic investigations were continued regarding the distribution of rainfall from fronts, on the movement of certain types of depressions, and on the persistence or dissipation of stratocumulus cloud.

(v) A study was made of the loss of heat from warm air masses as they move to colder regions.

(b) Research and development in medium-range forecasting (up to 4 days ahead).—The problem of extending the numerical method of calculating the future synoptic situation beyond 24 hr. was examined.

The experimental forecasting of the general character of the weather for an extended period of about 4 days ahead was maintained by the Forecasting Division on the same basis as in the previous year, primarily with the aim of developing the techniques and applying them to operational requirements.

(c) Research on long-range forecasting (beyond a period of a few days ahead).—Fundamental research into the possibility of long-range forecasting was continued. The main effort was devoted to establishing reliable values for the normal temperature over the northern hemisphere, so that departures from the normal values for the season can be recognized and assessed. Studies of the duration and extent of these anomalies were also in progress.

Preliminary studies were made of the effect of snow cover on future weather, and of the weather situations of the northern hemisphere associated with wet and dry spells in London in autumn, but no results of direct forecasting value were achieved.

(4) Research in Physical Meteorology

The Headquarters element of the Physical Research Division is located in London. Investigations requiring experimental facilities are carried out by groups of Meteorological Office staff at Kew Observatory, the Meteorological Research Flight at the Royal Aircraft Establishment Farnborough, the Chemical Defence Experimental Establishment Porton, the Meteorological Office radar station at East Hill, Cardington (Royal Air Force) and the School of Agriculture at Cambridge.

During the year increased attention was given to the possibility of producing an increase in rainfall by artificial means, in view of the effects of deficiencies in rainfall on agriculture and on water supplies for industrial and other purposes. Experiments and field trials related to the problem are to be made in the near future.

The high-altitude investigations of the Meteorological Research Flight were regularly extended to about 50,000 ft., using a Canberra aircraft.

Some other main activities are mentioned below.

(a) Cloud and precipitation.—A large part of the work of the Meteorological Research Flight is directed to increase knowledge on cloud and precipitation processes by obtaining reliable measurements or observations of the air motion around and within clouds at different stages of their development, and also of the constitution of cloud (water droplets, ice crystals, rain, snow, hail), the distributions of liquid-water content and of drop size within cloud and their variation. Further improvements were made in the instrumental methods used in flight, e.g. for measuring the liquid-water content of cloud. Observational evidence was obtained on the irregular “air bubble” mechanism of transfer of heat and moisture from the ground to a convective cloud, and on the parts played by droplet-coalescence and ice crystals in the formation of precipitation. Radar observation at East Hill was used, when appropriate, in association with flight exploration of cloud, and also in the studies of the “bright band” and other precipitation and cloud phenomena. Measurements were made by radar of the motion of small quantities of metallic foil dropped, from aircraft, around a cumuliform cloud to examine entrainment of air into the cloud, and are to be continued.

The problem of the temperature and humidity conditions which determine the formation and persistence of aircraft condensation trails was investigated from measurements obtained up to about 50,000 ft. by the Canberra aircraft which is equipped to obtain a record of the trails it produces.

(b) Turbulence in clear air at high altitudes.—Though a good deal is known of the relationship between the occurrence of clear-air turbulence (or bumpiness) and different weather systems, e.g. jet streams, there is much less reliable knowledge of the detailed characteristics of the atmosphere at the place and time of turbulence, and of the structure of the air gusts. This latter information is important to aviation, and it is hoped that appropriate measurements which will shortly be obtainable from the Canberra aircraft of the Meteorological Research Flight will contribute to progress in this matter.

In continuation of the study of variation of wind over short time intervals, at various heights, further measurements were made of series of smoke puffs released by aircraft at known heights. By the use of small quantities of metal foil, tracked by radar, it was possible to obtain measurements of wind fluctuations over longer intervals of time and on occasions when lower cloud would obscure smoke puffs from view. A start was made on the analysis of the observational material in relation to other simultaneous characteristics of the atmosphere obtained from measurements made in the aircraft.

(c) Upper troposphere and lower stratosphere.—The ascents made by the Canberra aircraft, usually every few days, provided the most accurate measurements yet available of atmospheric humidity at heights greater than 40,000 ft. The low values of relative humidity found (at times less than 1 per cent.) in the stratosphere are of considerable interest in connexion with the understanding of the general circulation of the atmosphere at high altitudes and with questions of the transmission of radiation through the atmosphere.

As in the previous two years, and in conjunction with Professor G. M. B. Dobson and his colleagues, measurements of atmospheric ozone content by a chemical method were made on a number of the high-level flights. There is

an indication that the beginning of the rise in ozone concentration to the maximum near a height of 22 Km. (72,000 ft.) may occur near 15 Km. (49,000 ft.).

(d) Radiation fog.—The temperature, humidity and wind measurements at intervals up to 3,000 ft., and other data, obtained at Cardington during recent years led to a satisfactory qualitative description of the formation of fog. A modified programme, supervised from Kew Observatory and to include attention to radiation effects, was introduced with the aim of better quantitative assessment of the heat and moisture exchanges which operate in conditions favourable to fog development.

(e) Agricultural investigations.—The influence of surface cover on soil temperature was investigated from continuous records of temperature (by apparatus devised for the purpose) at five depths down to 16 in. in the ground obtained over a year under different crops.

It is proposed to extend earlier work by making simultaneous measurements of natural evaporation from a number of cropped surfaces adjacent to one another at Cambridge, using the general method of vertical profiles of temperature, humidity and wind mentioned in previous reports.

(f) Laboratory study of evaporation.—In extension of earlier work on evaporation from a smooth surface an experimental study of the rate of evaporation from a saturated rough surface was conducted in a wind tunnel at Porton, and is expected to throw further light on the problem of vapour transfer in turbulent flow near a boundary.

(5) Work of the Observatories and Geophysical Research

(a) Kew Observatory.—*Meteorological observations and records.*—Autographic records of atmospheric pressure, dry-bulb 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. The early model of the Campbell-Stokes sunshine recorder was replaced by a modern instrument more readily adjustable.

Tabulations were prepared for the *Observatories' Year Book* and other official publications. A weekly statement of observations was distributed to meet the needs of inquirers.

Measurement of solar radiation.—Continuous records of solar intensity, total and diffuse radiation on a horizontal surface, and illumination of a horizontal surface were maintained. Analysis of the first five years' record continued, and reports were prepared. In addition to providing climatological information this analysis confirmed the mutual consistency of the various records, and yielded estimates of the transmission and absorption of the cloudless atmosphere at Kew. It is hoped to check these estimates later by measurements in the air.

The exposure of the horizontal surface radiation instruments was greatly improved by the construction of a platform round the anemometer mast above the dome. At the same time new and more powerful heliostats were provided for the thermopiles of the solar-intensity instruments. Construction of an illumination recorder designed to be free from temperature and cosine law errors was begun, but there was inordinate delay in the supply of the necessary optical filter.

Solarimeters were mounted above and below a Hastings aircraft of the Meteorological Research Flight with the intention of measuring the albedo of clouds and of the earth's surface. A number of interesting records were obtained and reduced.

The number of inquiries concerning solar radiation continued to increase. During the period there were contacts involving a substantial effort with British Electricity Authority, Imperial College, East Malling Research Station, Rothamsted Experimental Station, National Institute of Agricultural Engineering, Building Research Station, Road Research Laboratory, Fuel Research Station, Armament Research Establishment, National Institute of Oceanography, and Falkland Islands Dependencies Survey.

Fog and visibility investigation.—An instrument to measure the liquid-water content of fog was designed and constructed, the principle of operation being a comparison of the specific heats of foggy air during and after evaporation of the droplets. Development of this instrument continues. A heat-insulated chamber of about 30 m.³ is under construction to allow testing of this and similar instruments in artificial fog.

A simple method of measuring visibility at night, involving a judgement of equality rather than of extinction, was evolved and tests were begun.

Micrometeorological investigations.—In an attempt to resolve previously reported difficulties in determination of the vertical convective heat flux by simultaneous observation of wind and temperature fluctuations, a joint investigation with the Meteorological Office Unit at the School of Agriculture, Cambridge was planned. This involved the direct determination of all terms in the heat balance of the surface, except the convective heat loss, and of the surface drag, at the same time as the mean wind, temperature, and humidity profiles, and the wind and temperature fluctuations of periods down to about $\frac{1}{10}$ sec. An open site at Cardington was occupied. Unfortunately the observations were seriously curtailed by unsuitable weather, and conclusive results were not obtained. The record so far reduced indicates that the transfer of momentum computed from the wind fluctuations at 1.5 m. agrees with the drag at the surface, and that the convective heat flux is probably determined correctly by the fluctuations method. This result could not be obtained on the Kew site. Further work will be needed to confirm this. Arrangements were made with the Mathematical Services Division, Royal Aircraft Establishment, to compute certain statistics of the series of wind and temperature of observations previously obtained. Some of the series were transferred to punched cards for this purpose.

A full year of continuous record of the components of the heat balance of the surface was completed at the end of May 1954, and the results were studied. The apparatus was dismantled.

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) were re-standardized in August 1954 and the short-period vertical component instrument was adjusted. The *Monthly seismological bulletin*, which is widely distributed to other institutions, included particulars of 343 earthquakes recorded at Kew, the epicentres of 123 being determined. Copies of seismograms were supplied at the request of several observatories in other countries.

The staff of the *International seismological summary* continued to be accommodated in the Observatory.

Miscellaneous.—Climatological and other inquiries averaged about 200 a month. A number of visitors and school parties were shown the work of the Observatory. Several overseas visitors were entertained in the weeks following the General Assembly of the International Union of Geodesy and Geophysics in Rome.

Installation of the new heating system was completed early in the period.

(b) Meteorological Office, Edinburgh.—A paper on the annual variation of the geomagnetic elements was accepted by the *Journal of geophysical research*. Work continued on the connexion between various ionospheric characteristics and geomagnetic parameters, e.g. on the correlation between ionospheric data and day-to-day changes in the geomagnetic field during quiet periods. Preliminary study was made of possible relationships between solar radio noise (from available published data) and geomagnetic events.

In conformity with the arrangements of the International Association of Geomagnetism and Aeronomy, the three-hourly indices of magnetic activity (K) for Eskdalemuir and Lerwick, together with modified K figures used in evaluating a planetary index of magnetic disturbance, were forwarded regularly to De Bilt. The K indices are published in the *Journal of atmospheric and terrestrial physics*. Information on magnetic "sudden commencements" and "sudden impulses" and on the magnetic effects of solar flares was also supplied to De Bilt for publication in analyses of these phenomena as recorded throughout the world.

(c) Eskdalemuir Observatory.—*Meteorological observations and records.*—The normal instrumental and other observations were made for synoptic and climatological purposes. Autographic registration of atmospheric pressure, dry-bulb and wet-bulb temperature, wind, rainfall and sunshine was maintained. A night-sky (pole-star) recorder continued in operation. Hourly values of the meteorological elements were tabulated, and material for the *Observatories' Year Book* was prepared.

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

Solar radiation.—Recording of total and diffuse solar radiation continued during the year, a system of varying the circuit resistance with season being introduced to improve the accuracy of low intensity measurements. A bi-metallic pen recorder of total radiation, modified at Kew Observatory, was operated from July 1954.

Atmospheric electricity.—Photographic records of potential gradient were maintained throughout the year and standardized by regular absolute measurements. The electrometers used were standardized. The records were tabulated for publication.

Terrestrial magnetism.—Absolute observations of the magnetic elements were made at least thrice weekly. Magnetic declination was measured with a Kew-pattern unifilar magnetometer. Horizontal force was measured with a Schuster-Smith coil magnetometer; quartz-fibre magnetometers Q.H.M. 119 and 120 were also used for frequent horizontal force measurements. The suspension of Q.H.M. 119 was broken in transit between Lerwick and Eskdalemuir in August 1954; it was brought into use again in February 1955 following repair in Denmark. Q.H.M. 120 was used regularly till August 1954 when it was sent to Lerwick. Measurement of magnetic dip by the Schulze Inductor 103 was resumed in April 1954 after a general overhaul of the instrument. Balance magnetometer B.M.Z. 35 was used throughout to measure vertical force and B.M.Z. 53 was used till August 1954 when it was returned to the Department of Geodesy and Geophysics, Cambridge University.

A series of horizontal force and vertical force measurements was made with Eskdalemuir instruments during a visit to Abinger in July 1954 to aid in comparisons between Abinger, Eskdalemuir and Lerwick.

Declination, horizontal force and vertical force were recorded continuously by two sets of la Cour magnetographs, ordinary-run and quick-run. A supplementary Adie set of lower sensitivity was also operated; modifications were made to the latter to ensure the full recording of the greatest storms. The level of magnetic disturbance was low throughout the year; all recording was satisfactory.

Dover magnetometer 140 was overhauled, and a re-determination made of the moment of inertia of its magnet prior to the despatch of the instrument for use in the Argentine Island.

A highly sensitive supplementary declination variometer was operated for a few days in June round the time of the solar eclipse; no clear evidence of a solar eclipse effect was found.

Various statistical studies were made of long-period trends in the Eskdalemuir horizontal and vertical force base-lines, and of comparisons of the standard with the supplementary absolute instruments.

A direct-recording horizontal force variometer with photo-electric cell recording was brought into use in July 1954.

The magnetic records were tabulated in preparation for inclusion in the *Observatories' year book*. Three-hourly disturbance indices, K , were measured and daily character figures assigned. Hourly values of declination were sent weekly to the *Colliery guardian* and the *Iron and coal trade review*. Photographic copies of the magnetic records were supplied on request to Germany and Holland, and to the National Coal Board and other inquirers. 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 at Cambridge.

Visitors to the Observatory included parties of members of the Royal Meteorological Society and the Edinburgh Geological Society.

(d) **Lerwick Observatory.**—*Meteorological observations.*—Full hourly observations were maintained, being transmitted by teleprinter to the Central Forecasting Office, Dunstable. Autographic records of atmospheric pressure, temperature, wind, rainfall and sunshine were maintained. A night-sky (pole-star) recorder was kept in operation from the beginning of September to the end of April, twilight preventing useful records from May to August. Climatological tabulations were prepared.

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

The programme of upper air ascents was unchanged with radio-sonde ascents daily at 0300 and 1500 G.M.T. and radar wind measurements at 0300, 0900, 1500 and 2100 G.M.T. No radio-sonde ascent was missed, and the average level to which temperature was measured was 74 mb. (60,000 ft.). Only 6 radar wind ascents were missed. A re-conditioned radar set was brought into use early in the year. Special flights were made on June 30, 1954, about the time of the solar eclipse, to investigate the effect of solar radiation on the radio-sonde.

Solar radiation.—Records of total and diffuse solar radiation on a horizontal surface were maintained throughout the year and hourly values were tabulated.

Ozone.—Measurements of the total amount of atmospheric ozone, using a Dobson spectrophotometer, were made twice daily from March to October, and once daily from November to February, except that only occasional direct sun observations could be made at noon for a few weeks around the winter solstice.

Terrestrial magnetism.—Absolute measurements of the magnetic elements were made thrice weekly (or more often) using a Kew-pattern unifilar instrument for declination, a Schuster-Smith coil magnetometer and a Q.H.M. magnetometer for horizontal force, and a balance magnetometer B.M.Z. for vertical force.

Continuous photographic registration of declination and of horizontal and vertical force was maintained by two sets of la Cour magnetographs, standard and quick-run. Supplementary records were maintained using less sensitive magnetographs. Hourly and other values were measured from the records. Daily magnetic character figures and three-hourly range-indices, K , were assigned and geomagnetic sudden commencement data determined.

All magnetic storms were recorded satisfactorily.

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

Atmospheric electricity.—Continuous registration was maintained of the electrical potential gradient with a Benndorf electrograph. The records were standardized by measurement of the electric potential at 1 m. above the ground in the open.

During the year the Shelton and Ritchie master and slave clock system for providing the electrical contacts necessary for the electrograph was discontinued, and was replaced by a modified synchronome master electric clock.

The electrometers used for absolute observations were calibrated.

Miscellaneous.—Apparatus for recording the field strength of certain V.H.F. radio signals was kept in operation for the British Broadcasting Corporation.

A member of the staff of the Royal Observatory, Mauritius, and the officer in charge of the new magnetic observatory in the Argentine Islands, Falkland Islands Dependencies, visited the Observatory for extended periods for further training and practical experience.

(6) Special Investigations

A member of the staff of the Office gave evidence on meteorological aspects at the Public Inquiry into the proposed development of Gatwick Airport. Subsequent to the Inquiry, which ended on April 8, 1954, a number of requests were received for meteorological information relating to questions raised during the proceedings.

As in previous years, a large number of inquiries were dealt with concerning winds at high levels for aircraft operations. The information supplied was kept under review as additional basic data accumulate. Revised charts were prepared of the standard vector deviation of wind at the 300-mb., 200-mb. and 100-mb. levels.

The demand continued for statistics giving the mean number of simultaneous occurrences of specified values of surface temperature and of wind direction for airfields in various parts of the world.

Advice was given to a number of municipal and other authorities on meteorological factors involved in problems of smoke pollution.

(7) Climatological Research

A new Division for Climatological Research was formed from a part of the former Climatology Division (see p. 18). Branch responsibility for research in climatology, however, continued unchanged, and the relevant items are included in the sections dealing with the appropriate Branches.

§ 5. ORGANIZATION

(1) Structure

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 staff.

In April 1954 three posts in the grade of Senior Principal Scientific Officer were re-allocated and designated Assistant Director posts carrying responsibility for Central Forecasting, Climatological Research and Public Services. The absorption of these posts into the Deputy Directorates of Forecasting and

Research was accompanied by the re-grouping of Branches, whereby all those existing primarily for research were brought under the control of the Deputy Director (Research). At the same time the Forecasting Section at Victory House was made a separate Branch, M.O.24, and the Administrative Section at the Central Forecasting Office was designated M.O.25.

The new Headquarters structure is shown in Appendix 1, and a list of the Directorate and Heads of Branches is given in Appendix 2.

Early in 1955 the Secretary of State for Air set up a special Committee with Lord Brabazon of Tara as Chairman, and Sir Charles Darwin, Major R. H. Thornton, Sir Folliott H. Sandford and Mr. J. R. Simpson as members, to review the work and organization of the Meteorological Office. The Committee held its first meeting on March 31, 1955.

(2) Staff

(a) **Retirements.**—A change in the Directorate resulted from the retirement of Mr. J. Durward, C.M.G., on December 31, 1954. He was succeeded as Deputy Director (Services) by Dr. A. C. Best, O.B.E. Mr. Durward has remained in the Office in a temporary capacity. The year also saw the retirement of Mr. C. K. M. Douglas, O.B.E., Senior Principal Scientific Officer.

(b) **Transfers.**—Three Principal Scientific Officers were transferred from the Office during the year. One was seconded to the Atomic Energy Authority and another was awarded a Nuffield Foundation Research Fellowship to study the application of meteorology to agriculture in the Commonwealth and foreign countries. The third officer left to spend a year with the United States Weather Bureau, under an exchange scheme, to study methods of numerical weather forecasting.

One of the three Principal Scientific Officers transferred to the World Meteorological Organization returned to the Office during the year. The Principal Scientific Officer serving as Chief Scientist on the British North Greenland Expedition also returned to the Office. The Principal Scientific Officer seconded to the Ministry of Defence for duties at Supreme Headquarters Allied Powers in Europe was replaced on expiry of his term of duty.

(c) **Complements.**—Some slight reduction in the requirement for staff in the autumn caused mainly by changes in civil aviation commitments was offset by subsequent increases. Although 4 Scientific Officers were assigned to the Office by the Civil Service Commissioners the shortage in this grade persisted and recruiting visits to universities were continued. The Civil Service Commission assigned 24 Assistant Experimental Officers to the Meteorological Office of whom one held a temporary appointment and 18 were former Scientific Assistants.

The effects of regular recruitment of Scientific Assistants to temporary appointments were offset by a high rate of resignation, and a deficiency of trained assistant staff persisted through the year. The large turnover is illustrated in the following table :—

	1953-54	1954-55
Number of airmen meteorologists not accepting appointments as civilian assistants on completion of National Service	32	26
Resignations and other losses of assistants ..	185	205
Total losses	217	231
Number of assistants recruited throughout the year	183	179
Number of assistants still under training on March 31	81	103
Total establishment for assistants on March 31 ..	1,289	1,284

(d) **Strength of staff.**—The strength of staff at March 31, 1955, is shown in the table below.

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

	March 31, 1954	March 31, 1955
Scientific Officers	155	155
Experimental Officers	656	655
Nautical Officers	8	7
Assistants (Scientific)	1,456*	1,423**
Ocean Weather Ship Staff (Nautical Grades).. .. .	37	37
Signals Grades	208	209
Radar Maintenance Grades	53	53
Clerical and Typing Staff	99	94
Miscellaneous (non-Industrial)	38	38
Miscellaneous (Industrial)	199	199
Locally entered employees (overseas) ..	188	160
Total	3,097	3,030

(e) **Uniformed personnel.**—The strength of the Meteorological Section of the Royal Air Force Volunteer Reserve on March 31, 1955 was 89 officers and 24 airmen and airwomen, showing a loss of 17 officers and 21 other ranks during the year. This large loss was mainly due to reservists not extending their service when their initial engagement of five years expired during 1954. The numbers qualified to perform duties appropriate to their ranks were 70 officers and 23 other ranks. The total number of Flight Lieutenants in the Section is now 31, of whom 5 have been promoted during the year.

Applications for transfer to the Meteorological Section were received from 14 redundant pilots and navigators in the General Duties Branch of the Royal Air Force Volunteer Reserve. Following interview by the Chief Meteorological Officer, 8 were transferred to the Meteorological Section, 6 retaining their rank of Flight Lieutenant. Special courses of instruction for these entrants were arranged.

* Includes 216 airmen meteorologists. ** Includes 207 airmen meteorologists.

Suitably qualified reservists again gave valuable assistance during their training in filling posts on airfields which were vacant owing to leave or other absence of civilian Meteorological Office staff. Nineteen officers and 3 airmen and airwomen participated in major air exercises in the United Kingdom and 4 officers went to the British Zone of Germany. Three officers and 1 corporal gave demonstrations of forecasting and chart plotting on the Royal Air Force stand throughout the fortnight of the Radio Exhibition at Earls Court.

Two courses of instruction in weather forecasting were held at the Meteorological Office Training School, one in advanced forecasting attended by 7 officers, and one in initial forecasting attended by 9 officers who had no previous forecasting experience.

Despite the number of resignations from the Section, officers continued to undertake roster duties during week-ends at Biggin Hill and North Weald to provide a meteorological service for the Royal Auxiliary Squadrons. Two officers also gave similar assistance at Church Fenton.

National Service airmen.—The number of airmen serving in the trade of Meteorologist on engagements under the National Service Acts was 207 on March 31, 1954. They were held against a block establishment of airmen assistants.

Class "H" Reservists.—The steady flow of released National Service airmen into this Reserve continued throughout the year, but since July 1954 those airmen who have completed $3\frac{1}{2}$ years in Class "H" of the Reserve have been transferred to Class "G" and have no further liability for annual training. Thirty-seven reservists were allocated for training during the major air exercises of the year. Numbers on strength were as follows :—

Year of release	Meteorological Office staff	Former Meteorological Office staff	Total
1951	16	14	30
1952	66	79	145
1953	62	41	103
1954	80	46	126
1955	18	2	20
Total	242	182	424

Air Meteorological Observers.—Five Scientific Assistants seconded to the Royal Air Force in the category of aircrew were engaged in air meteorological observer duties on meteorological reconnaissance flights.

(f) 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.

The training programme was carried out by holding a number of courses, each of which was designed to meet a particular need. The courses were scheduled at frequent intervals throughout the year.

Course for Scientific Officers.—This course is designed for university graduates entering the Meteorological Office in the Scientific Officer grade. The course lasts for four months. During the year training was given to two officers.

Initial course for Forecasters.—This course is designed for newly appointed Assistant Experimental Officers. It lasts for 12 to 15 weeks according to previous synoptic experience, and provides instruction in the basic principles of meteorology and training in forecasting. Three courses were held for 38 trainees, including personnel from the Sudan, east Africa, west Africa and Hongkong.

Advanced course for Forecasters.—This is a four weeks' course for Assistant Experimental Officers nearing promotion, and is concerned mainly with the application of upper air analysis to forecasting. Four courses were held for 27 officers, including personnel from the Channel Islands and from the Royal Thai Navy.

Refresher course for experienced Forecasters.—This course provides instruction in recent advances in synoptic meteorology for officers who have not attended a course since the war. There were 6 courses attended by 69 officers including one from Hongkong.

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. Seventeen courses were held, attended by 168 assistants.

Course for Voluntary Observers.—Two courses each lasting four days are held annually, giving general instruction on the making of weather observations, with particular reference to health resorts and crop weather stations. This year's course was attended by 29 observers who contribute to the climatological statistics of the British Climatology Branch.

Training of Dominion, Colonial and foreign personnel.—Training in forecasting or assistant work was provided for a total of 23 Colonial and foreign personnel, either on behalf of the Overseas Governments concerned or on behalf of the Colonial Office who had recruited the personnel.

Courses for Royal Air Force Volunteer Reserve Officers.—An initial and an advanced course in forecasting were held for R.A.F.V.R. Officers. The courses follow in summarized form the lines of the longer courses for Meteorological Office staff, but they only last two weeks as this is the period of annual training laid down for Reservists. The two courses were attended by a total of 16 officers.

Courses for Nautical Officers.—A special course lasting one week was held for a newly appointed Port Meteorological Officer.

External training.—The concessions granted to members of the staff following approved courses of study, include payment of fees and time off with pay to attend classes and examinations. During the year 1 member was successful in the B.Sc. (General) Examination, and 20 in General Certificate of Education in one, two, or three subjects.

Over 80 Scientific Assistants and 4 Assistant Experimental Officers were granted study concessions during the year. In addition, staff who had been granted concessions in previous years continued their studies.

Study of instructional techniques for training Assistants.—Special arrangements were made for a party of four officers of the Egyptian Meteorological Department to study instructional techniques for the training of Assistants. The party attended the Training School for eight weeks.

(g) **Technical discussions.**—Meetings for the discussion of recently published meteorological papers, of research work in progress in the Office and of problems confronting the forecasting staff were held once a month from October 1954 to March 1955. These meetings are attended by members of the staff, and, on invitation, by staff of other Government Departments and by research workers attached to universities or to research organizations allied to industry.

The subjects discussed and the openers were :—

October 18, 1954	Thirty-day forecasting	Mr. J. Brazell
November 15, 1954	Weather radar in research and operation	Mr. W. G. Harper
December 20, 1954	Forecasting for long-distance flights	Mr. T. N. S. Harrower
January 17, 1954	Electronics applied to meteorological instrumentation	Mr. R. Almond
February 21, 1954	Prebaratic charts, their preparation and interpretation	Mr. P. F. Illsley
March 21, 1954	Recent investigations of fronts	Mr. I. J. W. Potheary

(3) Supply of Instruments

(a) **Provision and production of equipment.**—During the year 1,249 orders and contracts were placed, the total expenditure was £375,724 (including £85,000 paid to the Ministry of Supply and £15,885 to the War Office), and £58,268 was received by the sale of equipment and for testing and inspecting instruments. Provision and delivery of new equipment was satisfactory in the main, but there was some delay in the early part of the year in the production of radio-sondes owing to technical difficulties. These, however, were overcome and deliveries in the last half of the year were good. Important contracts placed during the year included the use at Manchester University of an electronic computer for forecasting research and the hire of a storm-warning radar equipment for trial on the roof of Victory House. Provisioning was in hand to implement the change, on January 1, 1956, from the Fahrenheit scale to the Centigrade scale in temperature-measuring instruments for the upper air.

(b) **Issue of equipment.**—Regular supplies of instruments and stores were issued for the maintenance of meteorological offices both at home and overseas. Advice was given to inquirers at home and in the Dominions and Colonies regarding the suitability of equipment and its sources of supply. Considerable

help was given to the Colonial Office and Crown Agents for Overseas Governments and Administrations in providing equipment for the new Geophysical Observatory at Argentine Island in the Falkland Islands Dependencies.

Demands for stores numbered 12,067, including some from Commonwealth, Colonial and foreign Governments and from private observers co-operating with the Office. Loans of meteorological equipment were made to other Government Departments and outside bodies engaged in research. The following examples are typical of the variety of interests in which meteorological instrumentation was applied.

Ministry of Supply—for wind tests on ballistic ranges, and also for the testing of equipment which has to be subjected to a considerable amount of climatic change.

Ministry of Works and the Department of Scientific and Industrial Research—for study of the effect of heat and humidity in building problems.

Post Office—to determine the effect of temperature on delays at telephone repeater stations.

Manchester University—for test of the effect of rainfall on the sensitivity of instruments recording the transits of cosmic-ray sources.

Industry—for use on aircraft test flights and humidity problems in workshops.

Various agricultural institutes and research establishments—for research in increased crop production, seed testing (including experimentation with varieties of wheat seed for planting on lands recovered from sea floods of 1953), fruit trials, pests and problems in connexion with livestock.

Medical research—for the investigation into chronic bronchitis being carried out by the Ministry of Fuel in conjunction with the Treasury Medical Advisers Department and the relation between weather changes and the phases of some medical conditions.

Expeditions to north Quebec, Spitsbergen, Iceland, west coast of Patagonia, and the Lyngen Glacier in Norway, sponsored by the University of Durham, British Schools Exploring Society and the Royal Geographical Society.

Exhibitions such as the British Industries Fair and the Radio Show at Olympia.

(c) Testing and calibration.—*General instruments and aircraft instruments.*—The total number of instruments tested, excluding balloons, was 93,290 ; the number of balloons of all sizes received and subjected to 5 per cent. check was 300,277. Fees received for the testing and inspection of instruments for manufacturers and others amounted to £1,983, including £1,262 for the calibration of radio-sondes. Instruction on the maintenance of instruments was given to climatological observers.

Radio-sondes.—The total number of radio-sondes received from the makers and approved was 26,986. The number calibrated was 20,413, and 2,372 recovered after flights were overhauled and recalibrated for future use. The

new calibration plant continued to give satisfactory results, and in addition to the calibration of radio-sondes for service in the Office a number were calibrated for export to overseas countries for the manufacturers, as their plant was unable to calibrate to the low temperatures required.

Training in radio-sonde calibration methods and in maintenance of equipment generally was given to representatives from the Gold Coast, Nigeria, Sudan, Pakistan, Ceylon and Hongkong.

(d) **Maintenance of radar wind equipment.**—Regular inspections of the equipment were maintained and the inspections followed by the installation of reconditioned sets at some stations. During the year reconditioned equipments were installed at Lerwick, Stornoway, Aldergrove, Shoeburyness, Fazakerley, Crawley and Larkhill. The performance of these reconditioned equipments showed a remarkable improvement over that of the old equipment. Work on small modifications was carried out. Difficulty was experienced in recruiting skilled staff.

(4) Library and Publications

The Meteorological Office Library is at Harrow.

(a) **Library.**—*Exchange of publications.*—Publications were exchanged with other national meteorological services and with certain independent institutions concerned with meteorology, glaciology, oceanography, seismology and terrestrial magnetism ; 336 exchange agreements were in operation in March 1955.

Publications were issued gratis by special sanction to 42 institutions.

Accessions.—The total number of separate papers and publications, excluding *Daily weather reports*, taken into the Library during the year was 7,553. This number included 302 papers copied photographically from periodicals that were not of sufficiently general meteorological interest to be held by the Library ; 20,125 *Daily weather reports* were received ; 8,096 additions were made to the author catalogue. Additions to the Library's collection of visual aids included 500 lantern slides, 120 photographs, 1 film and 4 film-strips. 1,750 micro-cards were received from the American Meteorological Society.

Financial arrangements for the purchase of non-periodical publications.—The Meteorological Office Headquarters Technical Libraries Grant was maintained at its original value. Arrangements were made for a small proportion of this to be made available to the Librarian for local purchase of second-hand publications, or of publications required with considerable urgency.

Binding of publications.—Progress in this work showed some slight improvement ; 392 publications were prepared for binding, but this figure was less than the total annual number of volumes received that required binding. Arrears have therefore increased.

Co-operation with other libraries.—The *Monthly bibliography of meteorological literature* was issued to 70 libraries and institutions.

Full co-operation was maintained with the Science Museum Library, the National Central Library and the libraries of the Ministry of Supply, Royal Geographical Society and the Royal Meteorological Society. Papers appearing in the *Quarterly journal of the Royal Meteorological Society* were classified.

Inter-library lending and borrowing continued on a large scale, and gives some idea of the extremely wide scatter of meteorological literature. The number of publications borrowed from other libraries is given below :—

	No. of publications
Science Museum	285
Ministry of Supply	142
Other Government Departments	177
National Central Library	62
Universities and Colleges	34
Scientific Societies and Research Institutes	210

The Library continued its corporate membership of the Association of Special Libraries and Information Bureaux (Aslib), and dealt with several inquiries from them. A Library representative attended their Annual Conference, and assistance was given with the preparation of the Aslib Book List by supplying them with full references, etc. to new books on meteorology and on associated geophysical subjects. In addition the Librarian accepted an invitation to membership of the Aslib Aeronautical Group.

Five members of the Library staff are members of the Circle of State Librarians which provides an unofficial forum for discussion of problems common to Government libraries. The Circle extended its activities to give guidance to the training of junior staff in librarianship.

Loans.—The number of publications issued on loan increased to the new record total of 13,708. A much larger number was consulted in the Library.

Papers and publications of special interest to research staff and specialist branches were sent on loan to them as soon as practicable after receipt, and before demands consequent upon the issue of the *Monthly bibliography of meteorological literature* had been received.

Other material issued on loan included 35,000 *Daily weather reports*, 1,367 lantern slides, 703 photographs, 83 films, and 13 film-strips. There was a marked increase in the demands made by staff for visual aids for lecture purposes. Demands from the public were about the average.

Bibliographies.—The *Monthly bibliography of meteorological literature* was issued regularly with a time lag of about two months from the date of receipt of the last publication. A total of 140 copies were collated and distributed each month.

Selected bibliographies were prepared in conjunction with the Meteorological Office Training School on the synoptic aspects of weather in the tropics, the Mediterranean, the Near East, the Far East, and western Europe. These were aimed at providing basic information for prospective overseas forecasters. Other selected bibliographies were prepared on noctilucent clouds, methods of handling meteorological frequencies and of frequencies for the British Isles, radar meteorology, climate of the Arctic, and evaporation.

Inquiries.—Inquiries were received from several other Government Departments, the World Meteorological Organization, universities and colleges, research institutions, and the general public at home and overseas, in addition to the very numerous inquiries from the staff.

The variety of the type of inquiry received is illustrated by the following selection : information on the relation of suicide frequencies to the passage of fronts ; water content of fog and drizzle ; thermo-nuclear explosion effects on weather ; film sequences showing thunder and lightning effects ; fog dispersal ; ultra-violet light at Davos and Guernsey ; levels of central African lakes ; history of the Fahrenheit scale ; cyclone tracks in the Indian Ocean ; artificial rain ; air density for specified temperatures and assumed probable pressures ; wind chill and effective temperature ; dust content of the air at various heights ; the uses of punched cards.

Miscellaneous.—Work was continued on the large-scale reorganization of the library stock. More than 3,000 volumes of old periodicals were transferred to Air Ministry Archives. This represents about half the number listed for transfer.

The Library collection of lantern slides was revised ; 800 older slides were transferred from the current collection to Library stock.

Surplus volumes of certain periodicals were sent to Her Majesty's Stationery Office for disposal.

A joint meeting was convened with the R.A.F. Training Command Branch and the Training School Branch to discuss practical uses of film-strips and to make suggestions for film-strips on specific subjects.

Much help was again given to the staff and to outside inquirers with the translation of titles, table headings, etc. of papers written in foreign languages. Translations of the titles of articles in two Russian periodicals were supplied to the Department of Scientific and Industrial Research for publication in their monthly periodical *Translated contents list of Russian periodicals*. The Air Ministry Translation Section and the Central Office of Information assisted by providing full translations of papers when required.

The Library was visited by a representative of Air Ministry Organization and Methods Division. A report on the Library was prepared by them for inclusion in their " Report on Air Ministry and Royal Air Force Libraries ". Recommendations made in the report that affected the Meteorological Office were discussed with other interested branches of the Air Ministry, and appropriate action agreed.

Arrangements were made for the discussions of interesting papers, current research work, etc. to be held at the Royal Society of Arts each month from October 1954 to March 1955. Openers were notified and abstracts of their statements were distributed to the staff and to specially invited guests.

Assistance was given to the Chief Information Officer in his preparations for the centenary celebrations of the Meteorological Office.

The World Meteorological Organization was provided with a list of periodicals published in the United Kingdom by bodies other than the Meteorological Office. A *questionnaire* issued by the World Meteorological Organization concerning the frequency of issue, contents, etc. of these periodicals was completed and returned.

The Head of the Library and Editing Branch served as Chairman of the Working Group on terminology set up by the World Meteorological Organization's Commission for Bibliography and Publication. Considerable work was done on the International Meteorological Lexicon. He also served as a member of the World Meteorological Organization Working Group on International Meteorological Tables, as a member of the Aeronautical Glossary Committee of the British Standards Institution, and as a member of the Advisory Committee on Anti-Locust Research.

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

Meteorological Magazine.—The *Meteorological Magazine* was published regularly throughout the year. The articles covered a wide field including descriptions of the exceptional weather of November 1953 to early February 1954 and of the aerial observations taken during the solar eclipse, June 30, 1954, investigations of high-level clear-air turbulence, forecasts for farmers, forecasts on television, use of facsimile for meteorological transmissions, bubble convection, buoyant motion and the open parcel, dust cloud in the stratosphere, the atmospheric circulation of the southern hemisphere, the North Atlantic ocean weather stations and an account of the new radio-sonde calibration plant. Reports of the meetings of the Committees and Commissions of the World Meteorological Organization and the annual report of the Snow Survey of Great Britain also appeared.

Marine publications.—Publication of the *Marine Observer* was continued with the four quarterly numbers for April, July and October 1954 and January 1955. The articles published dealt, amongst other matters, with drifts caused by winds and currents, cargo ventilation, storm over the British Isles, the judgement of visibility at sea, detection of ice by radar, meteorological aspects of marine drilling, a verification of Ekman's theory, and the history and development of the Meteorological Office.

Replacement No. 1 to the "Marine observer's guide" was published and distributed.

A completely revised edition of the atlas "Monthly meteorological charts of the Greenland and Barents Seas" was in the press.

A revised reprint of "International meteorological code. Decode for use of shipping" was published. Amendment List No. 1 to this publication was also published.

Reprints of the atlases "South Pacific Ocean currents" and "Monthly meteorological charts of the Atlantic" were sent for printing.

Further revisions were made to "Meteorology for mariners".

Observatories' year book.—The volume for 1938 was in the press and the preparation of the volume for 1939 nearly completed.

Other publications.—The second edition of Part II and of Part III of the “ Handbook of weather messages ” and “ Instructions for the preparation of weather maps with tables of the specifications and symbols ” were published, and the second edition of Part I of the “ Handbook of weather messages ” was sent for printing.

Publications in the press at the end of the year included the “ Handbook of meteorological instruments, Part I ” and the “ Weather map. An introduction to weather forecasting ”, 4th edition.

§ 6. INTERNATIONAL CO-OPERATION

(1) World Meteorological Organization

During the period under review, members of the Meteorological Office attended the following meetings.

(a) **Commission for Aeronautical Meteorology.**—The first session of this Commission, held in Montreal, Canada, from June 15 to July 14, 1954, in part simultaneously with the fourth session of the Meteorology Division of the International Civil Aviation Organization, was attended by Mr. W. H. Bigg, Mr. J. C. Cumming and Mr. P. J. Meade. The Commission adopted 3 resolutions and submitted 7 recommendations to the Executive Committee.

(b) **Executive Committee.**—The fifth session of the Executive Committee, held in Geneva from August 25 to September 11, 1954, was attended by Sir Graham Sutton and Dr. P. G. F. Caton. A considerable part of the session was devoted to preliminary discussion of the plans for the 2nd financial period, 1956–59, but in addition the recommendations of the Commissions for Agricultural Meteorology, Bibliography and Publications, and Aeronautical Meteorology, and of Regional Association V (south-west Pacific) were reviewed ; in all 34 resolutions were adopted. Sir Graham Sutton was appointed Chairman of a Working Group established to prepare plans for the development of the Technical Division of the Organization’s Secretariat.

(2) International Civil Aviation Organization

The Meteorological Office was represented at the following meetings :—

Fourth Session of the Meteorology Division, Montreal, June—July 1954.

Third North Atlantic Regional Air Navigation Meeting, Montreal, October 1954.

Advice was given on the meteorological aspects of the United Kingdom brief for the following meeting :—

European–Mediterranean Region, Special Communications Division Meeting, Paris, November 1954.

The Meteorological Office was represented on the United Kingdom Committee on International Language for Aviation.

(3) Commonwealth Meetings

The Meteorological Office was consulted on meteorological aspects of the meetings of the South Pacific Air Transport Council, the South Pacific Committee for Air Navigation and Ground Organization, and the South African Committee for Air Navigation and Ground Organization.

(4) North Atlantic Treaty Organization

Representatives of the Meteorological Office attended the following meetings :—

Eleventh meeting of the Standing Group Meteorological Committee held in Washington from June 9 to 12, 1954.

First and second meetings of the Standing Group Meteorological Committee Working Group on Weather Plans held in London from April 21 to 23, 1954, and in Paris from March 15 to 18, 1955, respectively.

First and second meetings of the Standing Group Meteorological Committee Working Group on Weather Communications held in London from April 26 to 29, 1954, and in Paris from March 21 to 24, 1955, respectively.

Third and fourth meetings of the S.H.A.P.E. Meteorological Committee held at Supreme Headquarters Allied Powers Europe from May 18 to 20, 1954, and from March 1 to 3, 1955, respectively.

Fourth and fifth meetings of the AIRCENT Meteorological Committee held at Headquarters Allied Forces Central Europe from November 8 to 10, 1954, and at Headquarters 2nd Allied Tactical Air Force from February 9 to 10, 1955, respectively.

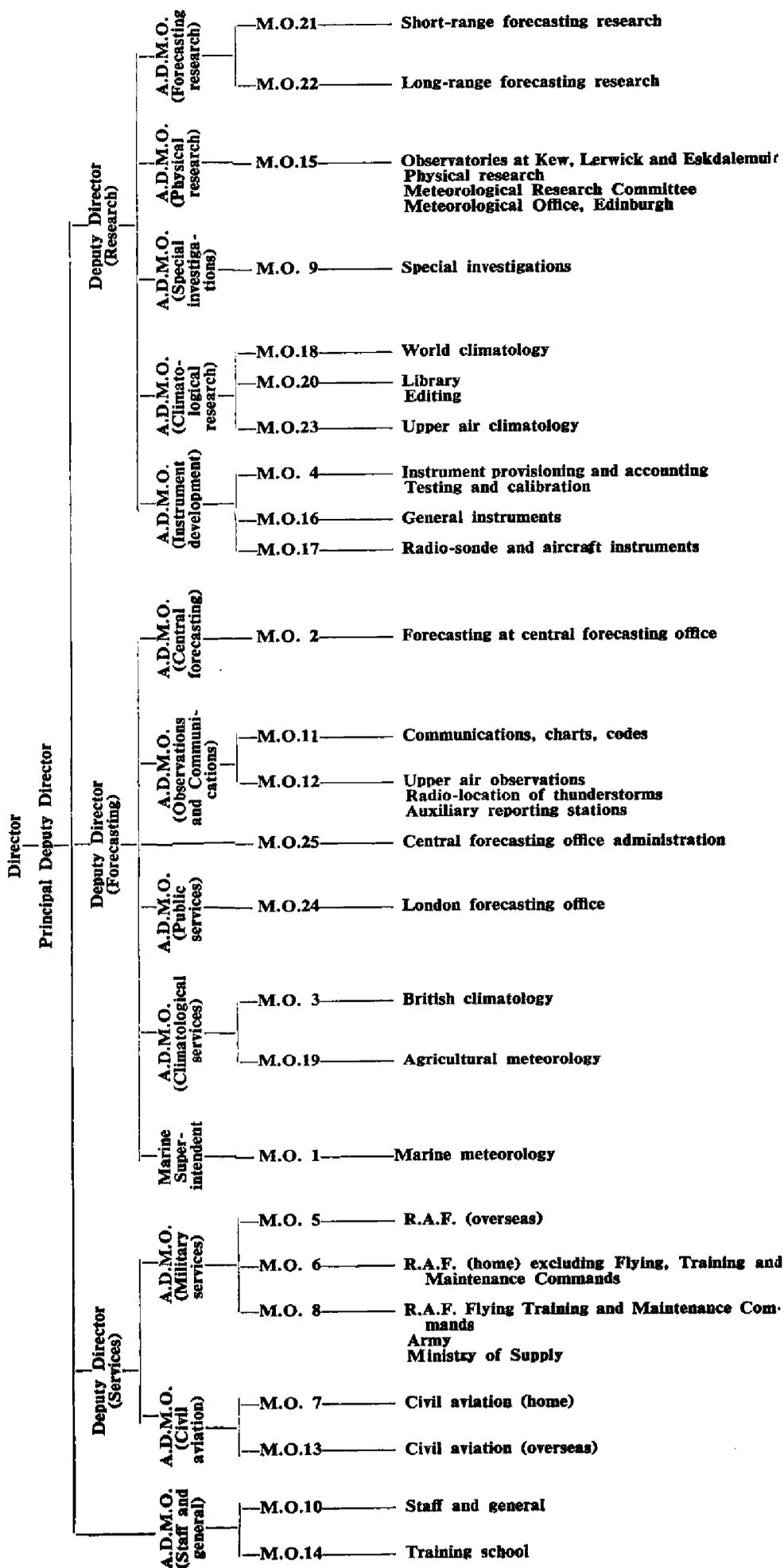
(5) International Union of Geodesy and Geophysics

The Director and five members of the Meteorological Office attended the Tenth General Assembly of the International Union of Geodesy and Geophysics held in Rome from September 14 to 25, 1954.

Dr. R. C. Sutcliffe was elected Secretary of the International Association of Meteorology for the period 1954–1960.

APPENDIX I

ORGANIZATION OF THE METEOROLOGICAL OFFICE



APPENDIX II

DIRECTORATE OF THE METEOROLOGICAL OFFICE AND HEADS OF BRANCHES

DIRECTOR

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

PRINCIPAL DEPUTY DIRECTOR

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

DEPUTY DIRECTOR (RESEARCH)	R. C. Sutcliffe, O.B.E., B.Sc., Ph.D.
<i>Assistant Director (Forecasting Research)</i>	J. S. Sawyer, M.A.
Short-Range Forecasting Research	
(M.O.21)	G. A. Corby, B.Sc.
Long-Range Forecasting Research	
(M.O.22)	J. M. Craddock, M.A.
<i>Assistant Director (Physical Research) ..</i>	H. W. L. Absalom, O.B.E., B.Sc., A.R.C.S., D.I.C.
Physical Research and Observatories	
(M.O.15)	R. F. Jones, B.A.
<i>Assistant Director (Special Investigations)</i>	P. J. Meade, O.B.E., B.Sc., A.R.C.S.
Special Investigations (M.O.9) ..	L. Dods, B.Sc.
<i>Assistant Director (Climatological Research)</i>	A. G. Forsdyke, B.Sc., Ph.D., A.R.C.S., D.I.C.
World Climatology (M.O.18) ..	H. H. Lamb, M.A.
Library and Editing (M.O.20) ..	G. A. Bull, B.Sc.
Upper Air Climatology (M.O.23) ..	Miss E. E. Austin, M.A.
<i>Assistant Director (Instrument Development)</i>	F. J. Scrase, O.B.E., M.A., Sc.D., F.Inst.P.
General Instruments (M.O.16) ..	R. Frith, O.B.E., M.A., Ph.D.
Radio-sonde and Aircraft Instruments	
(M.O.17)	D. N. Harrison, D.Phil.
Instrument Provisioning (M.O.4) ..	P. N. Skelton, M.B.E.
DEPUTY DIRECTOR (FORECASTING) ..	S. P. Peters, B.Sc.
<i>Assistant Director (Central Forecasting)</i>	C. J. Boyden, B.A.
Forecasting at C.F.O. (M.O.2) ..	—
<i>Assistant Director (Observations and Communications)</i>	C. V. Ockenden, B.Sc.
Communications, Charts and Codes	
(M.O.11)	W. A. L. Marshall, M.B.E.
Upper Air Observations (M.O.12) ..	A. L. Maidens, B.Sc.
C.F.O. Administration (M.O.25) ..	D. H. Clarke.
<i>Assistant Director (Public Services) ..</i>	J. S. Farquharson, M.A., D.Sc.
London Forecasting Office (M.O.24)	W. R. Hanson
<i>Assistant Director (Climatology Services)</i>	R. G. Veryard, B.Sc.
British Climatology (M.O.3)	J. Glasspoole, M.Sc., Ph.D.
Agricultural Meteorology (M.O.19)	R. W. Gloyne, B.Sc.
<i>Marine Superintendent (M.O.1) ..</i>	Cmdr C. E. N. Frankcom, O.B.E., R.D., R.N.R. (Retd)
DEPUTY DIRECTOR (SERVICES)	A. C. Best, O.B.E., D.Sc.
<i>Assistant Director (Military Services) ..</i>	R. P. Batty, O.B.E., B.A.
R.A.F. (Overseas) (M.O.5)	J. Pepper, M.A., B.Sc., Ph.D.
R.A.F. (Home) (M.O.6)	C. W. G. Daking, B.Sc.
Flying Training, Army and Ministry	
of Supply (M.O.8)	F. E. Coles, B.Sc., A.R.C.S., D.I.C.
<i>Assistant Director (Civil Aviation) ..</i>	W. H. Bigg, O.B.E., B.Sc.
Civil Aviation (Home) (M.O.7) ..	N. H. Smith, B.Sc.
Civil Aviation (Overseas) (M.O.13) ..	J. C. Cumming, O.B.E., M.A.
<i>Assistant Director (Staff and General) ..</i>	H. L. Wright, M.A.
Staff and General (M.O.10)	K. H. Smith, B.Sc.
Training (M.O.14)	A. H. Gordon, M.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	173	14	13	2
Scotland, East	0	6	3	40	355	37	19	4
Scotland, West	1	4	2	29	414	22	11	6
England, North-east	0	9	4	23	348	26	15	4
England, East	0	12	12	23	485	32	26	7
England, Midlands	0	12	18	40	1,054	55	43	3
England, South-east (including London)	1	18	10	60	767	62	67	16
England, South-west	0	7	7	30	485	33	13	5
England, North-west	0	4	3	24	459	24	33	7
Wales, North	0	3	2	9	184	9	6	2
Wales, South	0	3	6	15	273	22	9	4
Isle of Man	0	2	0	1	11	3	1	1
Scilly and Channel Isles	0	2	0	2	18	5	1	1
Northern Ireland	0	5	0	7	88	5	3	2
Total	3	95	67	314	5,114*	349	260	64

* Includes stations in earlier columns.

APPENDIX IV

PROVISION IN AIR ESTIMATES FOR METEOROLOGICAL SERVICES

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

Item	Service	Provision	Vote
		£	
1	<i>Staff</i>		
1a	Salaries, wages, etc. of staff at headquarters of the Meteorological Office	255,000	3
1b	Salaries, wages, etc. of civilians at meteorological observatories and outstation offices and in ocean weather ships	1,840,500	4
1c	Pay, etc. of airmen employed as air meteorological observers and meteorologists and of air force personnel of the Meteorological Research Flight ..	56,500	1
1d	National insurance contributions	3,500	1
1e	Pay, etc. of meteorological personnel of the Royal Air Force Reserve	4,500	2
1f	Superannuation allowances and gratuities	22,000	10
1g	Conveyance of personnel ; travelling allowances and expenses	74,000	5
2	<i>Equipment and Supplies</i>		
2a	Meteorological equipment	450,000	7
2b	Conveyance of equipment for meteorological services	15,000	5
2c	Mechanical transport vehicles for meteorological services	2,000	7
2d	Solid fuel, electricity, gas, water and sanitary services for meteorological observatories and outstation offices	4,500	6
2e	Liquid fuel, lubricants, etc., for aircraft of the Meteorological Research Flight and for vehicles required for meteorological services	25,000	6
2f	Liquid fuel for ocean weather ships	62,000	6
2g	Other equipment and services for aircraft of the Meteorological Research Flight	26,000	7
2h	Other equipment and services for ocean weather ships	232,000	7
2i	General stores for meteorological services	3,000	7
2j	Food and ration allowances for air force personnel ; food for crews of ocean weather ships	37,000	6
2k	Clothing, clothing allowance and laundry services for airmen ; clothing for crews of ocean weather ships	9,000	7
3	<i>Works services for meteorological observatories and outstation offices</i>		
3a	Capital expenditure	60,000	8
3b	Maintenance expenditure	17,000	8
4	<i>Telecommunication services for meteorological purposes</i>	260,000	9
5	<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>	7,500	9
	GROSS TOTAL.. .. .	<u>£3,486,000</u>	
10	<i>Deduct-Appropriations in aid</i>		
		£	
10a	Repayment in respect of meteorological staff employed on special services, etc.		
	£		
	Salaries, wages, etc. ..	2,000	3
	Salaries, wages, etc. ..	348,000	4
	Movement expenses ..	14,000	5
	Contributions towards non-effective benefits..	<u>4,000</u>	10
		368,000	
10b	Receipts relating to meteorological equipment	95,000	7
10c	Payments by airmen for issues of clothing and footwear	1,000	7
10d	Receipts in respect of operation of ocean weather ships	72,000	9
10e	Receipts for miscellaneous meteorological services	<u>11,000</u>	9
		547,000	
	NET TOTAL	<u>£2,939,000</u>	

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, 1955).
- Daily Weather Report*, containing weather maps for the northern hemisphere, British Isles, etc. and data (to March 31, 1955).
- Daily Weather Report Overseas Supplement*, containing surface and upper air data (to September 13, 1954).
- Meteorological Magazine* (to March 1955).
- Monthly Weather Report*, with summary for the year (to December 1954).
- Seismological Bulletin*. A diary of seismological disturbances recorded on the Galitzin aperiodic seismographs at Kew Observatory, Richmond (to February 1955).
- Marine Observer* (quarterly) (to January 1955).
- British Rainfall 1952*. 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, 1952 and 1953*. Southport Auxiliary Observatory. By George A. Lidster.
- Notes on the meteorological observations made in British Colonies and Protectorates, etc. in 1949 and summarized in the annual reports of Colonial Governments*.

Occasional

Handbook of Weather Messages :—

Part II. Codes and specifications. 2nd edition, 1954.

Part III. Coding, decoding and plotting. 2nd edition, 1954.

Instructions for the preparation of Weather Maps with tables of the specifications and symbols. 2nd edition, 1954.

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 5, Aden. Part 6, Nicosia.

Geophysical Memoirs :—

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110. On the accuracy of contour charts in forecasting upper winds. By R. Murray, M.A.

111. Nocturnal winds. By E. N. Lawrence, B.Sc.

112. Classification of upper air temperature according to tropopause pressure. By J. K. Bannon, B.A.

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14. Sea-breezes at North Front, Gibraltar. By A. Ward.

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